On modeling the relative fitness of storage

(data appendices)

Michael P. Mesnier

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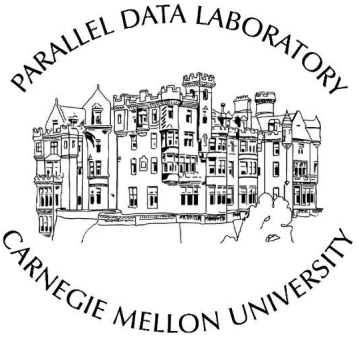
for the degree of Doctor of Philosophy

Thesis committee

Prof. Gregory R. Ganger, Chair
Prof. Christos Faloutsos
Dr. Mic Bowman (Intel Research)
Dr. Arif Merchant (Hewlett-Packard Laboratories)



Department of Electrical and Computer Engineering
Carnegie Mellon University
Pittsburgh, PA 15213

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Per-application summary

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Write fraction	1.00
Write fraction	0.72	Read jump	0.70	Read jump	0.66	Read queue	0.72
Read jump	0.56	Read size	0.54	Write size	0.50	Write queue	0.39
Read size	0.40	Write size	0.51	Read size	0.46	Read jump	0.24
Write size	0.37	Write fraction	0.49	Write queue	0.24	Read size	0.16
Write queue	0.37	Write queue	0.30	Write jump	0.21	Write size	0.09
Write jump	0.19	Write jump	0.29	Write fraction	0.19	Write jump	0.05
Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Write fraction	1.00
Write fraction	0.65	Read jump	0.72	Read jump	0.67	Read queue	0.88
Read jump	0.57	Read size	0.52	Write size	0.47	Write queue	0.48
Read size	0.42	Write fraction	0.52	Read size	0.46	Read jump	0.32
Write size	0.39	Write size	0.48	Write queue	0.28	Read size	0.28
Write queue	0.37	Write jump	0.34	Write fraction	0.22	Write size	0.23
Write jump	0.24	Write queue	0.27	Write jump	0.20	Write jump	0.16
Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Latency	1.00	Bandwidth	1.00	Throughput	1.00	Latency	1.00
Bandwidth	0.92	Read jump	0.16	Read queue	0.22	Write fraction	0.13
Throughput	0.79	Write fraction	0.14	Read size	0.15	Bandwidth	0.11
Read queue	0.32	Read queue	0.13	Write size	0.13	Read queue	0.09
Read jump	0.28	Latency	0.11	Read jump	0.13	Read jump	0.08
Write fraction	0.26	Write size	0.10	Bandwidth	0.11	Read latency	0.08
Read size	0.22	Read latency	0.09	Latency	0.11	Write latency	0.08
Write size	0.21	Read size	0.07	Write fraction	0.07	Read size	0.08
Read latency	0.15	Throughput	0.07	Write queue	0.05	Write queue	0.06
Write queue	0.12	Write jump	0.06	Write jump	0.03	Throughput	0.06
Write jump	0.10	Write queue	0.04	Read latency	0.02	Write size	0.05
Write latency	0.09	Write latency	0.02	Write latency	0.02	Write jump	0.04
Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Latency	1.00	Bandwidth	1.00	Write fraction	1.00	Latency	1.00
Write fraction	0.92	Write fraction	0.99	Bandwidth	0.98	Write fraction	0.70
Bandwidth	0.89	Latency	0.91	Latency	0.92	Bandwidth	0.64
Read latency	0.61	Read jump	0.85	Read latency	0.85	Throughput	0.45
Read jump	0.61	Read queue	0.82	Read jump	0.77	Read size	0.43
Read queue	0.60	Read latency	0.74	Throughput	0.64	Write jump	0.37
Throughput	0.60	Throughput	0.66	Read queue	0.60	Read queue	0.37
Read size	0.45	Read size	0.46	Read size	0.40	Read latency	0.26
Write size	0.33	Write size	0.41	Write size	0.36	Read jump	0.24
Write queue	0.32	Write queue	0.40	Write queue	0.34	Write size	0.22
Write jump	0.28	Write latency	0.23	Write latency	0.30	Write latency	0.21
Write latency	0.25	Write jump	0.17	Write jump	0.22	Write queue	0.21

Table A.1: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	8.2	9.2	6.4	9.1
Relative	8.2	8.6	6.7	9.4
Relative Performance	8.3	9.2	7.2	8.6
Relative Fitness	6.3	6.8	6.5	5.5

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	9.2	-	-	-
Array	-	8.2	-	-
Array	-	-	8.2	-
Array	-	-	-	7.4
Relative	**Array**	**Array**	**Array**	**Array**
Array	9.2	8.2	7.3	8.3
Array	9.1	8.2	7.2	8.0
Array	9.3	10.4	8.2	7.9
Array	8.6	8.2	6.2	7.4
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	10.7	8.6	7.0	8.3
Array	8.0	10.8	7.1	8.1
Array	7.9	10.0	10.8	8.3
Array	10.1	9.6	6.6	10.0
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	6.3	5.0	6.7
Array	7.1	1	5.1	5.4
Array	8.3	8.1	1	6.2
Array	7.6	5.3	4.0	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	10.9	-	-	-	7.4	-	-	-	9.3	-	-	-
Array B	-	10.0	-	-	-	6.9	-	-	-	7.9	-	-
Array C	-	-	6.1	-	-	-	8.3	-	-	-	10.1	-
Array D	-	-	-	9.9	-	-	-	3.0	-	-	-	9.3
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	10.9	7.9	7.7	8.1	7.4	7.4	4.3	6.7	9.3	9.3	9.9	10.0
Array B	10.7	10.0	5.7	8.3	7.7	6.9	6.3	7.7	9.0	7.9	9.7	8.0
Array C	10.0	10.1	6.1	6.4	8.1	10.7	8.3	6.9	9.7	10.3	10.1	10.4
Array D	12.3	10.6	5.1	9.9	4.6	5.9	3.6	3.0	8.9	8.3	9.9	9.3
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	10.7	10.1	8.6	9.7	10.7	8.1	4.9	7.0	10.6	7.6	7.7	8.3
Array B	7.6	10.6	6.7	7.9	7.6	10.3	5.7	7.7	9.0	11.6	8.9	8.9
Array C	8.3	10.0	11.0	10.3	6.0	10.0	10.9	7.3	9.4	10.1	10.6	7.4
Array D	11.1	10.9	9.4	10.4	9.3	8.1	4.3	8.6	9.9	9.9	6.1	10.9
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	6.1	6.0	6.1	1	5.4	4.6	6.4	1	7.4	4.3	7.6
Array B	5.3	1	4.7	5.3	8.6	1	7.1	5.4	7.4	1	3.4	5.6
Array C	11.0	10.0	1	7.3	7.4	8.7	1	6.9	6.6	5.7	1	4.4
Array D	8.3	6.4	4.9	1	8.9	5.7	3.1	1	5.6	3.7	4.0	1

Table A.2: Tree sizes (leaf nodes) and their averages.

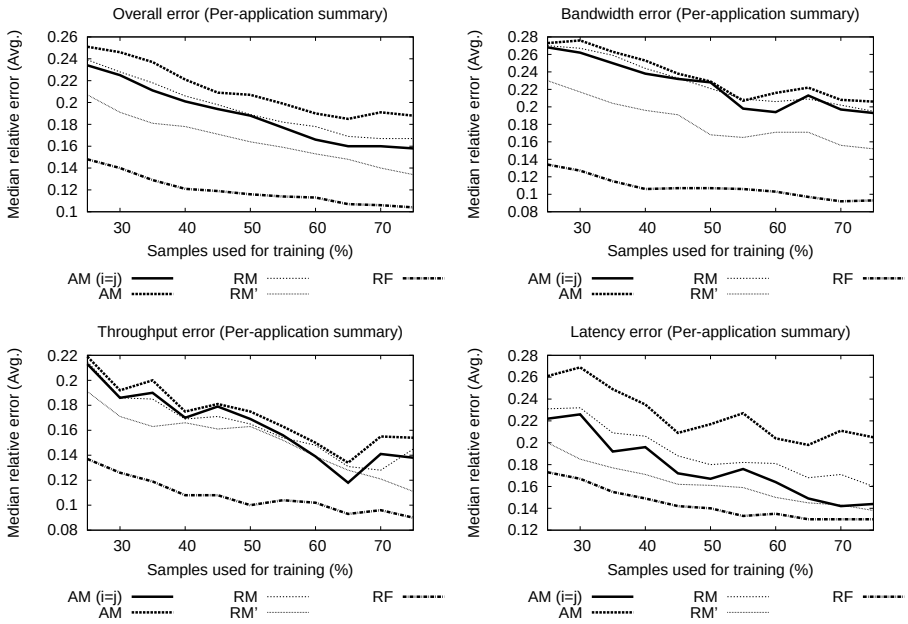

Figure A.1: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

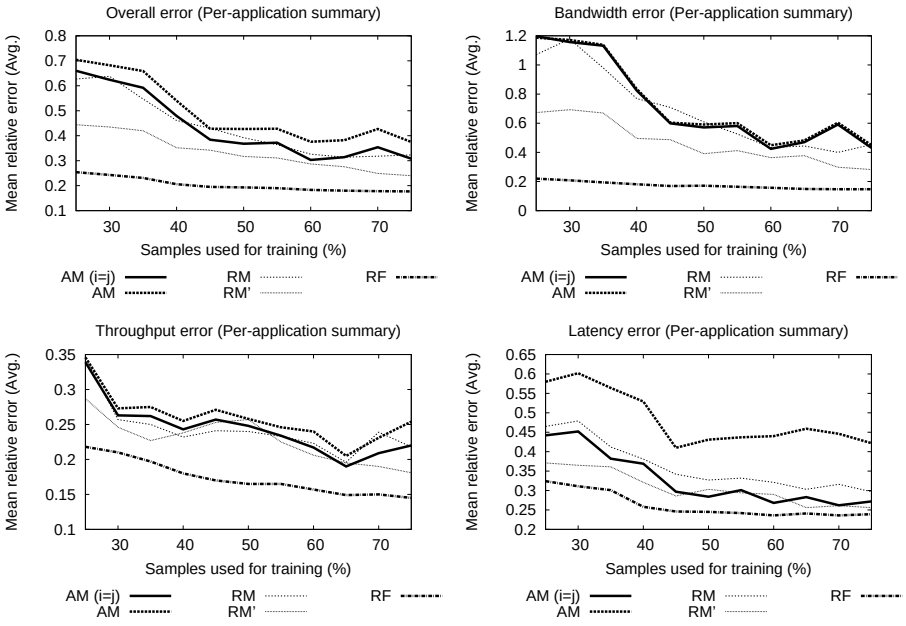

Figure A.2: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

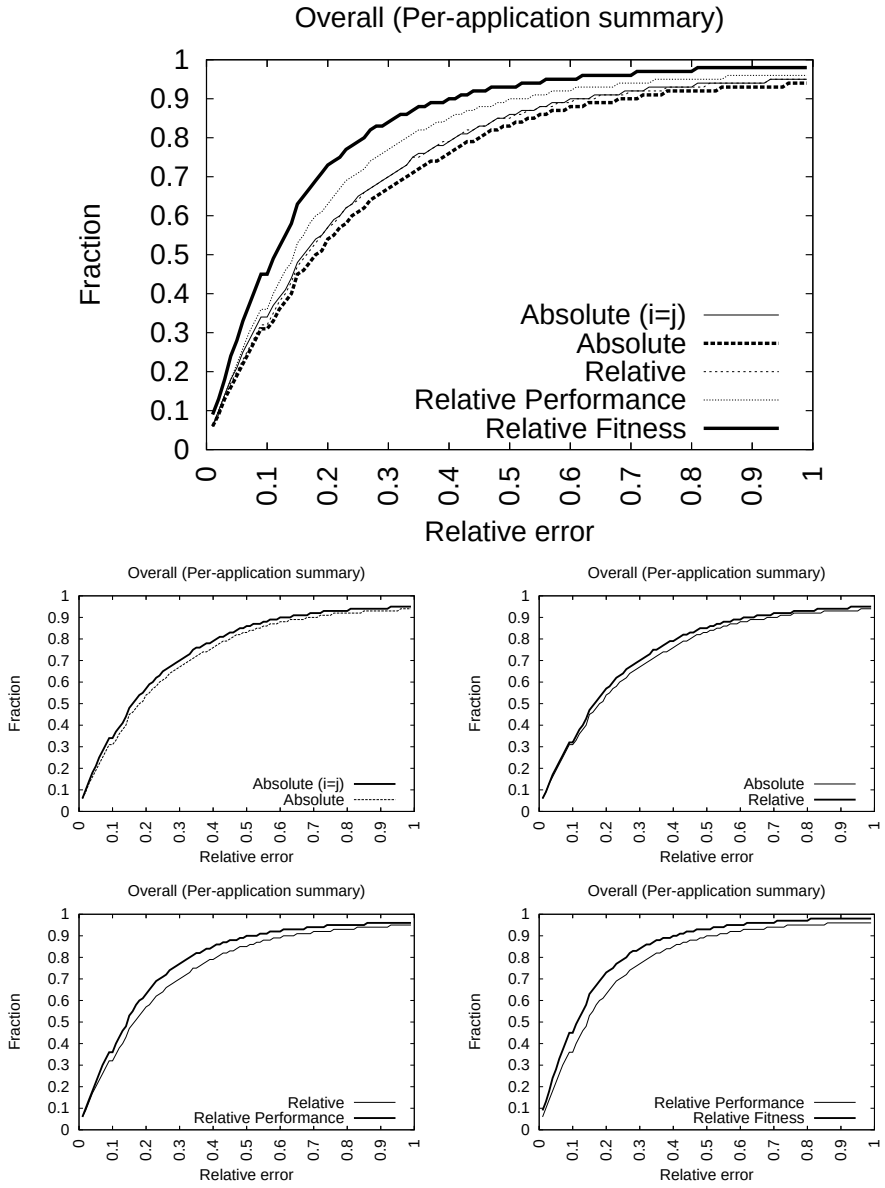

Figure A.3: The cumulative distribution of relative error over all pairwise predictions.

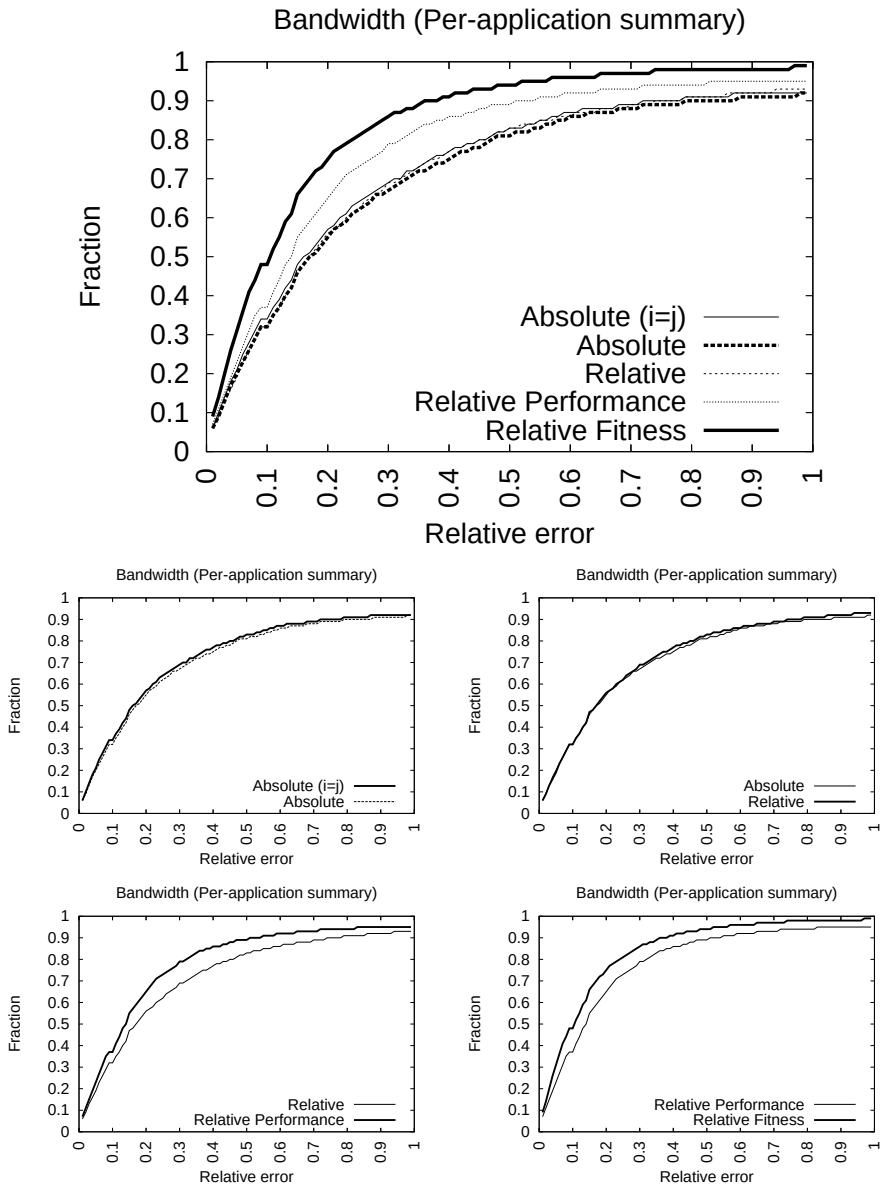

Figure A.4: The cumulative distribution of relative error over all pairwise predictions.

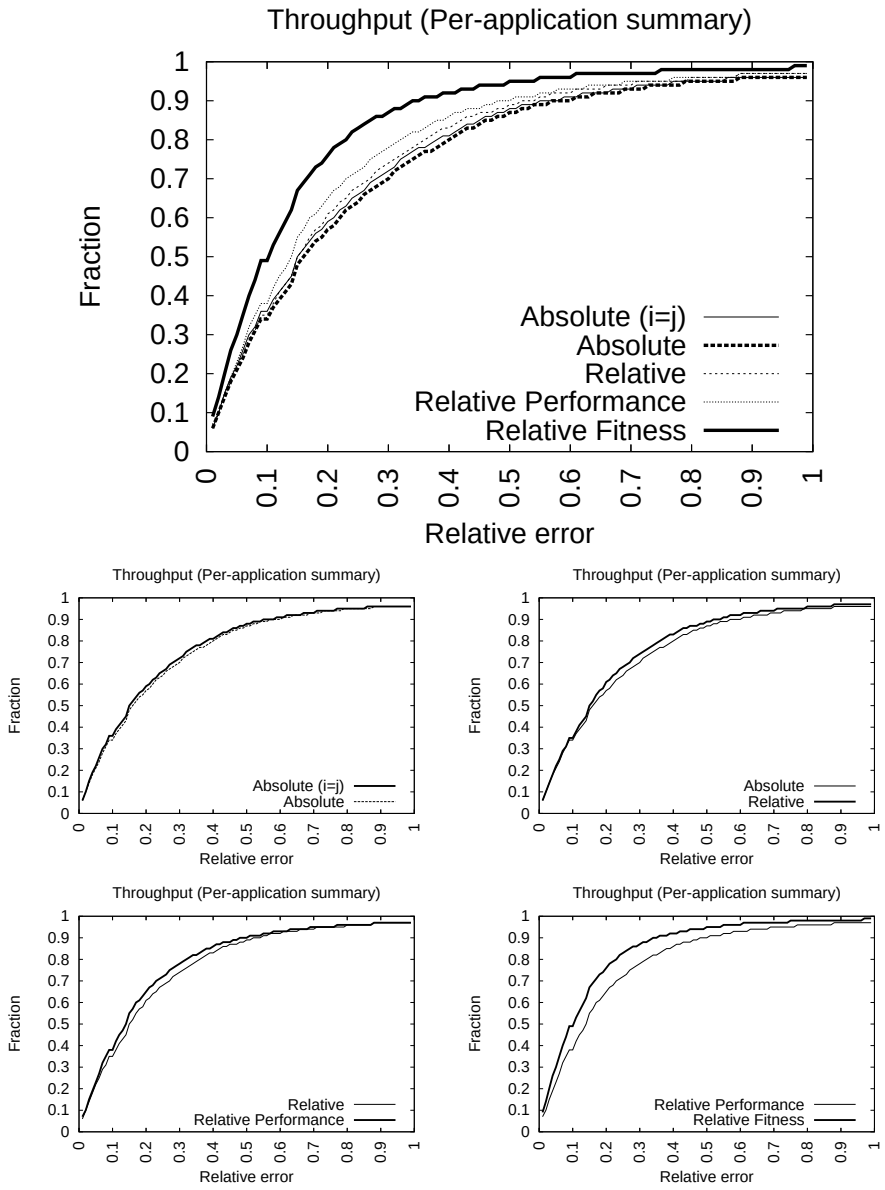

Figure A.5: The cumulative distribution of relative error over all pairwise predictions.

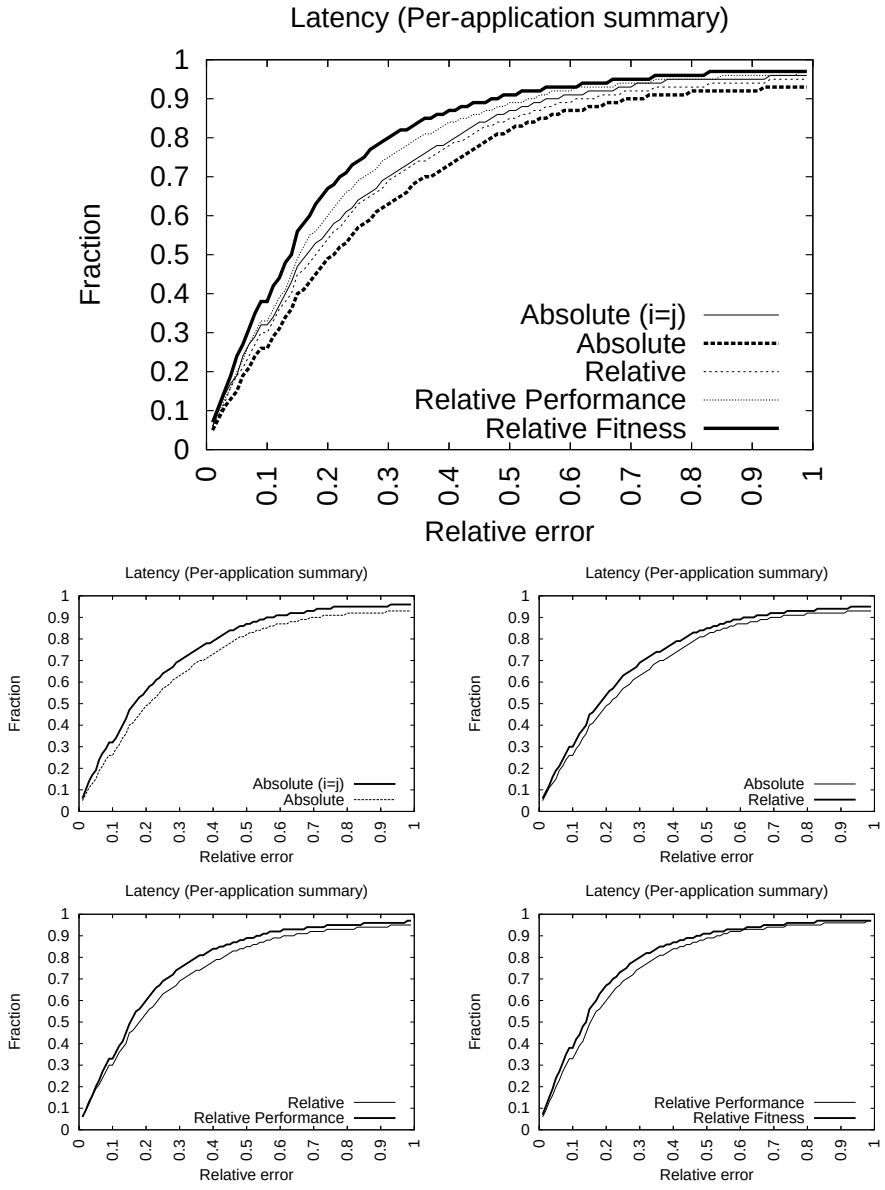

Figure A.6: The cumulative distribution of relative error over all pairwise predictions.

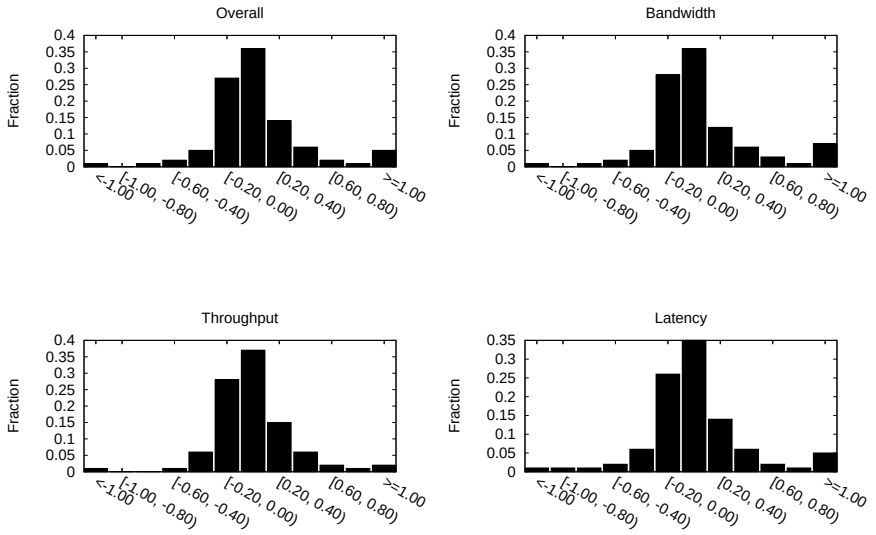

Figure A.7: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

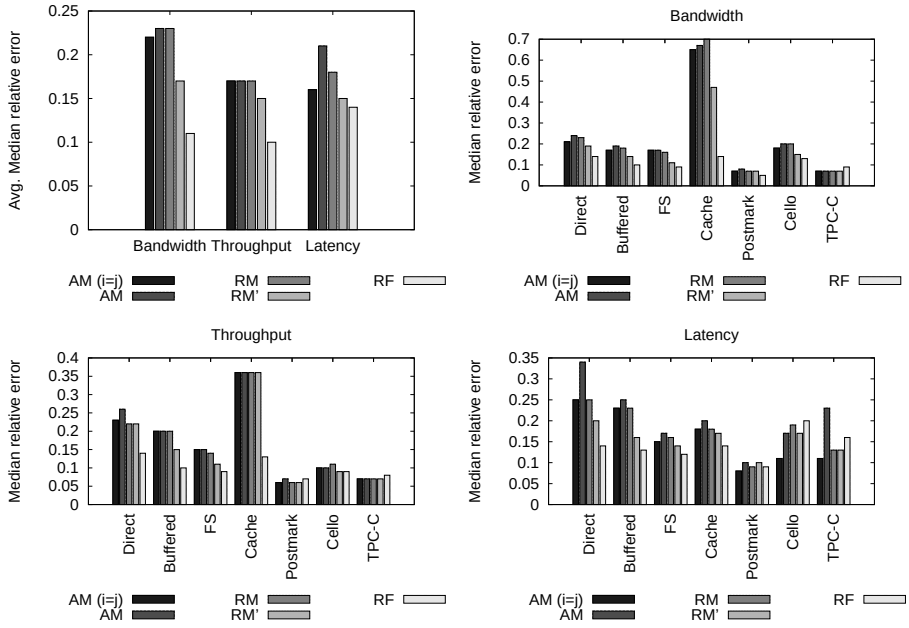

Figure A.8: Median relative error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	67 / 35 / 333	130 / 181 / 124	128 / 214 / 93	151 / 246 / 38	119 / 294 / 22
A → C	46 / 33 / 356	149 / 124 / 162	109 / 203 / 123	170 / 238 / 27	164 / 248 / 23
A → D	53 / 39 / 343	150 / 122 / 163	130 / 206 / 99	144 / 255 / 36	147 / 266 / 22
B → A	55 / 32 / 348	122 / 174 / 139	157 / 193 / 85	140 / 263 / 32	125 / 281 / 29
B → C	48 / 25 / 362	149 / 147 / 139	123 / 184 / 128	179 / 232 / 24	165 / 248 / 22
B → D	43 / 33 / 359	178 / 122 / 135	98 / 207 / 130	150 / 247 / 38	120 / 293 / 22
C → A	52 / 39 / 344	156 / 157 / 122	149 / 207 / 79	164 / 235 / 36	138 / 269 / 28
C → B	49 / 40 / 346	153 / 177 / 105	156 / 187 / 92	156 / 249 / 30	137 / 267 / 31
C → D	48 / 41 / 346	155 / 130 / 150	147 / 179 / 109	170 / 236 / 29	169 / 244 / 22
D → A	48 / 37 / 350	139 / 156 / 140	139 / 208 / 88	146 / 254 / 35	133 / 275 / 27
D → B	36 / 25 / 374	156 / 172 / 107	97 / 223 / 115	148 / 253 / 34	126 / 288 / 21
D → C	57 / 31 / 347	173 / 144 / 118	148 / 221 / 66	175 / 232 / 28	162 / 242 / 31
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	42 / 21 / 372	150 / 153 / 132	163 / 172 / 100	141 / 256 / 38	138 / 272 / 25
A → C	34 / 20 / 381	187 / 162 / 86	153 / 135 / 147	144 / 265 / 26	160 / 253 / 22
A → D	15 / 9 / 411	148 / 206 / 81	95 / 123 / 217	140 / 256 / 39	118 / 298 / 19
B → A	56 / 34 / 345	160 / 165 / 110	167 / 186 / 82	132 / 258 / 45	136 / 261 / 38
B → C	37 / 21 / 377	217 / 169 / 49	166 / 197 / 72	153 / 253 / 29	162 / 250 / 23
B → D	11 / 6 / 418	158 / 219 / 58	149 / 210 / 76	143 / 256 / 36	98 / 312 / 25
C → A	57 / 28 / 350	135 / 144 / 156	135 / 141 / 159	185 / 218 / 32	175 / 241 / 19
C → B	54 / 23 / 358	129 / 212 / 94	160 / 151 / 124	179 / 224 / 32	173 / 235 / 27
C → D	14 / 8 / 413	141 / 217 / 77	170 / 162 / 103	162 / 245 / 28	134 / 282 / 19
D → A	51 / 30 / 354	167 / 132 / 136	118 / 207 / 110	165 / 233 / 37	141 / 261 / 33
D → B	33 / 21 / 381	170 / 178 / 87	140 / 198 / 97	147 / 249 / 39	135 / 271 / 29
D → C	44 / 23 / 368	196 / 155 / 84	171 / 166 / 98	186 / 224 / 25	192 / 220 / 23
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	97 / 17 / 321	117 / 190 / 128	140 / 164 / 131	185 / 223 / 27	146 / 269 / 20
A → C	120 / 34 / 281	151 / 185 / 99	135 / 172 / 128	148 / 262 / 25	130 / 288 / 17
A → D	93 / 20 / 322	108 / 177 / 150	105 / 185 / 145	198 / 213 / 24	147 / 271 / 17
B → A	70 / 24 / 341	120 / 155 / 160	143 / 200 / 92	176 / 229 / 30	140 / 273 / 22
B → C	90 / 40 / 305	132 / 161 / 142	150 / 165 / 120	194 / 223 / 18	171 / 245 / 19
B → D	51 / 30 / 354	148 / 152 / 135	102 / 211 / 122	164 / 237 / 34	125 / 288 / 22
C → A	83 / 24 / 328	118 / 184 / 133	110 / 156 / 169	178 / 229 / 28	139 / 278 / 18
C → B	63 / 30 / 342	148 / 191 / 96	152 / 177 / 106	216 / 200 / 19	200 / 220 / 15
C → D	62 / 25 / 348	122 / 162 / 151	159 / 159 / 117	187 / 227 / 21	191 / 226 / 18
D → A	84 / 30 / 321	105 / 190 / 140	155 / 198 / 82	164 / 234 / 37	128 / 289 / 18
D → B	61 / 27 / 347	154 / 159 / 122	109 / 197 / 129	160 / 242 / 33	137 / 276 / 22
D → C	94 / 35 / 306	146 / 196 / 93	156 / 148 / 131	183 / 226 / 26	180 / 241 / 14
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table A.3: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Average					
	$i = j$	$i \neq j$			
Metric	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Bandwidth	0.22	0.23	0.23	0.17	0.11
Throughput	0.17	0.17	0.17	0.15	0.10
Latency	0.16	0.21	0.18	0.15	0.14
Bandwidth					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.21	0.24	0.23	0.19	0.14
Buffered	0.17	0.19	0.18	0.14	0.10
FS	0.17	0.17	0.16	0.11	0.09
Cache	0.65	0.67	0.70	0.47	0.14
Postmark	0.07	0.08	0.07	0.07	0.05
Cello	0.18	0.20	0.20	0.15	0.13
TPC-C	0.07	0.07	0.07	0.07	0.09
Throughput					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.23	0.26	0.22	0.22	0.14
Buffered	0.20	0.20	0.20	0.15	0.10
FS	0.15	0.15	0.14	0.11	0.09
Cache	0.36	0.36	0.36	0.36	0.13
Postmark	0.06	0.07	0.06	0.06	0.07
Cello	0.10	0.10	0.11	0.09	0.09
TPC-C	0.07	0.07	0.07	0.07	0.08
Latency					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.25	0.34	0.25	0.20	0.14
Buffered	0.23	0.25	0.23	0.16	0.13
FS	0.15	0.17	0.16	0.14	0.12
Cache	0.18	0.20	0.18	0.17	0.14
Postmark	0.08	0.10	0.09	0.10	0.09
Cello	0.11	0.17	0.19	0.17	0.20
TPC-C	0.11	0.23	0.13	0.13	0.16

Table A.4: Median relative error.

Average					
	$i = j$	$i \neq j$			
Metric	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Bandwidth	0.57	0.59	0.61	0.39	0.17
Throughput	0.25	0.26	0.24	0.26	0.16
Latency	0.28	0.43	0.33	0.30	0.24
Bandwidth					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.62	0.72	0.56	0.36	0.24
Buffered	0.34	0.34	0.32	0.21	0.16
FS	0.29	0.31	0.29	0.18	0.13
Cache	2.11	2.10	2.43	1.37	0.26
Postmark	0.33	0.34	0.31	0.32	0.11
Cello	0.21	0.23	0.25	0.20	0.18
TPC-C	0.09	0.10	0.10	0.09	0.11
Throughput					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.35	0.37	0.35	0.35	0.24
Buffered	0.29	0.30	0.27	0.23	0.17
FS	0.23	0.23	0.20	0.16	0.13
Cache	0.50	0.52	0.49	0.71	0.25
Postmark	0.12	0.14	0.12	0.13	0.13
Cello	0.14	0.15	0.14	0.13	0.12
TPC-C	0.10	0.10	0.10	0.09	0.11
Latency					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.45	1.06	0.47	0.34	0.25
Buffered	0.35	0.39	0.37	0.26	0.21
FS	0.22	0.25	0.25	0.22	0.21
Cache	0.38	0.46	0.43	0.55	0.29
Postmark	0.23	0.25	0.24	0.22	0.16
Cello	0.20	0.33	0.34	0.33	0.33
TPC-C	0.15	0.29	0.18	0.19	0.26

Table A.5: Mean relative error.

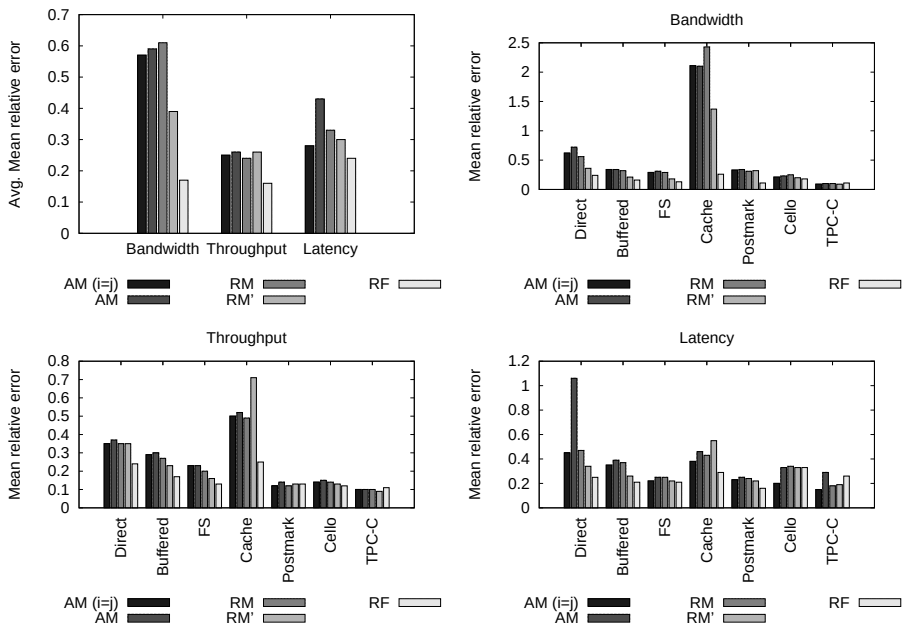

Figure A.9: Mean relative error.

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.17	0.17	0.16	0.17
Absolute	0.18	0.18	0.17	0.21
Relative	0.17	0.17	0.15	0.18
Relative Performance	0.14	0.13	0.13	0.16
Relative Fitness	0.11	0.10	0.10	0.13

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.15	0.18	0.19	0.21
Array B	0.18	0.14	0.20	0.20
Array C	0.18	0.16	0.17	0.21
Array D	0.18	0.16	0.19	0.20
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.15	0.15	0.19	0.18
Array B	0.16	0.14	0.20	0.18
Array C	0.16	0.15	0.17	0.17
Array D	0.16	0.16	0.19	0.20
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.04	0.12	0.17	0.14
Array B	0.13	0.04	0.17	0.13
Array C	0.14	0.14	0.04	0.17
Array D	0.13	0.11	0.17	0.04
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.09	0.12	0.11
Array B	0.09	0.0	0.14	0.09
Array C	0.11	0.12	0.0	0.13
Array D	0.10	0.08	0.14	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.17	0.19	0.17	0.18	0.13	0.13	0.16	0.25	0.17	0.20	0.25	0.21
Array B	0.18	0.16	0.18	0.17	0.14	0.12	0.16	0.25	0.21	0.15	0.25	0.18
Array C	0.18	0.17	0.16	0.18	0.14	0.14	0.15	0.25	0.22	0.18	0.20	0.19
Array D	0.17	0.17	0.18	0.17	0.14	0.13	0.16	0.24	0.22	0.18	0.24	0.17
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.17	0.17	0.18	0.19	0.13	0.13	0.17	0.18	0.17	0.16	0.23	0.17
Array B	0.15	0.16	0.18	0.19	0.14	0.12	0.19	0.18	0.19	0.15	0.22	0.17
Array C	0.17	0.16	0.16	0.18	0.13	0.11	0.15	0.19	0.19	0.17	0.20	0.17
Array D	0.16	0.16	0.20	0.17	0.15	0.14	0.17	0.24	0.16	0.18	0.20	0.17
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.04	0.12	0.13	0.14	0.03	0.11	0.17	0.16	0.04	0.14	0.20	0.12
Array B	0.12	0.04	0.14	0.12	0.11	0.03	0.18	0.12	0.16	0.04	0.20	0.13
Array C	0.14	0.15	0.03	0.16	0.13	0.12	0.03	0.18	0.16	0.16	0.05	0.17
Array D	0.12	0.11	0.14	0.04	0.12	0.10	0.16	0.05	0.14	0.12	0.22	0.04
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.08	0.12	0.10	0.0	0.08	0.11	0.10	0.0	0.13	0.12	0.12
Array B	0.08	0.0	0.13	0.09	0.08	0.0	0.12	0.08	0.13	0.0	0.17	0.10
Array C	0.10	0.10	0.0	0.12	0.11	0.11	0.0	0.12	0.14	0.16	0.0	0.15
Array D	0.09	0.08	0.12	0.0	0.09	0.07	0.14	0.0	0.12	0.10	0.18	0.0

Table A.6: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.36	0.50	0.26	0.31
Absolute	0.43	0.53	0.27	0.49
Relative	0.37	0.51	0.25	0.34
Relative Performance	0.29	0.33	0.25	0.29
Relative Fitness	0.19	0.17	0.17	0.23

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.28	0.58	0.52	0.66
Array B	0.32	0.38	0.44	0.41
Array C	0.33	0.39	0.38	0.41
Array D	0.32	0.38	0.41	0.40
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.28	0.41	0.39	0.41
Array B	0.30	0.38	0.40	0.42
Array C	0.30	0.40	0.38	0.38
Array D	0.30	0.35	0.38	0.40
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.09	0.24	0.41	0.31
Array B	0.25	0.10	0.38	0.27
Array C	0.24	0.27	0.12	0.30
Array D	0.23	0.23	0.37	0.13
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.16	0.21	0.19
Array B	0.17	0.0	0.26	0.16
Array C	0.17	0.22	0.0	0.23
Array D	0.15	0.14	0.25	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.38	0.62	0.50	0.55	0.21	0.23	0.30	0.34	0.25	0.88	0.75	1.09
Array B	0.47	0.59	0.63	0.54	0.22	0.21	0.30	0.35	0.28	0.34	0.39	0.36
Array C	0.46	0.55	0.53	0.52	0.22	0.24	0.30	0.35	0.29	0.39	0.32	0.36
Array D	0.45	0.54	0.57	0.51	0.22	0.23	0.30	0.34	0.29	0.37	0.38	0.33
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.38	0.69	0.51	0.58	0.21	0.21	0.27	0.28	0.25	0.32	0.41	0.39
Array B	0.39	0.59	0.51	0.54	0.22	0.21	0.32	0.30	0.29	0.34	0.38	0.41
Array C	0.40	0.66	0.53	0.51	0.23	0.20	0.30	0.28	0.27	0.34	0.32	0.36
Array D	0.40	0.46	0.50	0.51	0.24	0.23	0.28	0.34	0.25	0.36	0.35	0.33
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.14	0.29	0.47	0.37	0.06	0.21	0.30	0.27	0.08	0.24	0.45	0.28
Array B	0.33	0.13	0.48	0.26	0.19	0.07	0.30	0.29	0.23	0.09	0.36	0.26
Array C	0.28	0.31	0.15	0.29	0.20	0.23	0.06	0.26	0.24	0.28	0.14	0.33
Array D	0.29	0.28	0.33	0.15	0.17	0.17	0.42	0.13	0.22	0.23	0.37	0.12
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.15	0.19	0.17	0.0	0.13	0.18	0.18	0.0	0.21	0.24	0.23
Array B	0.16	0.0	0.24	0.14	0.15	0.0	0.22	0.15	0.21	0.0	0.32	0.18
Array C	0.16	0.20	0.0	0.20	0.17	0.20	0.0	0.21	0.20	0.26	0.0	0.28
Array D	0.13	0.13	0.21	0.0	0.13	0.11	0.22	0.0	0.19	0.17	0.32	0.0

Table A.7: Mean relative error

Appendix B

Mixed-model summary

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Write fraction	1.00
Write fraction	0.72	Read jump	0.70	Read jump	0.66	Read queue	0.72
Read jump	0.56	Read size	0.54	Write size	0.50	Write queue	0.39
Read size	0.40	Write size	0.51	Read size	0.46	Read jump	0.24
Write size	0.37	Write fraction	0.49	Write queue	0.24	Read size	0.16
Write queue	0.37	Write queue	0.30	Write jump	0.21	Write size	0.09
Write jump	0.19	Write jump	0.29	Write fraction	0.19	Write jump	0.05
Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Write fraction	1.00
Write fraction	0.65	Read jump	0.72	Read jump	0.67	Read queue	0.88
Read jump	0.57	Read size	0.52	Write size	0.47	Write queue	0.48
Read size	0.42	Write fraction	0.52	Read size	0.46	Read jump	0.32
Write size	0.39	Write size	0.48	Write queue	0.28	Read size	0.28
Write queue	0.37	Write jump	0.34	Write fraction	0.22	Write size	0.23
Write jump	0.24	Write queue	0.27	Write jump	0.20	Write jump	0.16
Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Latency	1.00	Bandwidth	1.00	Throughput	1.00	Latency	1.00
Bandwidth	0.92	Read jump	0.16	Read queue	0.22	Write fraction	0.13
Throughput	0.79	Write fraction	0.14	Read size	0.15	Bandwidth	0.11
Read queue	0.32	Read queue	0.13	Write size	0.13	Read queue	0.09
Read jump	0.28	Latency	0.11	Read jump	0.13	Read jump	0.08
Write fraction	0.26	Write size	0.10	Bandwidth	0.11	Read latency	0.08
Read size	0.22	Read latency	0.09	Latency	0.11	Write latency	0.08
Write size	0.21	Read size	0.07	Write fraction	0.07	Read size	0.08
Read latency	0.15	Throughput	0.07	Write queue	0.05	Write queue	0.06
Write queue	0.12	Write jump	0.06	Write jump	0.03	Throughput	0.06
Write jump	0.10	Write queue	0.04	Read latency	0.02	Write size	0.05
Write latency	0.09	Write latency	0.02	Write latency	0.02	Write jump	0.04
Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Latency	1.00	Bandwidth	1.00	Write fraction	1.00	Latency	1.00
Write fraction	0.92	Write fraction	0.99	Bandwidth	0.98	Write fraction	0.70
Bandwidth	0.89	Latency	0.91	Latency	0.92	Bandwidth	0.64
Read latency	0.61	Read jump	0.85	Read latency	0.85	Throughput	0.45
Read jump	0.61	Read queue	0.82	Read jump	0.77	Read size	0.43
Read queue	0.60	Read latency	0.74	Throughput	0.64	Write jump	0.37
Throughput	0.60	Throughput	0.66	Read queue	0.60	Read queue	0.37
Read size	0.45	Read size	0.46	Read size	0.40	Read latency	0.26
Write size	0.33	Write size	0.41	Write size	0.36	Read jump	0.24
Write queue	0.32	Write queue	0.40	Write queue	0.34	Write size	0.22
Write jump	0.28	Write latency	0.23	Write latency	0.30	Write latency	0.21
Write latency	0.25	Write jump	0.17	Write jump	0.22	Write queue	0.21

Table B.1: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	8.2	9.2	6.4	9.1
Relative	8.2	8.6	6.7	9.4
Relative Performance	8.3	9.2	7.2	8.6
Relative Fitness	6.3	6.8	6.5	5.5

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	9.2	-	-	-
Array	-	8.2	-	-
Array	-	-	8.2	-
Array	-	-	-	7.4
Relative	**Array**	**Array**	**Array**	**Array**
Array	9.2	8.2	7.3	8.3
Array	9.1	8.2	7.2	8.0
Array	9.3	10.4	8.2	7.9
Array	8.6	8.2	6.2	7.4
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	10.7	8.6	7.0	8.3
Array	8.0	10.8	7.1	8.1
Array	7.9	10.0	10.8	8.3
Array	10.1	9.6	6.6	10.0
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	6.3	5.0	6.7
Array	7.1	1	5.1	5.4
Array	8.3	8.1	1	6.2
Array	7.6	5.3	4.0	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	10.9	-	-	-	7.4	-	-	-	9.3	-	-	-
Array B	-	10.0	-	-	-	6.9	-	-	-	7.9	-	-
Array C	-	-	6.1	-	-	-	8.3	-	-	-	10.1	-
Array D	-	-	-	9.9	-	-	-	3.0	-	-	-	9.3
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	10.9	7.9	7.7	8.1	7.4	7.4	4.3	6.7	9.3	9.3	9.9	10.0
Array B	10.7	10.0	5.7	8.3	7.7	6.9	6.3	7.7	9.0	7.9	9.7	8.0
Array C	10.0	10.1	6.1	6.4	8.1	10.7	8.3	6.9	9.7	10.3	10.1	10.4
Array D	12.3	10.6	5.1	9.9	4.6	5.9	3.6	3.0	8.9	8.3	9.9	9.3
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	10.7	10.1	8.6	9.7	10.7	8.1	4.9	7.0	10.6	7.6	7.7	8.3
Array B	7.6	10.6	6.7	7.9	7.6	10.3	5.7	7.7	9.0	11.6	8.9	8.9
Array C	8.3	10.0	11.0	10.3	6.0	10.0	10.9	7.3	9.4	10.1	10.6	7.4
Array D	11.1	10.9	9.4	10.4	9.3	8.1	4.3	8.6	9.9	9.9	6.1	10.9
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	6.1	6.0	6.1	1	5.4	4.6	6.4	1	7.4	4.3	7.6
Array B	5.3	1	4.7	5.3	8.6	1	7.1	5.4	7.4	1	3.4	5.6
Array C	11.0	10.0	1	7.3	7.4	8.7	1	6.9	6.6	5.7	1	4.4
Array D	8.3	6.4	4.9	1	8.9	5.7	3.1	1	5.6	3.7	4.0	1

Table B.2: Tree sizes (leaf nodes) and their averages.

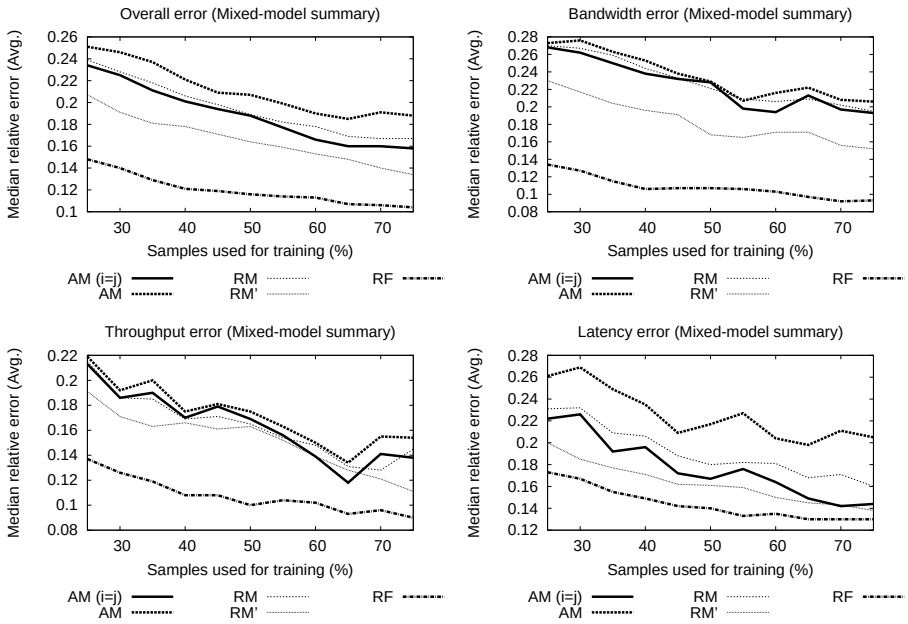

Figure B.1: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

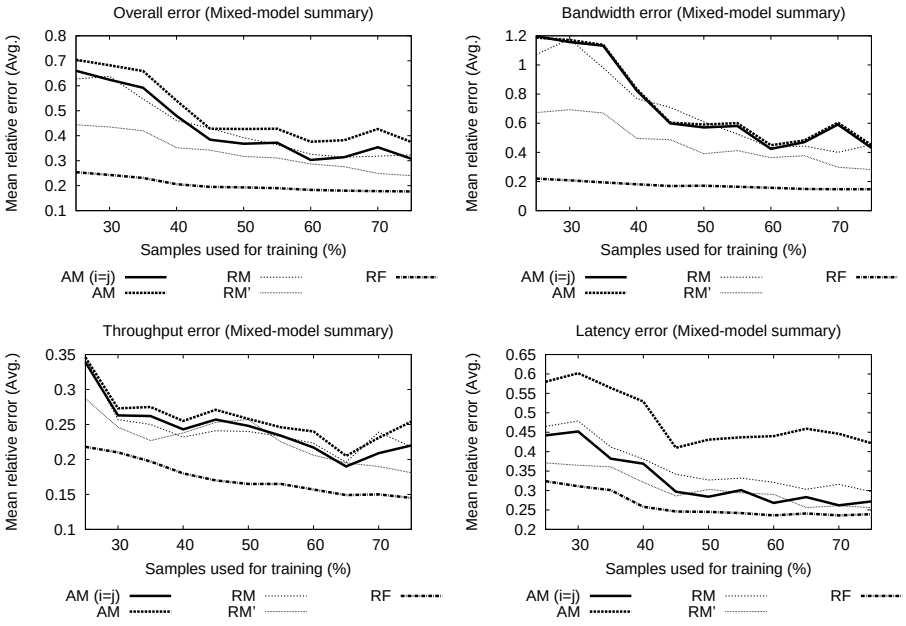

Figure B.2: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

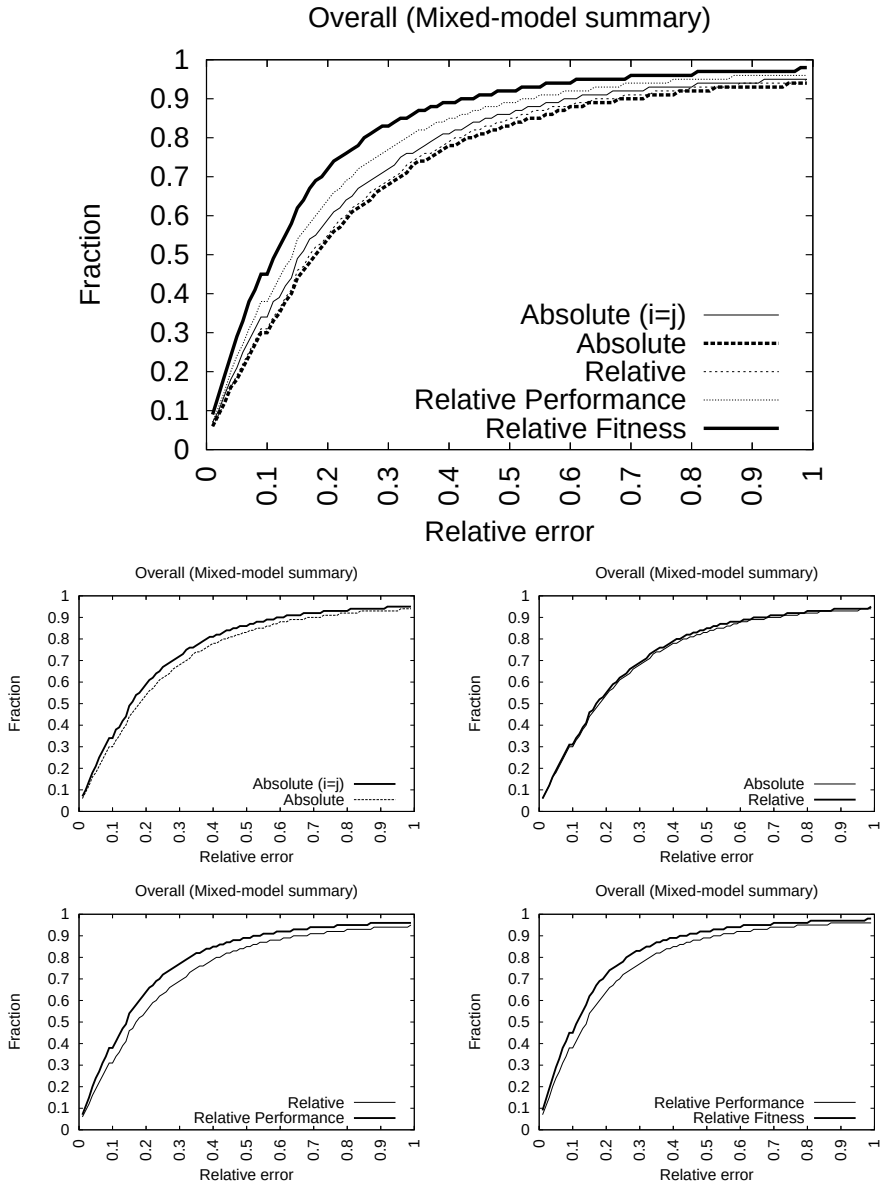

Figure B.3: The cumulative distribution of relative error over all pairwise predictions.

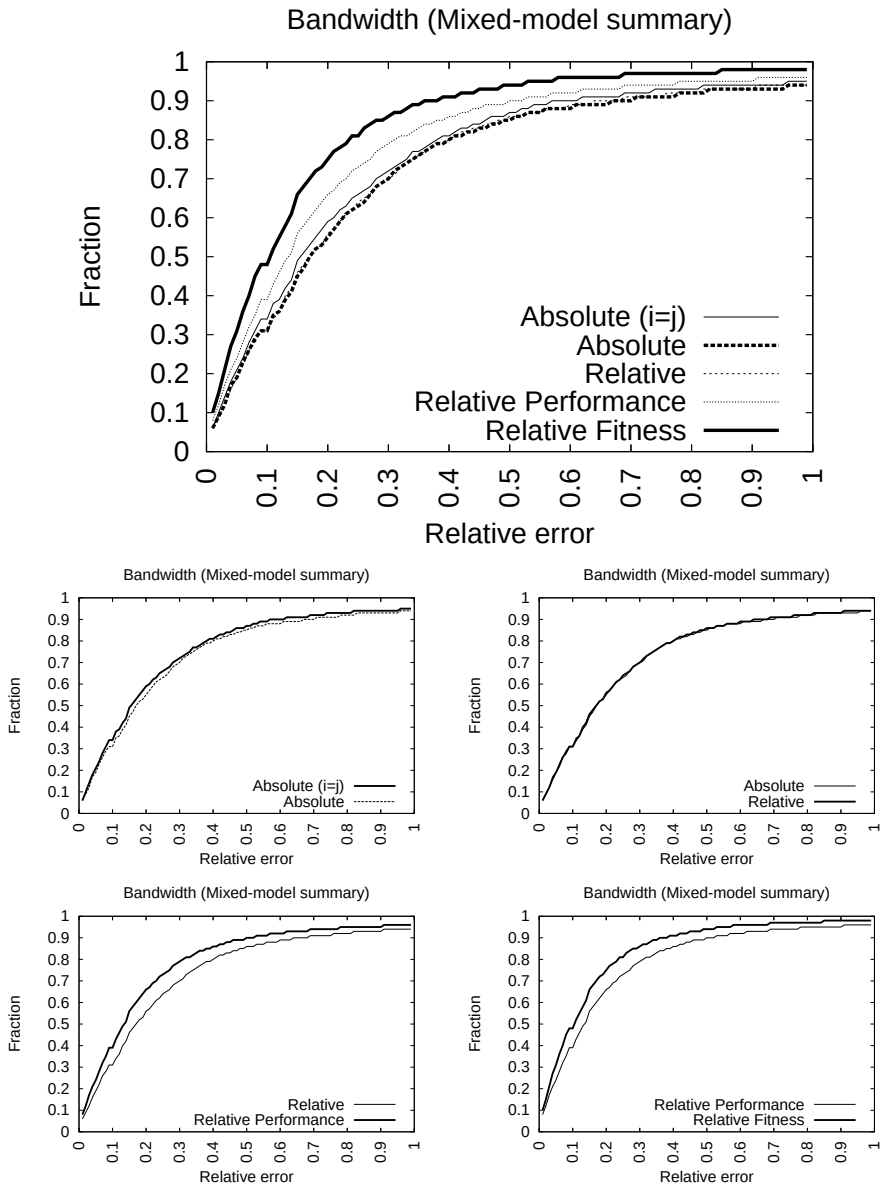

Figure B.4: The cumulative distribution of relative error over all pairwise predictions.

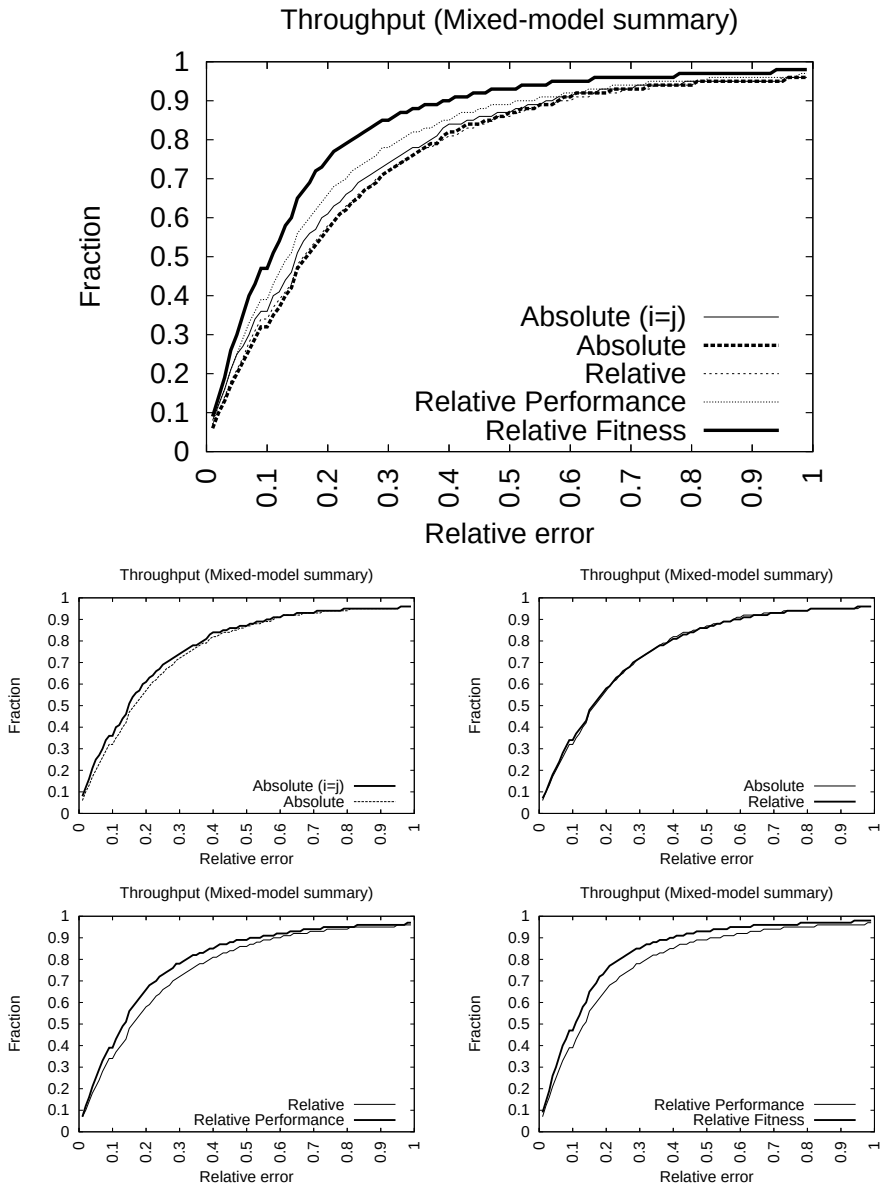

Figure B.5: The cumulative distribution of relative error over all pairwise predictions.

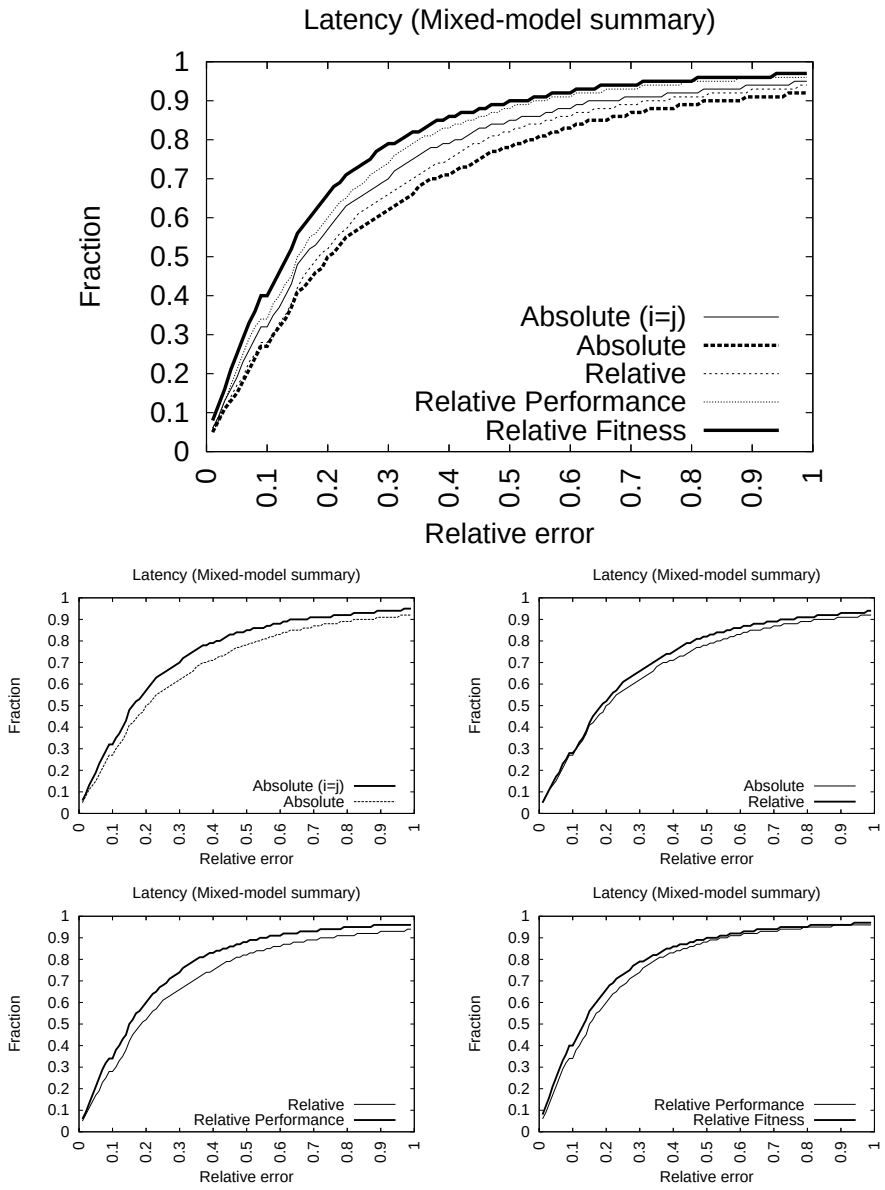

Figure B.6: The cumulative distribution of relative error over all pairwise predictions.

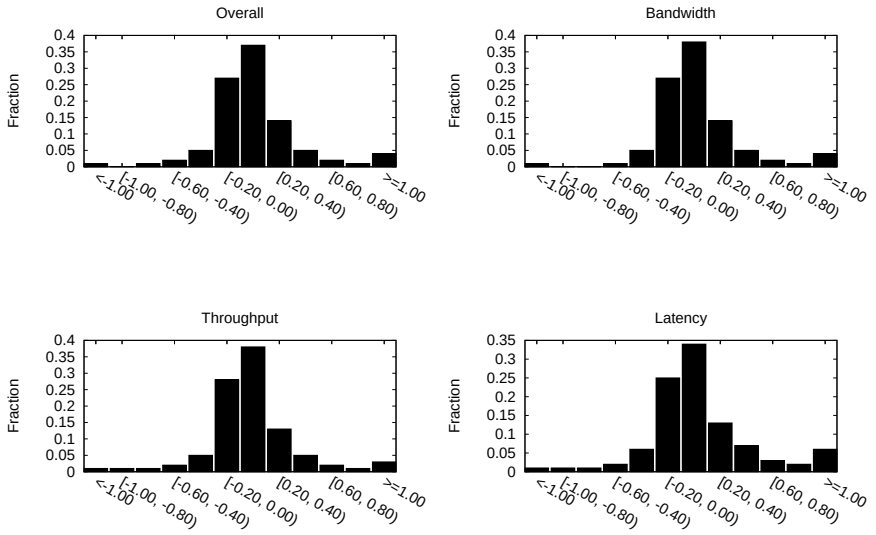

Figure B.7: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

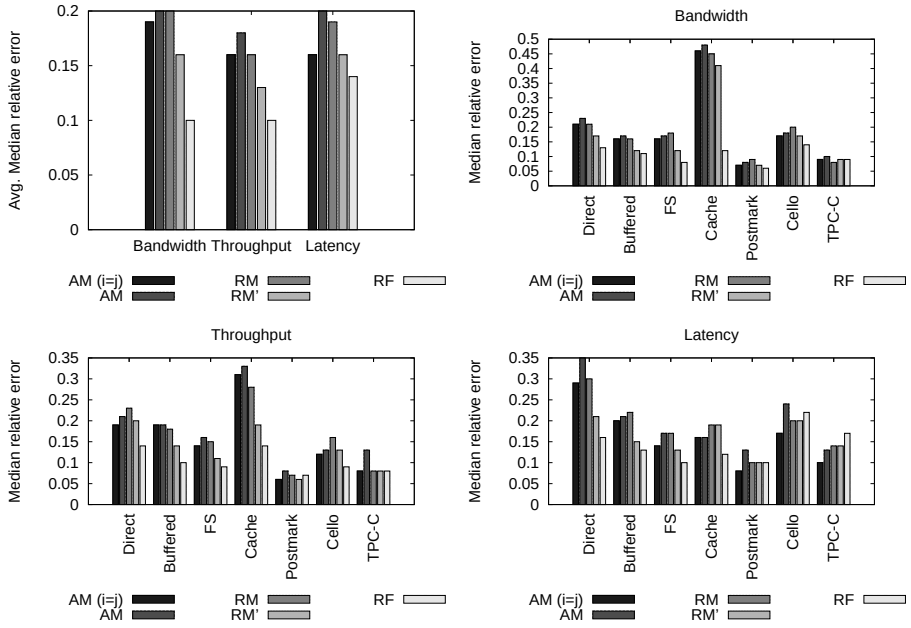

Figure B.8: Median relative error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	56 / 38 / 341	162 / 138 / 135	153 / 207 / 75	157 / 242 / 36	150 / 263 / 22
A → C	87 / 45 / 303	179 / 202 / 54	180 / 220 / 35	169 / 245 / 21	153 / 256 / 26
A → D	85 / 49 / 301	181 / 163 / 91	124 / 230 / 81	175 / 232 / 28	135 / 283 / 17
B → A	44 / 32 / 359	156 / 174 / 105	169 / 227 / 39	138 / 257 / 40	116 / 295 / 24
B → C	64 / 33 / 338	183 / 175 / 77	139 / 236 / 60	194 / 214 / 27	157 / 255 / 23
B → D	61 / 46 / 328	159 / 184 / 92	141 / 219 / 75	160 / 234 / 41	132 / 277 / 26
C → A	51 / 33 / 351	146 / 174 / 115	181 / 213 / 41	141 / 270 / 24	131 / 282 / 22
C → B	54 / 42 / 339	194 / 166 / 75	165 / 210 / 60	188 / 214 / 33	183 / 228 / 24
C → D	78 / 55 / 302	146 / 172 / 117	148 / 229 / 58	186 / 214 / 35	157 / 248 / 30
D → A	47 / 38 / 350	156 / 158 / 121	118 / 258 / 59	149 / 247 / 39	126 / 287 / 22
D → B	52 / 28 / 355	174 / 152 / 109	141 / 247 / 47	166 / 227 / 42	126 / 281 / 28
D → C	62 / 31 / 342	169 / 188 / 78	157 / 225 / 53	184 / 223 / 28	159 / 243 / 33
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	73 / 58 / 304	162 / 172 / 101	159 / 227 / 49	157 / 232 / 46	143 / 264 / 28
A → C	61 / 45 / 329	153 / 197 / 85	316 / 115 / 4	106 / 317 / 12	169 / 246 / 20
A → D	71 / 42 / 322	165 / 208 / 62	164 / 203 / 68	158 / 243 / 34	136 / 283 / 16
B → A	119 / 37 / 279	192 / 209 / 34	151 / 235 / 49	202 / 202 / 31	144 / 271 / 20
B → C	53 / 31 / 351	285 / 115 / 35	125 / 288 / 22	185 / 225 / 25	166 / 242 / 27
B → D	43 / 37 / 355	148 / 212 / 75	191 / 209 / 35	171 / 241 / 23	134 / 274 / 27
C → A	141 / 47 / 247	179 / 218 / 38	144 / 215 / 76	172 / 225 / 38	137 / 279 / 19
C → B	80 / 50 / 305	240 / 176 / 19	163 / 248 / 24	194 / 205 / 36	184 / 221 / 30
C → D	63 / 51 / 321	176 / 203 / 56	185 / 216 / 34	174 / 231 / 30	158 / 245 / 32
D → A	120 / 41 / 274	161 / 213 / 61	138 / 230 / 67	168 / 231 / 36	124 / 289 / 22
D → B	56 / 42 / 337	192 / 167 / 76	152 / 223 / 60	169 / 233 / 33	149 / 256 / 30
D → C	51 / 37 / 347	172 / 170 / 93	177 / 227 / 31	213 / 197 / 25	200 / 210 / 25
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	129 / 49 / 257	173 / 220 / 42	175 / 240 / 20	163 / 247 / 25	122 / 290 / 23
A → C	139 / 44 / 252	148 / 213 / 74	145 / 237 / 53	183 / 234 / 18	136 / 284 / 15
A → D	65 / 30 / 340	156 / 196 / 83	152 / 219 / 64	192 / 217 / 26	148 / 265 / 22
B → A	96 / 45 / 294	161 / 180 / 94	167 / 220 / 48	205 / 209 / 21	169 / 245 / 21
B → C	87 / 38 / 310	233 / 159 / 43	169 / 255 / 11	175 / 240 / 20	170 / 243 / 22
B → D	54 / 26 / 355	152 / 192 / 91	142 / 245 / 48	172 / 226 / 37	124 / 288 / 23
C → A	99 / 35 / 301	145 / 166 / 124	163 / 203 / 69	191 / 220 / 24	161 / 250 / 24
C → B	93 / 46 / 296	169 / 178 / 88	179 / 195 / 61	196 / 213 / 26	155 / 261 / 19
C → D	61 / 31 / 343	139 / 158 / 138	180 / 175 / 80	179 / 230 / 26	164 / 251 / 20
D → A	95 / 41 / 299	158 / 170 / 107	157 / 236 / 42	194 / 218 / 23	140 / 273 / 22
D → B	88 / 38 / 309	168 / 201 / 66	162 / 240 / 33	171 / 235 / 29	135 / 280 / 20
D → C	91 / 44 / 300	180 / 177 / 78	178 / 207 / 50	181 / 237 / 17	149 / 264 / 22
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table B.3: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Average					
	$i = j$	$i \neq j$			
Metric	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Bandwidth	0.19	0.20	0.20	0.16	0.10
Throughput	0.16	0.18	0.16	0.13	0.10
Latency	0.16	0.20	0.19	0.16	0.14

Bandwidth					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.21	0.23	0.21	0.17	0.13
Buffered	0.16	0.17	0.16	0.12	0.11
FS	0.16	0.17	0.18	0.12	0.08
Cache	0.46	0.48	0.45	0.41	0.12
Postmark	0.07	0.08	0.09	0.07	0.06
Cello	0.17	0.18	0.20	0.17	0.14
TPC-C	0.09	0.10	0.08	0.09	0.09

Throughput					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.19	0.21	0.23	0.20	0.14
Buffered	0.19	0.19	0.18	0.14	0.10
FS	0.14	0.16	0.15	0.11	0.09
Cache	0.31	0.33	0.28	0.19	0.14
Postmark	0.06	0.08	0.07	0.06	0.07
Cello	0.12	0.13	0.16	0.13	0.09
TPC-C	0.08	0.13	0.08	0.08	0.08

Latency					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.29	0.35	0.30	0.21	0.16
Buffered	0.20	0.21	0.22	0.15	0.13
FS	0.14	0.17	0.17	0.13	0.10
Cache	0.16	0.16	0.19	0.19	0.12
Postmark	0.08	0.13	0.10	0.10	0.10
Cello	0.17	0.24	0.20	0.20	0.22
TPC-C	0.10	0.13	0.14	0.14	0.17

Table B.4: Median relative error.

Average					
	$i = j$	$i \neq j$			
Metric	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Bandwidth	0.34	0.37	0.41	0.35	0.34
Throughput	0.26	0.29	0.27	0.43	0.41
Latency	0.32	0.55	0.43	0.32	0.30
Bandwidth					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.40	0.42	0.41	0.36	0.38
Buffered	0.24	0.25	0.23	0.19	0.17
FS	0.27	0.31	0.30	0.18	0.13
Cache	1.02	1.02	1.25	1.21	1.21
Postmark	0.15	0.17	0.23	0.15	0.14
Cello	0.22	0.25	0.29	0.23	0.20
TPC-C	0.11	0.16	0.13	0.11	0.12
Throughput					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.26	0.28	0.40	0.75	0.25
Buffered	0.26	0.27	0.30	0.22	0.19
FS	0.27	0.30	0.29	0.17	0.15
Cache	0.44	0.44	0.39	1.38	1.86
Postmark	0.16	0.15	0.13	0.16	0.14
Cello	0.17	0.19	0.24	0.21	0.14
TPC-C	0.26	0.37	0.15	0.13	0.11
Latency					
	$i = j$	$i \neq j$			
Workload	**Absolute**	**Absolute**	**Relative**	**Relative'**	**Relative fitness**
Direct	0.52	0.63	0.50	0.35	0.30
Buffered	0.33	0.35	0.33	0.24	0.20
FS	0.30	0.48	0.36	0.22	0.20
Cache	0.42	0.80	0.88	0.59	0.31
Postmark	0.29	0.66	0.26	0.24	0.22
Cello	0.25	0.54	0.39	0.34	0.42
TPC-C	0.13	0.42	0.26	0.23	0.46

Table B.5: Mean relative error.

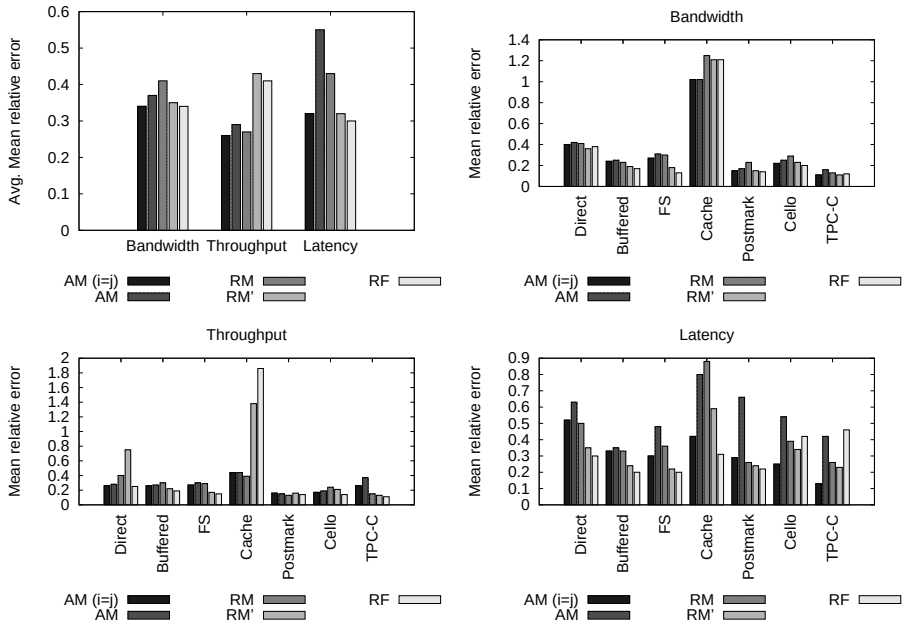

Figure B.9: Mean relative error.

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.16	0.16	0.15	0.17
Absolute	0.18	0.18	0.17	0.21
Relative	0.18	0.18	0.16	0.19
Relative Performance	0.14	0.13	0.13	0.15
Relative Fitness	0.11	0.10	0.10	0.13

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.15	0.16	0.20	0.20
Array B	0.18	0.14	0.20	0.19
Array C	0.19	0.16	0.17	0.20
Array D	0.19	0.16	0.19	0.18
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.15	0.15	0.19	0.18
Array B	0.16	0.14	0.26	0.17
Array C	0.17	0.17	0.17	0.18
Array D	0.17	0.15	0.19	0.18
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.01	0.12	0.21	0.13
Array B	0.12	0.01	0.17	0.12
Array C	0.14	0.15	0.01	0.15
Array D	0.12	0.11	0.15	0.01
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.09	0.13	0.11
Array B	0.10	0.0	0.14	0.09
Array C	0.10	0.12	0.0	0.12
Array D	0.10	0.09	0.14	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.17	0.16	0.20	0.20	0.13	0.14	0.17	0.21	0.15	0.24	0.30	0.18
Array B	0.17	0.15	0.19	0.18	0.18	0.12	0.18	0.20	0.19	0.17	0.22	0.19
Array C	0.18	0.15	0.17	0.20	0.18	0.14	0.16	0.20	0.20	0.20	0.18	0.19
Array D	0.17	0.16	0.18	0.16	0.18	0.13	0.17	0.20	0.20	0.20	0.22	0.17
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.17	0.15	0.18	0.19	0.13	0.12	0.15	0.18	0.15	0.18	0.23	0.18
Array B	0.16	0.15	0.20	0.17	0.14	0.12	0.30	0.17	0.17	0.17	0.30	0.18
Array C	0.16	0.18	0.17	0.18	0.16	0.18	0.16	0.19	0.18	0.17	0.18	0.18
Array D	0.19	0.17	0.18	0.16	0.15	0.12	0.17	0.20	0.17	0.17	0.21	0.17
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.01	0.12	0.15	0.11	0.01	0.10	0.34	0.14	0.01	0.16	0.19	0.12
Array B	0.13	0.01	0.15	0.12	0.09	0.01	0.15	0.14	0.14	0.01	0.21	0.11
Array C	0.14	0.15	0.01	0.14	0.13	0.12	0.01	0.14	0.15	0.16	0.01	0.16
Array D	0.12	0.10	0.14	0.01	0.10	0.10	0.14	0.01	0.13	0.13	0.19	0.01
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.09	0.13	0.10	0.0	0.07	0.12	0.10	0.0	0.12	0.14	0.12
Array B	0.08	0.0	0.13	0.08	0.10	0.0	0.12	0.10	0.14	0.0	0.17	0.09
Array C	0.09	0.12	0.0	0.12	0.10	0.12	0.0	0.11	0.12	0.15	0.0	0.13
Array D	0.08	0.07	0.13	0.0	0.09	0.08	0.15	0.0	0.12	0.11	0.16	0.0

Table B.6: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.31	0.32	0.26	0.35
Absolute	0.39	0.35	0.28	0.53
Relative	0.36	0.37	0.29	0.41
Relative Performance	0.33	0.30	0.41	0.30
Relative Fitness	0.29	0.28	0.31	0.27

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.27	0.43	0.51	0.49
Array B	0.32	0.29	0.44	0.37
Array C	0.32	0.32	0.32	0.38
Array D	0.32	0.37	0.37	0.36
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.27	0.32	0.35	0.35
Array B	0.32	0.29	0.58	0.33
Array C	0.29	0.33	0.32	0.36
Array D	0.33	0.34	0.38	0.36
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.03	0.26	0.42	0.26
Array B	0.24	0.03	0.69	0.31
Array C	0.24	0.43	0.04	0.42
Array D	0.21	0.23	0.29	0.04
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.18	0.24	0.20
Array B	0.19	0.0	0.41	0.18
Array C	0.20	0.83	0.0	0.44
Array D	0.15	0.19	0.24	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.33	0.30	0.41	0.33	0.22	0.20	0.30	0.33	0.25	0.79	0.82	0.81
Array B	0.37	0.28	0.40	0.31	0.28	0.20	0.31	0.32	0.30	0.39	0.63	0.49
Array C	0.38	0.29	0.37	0.32	0.29	0.21	0.28	0.31	0.29	0.44	0.32	0.51
Array D	0.38	0.30	0.39	0.31	0.27	0.22	0.29	0.32	0.30	0.59	0.44	0.44
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.33	0.33	0.39	0.36	0.22	0.20	0.25	0.31	0.25	0.45	0.42	0.37
Array B	0.42	0.28	0.39	0.35	0.27	0.20	0.59	0.26	0.26	0.39	0.77	0.37
Array C	0.34	0.34	0.37	0.32	0.25	0.24	0.28	0.36	0.29	0.39	0.32	0.40
Array D	0.44	0.34	0.38	0.31	0.25	0.26	0.29	0.32	0.31	0.43	0.47	0.44
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.04	0.27	0.41	0.30	0.01	0.17	0.54	0.24	0.02	0.33	0.31	0.25
Array B	0.27	0.04	0.42	0.32	0.21	0.02	1.13	0.43	0.24	0.02	0.54	0.20
Array C	0.29	0.26	0.04	0.32	0.20	0.76	0.02	0.64	0.24	0.29	0.04	0.30
Array D	0.23	0.23	0.31	0.07	0.16	0.15	0.24	0.02	0.23	0.32	0.33	0.04
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.14	0.21	0.17	0.0	0.13	0.21	0.17	0.0	0.26	0.30	0.26
Array B	0.14	0.0	0.61	0.14	0.20	0.0	0.20	0.19	0.24	0.0	0.41	0.22
Array C	0.21	1.09	0.0	0.21	0.17	1.10	0.0	0.85	0.23	0.28	0.0	0.26
Array D	0.13	0.13	0.22	0.0	0.14	0.14	0.22	0.0	0.19	0.30	0.28	0.0

Table B.7: Mean relative error

Appendix C

FitnessDirect model training

Application	Samples	Iters	First sample	Last sample
Direct (raw)	200	3	0	99
Total used	100			

Table C.1: Multiple training samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

	Array A	Array B	Array C	Array D	MAD	COV	Max. Diff.
Write fraction	0.48	0.48	0.48	0.48	0.0	0.2%	0.0%
Write size (KB)	102.18	102.12	102.40	102.06	0.1	0.1%	0.3%
Read size (KB)	119.88	119.54	120.06	119.65	0.2	0.2%	0.4%
Write jump (MB)	2421.29	2467.32	2445.39	2432.69	14.7	0.7%	1.9%
Read jump (MB)	2983.15	2973.14	3025.42	2979.56	17.6	0.7%	1.8%
Write queue	8.69	3.02	4.37	3.47	1.9	46.0%	187.8%
Read queue	3.13	4.92	3.51	4.37	0.7	17.6%	57.2%
Bandwidth (MB/sec)	30.42	30.05	12.93	37.42	7.4	32.6%	189.4%
Throughput (IO/sec)	280.10	360.82	116.16	442.60	101.8	40.2%	281.0%
Latency (ms)	25.03	25.27	81.70	22.75	21.5	64.2%	259.1%
Write latency (ms)	25.14	11.40	77.46	14.54	22.7	83.0%	579.5%
Read latency (ms)	17.38	40.74	60.74	28.27	14.0	43.8%	249.5%

Table C.2: Workload characteristics and performance are measured for each sample, on each storage device. The average value for each measurement is reported in this table. The mean absolute deviation (MAD), coefficient of variation (COV), and maximum relative differences of these averages are also reported; these metrics quantify how the averages change among the storage devices. For example, the mean average deviation of the averages for Read latency (ms) is 13.96, their coeefficient of variation is 43.806%, and the maximum relative difference is 249.48%.

Array A								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.1%	0.0	0.2	0.6	0.8	1.0	1.0	0.5
Write size (KB)	0.1%	0.0	3.0	101.0	171.1	217.1	251.3	102.2
Read size (KB)	0.0%	0.0	61.0	115.0	192.2	235.1	255.3	119.9
Write jump (MB)	0.0%	0.0	0.0	2567.0	4116.0	4762.0	5525.0	2421.3
Read jump (MB)	0.0%	0.0	1476.0	3381.0	4428.0	4986.0	5662.0	2983.2
Write queue	0.2%	0.0	6.0	6.8	10.3	17.6	37.0	8.7
Read queue	0.5%	0.0	1.1	1.9	3.8	6.5	15.9	3.1
Bandwidth (MB/sec)	1.0%	3.5	15.7	26.9	39.2	54.8	103.4	30.4
Throughput (IO/sec)	0.8%	102.0	148.0	220.0	320.0	451.0	1184.0	280.1
Latency (ms)	0.8%	1.2	9.5	16.0	28.5	62.5	138.6	25.0
Write latency (ms)	0.6%	0.0	6.8	13.6	25.8	72.3	165.7	25.1
Read latency (ms)	0.4%	0.0	8.2	13.6	21.5	36.6	67.0	17.4
Array B								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.2%	0.0	0.2	0.6	0.8	1.0	1.0	0.5
Write size (KB)	0.1%	0.0	3.0	101.6	171.0	217.0	251.0	102.1
Read size (KB)	0.0%	0.0	61.0	115.0	192.3	235.2	255.1	119.5
Write jump (MB)	0.7%	0.0	0.0	2550.0	4182.0	4917.0	5589.0	2467.3
Read jump (MB)	0.6%	0.0	1465.0	3378.0	4396.0	4965.0	5722.0	2973.1
Write queue	0.4%	0.0	1.0	1.2	2.5	7.0	31.9	3.0
Read queue	0.0%	0.0	1.4	2.9	6.4	12.5	18.4	4.9
Bandwidth (MB/sec)	1.2%	5.4	17.8	26.4	39.4	49.3	91.3	30.1
Throughput (IO/sec)	1.2%	68.0	175.0	243.0	332.0	423.0	9477.0	360.8
Latency (ms)	0.5%	0.8	9.3	15.0	27.9	53.9	134.5	25.3
Write latency (ms)	0.1%	0.0	0.8	4.0	7.9	24.6	135.0	11.4
Read latency (ms)	0.6%	0.0	14.6	21.6	41.8	105.3	264.1	40.7
Array C								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.2%	0.0	0.2	0.6	0.8	1.0	1.0	0.5
Write size (KB)	0.1%	0.0	3.0	103.1	171.3	216.7	251.0	102.4
Read size (KB)	0.1%	0.0	61.0	115.1	192.6	235.0	255.5	120.1
Write jump (MB)	1.3%	0.0	0.0	2644.0	4143.0	4848.0	5775.0	2445.4
Read jump (MB)	1.1%	0.0	1475.0	3449.0	4370.0	5097.0	5885.0	3025.4
Write queue	0.4%	0.0	1.0	1.6	5.4	11.6	32.0	4.4
Read queue	0.5%	0.0	1.1	2.0	5.2	9.0	15.9	3.5
Bandwidth (MB/sec)	1.2%	0.3	6.1	9.5	12.7	17.5	105.3	12.9
Throughput (IO/sec)	1.4%	34.0	59.0	77.0	113.0	166.0	1229.0	116.2
Latency (ms)	1.1%	1.0	25.5	43.7	90.6	190.3	578.0	81.7
Write latency (ms)	1.2%	0.0	18.6	40.4	78.8	184.6	583.5	77.5
Read latency (ms)	1.0%	0.0	17.8	31.5	66.9	156.4	423.9	60.7
Array D								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.0%	0.0	0.2	0.6	0.8	1.0	1.0	0.5
Write size (KB)	0.1%	0.0	3.0	101.9	171.1	217.0	251.0	102.1
Read size (KB)	0.1%	0.0	61.0	115.3	192.1	235.2	255.3	119.7
Write jump (MB)	0.9%	0.0	0.0	2528.0	4158.0	4813.0	5519.0	2432.7
Read jump (MB)	0.3%	0.0	1480.0	3401.0	4398.0	4961.0	5692.0	2979.6
Write queue	0.3%	0.0	1.0	1.2	3.2	8.5	32.0	3.5
Read queue	0.4%	0.0	1.5	3.0	5.9	10.1	29.0	4.4
Bandwidth (MB/sec)	2.1%	7.0	21.2	31.2	47.2	73.4	111.0	37.4
Throughput (IO/sec)	1.7%	92.0	191.0	263.0	387.0	633.0	9133.0	442.6
Latency (ms)	1.0%	0.7	8.4	12.2	21.1	47.1	168.4	22.8
Write latency (ms)	0.0%	0.0	0.5	2.5	7.3	35.4	180.4	14.5
Read latency (ms)	1.6%	0.0	11.1	19.3	43.1	61.6	134.8	28.3

Table C.3: Workload characteristics and performance are measured for each sample, on each storage device. The minimum value, percentiles, maximum value and average are reported for each measurement. In addition, the relative difference between the average performance of the best and second-to-best iteration is reported. This value quantifies the change in a given measurement across multiple runs of the same sample on the same storage device.

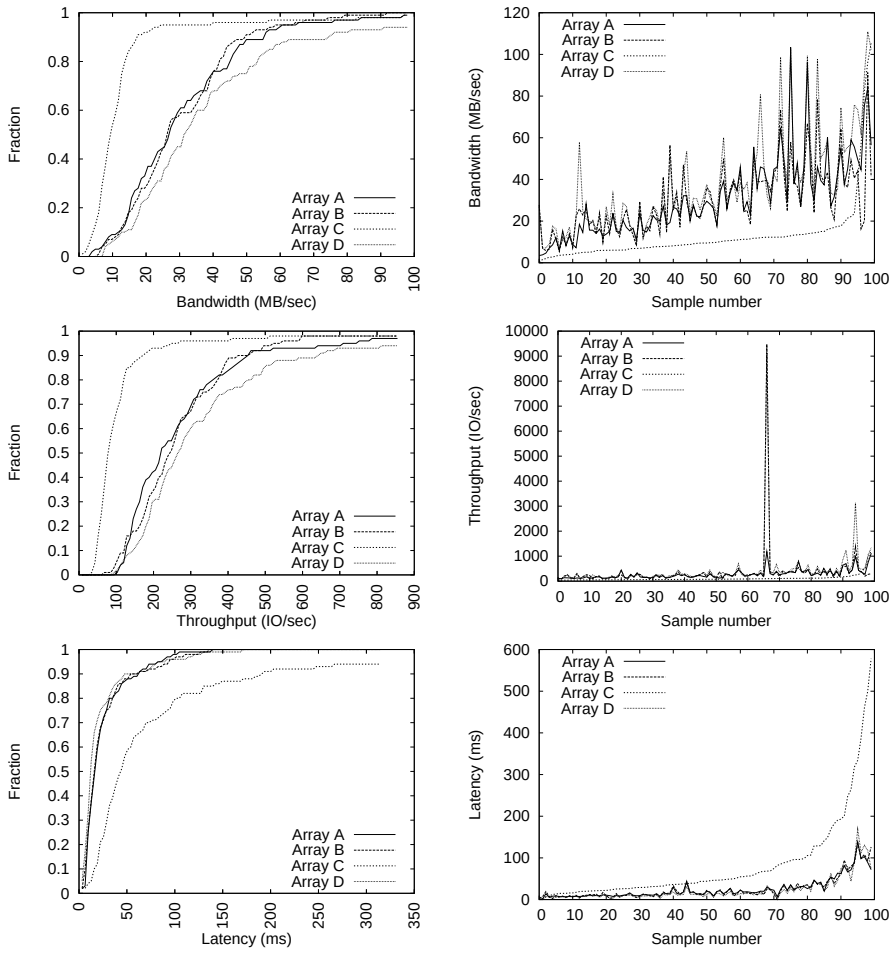

Figure C.1: The cumulative distribution of performance is shown (top). In addition, the performance of each array is shown (bottom), sorted by the performance of Array C.

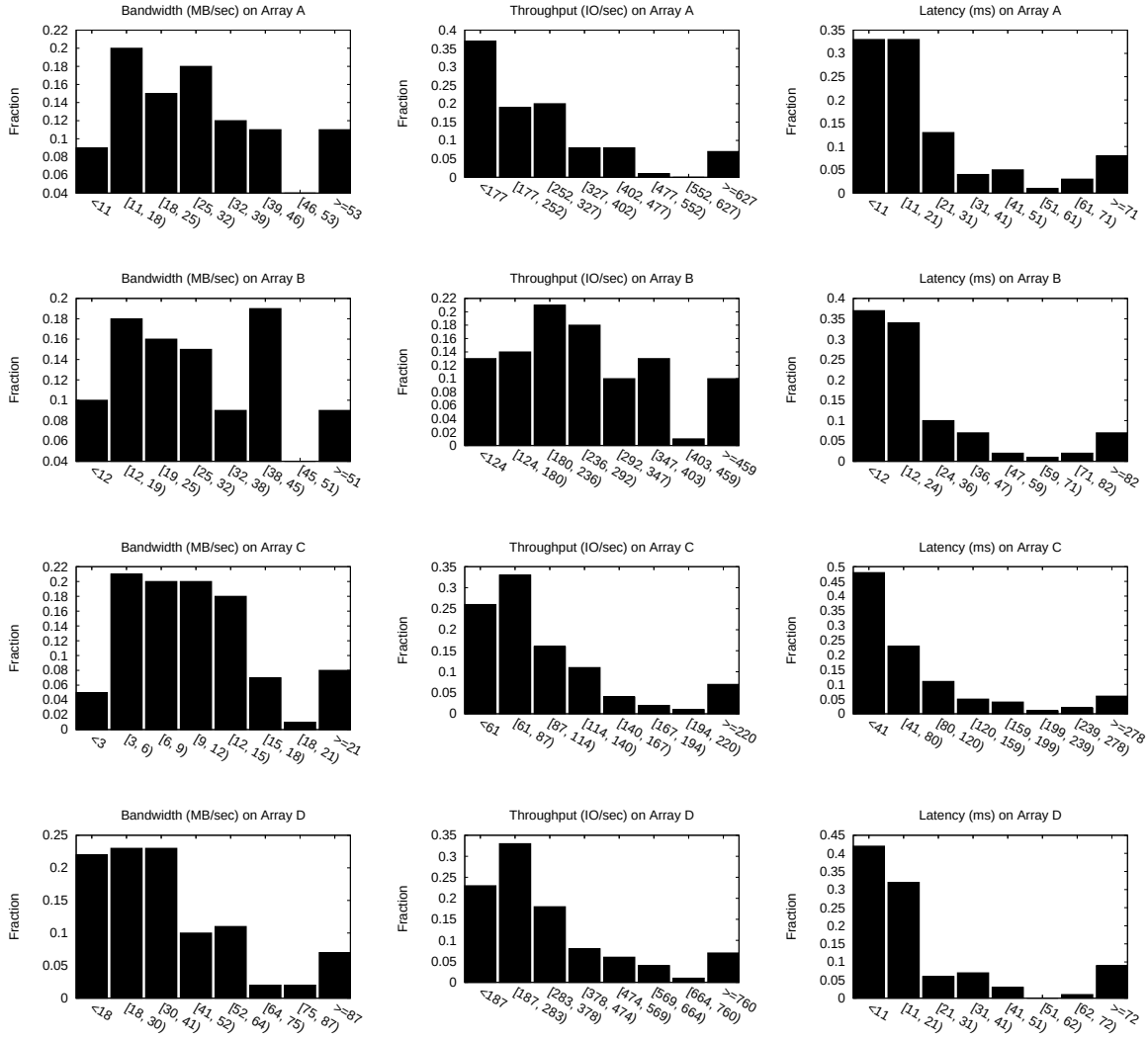

Figure C.2: Probability distributions of performance.

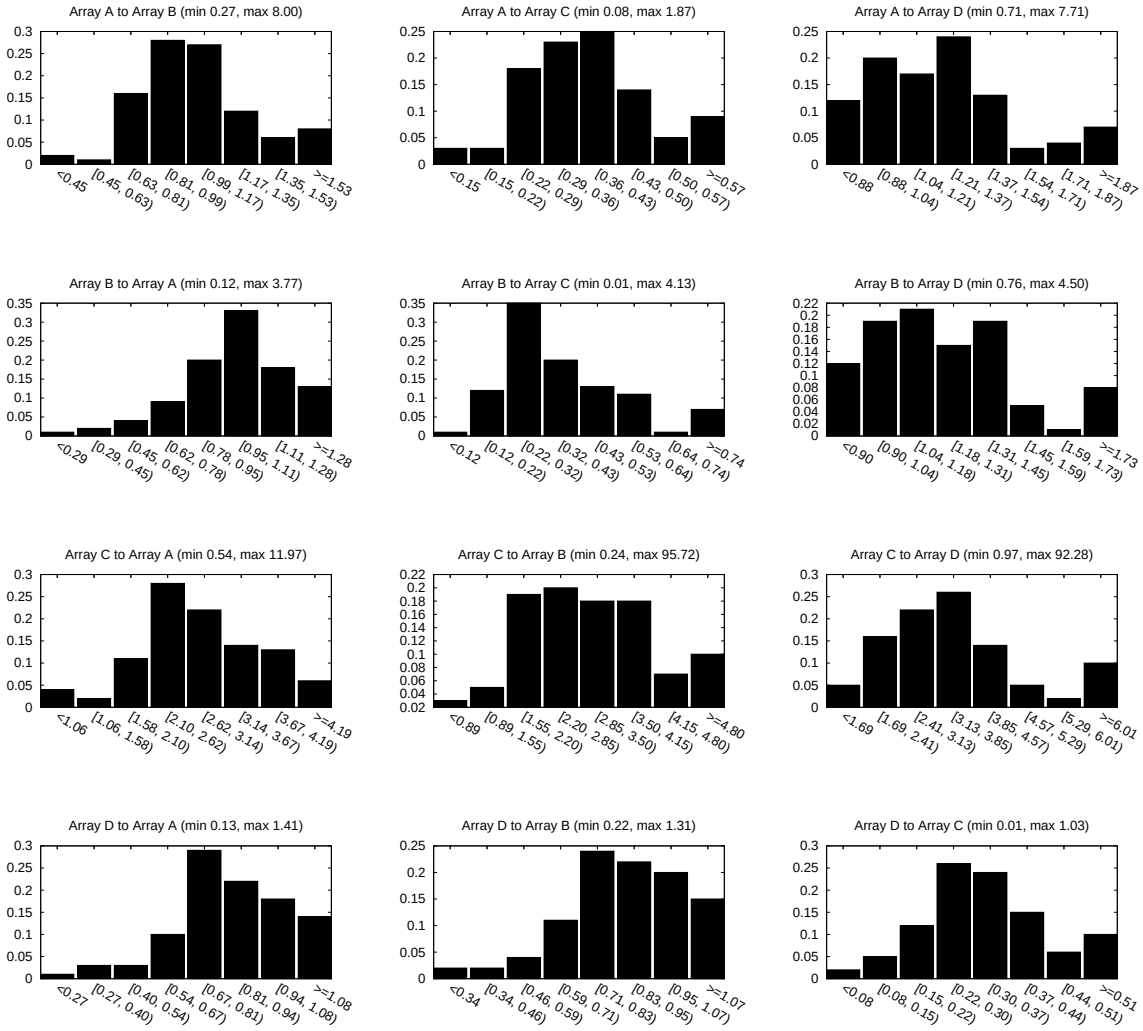

Figure C.3: Each graph shows the probability distribution of the **Bandwidth** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

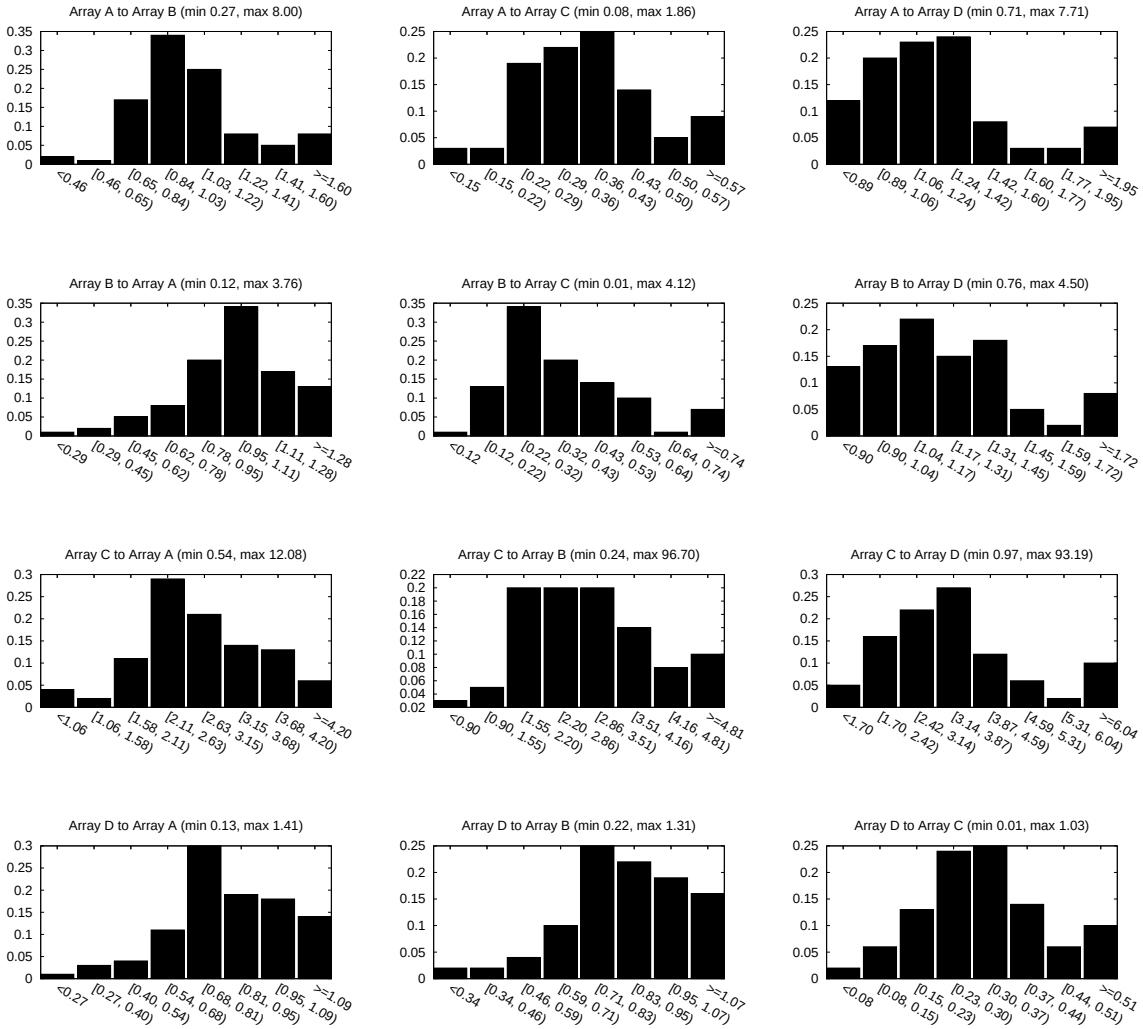

Figure C.4: Each graph shows the probability distribution of the **Throughput** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

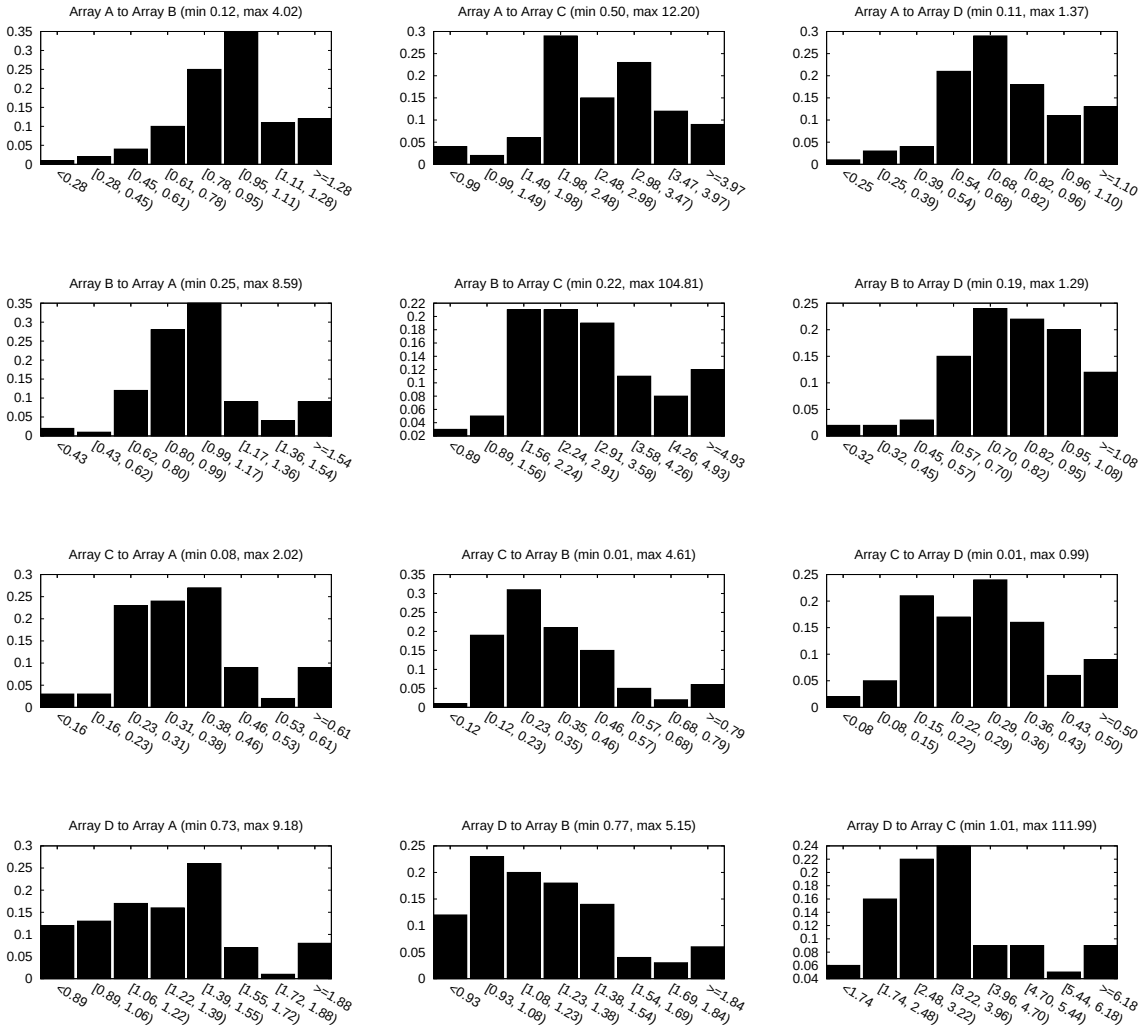

Figure C.5: Each graph shows the probability distribution of the **Latency** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

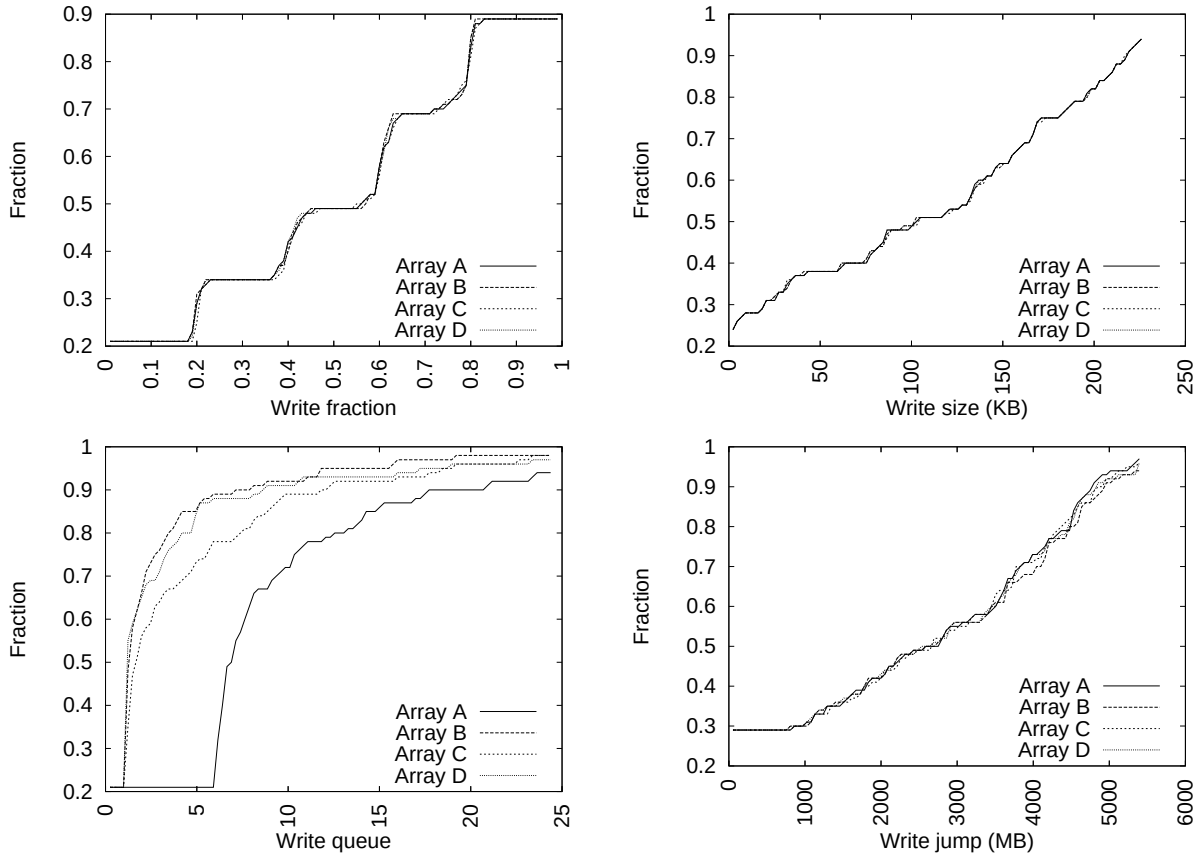

Figure C.6: The cumulative distribution of workload characteristics.

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Write queue	1.00
Write queue	0.76	Read size	0.63	Write size	0.80	Read queue	0.86
Read jump	0.44	Read jump	0.56	Write jump	0.71	Read size	0.24
Read size	0.41	Write size	0.54	Read jump	0.61	Read jump	0.23
Write size	0.38	Write queue	0.44	Write fraction	0.49	Write jump	0.10
Write jump	0.27	Write jump	0.27	Write queue	0.43	Write fraction	0.08
Write fraction	0.14	Write fraction	0.05	Read size	0.25	Write size	0.07
Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Write queue	1.00
Write queue	0.86	Write queue	0.71	Read size	0.68	Read queue	0.80
Read size	0.47	Read size	0.62	Write size	0.51	Read size	0.19
Write size	0.38	Read jump	0.57	Read jump	0.42	Write size	0.16
Read jump	0.37	Write size	0.52	Write jump	0.40	Read jump	0.16
Write jump	0.21	Write jump	0.24	Write queue	0.36	Write jump	0.06
Write fraction	0.08	Write fraction	0.12	Write fraction	0.10	Write fraction	0.04
Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Latency	1.00	Bandwidth	1.00	Throughput	1.00	Latency	1.00
Bandwidth	0.83	Latency	0.24	Bandwidth	0.26	Write latency	0.16
Throughput	0.59	Write fraction	0.15	Latency	0.11	Read latency	0.16
Read queue	0.19	Write jump	0.12	Read queue	0.11	Bandwidth	0.10
Read latency	0.17	Throughput	0.11	Write queue	0.08	Read queue	0.09
Write fraction	0.17	Read size	0.10	Write size	0.05	Write queue	0.08
Write latency	0.16	Read queue	0.10	Write fraction	0.05	Read jump	0.08
Write queue	0.16	Read jump	0.09	Read size	0.05	Write fraction	0.06
Read jump	0.14	Write queue	0.09	Write jump	0.04	Read size	0.05
Read size	0.13	Read latency	0.08	Read jump	0.04	Write size	0.02
Write jump	0.11	Write size	0.05	Write latency	0.02	Write jump	0.02
Write size	0.07	Write latency	0.04	Read latency	0.01	Throughput	0.01
Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Write fraction	1.00	Write fraction	1.00	Write fraction	1.00	Write fraction	1.00
Latency	0.89	Latency	0.93	Latency	0.89	Latency	0.85
Bandwidth	0.64	Bandwidth	0.80	Bandwidth	0.84	Throughput	0.81
Throughput	0.49	Throughput	0.35	Write queue	0.38	Write jump	0.40
Write jump	0.29	Read jump	0.32	Throughput	0.32	Bandwidth	0.28
Write queue	0.27	Write queue	0.29	Write latency	0.28	Read latency	0.28
Write latency	0.26	Write latency	0.26	Read jump	0.25	Write latency	0.24
Read latency	0.23	Write jump	0.23	Read latency	0.23	Read size	0.20
Read jump	0.23	Read latency	0.18	Write jump	0.23	Read queue	0.20
Read queue	0.15	Write size	0.16	Read queue	0.15	Write queue	0.15
Write size	0.12	Read size	0.11	Write size	0.14	Read jump	0.13
Read size	0.12	Read queue	0.11	Read size	0.05	Write size	0.07

Table C.4: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	11.9	14.5	7.8	13.5
Relative	11.6	11.5	9.1	14.2
Relative Performance	13.1	15.8	6.8	16.6
Relative Fitness	10.6	11.2	10.4	10.2

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	14.0	-	-	-
Array	-	9.7	-	-
Array	-	-	15.0	-
Array	-	-	-	9.0
Relative	**Array**	**Array**	**Array**	**Array**
Array	14.0	10.3	14.3	7.3
Array	14.7	9.7	10.7	3.7
Array	15.0	17.3	15.0	9.0
Array	13.0	14.7	9.0	9.0
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	16.7	12.3	13.3	8.7
Array	13.3	16.7	9.0	13.0
Array	9.0	18.3	16.3	14.7
Array	18.3	17.3	9.3	17.0
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	6.3	2.7	4.7
Array	13.0	1	11.0	5.7
Array	17.0	16.0	1	13.3
Array	13.3	13.3	11.0	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	20.0	-	-	-	4.0	-	-	-	18.0	-	-	-
Array B	-	15.0	-	-	-	5.0	-	-	-	9.0	-	-
Array C	-	-	9.0	-	-	-	20.0	-	-	-	16.0	-
Array D	-	-	-	14.0	-	-	-	2.0	-	-	-	11.0
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	20.0	10.0	13.0	14.0	4.0	3.0	15.0	1.0	18.0	18.0	15.0	7.0
Array B	20.0	15.0	1.0	4.0	6.0	5.0	15.0	1.0	18.0	9.0	16.0	6.0
Array C	19.0	15.0	9.0	7.0	11.0	20.0	20.0	1.0	15.0	17.0	16.0	19.0
Array D	21.0	13.0	1.0	14.0	6.0	18.0	12.0	2.0	12.0	13.0	14.0	11.0
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	18.0	18.0	17.0	16.0	16.0	1.0	3.0	1.0	16.0	18.0	20.0	9.0
Array B	18.0	15.0	5.0	8.0	5.0	17.0	1.0	18.0	17.0	18.0	21.0	13.0
Array C	4.0	16.0	19.0	22.0	2.0	18.0	16.0	3.0	21.0	21.0	14.0	19.0
Array D	21.0	23.0	22.0	16.0	17.0	11.0	1.0	18.0	17.0	18.0	5.0	17.0
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	1.0	3.0	5.0	1	1.0	3.0	6.0	1	17.0	2.0	3.0
Array B	12.0	1	10.0	4.0	16.0	1	11.0	10.0	11.0	1	12.0	3.0
Array C	14.0	17.0	1	17.0	19.0	12.0	1	15.0	18.0	19.0	1	8.0
Array D	16.0	18.0	18.0	1	17.0	10.0	5.0	1	7.0	12.0	10.0	1

Table C.5: Tree sizes (leaf nodes) and their averages.

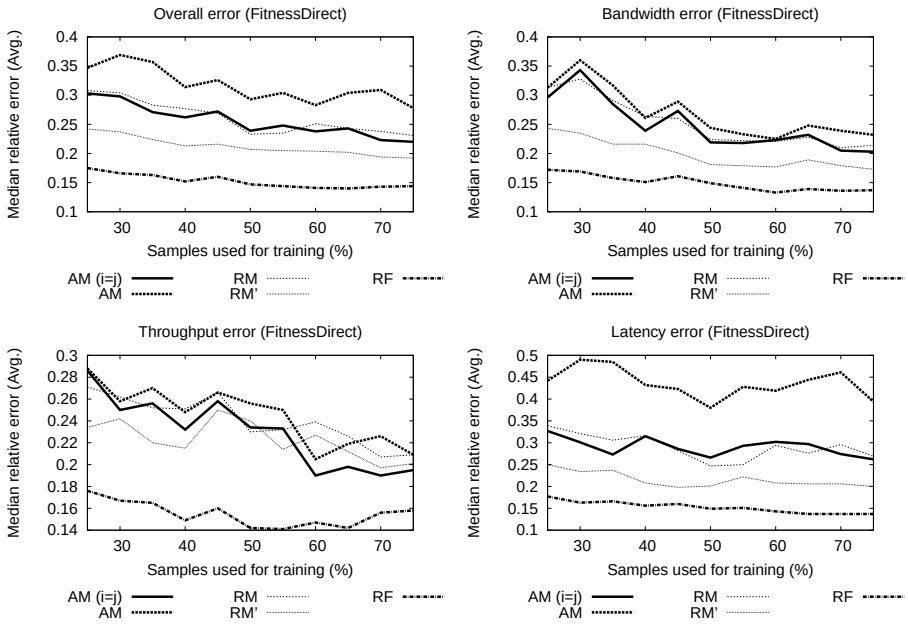

Figure C.7: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

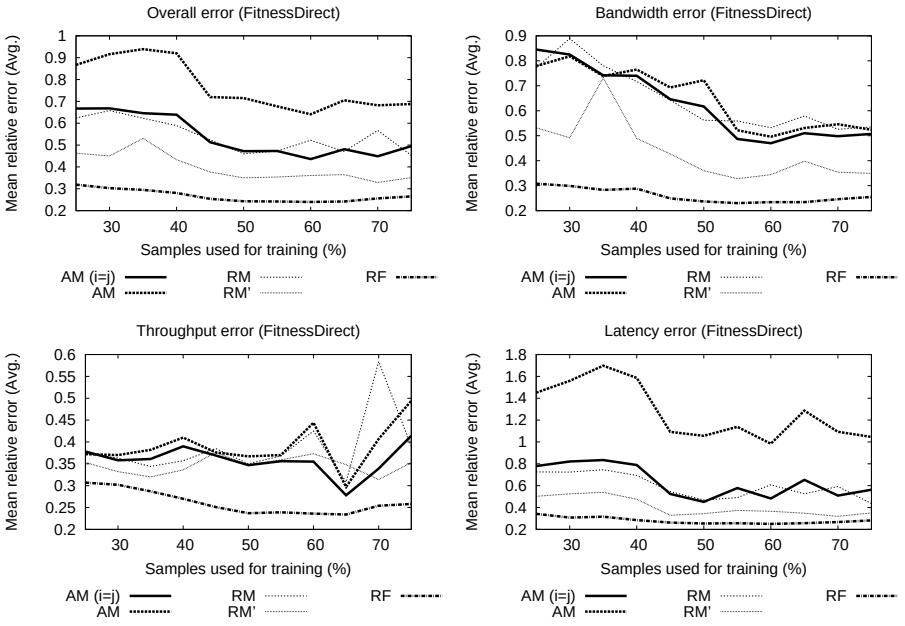

Figure C.8: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

Appendix D

FitnessBuffered model training

Application	Samples	Iters	First sample	Last sample
Buffered (sd)	200	3	0	99
Total used	100			

Table D.1: Multiple training samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

	Array A	Array B	Array C	Array D	MAD	COV	Max. Diff.
Write fraction	0.31	0.31	0.30	0.31	0.0	1.8%	3.3%
Write size (KB)	99.62	100.34	104.30	99.77	1.6	1.9%	4.7%
Read size (KB)	63.82	63.94	63.77	63.77	0.1	0.1%	0.3%
Write jump (MB)	255.22	237.39	302.71	252.20	20.4	9.4%	27.5%
Read jump (MB)	2057.00	2061.67	2116.93	2055.77	22.0	1.2%	3.0%
Write queue	26.36	26.24	24.97	25.96	0.5	2.1%	5.6%
Read queue	5.07	5.07	4.79	5.06	0.1	2.4%	5.8%
Bandwidth (MB/sec)	27.54	20.96	16.18	28.83	4.8	21.9%	78.2%
Throughput (IO/sec)	372.61	280.07	225.89	421.02	71.9	23.5%	86.4%
Latency (ms)	34.78	35.61	74.23	28.05	15.5	42.1%	164.6%
Write latency (ms)	66.61	52.38	146.08	36.67	35.3	55.9%	298.4%
Read latency (ms)	13.78	21.20	25.35	16.38	4.1	23.2%	84.0%

Table D.2: Workload characteristics and performance are measured for each sample, on each storage device. The average value for each measurement is reported in this table. The mean absolute deviation (MAD), coefficient of variation (COV), and maximum relative differences of these averages are also reported; these metrics quantify how the averages change among the storage devices. For example, the mean average deviation of the averages for Read latency (ms) is 4.10, their coeefficient of variation is 23.199%, and the maximum relative difference is 83.96%.

Array A								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	1.6%	0.0	0.1	0.3	0.4	0.6	1.0	0.3
Write size (KB)	0.4%	0.0	7.8	118.6	168.4	188.8	227.4	99.6
Read size (KB)	0.2%	0.0	30.0	59.8	94.1	119.9	255.1	63.8
Write jump (MB)	1.8%	0.0	1.0	220.0	340.0	650.0	1166.0	255.2
Read jump (MB)	0.3%	0.0	1353.0	2267.0	2926.0	3438.0	4359.0	2057.0
Write queue	0.8%	0.0	12.9	23.9	41.2	54.8	64.0	26.4
Read queue	0.4%	0.0	1.5	2.6	6.6	10.8	26.9	5.1
Bandwidth (MB/sec)	1.5%	6.7	16.7	23.2	34.6	46.0	87.2	27.5
Throughput (IO/sec)	0.1%	121.0	224.0	296.0	409.0	521.0	4219.0	372.6
Latency (ms)	0.4%	2.3	16.0	28.6	45.6	62.4	135.2	34.8
Write latency (ms)	0.2%	0.0	43.4	68.6	92.7	121.4	162.4	66.6
Read latency (ms)	0.0%	0.0	6.4	9.9	17.9	28.9	54.9	13.8
Array B								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.3%	0.0	0.1	0.3	0.5	0.6	1.0	0.3
Write size (KB)	0.1%	0.0	8.0	119.5	167.6	191.9	224.8	100.3
Read size (KB)	0.3%	0.0	29.9	60.1	94.7	120.3	252.3	63.9
Write jump (MB)	12.7%	0.0	1.0	247.0	332.0	520.0	1381.0	237.4
Read jump (MB)	0.0%	0.0	1409.0	2259.0	2870.0	3406.0	4386.0	2061.7
Write queue	3.1%	0.0	13.6	25.7	38.6	55.8	64.0	26.2
Read queue	1.7%	0.0	1.5	2.8	7.3	10.9	24.3	5.1
Bandwidth (MB/sec)	1.9%	4.7	13.2	18.4	27.1	32.6	56.9	21.0
Throughput (IO/sec)	1.6%	69.0	187.0	233.0	309.0	391.0	2789.0	280.1
Latency (ms)	1.6%	3.1	14.4	21.8	35.5	64.6	264.0	35.6
Write latency (ms)	2.4%	0.0	25.1	41.8	61.8	118.1	271.3	52.4
Read latency (ms)	0.5%	0.0	11.0	15.3	21.4	42.7	95.6	21.2
Array C								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.5%	0.0	0.1	0.3	0.4	0.6	1.0	0.3
Write size (KB)	0.0%	0.0	7.6	126.8	174.3	195.7	238.2	104.3
Read size (KB)	0.1%	0.0	30.2	59.9	94.3	121.2	255.3	63.8
Write jump (MB)	135.5%	0.0	1.0	56.0	241.0	330.0	16383.0	302.7
Read jump (MB)	0.3%	0.0	1442.0	2381.0	3029.0	3447.0	4360.0	2116.9
Write queue	0.6%	0.0	11.7	22.3	41.0	50.9	64.0	25.0
Read queue	3.8%	0.0	1.5	2.7	6.6	10.5	22.9	4.8
Bandwidth (MB/sec)	1.8%	3.0	8.8	12.7	16.7	23.9	96.8	16.2
Throughput (IO/sec)	4.1%	59.0	117.0	148.0	188.0	290.0	3610.0	225.9
Latency (ms)	1.3%	1.6	27.2	50.4	76.8	154.9	485.7	74.2
Write latency (ms)	0.3%	0.0	93.9	136.1	183.0	332.5	489.2	146.1
Read latency (ms)	2.0%	0.0	9.8	16.3	32.2	62.5	123.5	25.4
Array D								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	3.2%	0.0	0.1	0.3	0.4	0.6	1.0	0.3
Write size (KB)	0.1%	0.0	7.3	118.7	167.0	188.7	226.7	99.8
Read size (KB)	0.2%	0.0	29.3	60.0	95.1	121.1	255.8	63.8
Write jump (MB)	1.0%	0.0	1.0	227.0	350.0	561.0	1358.0	252.2
Read jump (MB)	0.3%	0.0	1353.0	2276.0	2916.0	3381.0	4456.0	2055.8
Write queue	1.0%	0.0	14.3	23.8	36.3	54.5	64.0	26.0
Read queue	0.5%	0.0	1.5	2.6	7.7	10.9	24.8	5.1
Bandwidth (MB/sec)	3.5%	5.2	14.6	21.9	38.2	51.0	103.6	28.8
Throughput (IO/sec)	3.6%	99.0	203.0	288.0	408.0	625.0	7850.0	421.0
Latency (ms)	1.7%	1.2	11.5	16.5	27.4	44.8	211.9	28.0
Write latency (ms)	0.7%	0.0	5.2	28.9	42.5	71.1	214.8	36.7
Read latency (ms)	3.6%	0.0	9.3	12.2	18.6	33.3	55.7	16.4

Table D.3: Workload characteristics and performance are measured for each sample, on each storage device. The minimum value, percentiles, maximum value and average are reported for each measurement. In addition, the relative difference between the average performance of the best and second-to-best iteration is reported. This value quantifies the change in a given measurement across multiple runs of the same sample on the same storage device.

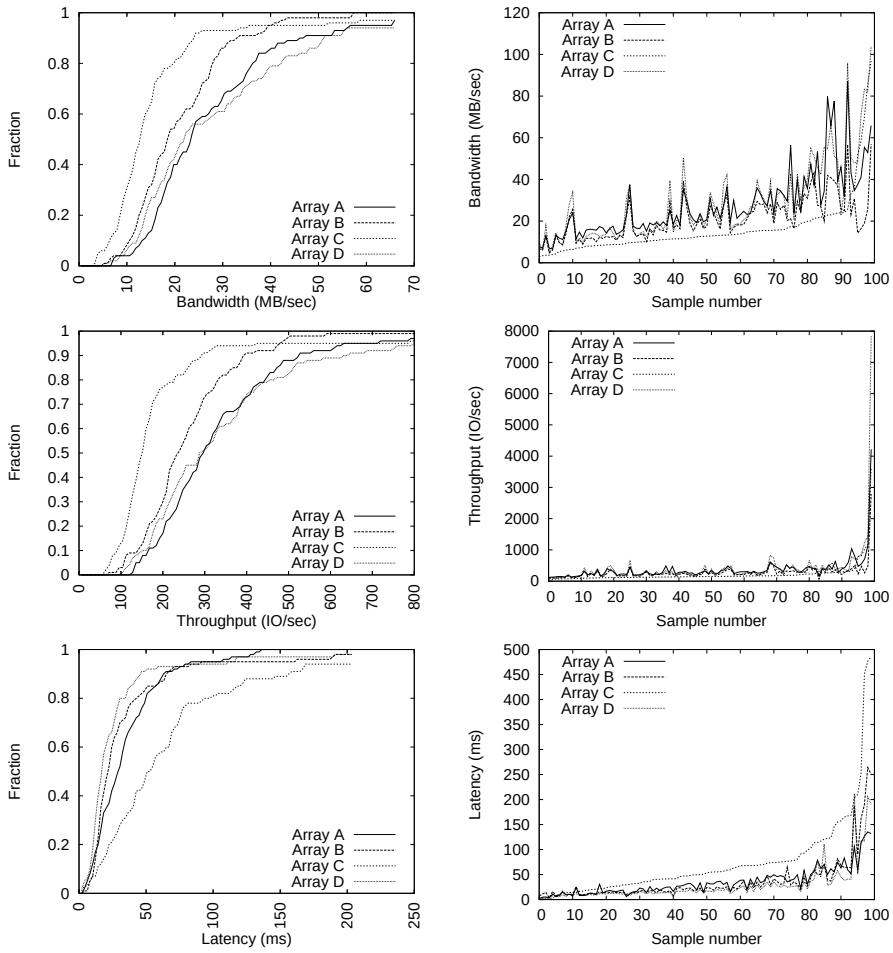

Figure D.1: The cumulative distribution of performance is shown (top). In addition, the performance of each array is shown (bottom), sorted by the performance of Array C.

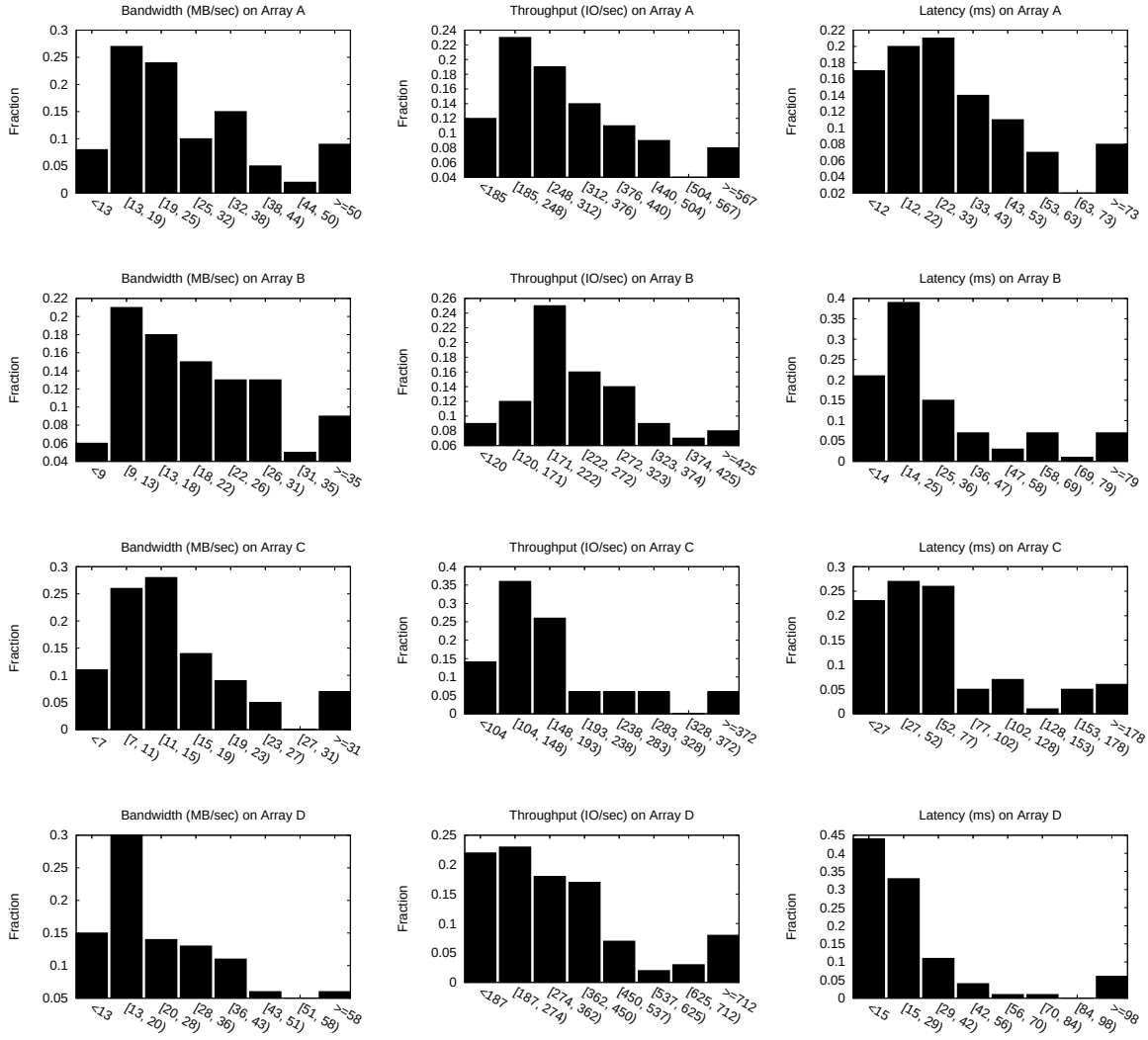

Figure D.2: Probability distributions of performance.

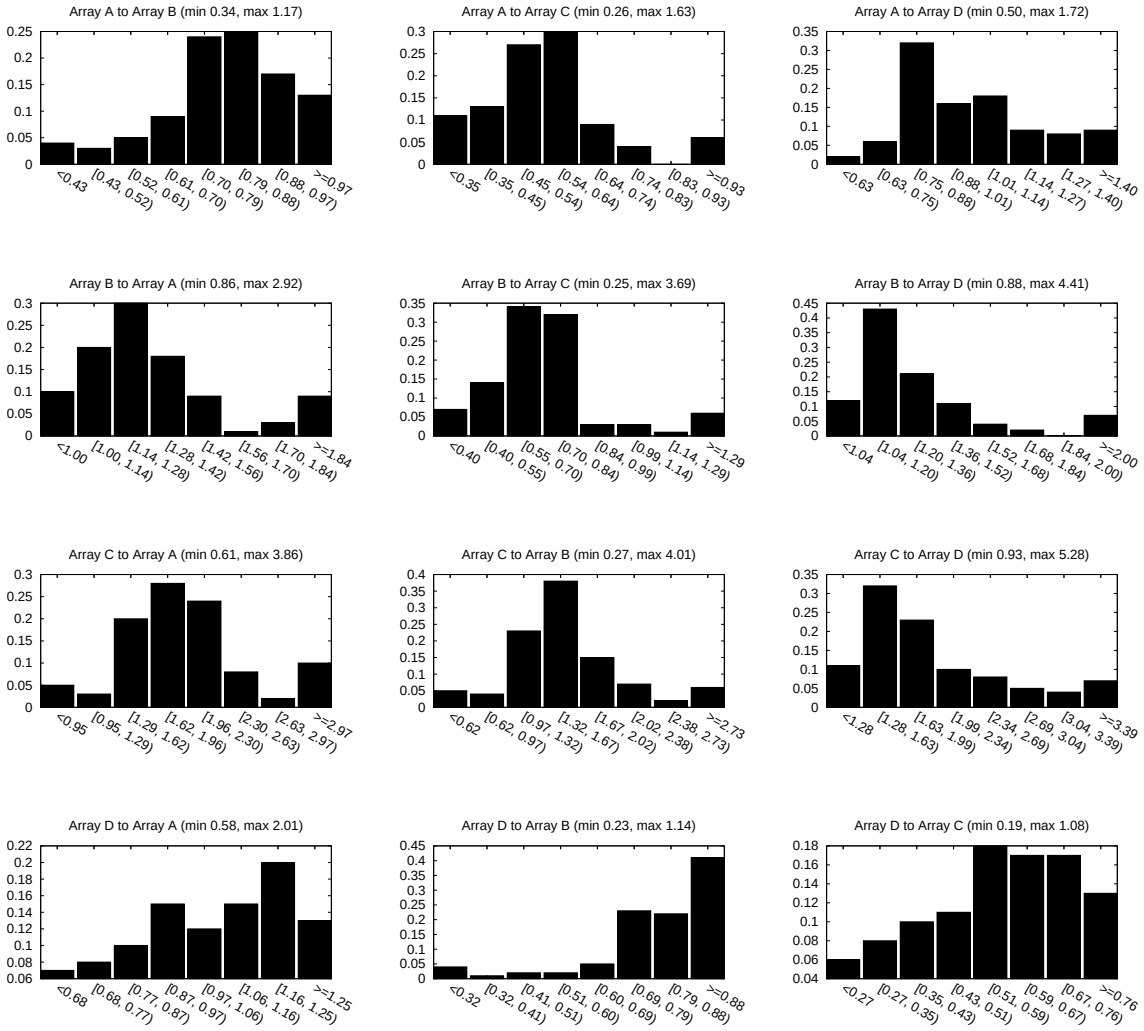

Figure D.3: Each graph shows the probability distribution of the **Bandwidth** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

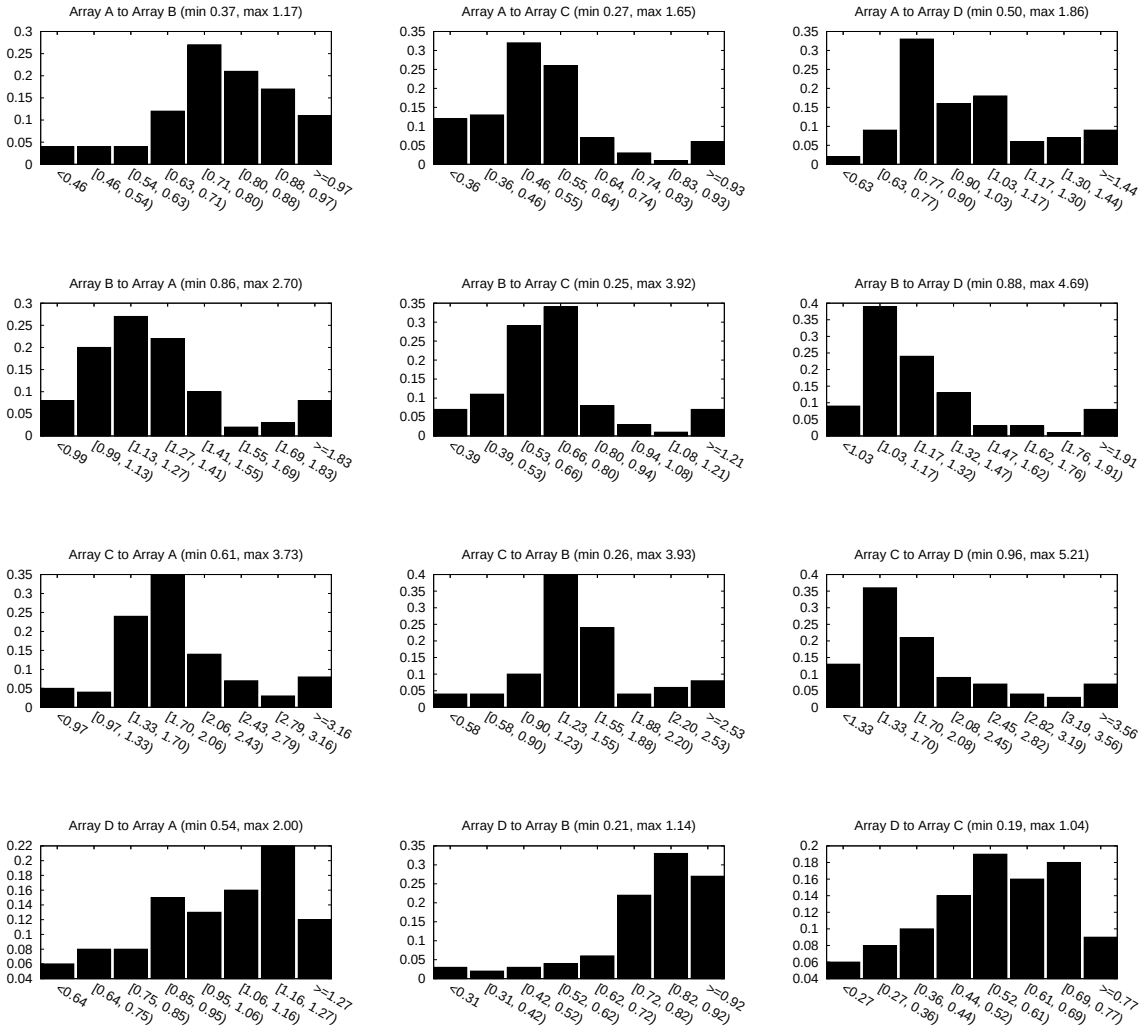

Figure D.4: Each graph shows the probability distribution of the **Throughput** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

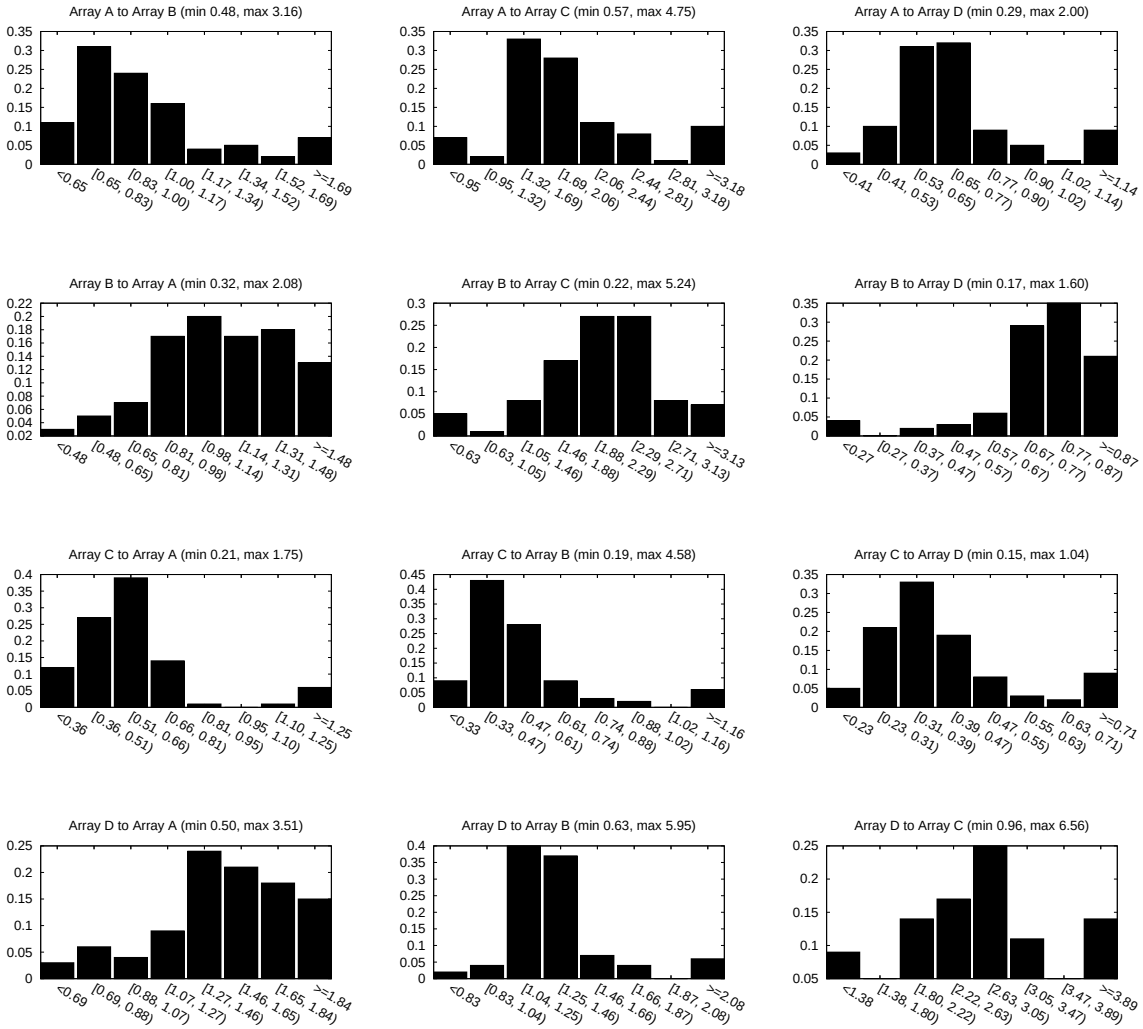

Figure D.5: Each graph shows the probability distribution of the **Latency** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

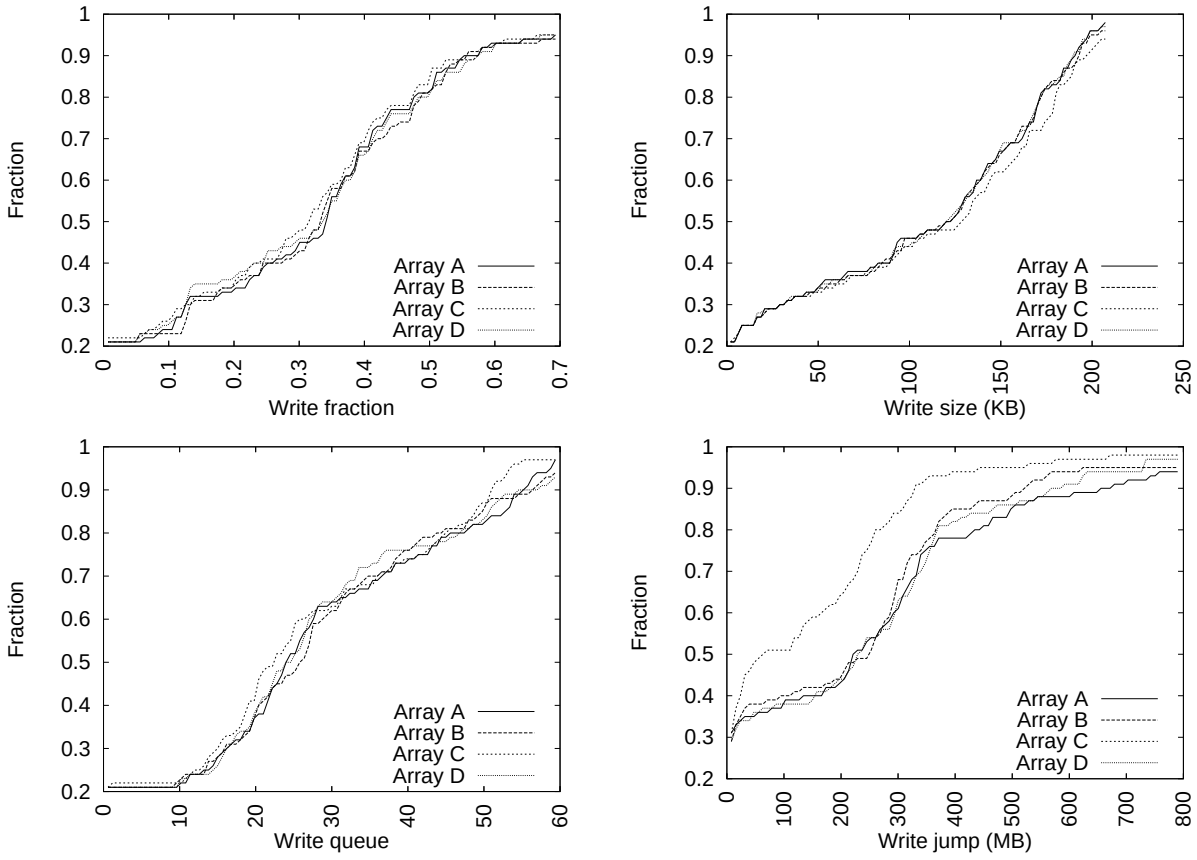

Figure D.6: The cumulative distribution of workload characteristics.

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Write fraction	1.00
Write fraction	0.75	Read jump	0.61	Read jump	0.67	Read queue	0.53
Read jump	0.51	Read size	0.52	Read size	0.55	Read jump	0.14
Read size	0.44	Write size	0.33	Write queue	0.22	Read size	0.13
Write size	0.19	Write fraction	0.26	Write jump	0.17	Write queue	0.09
Write queue	0.17	Write jump	0.20	Write fraction	0.13	Write size	0.06
Write jump	0.15	Write queue	0.13	Write size	0.10	Write jump	0.04
Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Write fraction	1.00
Write fraction	0.70	Read jump	0.79	Read jump	0.73	Read queue	0.69
Read jump	0.56	Read size	0.36	Read size	0.34	Read size	0.26
Read size	0.36	Write jump	0.32	Write queue	0.25	Read jump	0.17
Write jump	0.21	Write fraction	0.30	Write size	0.19	Write size	0.13
Write size	0.20	Write size	0.23	Write jump	0.17	Write jump	0.09
Write queue	0.14	Write queue	0.05	Write fraction	0.16	Write queue	0.09
Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Latency	1.00	Bandwidth	1.00	Throughput	1.00	Latency	1.00
Throughput	0.92	Read jump	0.27	Read queue	0.17	Write fraction	0.12
Bandwidth	0.74	Read latency	0.14	Read jump	0.10	Bandwidth	0.06
Read jump	0.31	Read queue	0.10	Read size	0.10	Read size	0.05
Read queue	0.24	Write size	0.07	Latency	0.07	Read jump	0.05
Write fraction	0.19	Write fraction	0.05	Write fraction	0.06	Read queue	0.03
Read size	0.15	Throughput	0.04	Write latency	0.04	Read latency	0.02
Read latency	0.11	Read size	0.04	Bandwidth	0.03	Write jump	0.02
Write size	0.08	Write jump	0.04	Write queue	0.03	Write latency	0.02
Write jump	0.06	Latency	0.04	Write size	0.02	Throughput	0.02
Write latency	0.05	Write latency	0.01	Write jump	0.02	Write queue	0.02
Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Bandwidth	1.00	Read latency	1.00	Read latency	1.00	Latency	1.00
Read latency	0.96	Read queue	0.92	Read jump	0.76	Bandwidth	0.72
Latency	0.95	Read jump	0.90	Bandwidth	0.70	Read size	0.34
Read jump	0.80	Bandwidth	0.80	Read queue	0.66	Write jump	0.33
Read queue	0.77	Write fraction	0.61	Write fraction	0.61	Read latency	0.26
Write fraction	0.64	Read size	0.48	Latency	0.59	Write fraction	0.25
Read size	0.57	Latency	0.39	Read size	0.46	Throughput	0.24
Throughput	0.44	Throughput	0.37	Throughput	0.37	Read queue	0.23
Write jump	0.26	Write queue	0.24	Write size	0.36	Read jump	0.22
Write size	0.25	Write size	0.12	Write queue	0.27	Write size	0.09
Write queue	0.22	Write jump	0.09	Write jump	0.11	Write queue	0.02

Table D.4: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	13.5	15.0	10.2	15.2
Relative	14.3	14.0	9.9	19.0
Relative Performance	12.7	12.2	13.0	13.0
Relative Fitness	8.7	9.4	10.9	5.8

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	19.7	-	-	-
Array	-	14.3	-	-
Array	-	-	8.0	-
Array	-	-	-	12.0
Relative	**Array**	**Array**	**Array**	**Array**
Array	19.7	13.3	9.3	15.3
Array	15.7	14.3	7.3	17.7
Array	18.0	18.3	8.0	16.3
Array	15.0	14.3	11.0	12.0
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	16.3	10.3	15.7	15.0
Array	12.3	17.3	6.7	9.3
Array	18.3	20.0	16.3	12.0
Array	16.3	12.7	4.3	15.0
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	10.7	9.7	6.7
Array	13.3	1	7.0	7.3
Array	11.3	11.0	1	7.3
Array	12.7	6.0	1.7	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	19.0	-	-	-	18.0	-	-	-	22.0	-	-	-
Array B	-	13.0	-	-	-	14.0	-	-	-	16.0	-	-
Array C	-	-	8.0	-	-	-	8.0	-	-	-	8.0	-
Array D	-	-	-	20.0	-	-	-	1.0	-	-	-	15.0
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	19.0	10.0	6.0	7.0	18.0	10.0	1.0	16.0	22.0	20.0	21.0	23.0
Array B	17.0	13.0	9.0	18.0	10.0	14.0	1.0	21.0	20.0	16.0	12.0	14.0
Array C	14.0	24.0	8.0	12.0	17.0	20.0	8.0	15.0	23.0	11.0	8.0	22.0
Array D	20.0	20.0	11.0	20.0	3.0	4.0	1.0	1.0	22.0	19.0	21.0	15.0
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	15.0	8.0	15.0	11.0	17.0	12.0	18.0	18.0	17.0	11.0	14.0	16.0
Array B	6.0	17.0	6.0	11.0	18.0	16.0	7.0	8.0	13.0	19.0	7.0	9.0
Array C	20.0	21.0	16.0	20.0	12.0	17.0	17.0	12.0	23.0	22.0	16.0	4.0
Array D	14.0	11.0	4.0	17.0	17.0	14.0	3.0	16.0	18.0	13.0	6.0	12.0
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	7.0	15.0	5.0	1	11.0	13.0	5.0	1	14.0	1.0	10.0
Array B	8.0	1	1.0	8.0	17.0	1	19.0	9.0	15.0	1	1.0	5.0
Array C	17.0	18.0	1	10.0	14.0	11.0	1	9.0	3.0	4.0	1	3.0
Array D	16.0	6.0	2.0	1	13.0	8.0	2.0	1	9.0	4.0	1.0	1

Table D.5: Tree sizes (leaf nodes) and their averages.

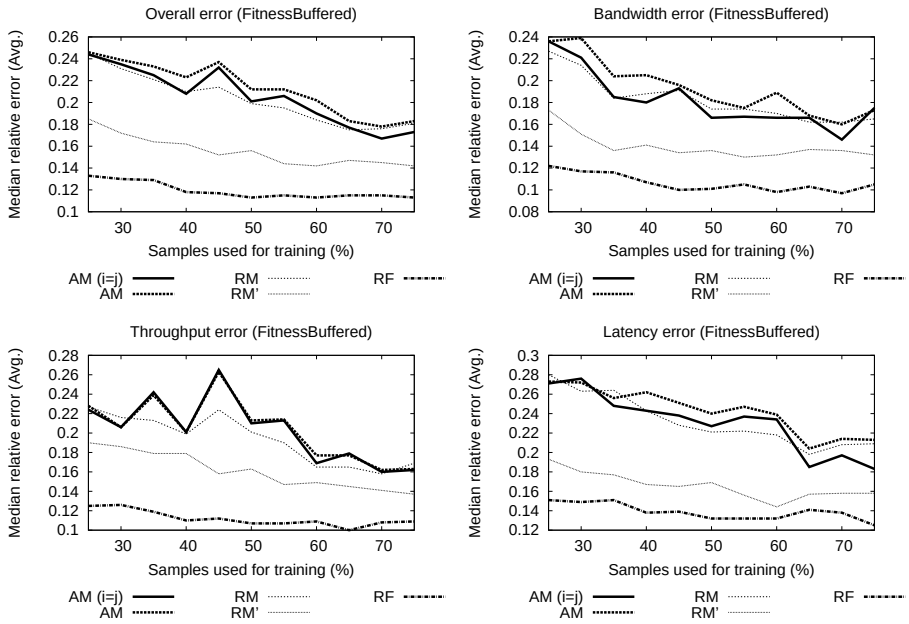

Figure D.7: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

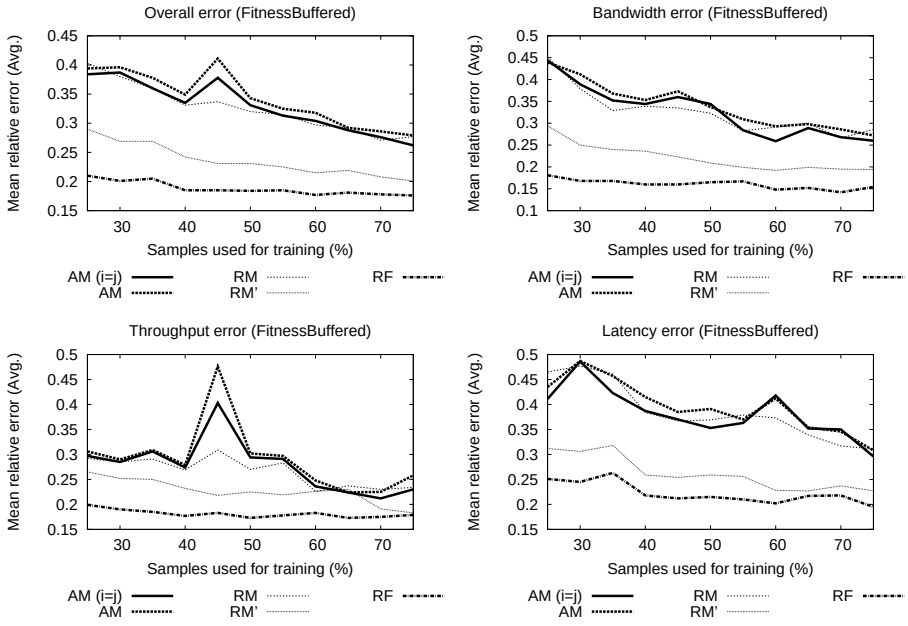

Figure D.8: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

Appendix E

FitnessFS model training

Application	Samples	Iters	First sample	Last sample
FS (fs)	200	3	0	99
Total used	100			

Table E.1: Multiple training samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

	Array A	Array B	Array C	Array D	MAD	COV	Max. Diff.
Write fraction	0.30	0.30	0.30	0.30	0.0	0.6%	0.0%
Write size (KB)	104.56	106.12	109.11	105.15	1.4	1.6%	4.3%
Read size (KB)	59.72	59.59	59.30	59.10	0.2	0.4%	1.1%
Write jump (MB)	71.10	55.13	39.51	110.04	21.6	38.0%	178.5%
Read jump (MB)	630.12	629.82	636.29	638.64	3.8	0.6%	1.4%
Write queue	25.12	20.08	21.22	20.34	1.7	9.3%	25.1%
Read queue	2.87	2.83	2.91	2.83	0.0	1.1%	2.8%
Bandwidth (MB/sec)	23.48	17.59	15.43	23.88	3.6	18.3%	54.8%
Throughput (IO/sec)	302.07	227.98	203.18	316.14	46.8	18.2%	55.6%
Latency (ms)	24.69	21.51	49.03	17.55	10.4	43.6%	179.4%
Write latency (ms)	51.24	39.88	116.70	23.68	29.4	61.1%	392.8%
Read latency (ms)	9.84	15.58	16.99	13.15	2.4	19.5%	72.7%

Table E.2: Workload characteristics and performance are measured for each sample, on each storage device. The average value for each measurement is reported in this table. The mean absolute deviation (MAD), coefficient of variation (COV), and maximum relative differences of these averages are also reported; these metrics quantify how the averages change among the storage devices. For example, the mean average deviation of the averages for Read latency (ms) is 2.40, their coeefficient of variation is 19.547%, and the maximum relative difference is 72.66%.

Array A								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.8%	0.0	0.1	0.3	0.4	0.6	1.0	0.3
Write size (KB)	0.3%	0.0	7.0	124.3	174.4	191.1	240.9	104.6
Read size (KB)	0.1%	0.0	28.8	59.3	87.2	113.3	237.1	59.7
Write jump (MB)	7.9%	0.0	3.0	70.0	104.0	132.0	765.0	71.1
Read jump (MB)	0.9%	0.0	427.0	635.0	854.0	1005.0	1446.0	630.1
Write queue	4.6%	0.0	16.2	20.6	31.8	53.5	69.0	25.1
Read queue	1.2%	0.0	1.1	1.6	3.1	5.3	12.7	2.9
Bandwidth (MB/sec)	1.1%	5.3	16.3	20.7	25.0	45.4	65.3	23.5
Throughput (IO/sec)	1.0%	135.0	210.0	252.0	303.0	454.0	2187.0	302.1
Latency (ms)	0.7%	1.0	14.7	22.8	27.8	38.5	105.1	24.7
Write latency (ms)	3.4%	0.0	43.1	54.9	63.6	80.5	134.1	51.2
Read latency (ms)	0.2%	0.0	5.5	7.6	11.4	18.9	46.2	9.8
Array B								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	1.0%	0.0	0.1	0.3	0.4	0.6	1.0	0.3
Write size (KB)	0.3%	0.0	7.6	125.8	176.7	192.6	240.6	106.1
Read size (KB)	0.1%	0.0	28.6	59.3	87.7	112.0	240.7	59.6
Write jump (MB)	5.1%	0.0	3.0	51.0	92.0	123.0	186.0	55.1
Read jump (MB)	0.1%	0.0	416.0	631.0	870.0	1023.0	1445.0	629.8
Write queue	2.8%	0.0	10.1	15.0	24.8	53.4	64.0	20.1
Read queue	1.7%	0.0	1.1	1.6	3.1	5.4	11.9	2.8
Bandwidth (MB/sec)	1.9%	3.5	12.3	15.6	20.2	28.1	51.2	17.6
Throughput (IO/sec)	1.3%	65.0	160.0	194.0	238.0	341.0	1472.0	228.0
Latency (ms)	2.9%	1.2	12.6	17.7	22.1	28.5	192.5	21.5
Write latency (ms)	6.8%	0.0	22.1	32.5	41.0	67.0	453.3	39.9
Read latency (ms)	3.0%	0.0	10.1	11.7	15.2	22.7	93.5	15.6
Array C								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	2.7%	0.0	0.1	0.3	0.4	0.6	1.0	0.3
Write size (KB)	0.9%	0.0	6.8	129.8	181.8	201.3	242.8	109.1
Read size (KB)	0.0%	0.0	28.1	59.1	88.2	113.7	170.6	59.3
Write jump (MB)	2.7%	0.0	2.0	20.0	65.0	107.0	203.0	39.5
Read jump (MB)	0.7%	0.0	407.0	645.0	848.0	1030.0	1449.0	636.3
Write queue	7.1%	0.0	11.6	16.0	31.0	53.0	64.0	21.2
Read queue	0.5%	0.0	1.2	1.6	3.4	6.0	12.0	2.9
Bandwidth (MB/sec)	1.3%	3.6	9.6	12.1	15.3	21.6	86.2	15.4
Throughput (IO/sec)	1.1%	74.0	124.0	144.0	187.0	269.0	2294.0	203.2
Latency (ms)	4.3%	2.1	27.9	44.4	53.4	80.2	249.6	49.0
Write latency (ms)	7.9%	0.0	88.6	115.9	132.3	205.5	399.3	116.7
Read latency (ms)	0.1%	0.0	7.8	11.2	16.0	37.7	121.5	17.0
Array D								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	1.9%	0.0	0.1	0.3	0.4	0.6	1.0	0.3
Write size (KB)	0.1%	0.0	6.5	124.8	177.2	192.8	238.2	105.2
Read size (KB)	0.3%	4.0	28.8	59.2	87.7	113.2	155.1	59.1
Write jump (MB)	51.4%	0.0	3.0	65.0	103.0	124.0	4144.0	110.0
Read jump (MB)	1.3%	0.0	428.0	625.0	865.0	1030.0	1476.0	638.6
Write queue	2.7%	0.0	10.9	15.6	25.0	52.0	64.0	20.3
Read queue	1.2%	1.0	1.1	1.6	3.1	5.6	12.3	2.8
Bandwidth (MB/sec)	2.3%	4.6	13.4	18.0	26.2	42.2	100.7	23.9
Throughput (IO/sec)	1.7%	106.0	172.0	225.0	320.0	507.0	3339.0	316.1
Latency (ms)	0.6%	0.9	9.9	14.3	16.9	22.7	168.6	17.6
Write latency (ms)	1.4%	0.0	4.4	23.7	29.0	36.8	170.8	23.7
Read latency (ms)	10.2%	0.2	9.1	10.7	12.9	18.8	139.7	13.1

Table E.3: Workload characteristics and performance are measured for each sample, on each storage device. The minimum value, percentiles, maximum value and average are reported for each measurement. In addition, the relative difference between the average performance of the best and second-to-best iteration is reported. This value quantifies the change in a given measurement across multiple runs of the same sample on the same storage device.

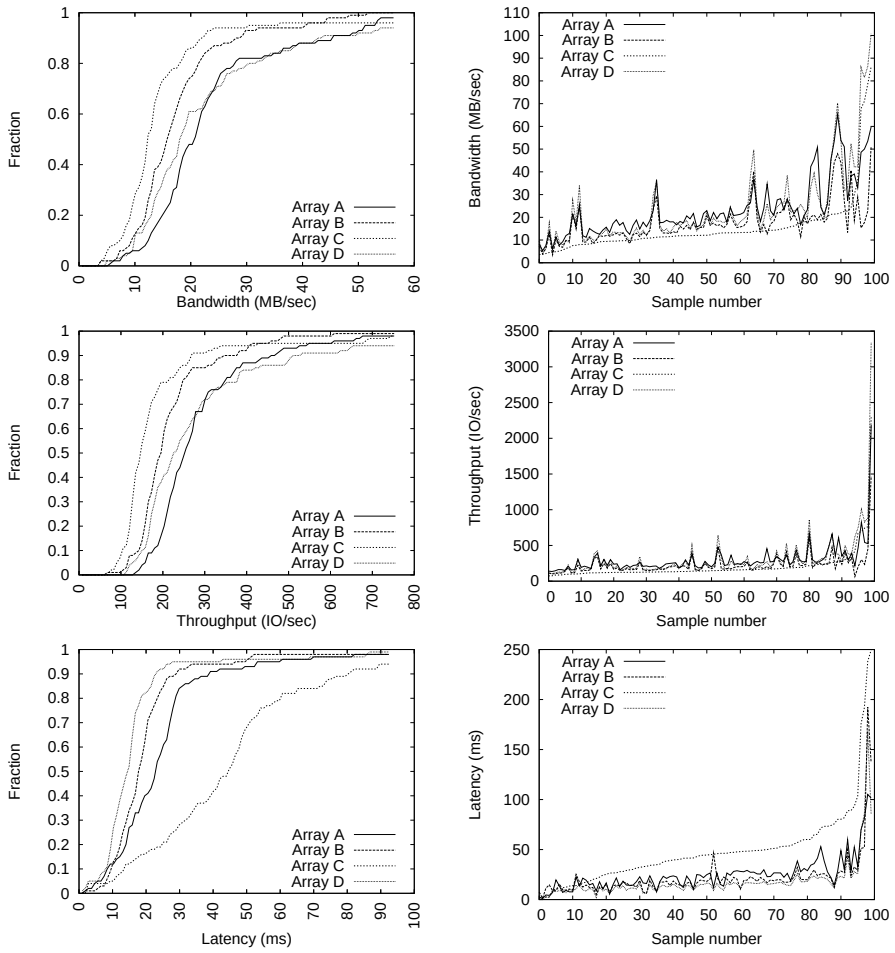

Figure E.1: The cumulative distribution of performance is shown (top). In addition, the performance of each array is shown (bottom), sorted by the performance of Array C.

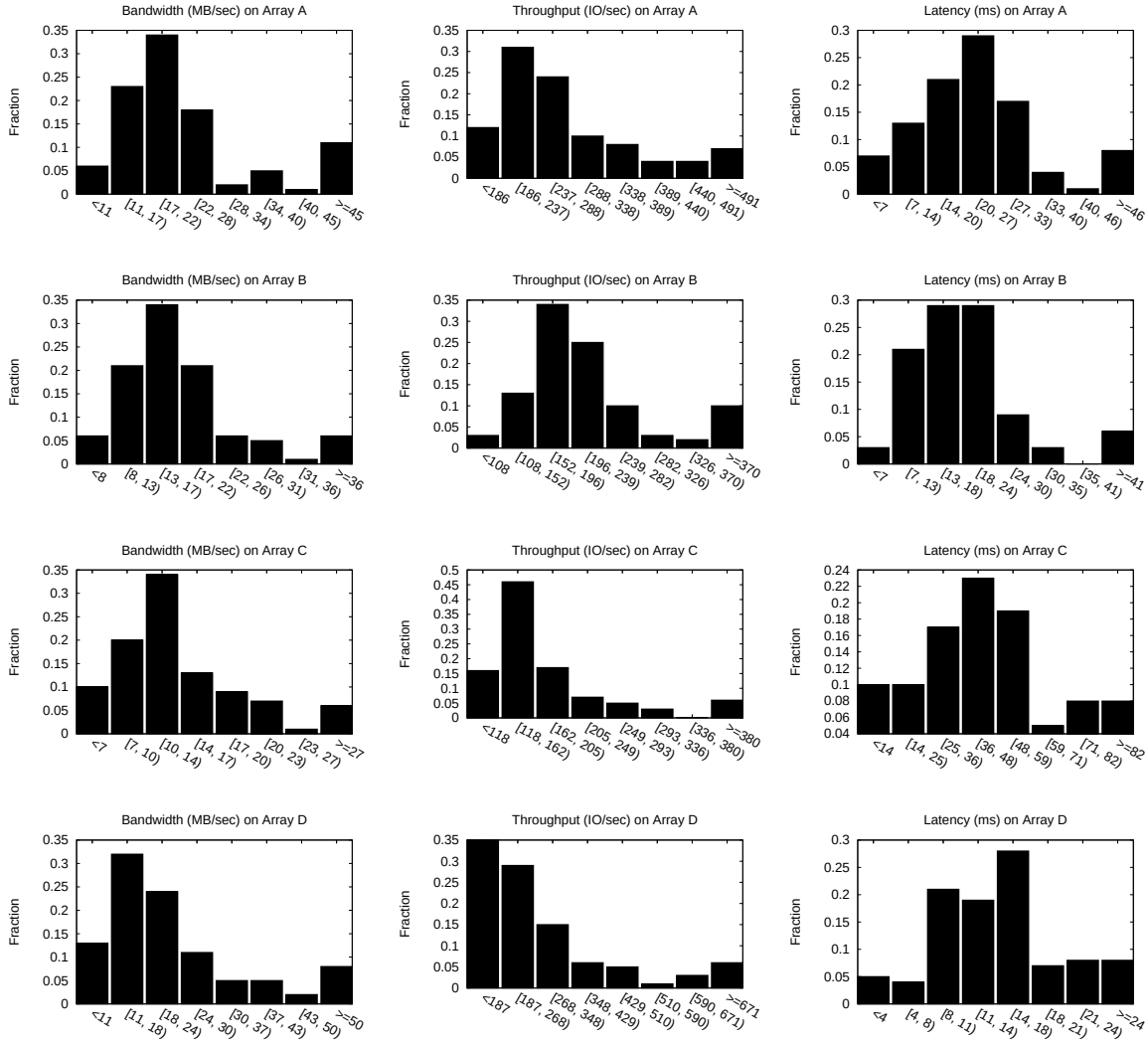

Figure E.2: Probability distributions of performance.

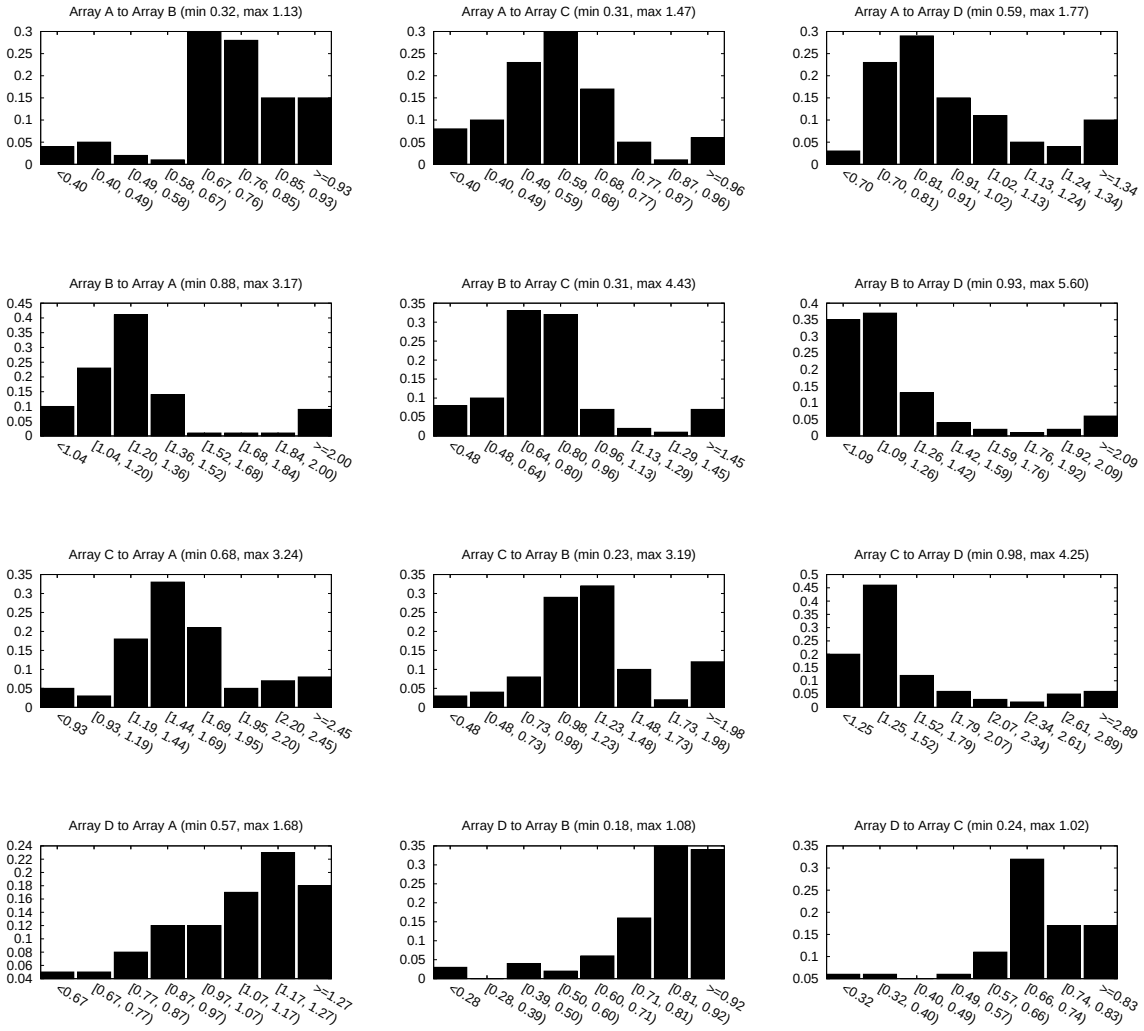

Figure E.3: Each graph shows the probability distribution of the **Bandwidth** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

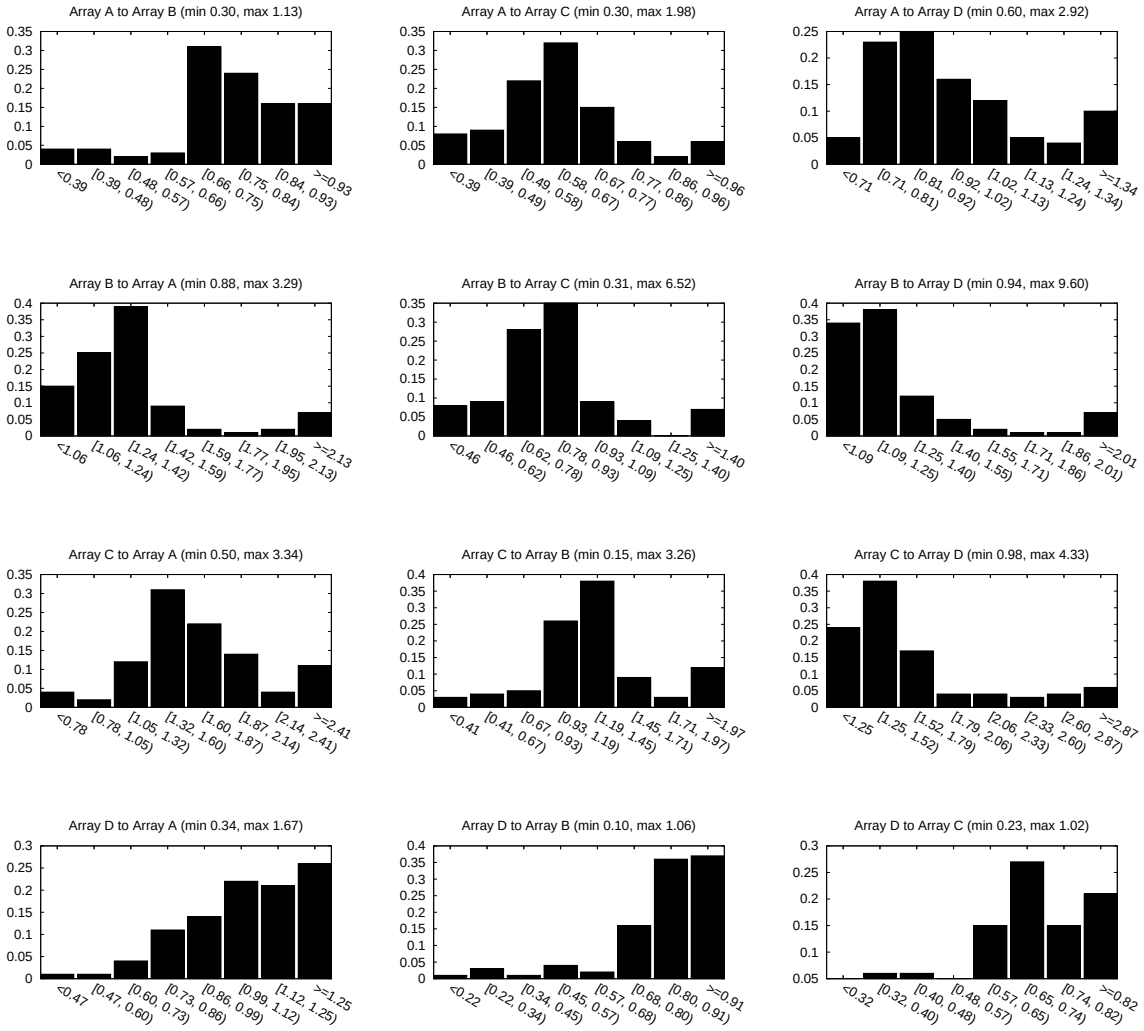

Figure E.4: Each graph shows the probability distribution of the **Throughput** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

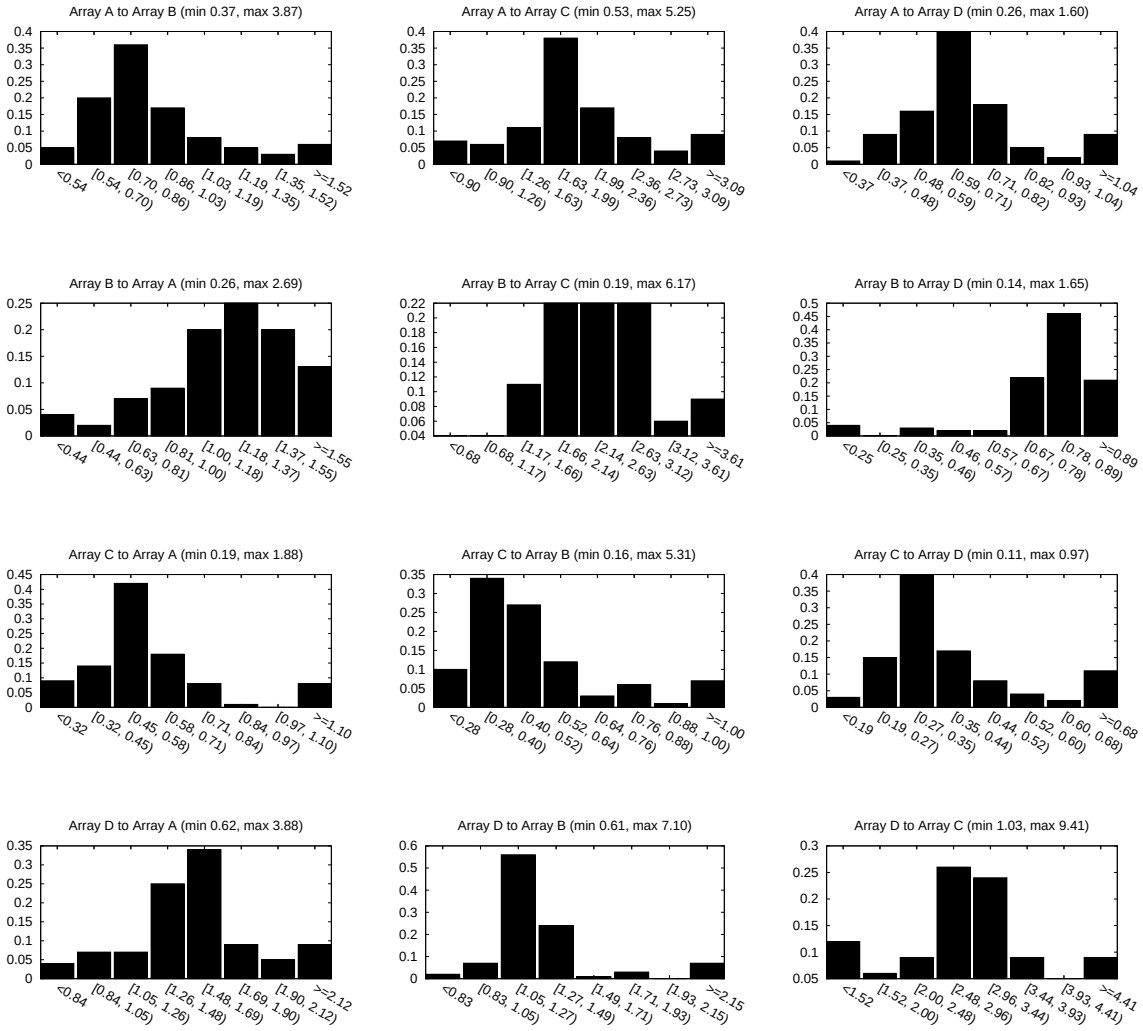

Figure E.5: Each graph shows the probability distribution of the **Latency** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

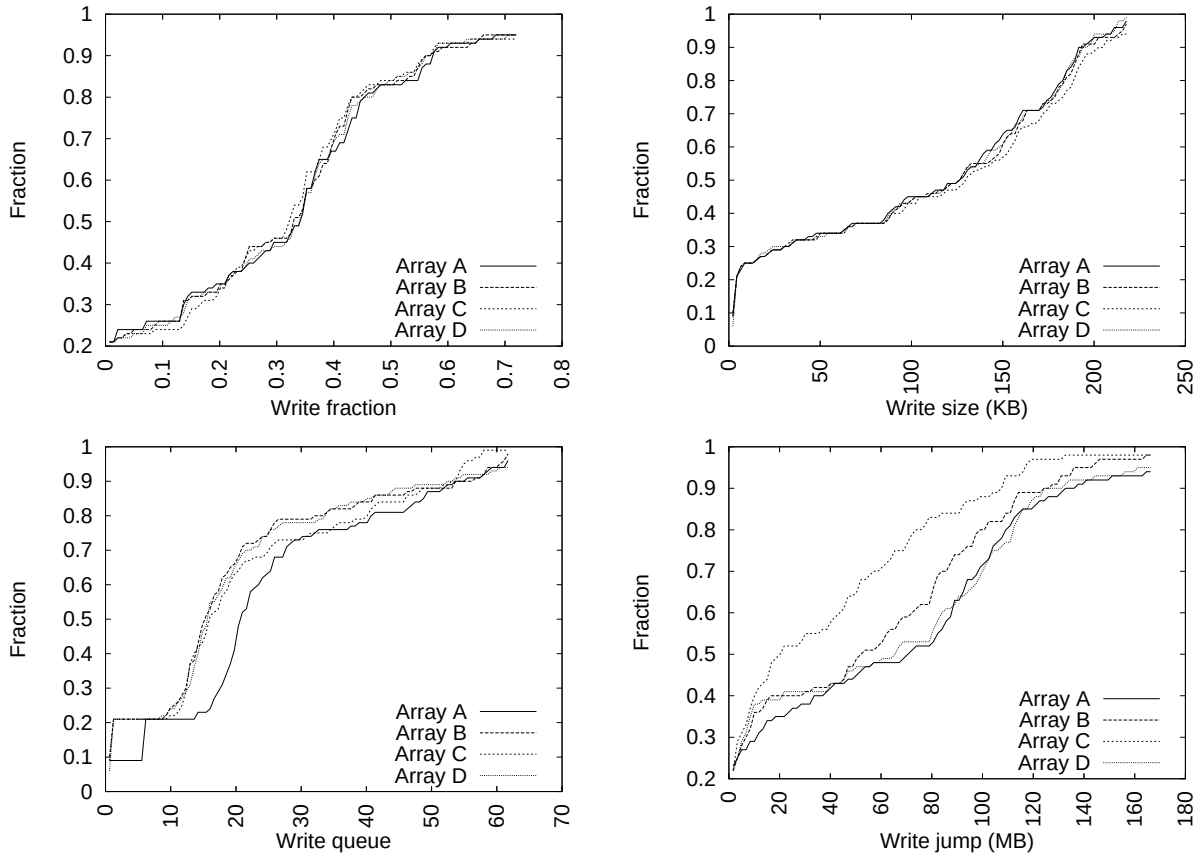

Figure E.6: The cumulative distribution of workload characteristics.

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Write fraction	1.00	Read queue	1.00	Read queue	1.00	Write fraction	1.00
Read queue	0.92	Write fraction	0.88	Write size	0.81	Read queue	0.40
Read jump	0.53	Read jump	0.79	Read jump	0.60	Read jump	0.11
Write size	0.35	Write jump	0.51	Read size	0.31	Write queue	0.03
Write queue	0.18	Write queue	0.34	Write queue	0.16	Write size	0.03
Read size	0.18	Write size	0.19	Write fraction	0.10	Read size	0.02
Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Write fraction	1.00	Read queue	1.00	Read queue	1.00	Write fraction	1.00
Read queue	0.89	Write fraction	0.79	Read jump	0.77	Read queue	0.37
Read jump	0.63	Read jump	0.74	Write size	0.77	Read jump	0.20
Write size	0.42	Write jump	0.61	Read size	0.38	Write jump	0.11
Write jump	0.31	Read size	0.35	Write queue	0.29	Write size	0.11
Read size	0.30	Write size	0.33	Write fraction	0.24	Read size	0.10
Write queue	0.20	Write queue	0.14	Write jump	0.09	Write queue	0.10
Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Latency	1.00	Bandwidth	1.00	Throughput	1.00	Latency	1.00
Bandwidth	0.88	Read queue	0.14	Write size	0.27	Write fraction	0.10
Throughput	0.76	Read jump	0.12	Read queue	0.21	Read jump	0.08
Read queue	0.29	Latency	0.09	Read size	0.14	Write latency	0.07
Write size	0.28	Write fraction	0.09	Read jump	0.12	Read size	0.06
Read jump	0.26	Read latency	0.07	Latency	0.10	Bandwidth	0.05
Write fraction	0.20	Write jump	0.06	Write fraction	0.07	Write queue	0.05
Read size	0.18	Write size	0.05	Read latency	0.04	Write size	0.05
Read latency	0.11	Read size	0.03	Bandwidth	0.04	Write jump	0.03
Write jump	0.08	Throughput	0.03	Write queue	0.01	Read queue	0.03
Write queue	0.07	Write queue	0.02	Write latency	0.01	Throughput	0.03
Write latency	0.07	Write latency	0.00	Write jump	0.00	Read latency	0.02
Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Bandwidth	1.00	Read queue	1.00	Read latency	1.00	Bandwidth	1.00
Read latency	0.88	Read latency	0.92	Read jump	0.90	Read size	0.77
Read queue	0.84	Read jump	0.87	Bandwidth	0.80	Latency	0.72
Read jump	0.80	Bandwidth	0.65	Throughput	0.64	Write fraction	0.61
Latency	0.66	Throughput	0.57	Read queue	0.61	Write jump	0.44
Read size	0.65	Latency	0.51	Read size	0.58	Read queue	0.43
Throughput	0.56	Write fraction	0.32	Write fraction	0.41	Write latency	0.42
Write fraction	0.55	Write queue	0.31	Latency	0.39	Write size	0.34
Write latency	0.33	Read size	0.24	Write latency	0.23	Write queue	0.28
Write size	0.33	Write size	0.23	Write size	0.22	Read latency	0.23
Write queue	0.29	Write latency	0.17	Write jump	0.19	Read jump	0.18

Table E.4: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	10.9	13.2	8.5	11.0
Relative	13.2	15.9	10.0	13.8
Relative Performance	13.2	14.8	12.8	11.9
Relative Fitness	7.7	8.6	7.9	6.5

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	12.0	-	-	-
Array	-	10.3	-	-
Array	-	-	11.7	-
Array	-	-	-	9.7
Relative	**Array**	**Array**	**Array**	**Array**
Array	12.0	16.0	11.3	15.7
Array	13.7	10.3	8.7	16.0
Array	17.3	15.7	11.7	13.0
Array	14.0	9.7	7.7	9.7
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	16.7	18.0	7.7	14.0
Array	11.0	17.0	16.7	14.7
Array	12.0	8.0	17.0	9.7
Array	18.7	13.7	14.0	12.3
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	7.3	7.0	16.0
Array	5.3	1	4.3	6.3
Array	10.7	13.3	1	5.0
Array	10.7	3.7	2.3	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	16.0	-	-	-	15.0	-	-	-	5.0	-	-	-
Array B	-	18.0	-	-	-	5.0	-	-	-	8.0	-	-
Array C	-	-	4.0	-	-	-	13.0	-	-	-	18.0	-
Array D	-	-	-	15.0	-	-	-	1.0	-	-	-	13.0
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	16.0	19.0	16.0	21.0	15.0	21.0	1.0	12.0	5.0	8.0	17.0	14.0
Array B	16.0	18.0	8.0	20.0	17.0	5.0	1.0	13.0	8.0	8.0	17.0	15.0
Array C	22.0	15.0	4.0	11.0	15.0	13.0	13.0	14.0	15.0	19.0	18.0	14.0
Array D	21.0	18.0	4.0	15.0	10.0	2.0	1.0	1.0	11.0	9.0	18.0	13.0
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	17.0	21.0	13.0	18.0	17.0	23.0	1.0	13.0	16.0	10.0	9.0	11.0
Array B	11.0	17.0	18.0	18.0	15.0	17.0	16.0	11.0	7.0	17.0	16.0	15.0
Array C	11.0	8.0	18.0	9.0	15.0	11.0	16.0	14.0	10.0	5.0	17.0	6.0
Array D	19.0	15.0	16.0	16.0	19.0	9.0	7.0	2.0	18.0	17.0	19.0	19.0
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	11.0	8.0	17.0	1	9.0	3.0	12.0	1	2.0	10.0	19.0
Array B	3.0	1	3.0	4.0	8.0	1	5.0	3.0	5.0	1	5.0	12.0
Array C	18.0	18.0	1	7.0	5.0	18.0	1	6.0	9.0	4.0	1	2.0
Array D	9.0	3.0	2.0	1	17.0	5.0	4.0	1	6.0	3.0	1.0	1

Table E.5: Tree sizes (leaf nodes) and their averages.

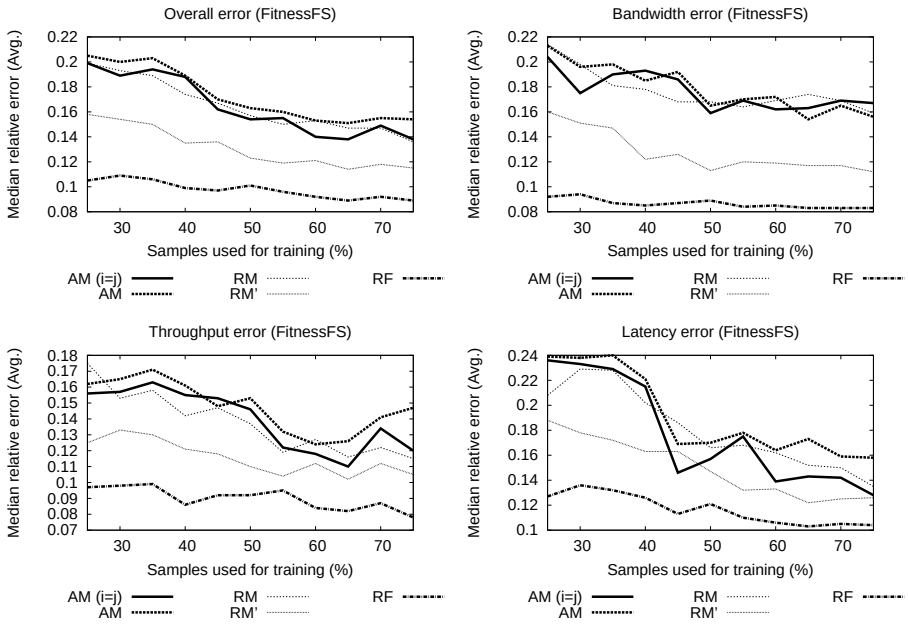

Figure E.7: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

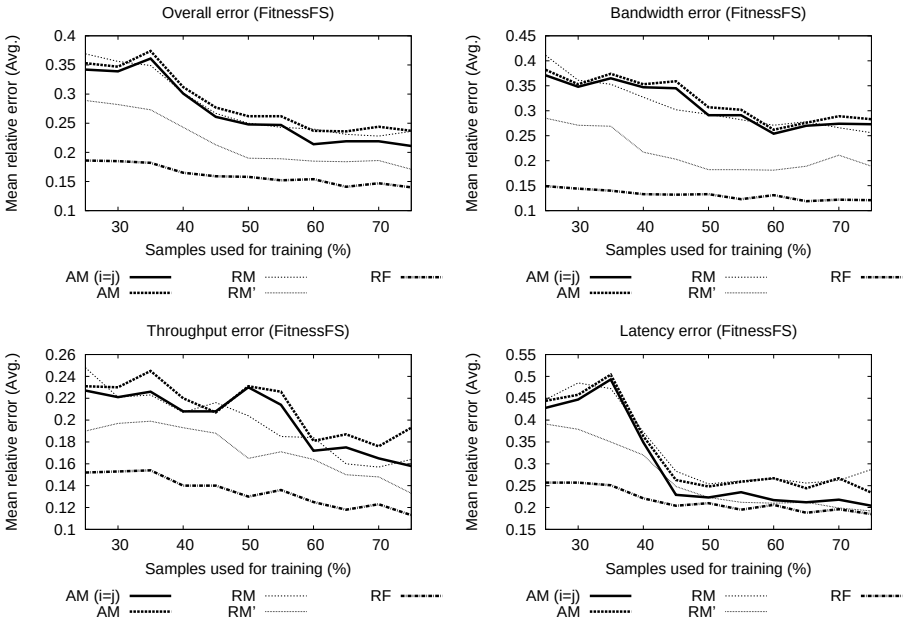

Figure E.8: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

Appendix F

FitnessCache model training

Application	Samples	Iters	First sample	Last sample
Cache (cache)	70	3	0	34
Total used	35			

Table F.1: Multiple training samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

	Array A	Array B	Array C	Array D	MAD	COV	Max. Diff.
Write fraction	0.00	0.00	0.00	0.00	0.0	nan%	nan%
Write size (KB)	0.00	0.00	0.00	0.00	0.0	nan%	nan%
Read size (KB)	15.77	15.77	15.77	15.77	0.0	0.0%	0.0%
Write jump (MB)	0.00	0.00	0.00	0.00	0.0	nan%	nan%
Read jump (MB)	1855.03	1861.46	1856.29	1850.03	3.2	0.2%	0.6%
Write queue	0.00	0.00	0.00	0.00	0.0	nan%	nan%
Read queue	6.76	6.68	5.70	5.59	0.5	8.7%	20.9%
Bandwidth (MB/sec)	16.18	15.66	35.25	40.11	10.9	41.1%	156.1%
Throughput (IO/sec)	1473.03	1020.89	5534.83	6542.57	2395.9	66.6%	540.9%
Latency (ms)	6.71	7.89	14.40	4.46	3.0	44.2%	222.9%
Write latency (ms)	0.00	0.00	0.00	0.00	0.0	nan%	nan%
Read latency (ms)	6.71	7.89	14.40	4.46	3.0	44.2%	222.9%

Table F.2: Workload characteristics and performance are measured for each sample, on each storage device. The average value for each measurement is reported in this table. The mean absolute deviation (MAD), coefficient of variation (COV), and maximum relative differences of these averages are also reported; these metrics quantify how the averages change among the storage devices. For example, the mean average deviation of the averages for Read latency (ms) is 3.02, their coeefficient of variation is 44.193%, and the maximum relative difference is 222.87%.

Array A								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Write size (KB)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read size (KB)	0.0%	1.0	2.0	8.0	16.0	32.0	64.0	15.8
Write jump (MB)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read jump (MB)	0.4%	4.0	5.0	5.0	3822.0	4815.0	5471.0	1855.0
Write queue	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read queue	0.3%	1.0	1.6	3.9	14.1	15.2	16.0	6.8
Bandwidth (MB/sec)	0.3%	0.5	2.4	7.2	23.6	35.7	72.8	16.2
Throughput (IO/sec)	1.0%	156.0	403.0	1149.0	2043.0	2549.0	4253.0	1473.0
Latency (ms)	0.1%	0.4	1.5	6.5	9.2	13.8	18.6	6.7
Write latency (ms)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read latency (ms)	0.1%	0.4	1.5	6.5	9.2	13.8	18.6	6.7

Array B								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Write size (KB)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read size (KB)	0.0%	1.0	2.0	8.0	16.0	32.0	64.0	15.8
Write jump (MB)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read jump (MB)	0.1%	4.0	5.0	5.0	3794.0	4832.0	5542.0	1861.5
Write queue	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read queue	0.0%	1.0	1.6	3.8	14.1	14.9	15.9	6.7
Bandwidth (MB/sec)	0.0%	0.3	1.4	5.0	13.6	39.3	104.7	15.7
Throughput (IO/sec)	1.0%	108.0	265.0	672.0	1528.0	2159.0	2929.0	1020.9
Latency (ms)	0.2%	2.2	2.8	5.5	10.6	14.5	20.7	7.9
Write latency (ms)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read latency (ms)	0.2%	2.2	2.8	5.5	10.6	14.5	20.7	7.9

Array C								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Write size (KB)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read size (KB)	0.0%	1.0	2.0	8.0	16.0	32.0	64.0	15.8
Write jump (MB)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read jump (MB)	0.3%	5.0	5.0	5.0	3820.0	4863.0	5520.0	1856.3
Write queue	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read queue	0.2%	1.0	1.6	3.6	6.9	14.1	14.8	5.7
Bandwidth (MB/sec)	0.0%	0.4	1.8	8.6	49.9	106.8	109.6	35.2
Throughput (IO/sec)	0.3%	49.0	144.0	1743.0	6772.0	13918.0	25519.0	5534.8
Latency (ms)	0.0%	0.2	0.3	1.9	13.4	25.9	97.9	14.4
Write latency (ms)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read latency (ms)	0.1%	0.2	0.3	1.9	13.4	25.9	97.9	14.4

Array D								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Write size (KB)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read size (KB)	0.0%	1.0	2.0	8.0	16.0	32.0	64.1	15.8
Write jump (MB)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read jump (MB)	0.9%	5.0	5.0	5.0	3812.0	4795.0	5470.0	1850.0
Write queue	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read queue	0.2%	1.0	1.6	3.5	6.7	14.1	14.7	5.6
Bandwidth (MB/sec)	0.2%	0.5	4.2	21.3	60.7	107.0	110.9	40.1
Throughput (IO/sec)	0.3%	134.0	402.0	1771.0	7760.0	15547.0	27676.0	6542.6
Latency (ms)	0.1%	0.1	0.2	2.0	7.5	9.4	12.8	4.5
Write latency (ms)	nan%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Read latency (ms)	0.1%	0.1	0.2	2.0	7.5	9.4	12.8	4.5

Table F.3: Workload characteristics and performance are measured for each sample, on each storage device. The minimum value, percentiles, maximum value and average are reported for each measurement. In addition, the relative difference between the average performance of the best and second-to-best iteration is reported. This value quantifies the change in a given measurement across multiple runs of the same sample on the same storage device.

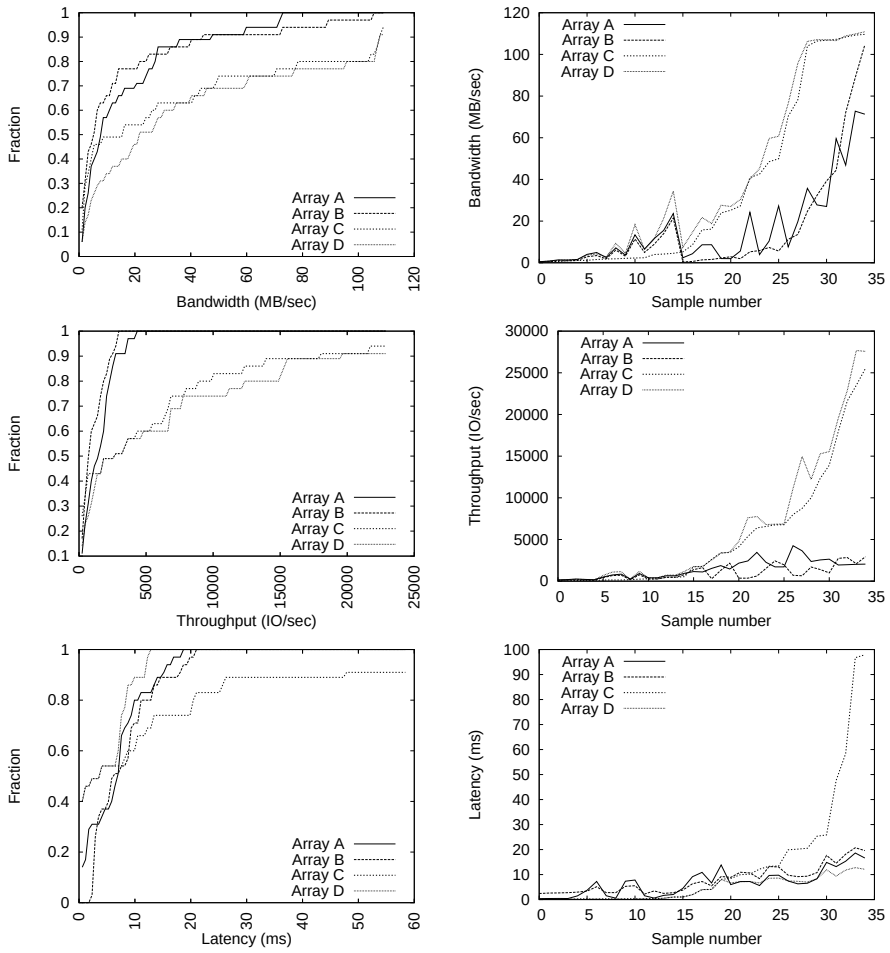

Figure F.1: The cumulative distribution of performance is shown (top). In addition, the performance of each array is shown (bottom), sorted by the performance of Array C.

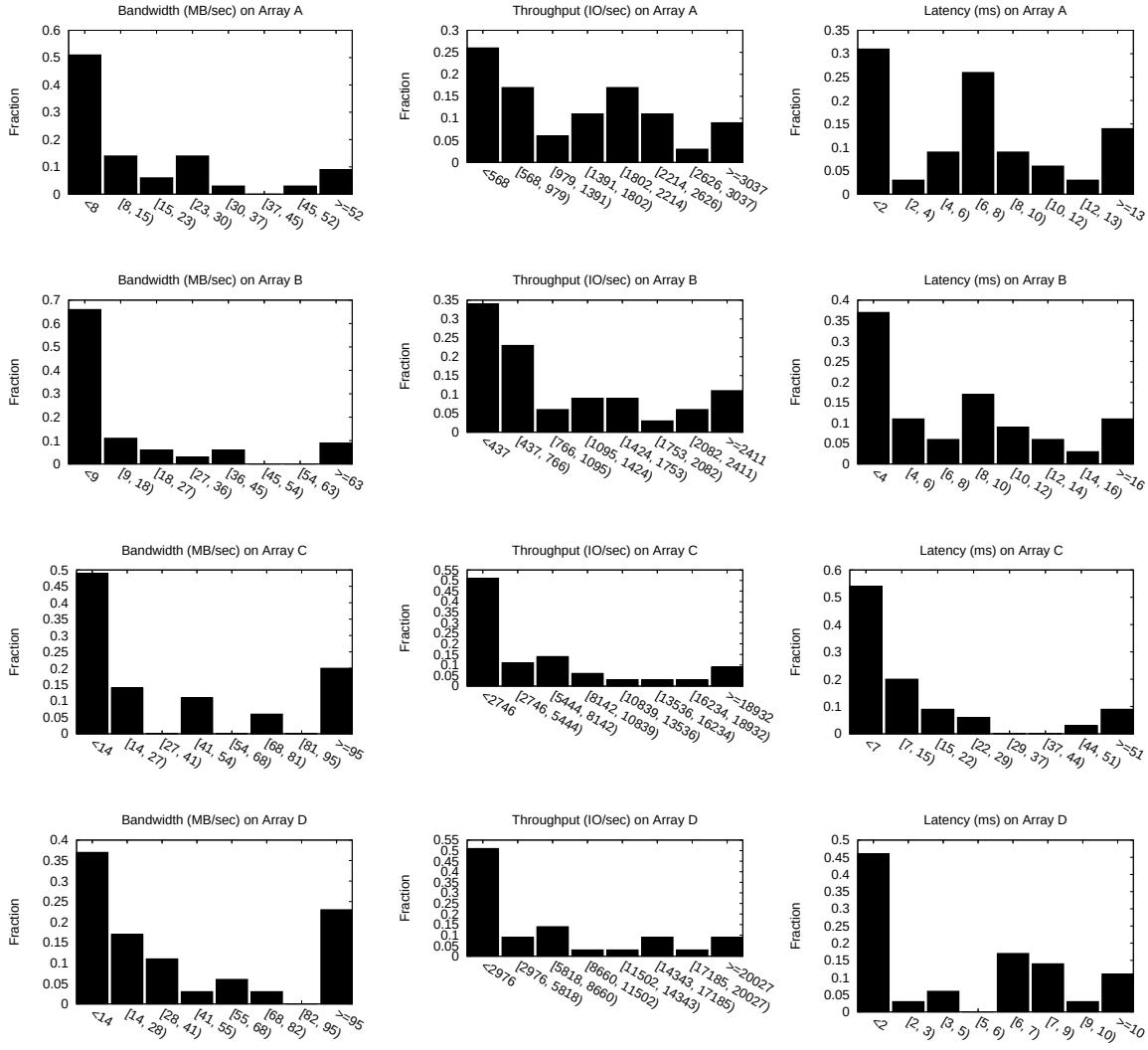

Figure F.2: Probability distributions of performance.

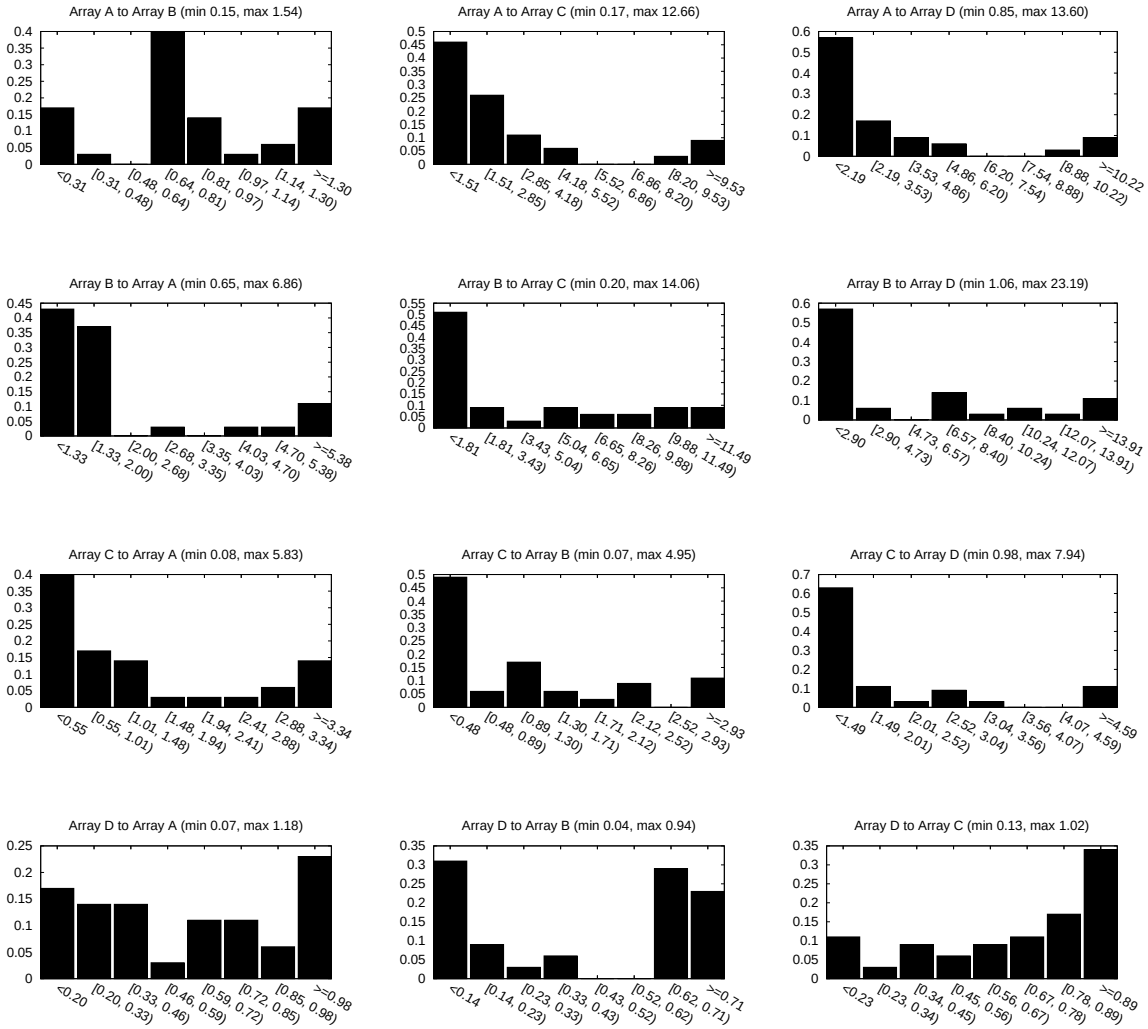

Figure F.3: Each graph shows the probability distribution of the **Bandwidth** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

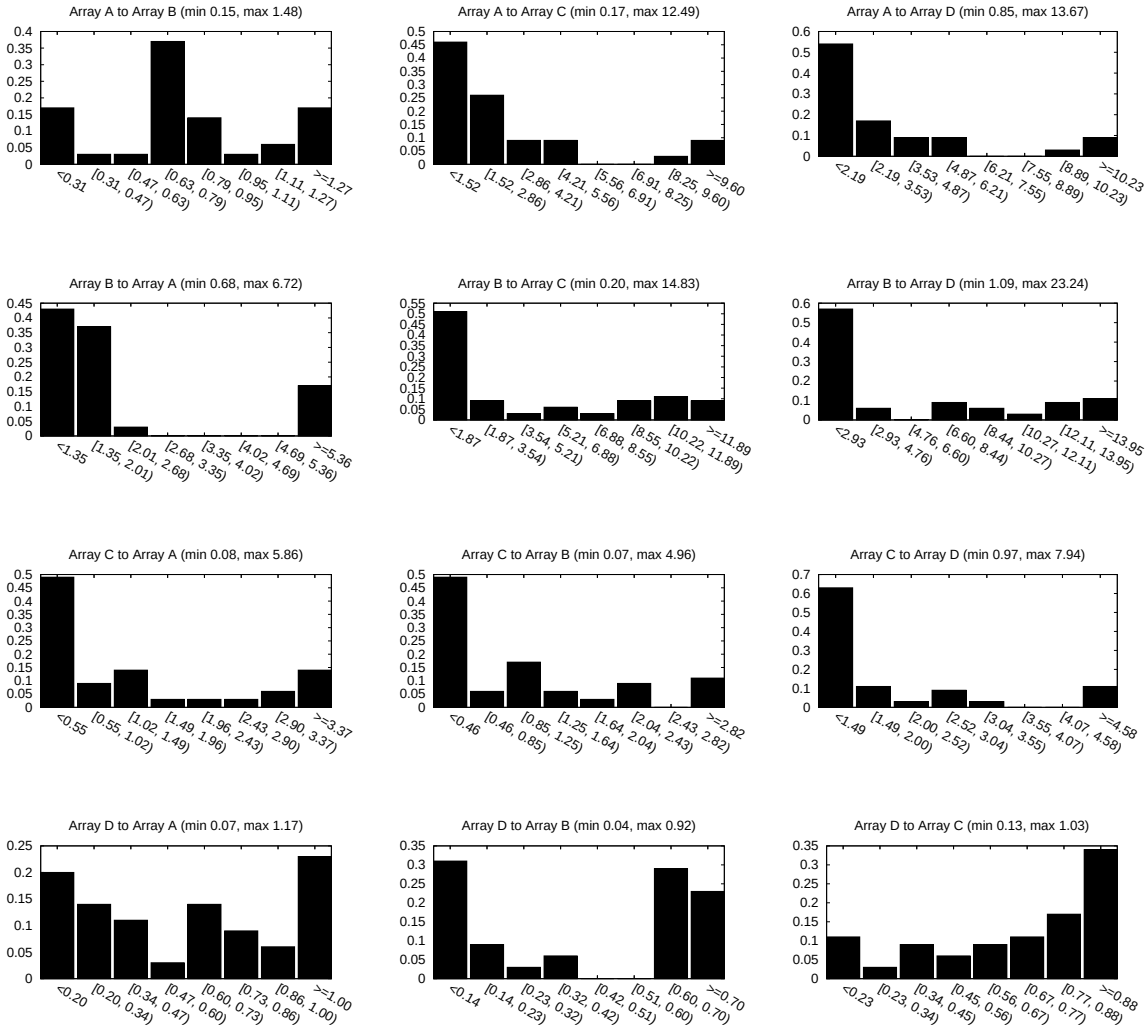

Figure F.4: Each graph shows the probability distribution of the **Throughput** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

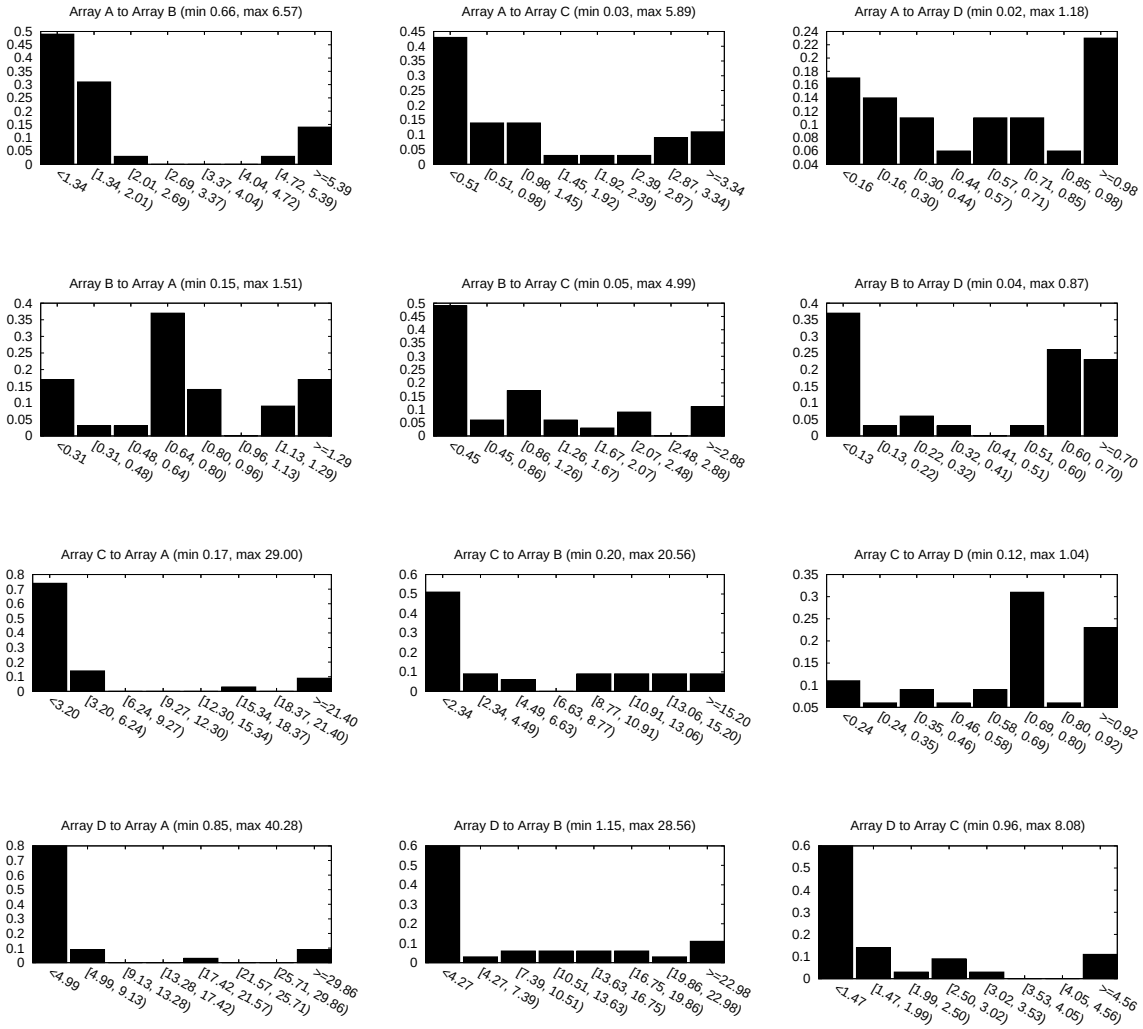

Figure F.5: Each graph shows the probability distribution of the **Latency** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

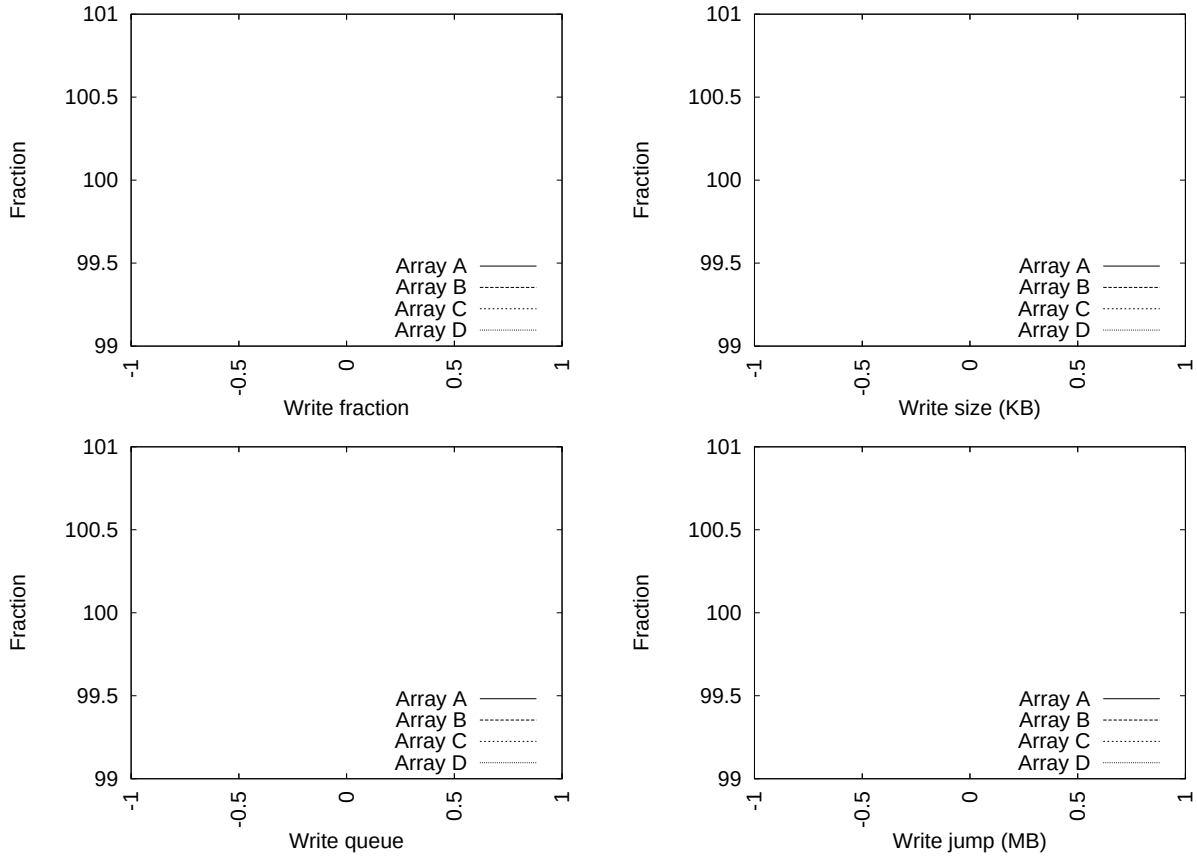

Figure F.6: The cumulative distribution of workload characteristics.

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read jump	1.00	Read size	1.00	Read jump	1.00	Read queue	1.00
Read queue	0.91	Read jump	0.68	Read queue	0.83	Read jump	0.80
Read size	0.81	Read queue	0.35	Read size	0.44	Read size	0.57
Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read jump	1.00	Read size	1.00	Read jump	1.00	Read queue	1.00
Read queue	0.87	Read jump	0.71	Read queue	0.61	Read jump	0.72
Read size	0.70	Read queue	0.39	Read size	0.34	Read size	0.45
Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Bandwidth	1.00	Bandwidth	1.00	Throughput	1.00	Latency	1.00
Latency	0.72	Read jump	0.15	Read queue	0.52	Read queue	0.35
Throughput	0.46	Read queue	0.08	Read jump	0.51	Throughput	0.22
Read queue	0.43	Read size	0.08	Latency	0.33	Read size	0.19
Read jump	0.31	Latency	0.07	Read size	0.24	Bandwidth	0.15
Read size	0.25	Throughput	0.02	Bandwidth	0.23	Read jump	0.04
Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Latency	1.00	Latency	1.00	Latency	1.00	Latency	1.00
Throughput	0.52	Read jump	0.48	Throughput	0.50	Throughput	0.69
Read jump	0.49	Throughput	0.42	Bandwidth	0.44	Read jump	0.62
Bandwidth	0.41	Bandwidth	0.41	Read jump	0.41	Read queue	0.61
Read queue	0.39	Read queue	0.30	Read queue	0.31	Bandwidth	0.35
Read size	0.20	Read size	0.19	Read size	0.16	Read size	0.28

Table F.4: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	5.5	4.2	5.0	7.2
Relative	5.2	4.0	4.8	6.9
Relative Performance	5.7	6.1	5.1	6.0
Relative Fitness	5.1	4.7	5.7	4.9

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	5.0	-	-	-
Array	-	5.7	-	-
Array	-	-	6.0	-
Array	-	-	-	5.3
Relative	**Array**	**Array**	**Array**	**Array**
Array	5.0	4.3	5.7	5.7
Array	5.3	5.7	5.3	5.7
Array	5.3	3.7	6.0	5.3
Array	5.7	4.7	6.3	5.3
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	5.7	6.3	3.0	6.3
Array	5.3	6.3	6.3	5.3
Array	5.7	6.3	7.3	6.0
Array	5.0	6.3	6.7	6.0
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	6.0	5.7	5.7
Array	4.3	1	4.3	5.0
Array	5.0	5.3	1	4.3
Array	5.7	4.7	5.0	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	5.0	-	-	-	5.0	-	-	-	5.0	-	-	-
Array B	-	5.0	-	-	-	5.0	-	-	-	7.0	-	-
Array C	-	-	3.0	-	-	-	5.0	-	-	-	10.0	-
Array D	-	-	-	4.0	-	-	-	5.0	-	-	-	7.0
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	5.0	1.0	3.0	5.0	5.0	5.0	6.0	5.0	5.0	7.0	8.0	7.0
Array B	6.0	5.0	3.0	5.0	5.0	5.0	4.0	5.0	5.0	7.0	9.0	7.0
Array C	5.0	1.0	3.0	4.0	5.0	5.0	5.0	5.0	6.0	5.0	10.0	7.0
Array D	6.0	6.0	3.0	4.0	5.0	3.0	5.0	5.0	6.0	5.0	11.0	7.0
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	6.0	8.0	3.0	7.0	5.0	6.0	2.0	5.0	6.0	5.0	4.0	7.0
Array B	4.0	7.0	4.0	6.0	5.0	5.0	8.0	3.0	7.0	7.0	7.0	7.0
Array C	7.0	7.0	6.0	6.0	4.0	7.0	8.0	5.0	6.0	5.0	8.0	7.0
Array D	5.0	9.0	7.0	6.0	4.0	5.0	7.0	5.0	6.0	5.0	6.0	7.0
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	5.0	5.0	3.0	1	6.0	6.0	8.0	1	7.0	6.0	6.0
Array B	1.0	1	4.0	7.0	6.0	1	7.0	4.0	6.0	1	2.0	4.0
Array C	4.0	5.0	1	5.0	5.0	5.0	1	5.0	6.0	6.0	1	3.0
Array D	6.0	6.0	5.0	1	5.0	6.0	5.0	1	6.0	2.0	5.0	1

Table F.5: Tree sizes (leaf nodes) and their averages.

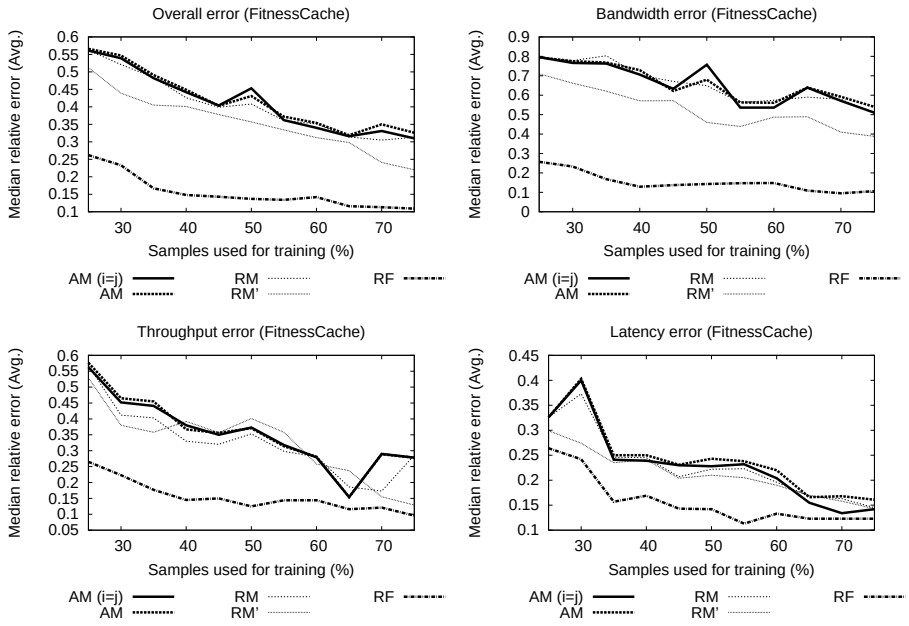

Figure F.7: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

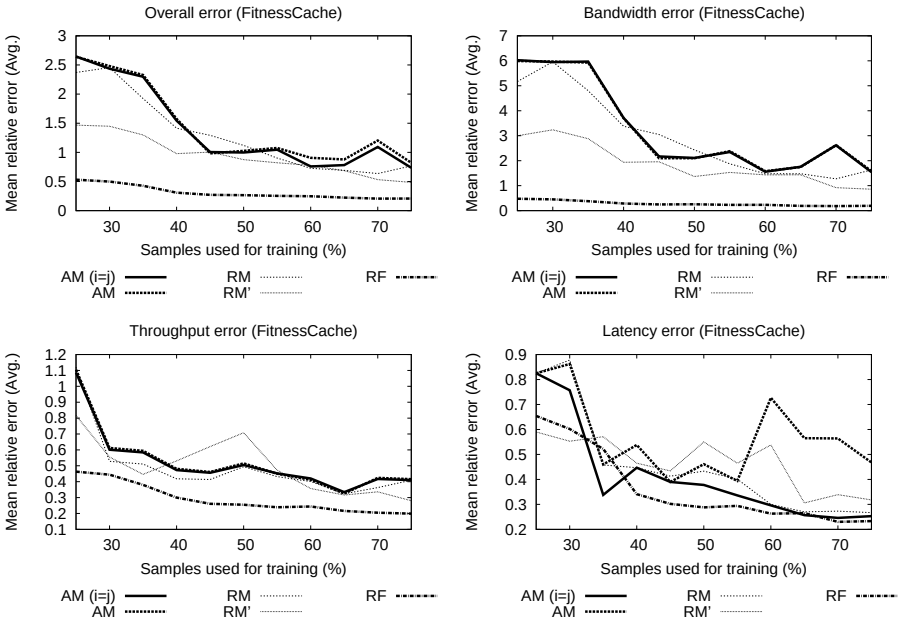

Figure F.8: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

Appendix G

Postmark model training

Application	Samples	Iters	First sample	Last sample
Postmark (phase 1) (pmc)	50	3	0	24
Postmark (phase 2) (pmt)	50	3	0	24
Total used	50			

Table G.1: Multiple training samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

	Array A	Array B	Array C	Array D	MAD	COV	Max. Diff.
Write fraction	0.76	0.77	0.76	0.77	0.0	0.7%	1.3%
Write size (KB)	110.72	109.48	108.27	109.50	0.6	0.8%	2.3%
Read size (KB)	53.72	54.12	51.53	54.11	0.9	2.0%	5.0%
Write jump (MB)	1754.38	1722.18	1518.64	1771.54	86.5	6.0%	16.6%
Read jump (MB)	3654.38	3631.52	3784.66	3558.88	63.6	2.2%	6.3%
Write queue	44.46	28.20	32.88	27.34	5.6	20.5%	62.6%
Read queue	2.23	1.95	1.66	1.54	0.2	14.5%	44.8%
Bandwidth (MB/sec)	27.39	22.20	14.48	38.62	7.3	34.2%	166.7%
Throughput (IO/sec)	278.92	232.44	165.42	421.64	75.7	34.2%	154.9%
Latency (ms)	50.74	28.62	110.14	19.82	28.9	67.3%	455.7%
Write latency (ms)	75.90	38.05	175.20	23.71	48.5	75.6%	638.9%
Read latency (ms)	8.76	27.90	7.42	10.88	7.1	60.2%	276.0%

Table G.2: Workload characteristics and performance are measured for each sample, on each storage device. The average value for each measurement is reported in this table. The mean absolute deviation (MAD), coefficient of variation (COV), and maximum relative differences of these averages are also reported; these metrics quantify how the averages change among the storage devices. For example, the mean average deviation of the averages for Read latency (ms) is 7.08, their coeefficient of variation is 60.169%, and the maximum relative difference is 276.01%.

Array A								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	1.0%	0.5	0.6	0.7	0.9	0.9	1.0	0.8
Write size (KB)	2.8%	29.4	88.8	118.6	130.9	143.4	148.0	110.7
Read size (KB)	1.2%	4.0	4.0	4.0	103.8	139.8	152.4	53.7
Write jump (MB)	3.6%	391.0	1566.0	1688.0	1861.0	2124.0	3166.0	1754.4
Read jump (MB)	2.1%	921.0	1373.0	2123.0	5815.0	5947.0	6304.0	3654.4
Write queue	2.3%	17.1	25.9	49.5	53.1	61.1	84.2	44.5
Read queue	23.1%	1.0	1.1	1.2	1.2	1.3	31.7	2.2
Bandwidth (MB/sec)	3.0%	7.0	22.2	28.3	31.9	37.4	40.3	27.4
Throughput (IO/sec)	0.4%	214.0	235.0	279.0	307.0	329.0	372.0	278.9
Latency (ms)	1.8%	30.9	34.2	44.6	55.4	75.6	109.2	50.7
Write latency (ms)	3.5%	50.0	59.5	64.4	88.9	105.0	156.7	75.9
Read latency (ms)	14.7%	4.8	5.4	5.8	6.0	6.7	89.7	8.8

Array B								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.3%	0.5	0.6	0.7	0.9	0.9	1.0	0.8
Write size (KB)	3.2%	25.6	90.0	114.2	127.6	137.1	152.1	109.5
Read size (KB)	2.0%	4.0	4.0	4.1	108.5	141.5	155.1	54.1
Write jump (MB)	3.4%	388.0	1545.0	1657.0	1858.0	2121.0	3161.0	1722.2
Read jump (MB)	0.5%	1071.0	1423.0	2386.0	5903.0	5993.0	6115.0	3631.5
Write queue	3.0%	16.7	21.0	23.4	29.9	49.7	57.6	28.2
Read queue	0.9%	1.0	1.1	1.2	1.2	1.3	20.1	1.9
Bandwidth (MB/sec)	3.4%	5.7	17.2	19.0	29.8	32.4	36.6	22.2
Throughput (IO/sec)	0.3%	136.0	155.0	247.0	283.0	313.0	405.0	232.4
Latency (ms)	1.1%	12.7	19.5	23.0	25.8	34.5	130.1	28.6
Write latency (ms)	1.2%	22.2	25.7	29.1	31.4	55.7	175.0	38.1
Read latency (ms)	14.4%	7.9	13.4	15.7	30.6	37.5	228.5	27.9

Array C								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.1%	0.5	0.6	0.7	0.9	0.9	1.0	0.8
Write size (KB)	5.8%	23.1	88.4	112.1	129.0	139.6	151.1	108.3
Read size (KB)	5.0%	4.0	4.0	4.0	103.0	131.8	152.5	51.5
Write jump (MB)	3.4%	307.0	1322.0	1591.0	1707.0	1970.0	2317.0	1518.6
Read jump (MB)	1.0%	1139.0	1666.0	2101.0	6050.0	6182.0	6406.0	3784.7
Write queue	3.6%	16.4	24.3	31.1	42.6	46.4	53.6	32.9
Read queue	5.2%	1.0	1.0	1.3	1.3	1.5	11.3	1.7
Bandwidth (MB/sec)	2.3%	4.6	13.8	15.4	16.2	17.3	18.5	14.5
Throughput (IO/sec)	3.5%	124.0	145.0	158.0	174.0	205.0	243.0	165.4
Latency (ms)	3.2%	46.2	68.3	91.6	136.6	197.2	262.8	110.1
Write latency (ms)	2.5%	116.5	127.3	141.3	205.1	288.1	384.9	175.2
Read latency (ms)	3.0%	0.8	4.0	7.4	9.0	10.4	27.5	7.4

Array D								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.3%	0.6	0.6	0.7	0.9	0.9	1.0	0.8
Write size (KB)	1.9%	42.0	87.9	116.8	128.6	143.7	150.1	109.5
Read size (KB)	0.3%	4.0	4.0	4.0	108.4	141.9	152.6	54.1
Write jump (MB)	4.2%	549.0	1571.0	1712.0	1850.0	2298.0	3028.0	1771.5
Read jump (MB)	0.2%	980.0	1306.0	2033.0	5791.0	5844.0	6310.0	3558.9
Write queue	2.9%	16.5	19.6	22.8	29.2	50.4	56.2	27.3
Read queue	2.2%	1.0	1.1	1.2	1.2	1.3	9.1	1.5
Bandwidth (MB/sec)	2.1%	6.5	19.9	25.0	54.1	66.6	74.4	38.6
Throughput (IO/sec)	1.2%	167.0	193.0	329.0	549.0	804.0	1285.0	421.6
Latency (ms)	0.9%	9.1	14.7	17.3	21.8	27.9	43.5	19.8
Write latency (ms)	1.8%	15.6	19.6	21.4	23.6	30.2	54.1	23.7
Read latency (ms)	0.0%	3.1	8.3	11.5	13.0	13.9	17.6	10.9

Table G.3: Workload characteristics and performance are measured for each sample, on each storage device. The minimum value, percentiles, maximum value and average are reported for each measurement. In addition, the relative difference between the average performance of the best and second-to-best iteration is reported. This value quantifies the change in a given measurement across multiple runs of the same sample on the same storage device.

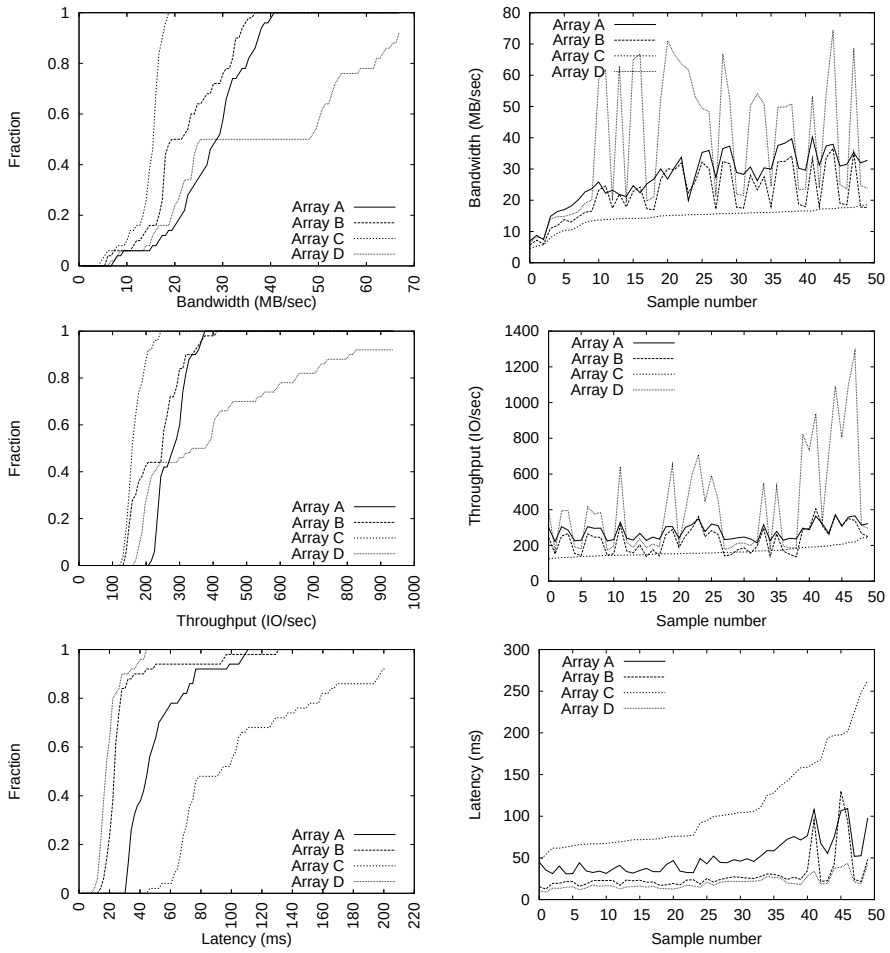

Figure G.1: The cumulative distribution of performance is shown (top). In addition, the performance of each array is shown (bottom), sorted by the performance of Array C.

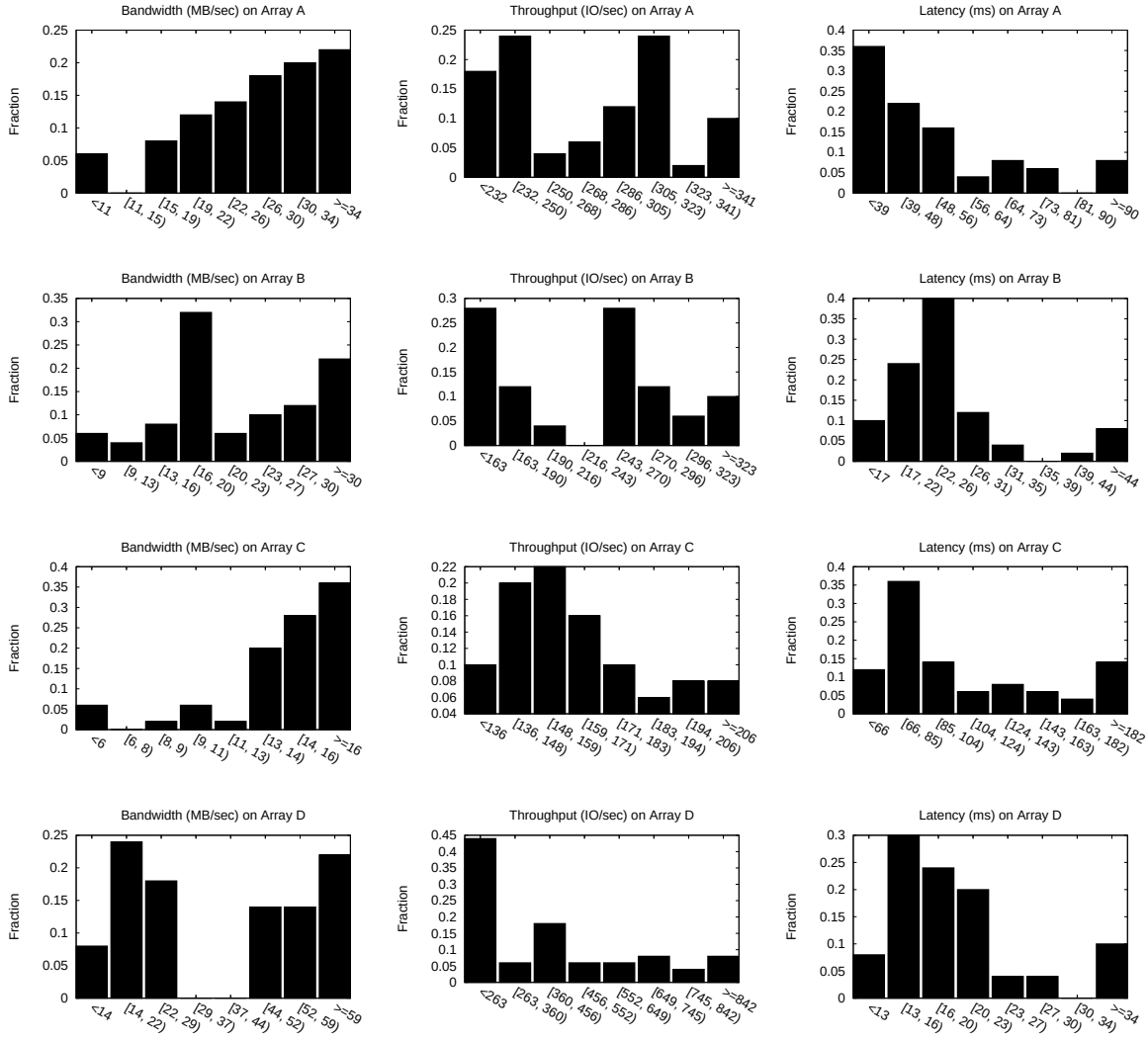

Figure G.2: Probability distributions of performance.

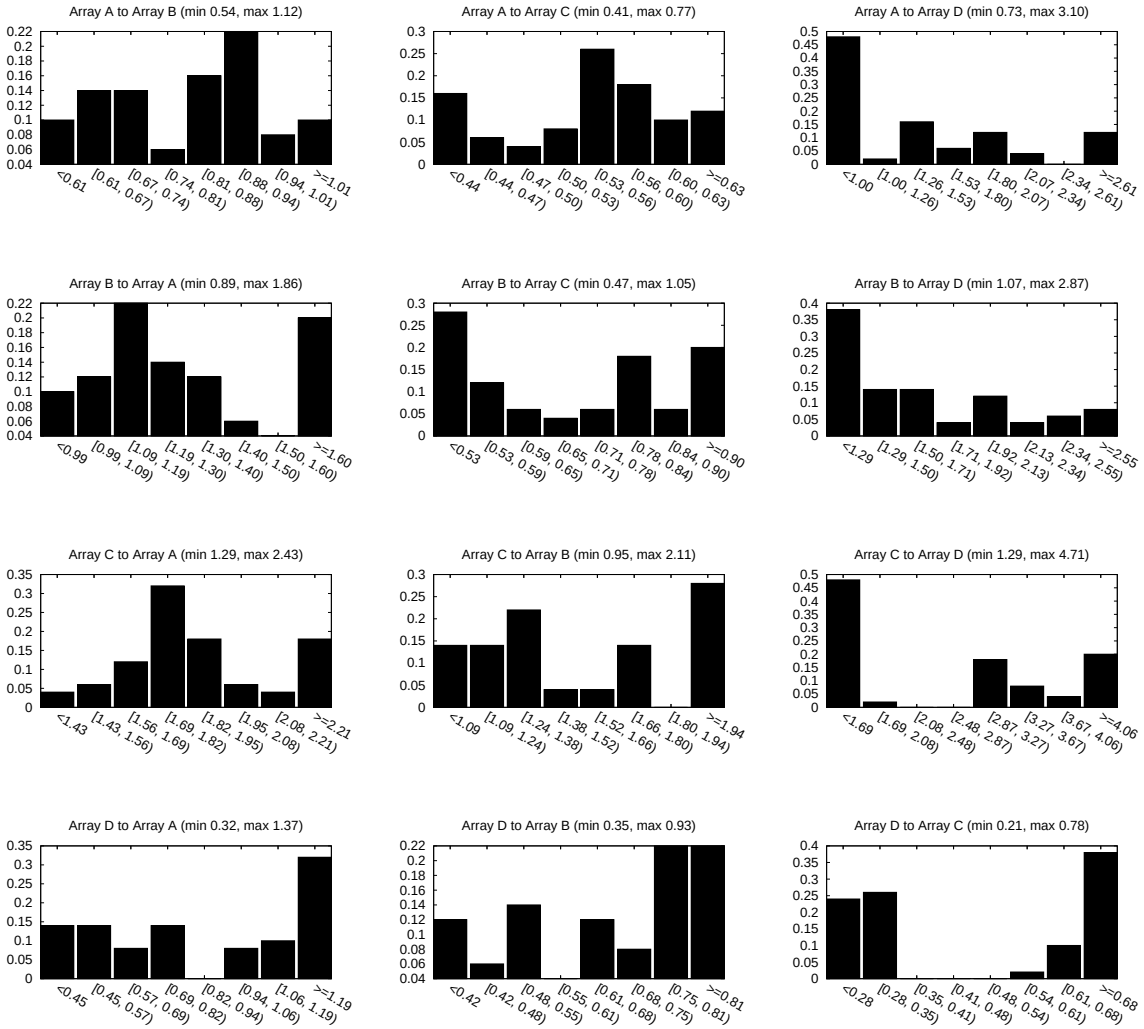

Figure G.3: Each graph shows the probability distribution of the **Bandwidth** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

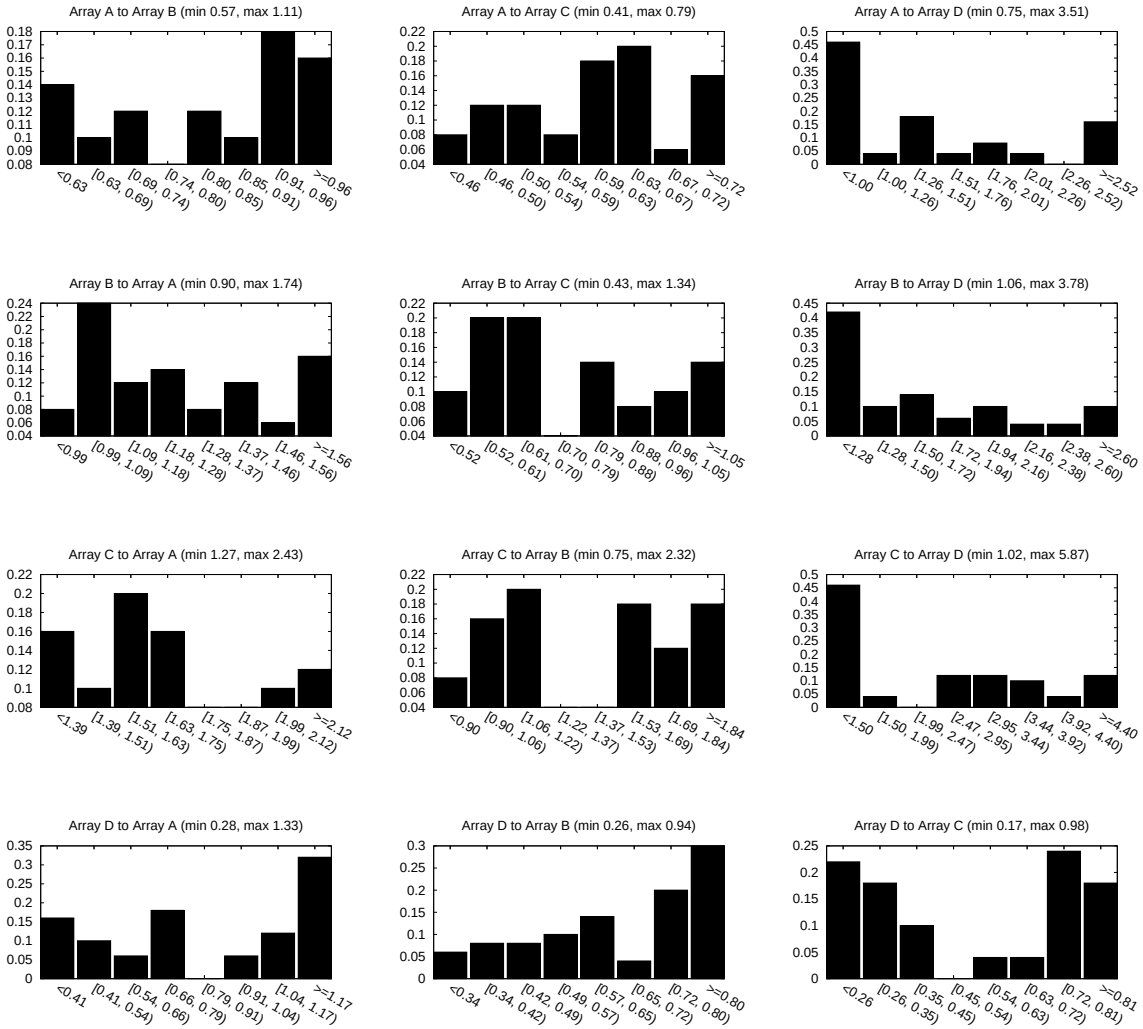

Figure G.4: Each graph shows the probability distribution of the **Throughput** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

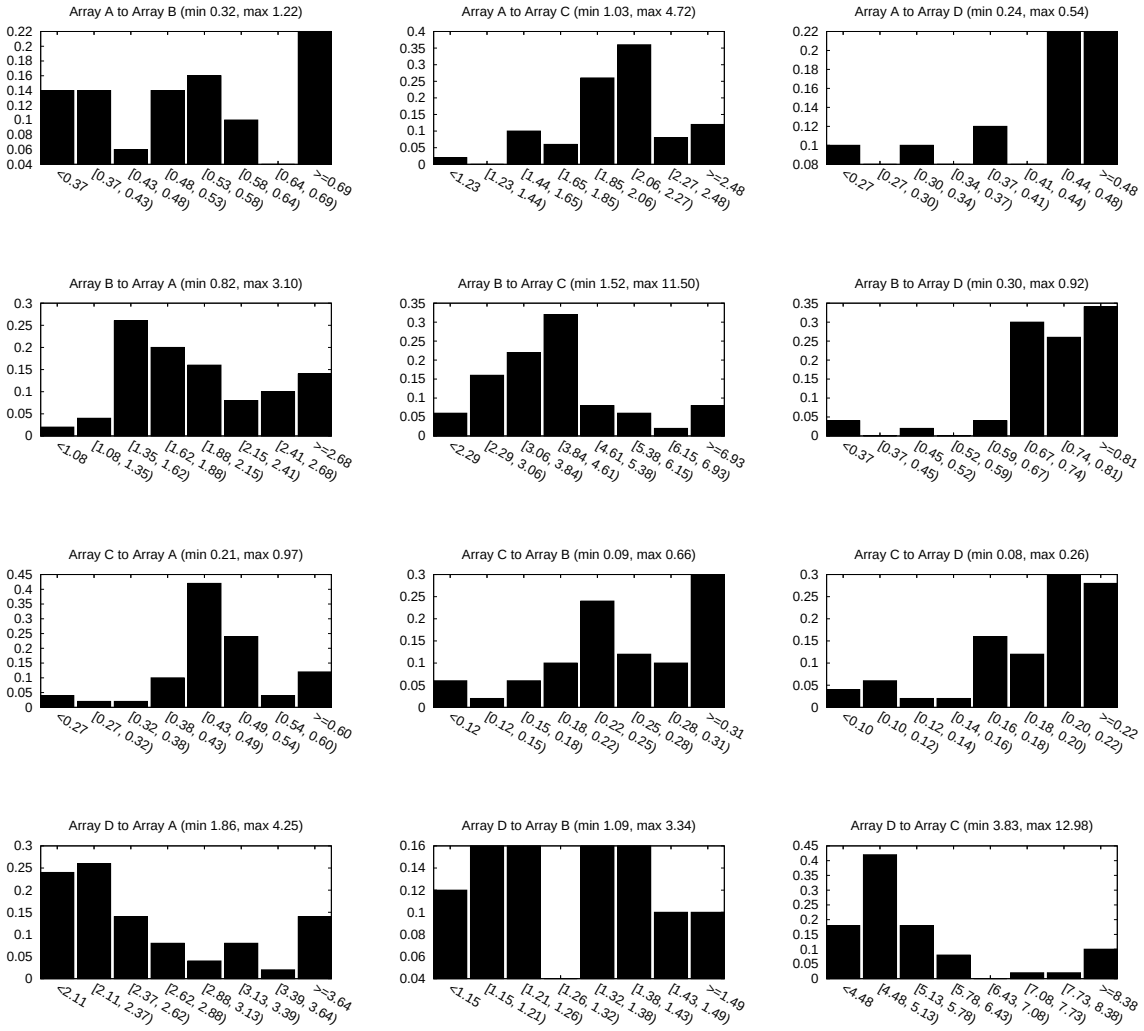

Figure G.5: Each graph shows the probability distribution of the **Latency** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

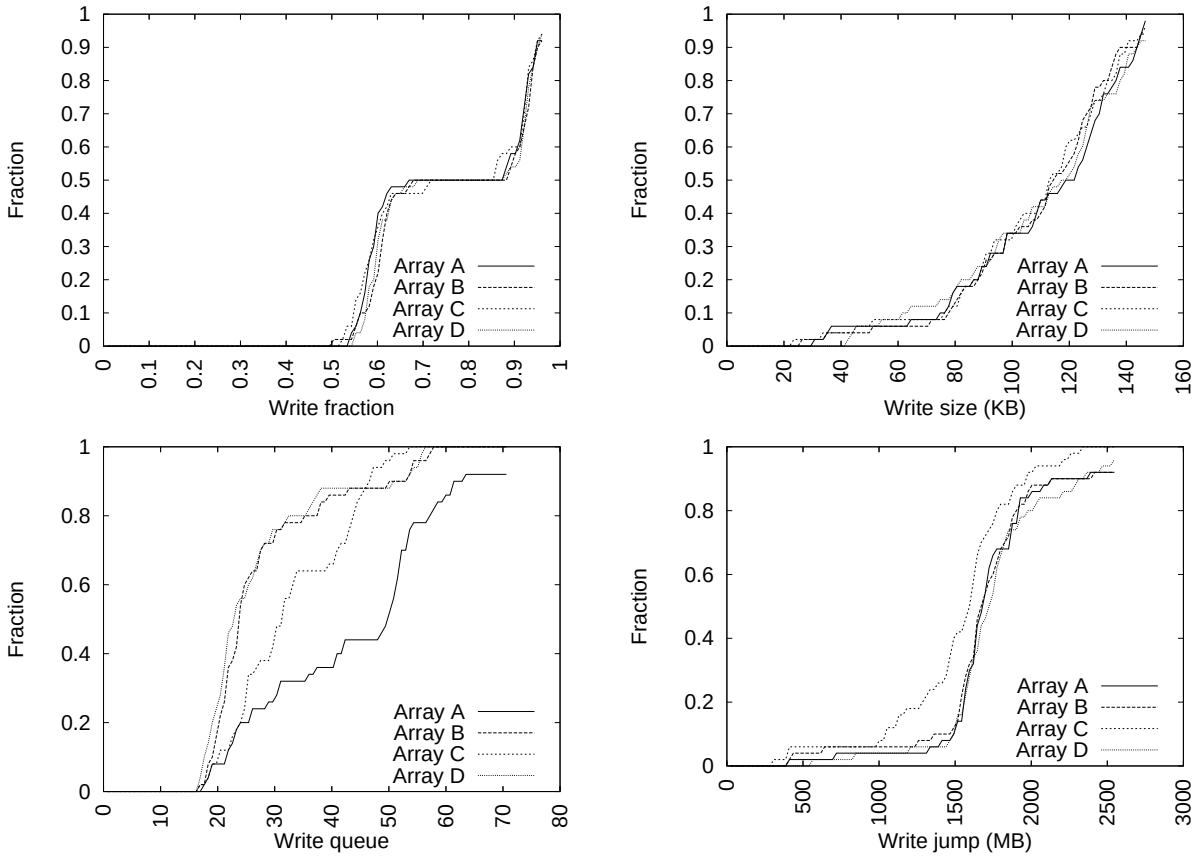

Figure G.6: The cumulative distribution of workload characteristics.

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Write fraction	1.00	Write size	1.00	Read size	1.00	Write fraction	1.00
Write size	0.92	Write fraction	0.76	Write size	0.62	Write queue	0.40
Read size	0.49	Read size	0.27	Write jump	0.48	Write size	0.30
Write queue	0.44	Read jump	0.22	Write queue	0.44	Read queue	0.25
Read jump	0.25	Write queue	0.15	Read queue	0.18	Read jump	0.25

Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Write fraction	1.00	Write fraction	1.00	Read size	1.00	Write fraction	1.00
Write size	0.77	Write size	0.99	Write fraction	0.91	Read queue	0.54
Read queue	0.41	Read size	0.27	Write size	0.83	Write size	0.44
Read size	0.41	Read queue	0.24	Write jump	0.53	Write jump	0.31
Write queue	0.28	Write queue	0.19	Read queue	0.49	Read jump	0.29
Write jump	0.24	Read jump	0.10	Write queue	0.48	Write queue	0.25
Read jump	0.18	Write jump	0.03	Read jump	0.14	Read size	0.20

Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Write fraction	1.00	Write fraction	1.00	Read size	1.00	Write fraction	1.00
Read size	0.65	Bandwidth	0.97	Write size	0.50	Latency	0.79
Write size	0.65	Write size	0.82	Write queue	0.33	Read queue	0.59
Bandwidth	0.63	Read queue	0.26	Read queue	0.33	Throughput	0.54
Latency	0.51	Read size	0.23	Throughput	0.31	Read size	0.38
Read queue	0.49	Latency	0.18	Latency	0.31	Bandwidth	0.28
Throughput	0.36	Write queue	0.11	Write fraction	0.28	Write jump	0.22
Write queue	0.25	Write latency	0.06	Write jump	0.26	Write latency	0.22
Write jump	0.19	Throughput	0.06	Bandwidth	0.08	Read jump	0.21
Write latency	0.11	Read latency	0.05	Read latency	0.07	Write queue	0.15
Read jump	0.10	Write jump	0.02	Read jump	0.06	Write size	0.09

Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Write fraction	1.00	Write fraction	1.00	Write fraction	1.00	Write size	1.00
Write size	0.58	Bandwidth	0.47	Write size	0.38	Read size	0.83
Bandwidth	0.52	Read size	0.47	Bandwidth	0.33	Read queue	0.82
Read queue	0.50	Throughput	0.43	Read queue	0.32	Bandwidth	0.73
Read size	0.44	Write size	0.39	Read jump	0.32	Latency	0.60
Write queue	0.35	Read queue	0.38	Write queue	0.26	Write fraction	0.58
Throughput	0.32	Write queue	0.29	Throughput	0.22	Write queue	0.47
Latency	0.26	Read jump	0.19	Latency	0.15	Write jump	0.47
Read jump	0.25	Write jump	0.13	Write jump	0.11	Write latency	0.41
Write jump	0.21	Write latency	0.11	Read size	0.09	Read latency	0.21
Write latency	0.17	Latency	0.11	Read latency	0.08	Throughput	0.19
Read latency	0.10	Read latency	0.04	Write latency	0.05	Read jump	0.12

Table G.4: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	7.7	9.8	6.2	7.2
Relative	8.0	9.3	6.8	7.8
Relative Performance	6.8	8.4	5.4	6.7
Relative Fitness	6.2	6.5	6.2	5.8

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	6.0	-	-	-
Array	-	8.0	-	-
Array	-	-	9.0	-
Array	-	-	-	8.0
Relative	**Array**	**Array**	**Array**	**Array**
Array	6.0	8.3	6.3	8.0
Array	8.7	8.0	10.7	7.7
Array	5.0	10.3	9.0	8.3
Array	7.7	9.0	5.7	8.0
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	8.3	6.3	5.0	7.7
Array	5.3	8.3	6.3	7.3
Array	5.3	9.0	8.0	8.0
Array	6.0	9.7	6.0	8.3
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	7.3	4.3	6.3
Array	8.0	1	3.3	6.7
Array	7.0	6.3	1	7.3
Array	6.3	6.0	4.7	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	10.0	-	-	-	2.0	-	-	-	6.0	-	-	-
Array B	-	11.0	-	-	-	8.0	-	-	-	5.0	-	-
Array C	-	-	10.0	-	-	-	7.0	-	-	-	10.0	-
Array D	-	-	-	8.0	-	-	-	8.0	-	-	-	8.0
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	10.0	10.0	10.0	7.0	2.0	8.0	3.0	7.0	6.0	7.0	6.0	10.0
Array B	10.0	11.0	11.0	7.0	9.0	8.0	11.0	9.0	7.0	5.0	10.0	7.0
Array C	4.0	10.0	10.0	8.0	4.0	8.0	7.0	9.0	7.0	13.0	10.0	8.0
Array D	12.0	11.0	12.0	8.0	2.0	9.0	2.0	8.0	9.0	7.0	3.0	8.0
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	9.0	10.0	8.0	7.0	8.0	4.0	2.0	8.0	8.0	5.0	5.0	8.0
Array B	7.0	9.0	9.0	7.0	3.0	7.0	4.0	8.0	6.0	9.0	6.0	7.0
Array C	8.0	8.0	7.0	7.0	4.0	8.0	8.0	8.0	4.0	11.0	9.0	9.0
Array D	9.0	12.0	9.0	7.0	3.0	9.0	4.0	9.0	6.0	8.0	5.0	9.0
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	8.0	4.0	7.0	1	6.0	2.0	8.0	1	8.0	7.0	4.0
Array B	5.0	1	4.0	7.0	9.0	1	4.0	6.0	10.0	1	2.0	7.0
Array C	11.0	6.0	1	8.0	6.0	9.0	1	6.0	4.0	4.0	1	8.0
Array D	7.0	8.0	3.0	1	8.0	7.0	3.0	1	4.0	3.0	8.0	1

Table G.5: Tree sizes (leaf nodes) and their averages.

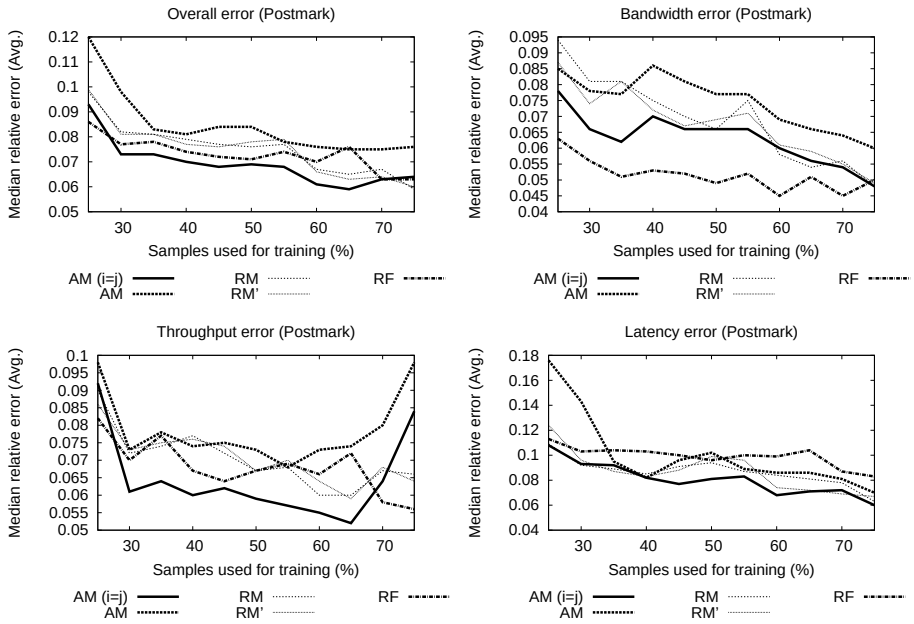

Figure G.7: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

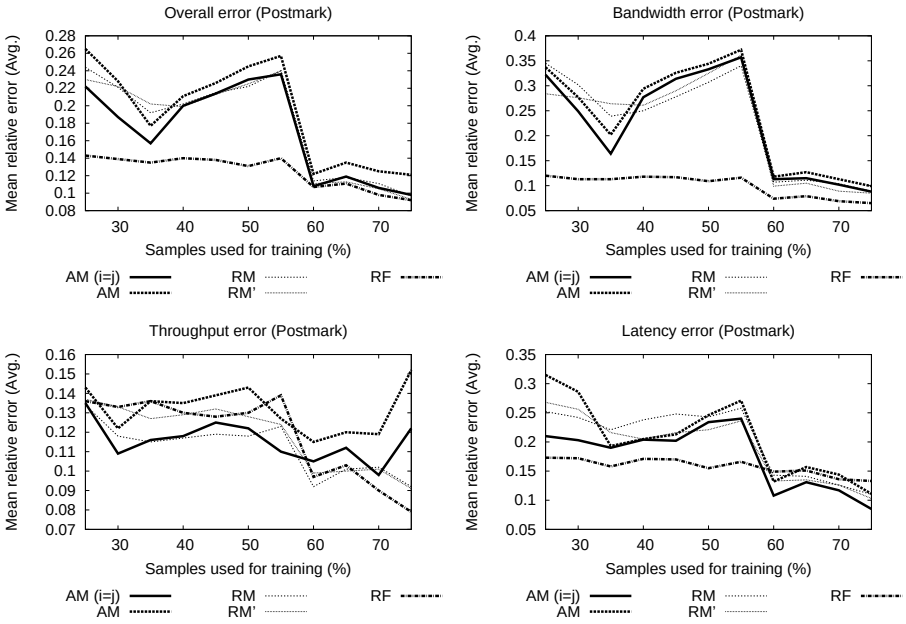

Figure G.8: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

Appendix H

Cello model training

Application	Samples	Iters	First sample	Last sample
(srt)	78	3	0	38
Total used	39			

Table H.1: Multiple training samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

	Array A	Array B	Array C	Array D	MAD	COV	Max. Diff.
Write fraction	0.45	0.44	0.44	0.47	0.0	2.8%	6.8%
Write size (KB)	17.70	21.41	17.67	20.69	1.7	8.8%	21.2%
Read size (KB)	6.98	7.14	7.37	7.22	0.1	1.9%	5.6%
Write jump (MB)	8.64	8.79	9.15	12.44	1.3	16.0%	44.0%
Read jump (MB)	313.28	303.72	301.67	326.10	8.5	3.1%	8.1%
Write queue	57.95	51.73	53.74	59.93	3.1	5.8%	15.8%
Read queue	5.99	5.84	5.76	6.08	0.1	2.1%	5.6%
Bandwidth (MB/sec)	8.60	4.33	5.04	10.03	2.3	34.1%	131.6%
Throughput (IO/sec)	807.82	435.87	481.05	974.33	216.3	33.3%	123.5%
Latency (ms)	19.10	44.86	42.51	7.40	15.2	55.5%	506.2%
Write latency (ms)	41.15	123.67	108.74	9.10	45.5	66.8%	1259.0%
Read latency (ms)	6.98	9.35	9.14	10.14	1.0	13.2%	45.3%

Table H.2: Workload characteristics and performance are measured for each sample, on each storage device. The average value for each measurement is reported in this table. The mean absolute deviation (MAD), coefficient of variation (COV), and maximum relative differences of these averages are also reported; these metrics quantify how the averages change among the storage devices. For example, the mean average deviation of the averages for Read latency (ms) is 0.96, their coeefficient of variation is 13.160%, and the maximum relative difference is 45.27%.

Array A								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	10.7%	0.2	0.4	0.5	0.5	0.6	0.6	0.4
Write size (KB)	1.5%	11.3	13.7	16.2	19.4	23.5	34.8	17.7
Read size (KB)	0.1%	5.7	6.1	6.7	7.5	8.0	12.2	7.0
Write jump (MB)	14.5%	0.0	5.0	7.0	9.0	10.0	42.0	8.6
Read jump (MB)	0.5%	106.0	200.0	301.0	401.0	479.0	534.0	313.3
Write queue	0.1%	52.2	56.3	57.9	59.7	60.1	60.5	57.9
Read queue	0.1%	1.0	1.6	4.7	10.1	10.5	20.8	6.0
Bandwidth (MB/sec)	5.0%	4.4	6.2	8.1	10.2	11.5	18.9	8.6
Throughput (IO/sec)	2.8%	460.0	588.0	765.0	1017.0	1090.0	1215.0	807.8
Latency (ms)	8.2%	7.6	17.3	19.2	21.4	23.9	26.9	19.1
Write latency (ms)	0.1%	34.0	38.1	40.2	43.3	45.7	50.0	41.2
Read latency (ms)	0.5%	2.1	3.5	5.8	9.8	10.3	18.1	7.0

Array B								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	7.8%	0.1	0.3	0.4	0.5	0.6	0.7	0.4
Write size (KB)	6.7%	9.2	12.2	15.3	21.6	29.0	144.0	21.4
Read size (KB)	0.3%	5.3	6.0	6.8	7.4	8.4	15.2	7.1
Write jump (MB)	0.4%	0.0	0.0	1.0	12.0	23.0	62.0	8.8
Read jump (MB)	0.7%	112.0	200.0	260.0	380.0	438.0	646.0	303.7
Write queue	1.4%	42.8	49.9	52.1	54.2	55.1	56.2	51.7
Read queue	0.2%	1.0	1.6	4.2	9.5	10.3	20.5	5.8
Bandwidth (MB/sec)	7.6%	1.8	3.1	4.1	5.2	5.7	7.0	4.3
Throughput (IO/sec)	0.4%	218.0	312.0	408.0	550.0	629.0	784.0	435.9
Latency (ms)	8.5%	6.7	30.0	40.5	54.2	72.7	91.7	44.9
Write latency (ms)	1.9%	106.9	117.7	123.0	129.6	131.7	143.2	123.7
Read latency (ms)	0.3%	4.7	6.1	7.8	11.5	13.2	20.4	9.4

Array C								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	6.2%	0.1	0.4	0.4	0.5	0.6	0.7	0.4
Write size (KB)	4.9%	9.5	12.2	17.0	20.3	25.9	33.2	17.7
Read size (KB)	0.5%	5.4	6.1	6.9	7.9	9.6	15.4	7.4
Write jump (MB)	0.8%	0.0	0.0	6.0	13.0	20.0	42.0	9.2
Read jump (MB)	1.1%	113.0	209.0	296.0	371.0	425.0	515.0	301.7
Write queue	0.3%	48.6	51.8	53.5	55.4	56.0	57.0	53.7
Read queue	0.1%	1.0	1.6	4.3	9.0	9.9	20.4	5.8
Bandwidth (MB/sec)	4.9%	2.4	4.0	4.7	5.8	6.6	8.9	5.0
Throughput (IO/sec)	0.1%	282.0	374.0	472.0	556.0	656.0	671.0	481.1
Latency (ms)	5.8%	17.9	31.6	39.4	49.3	59.9	72.8	42.5
Write latency (ms)	1.0%	99.0	103.4	107.6	112.0	114.8	127.5	108.7
Read latency (ms)	0.1%	2.5	4.4	6.8	12.8	17.3	25.6	9.1

Array D								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	7.0%	0.2	0.4	0.5	0.6	0.6	0.7	0.5
Write size (KB)	3.4%	11.7	13.7	16.9	21.1	27.4	117.0	20.7
Read size (KB)	0.6%	5.8	6.2	6.9	7.6	8.1	13.2	7.2
Write jump (MB)	21.7%	4.0	5.0	7.0	11.0	32.0	52.0	12.4
Read jump (MB)	1.0%	110.0	224.0	287.0	422.0	488.0	542.0	326.1
Write queue	1.5%	52.0	58.8	60.4	61.4	62.2	63.0	59.9
Read queue	0.2%	1.0	1.7	4.8	10.0	10.7	21.6	6.1
Bandwidth (MB/sec)	18.0%	4.3	7.2	9.5	12.5	13.5	17.2	10.0
Throughput (IO/sec)	18.4%	401.0	744.0	876.0	1186.0	1433.0	1712.0	974.3
Latency (ms)	6.9%	4.0	5.2	7.1	8.8	10.0	15.3	7.4
Write latency (ms)	0.2%	6.9	7.5	8.7	9.9	11.2	16.4	9.1
Read latency (ms)	16.9%	3.7	6.0	8.1	13.5	16.1	23.3	10.1

Table H.3: Workload characteristics and performance are measured for each sample, on each storage device. The minimum value, percentiles, maximum value and average are reported for each measurement. In addition, the relative difference between the average performance of the best and second-to-best iteration is reported. This value quantifies the change in a given measurement across multiple runs of the same sample on the same storage device.

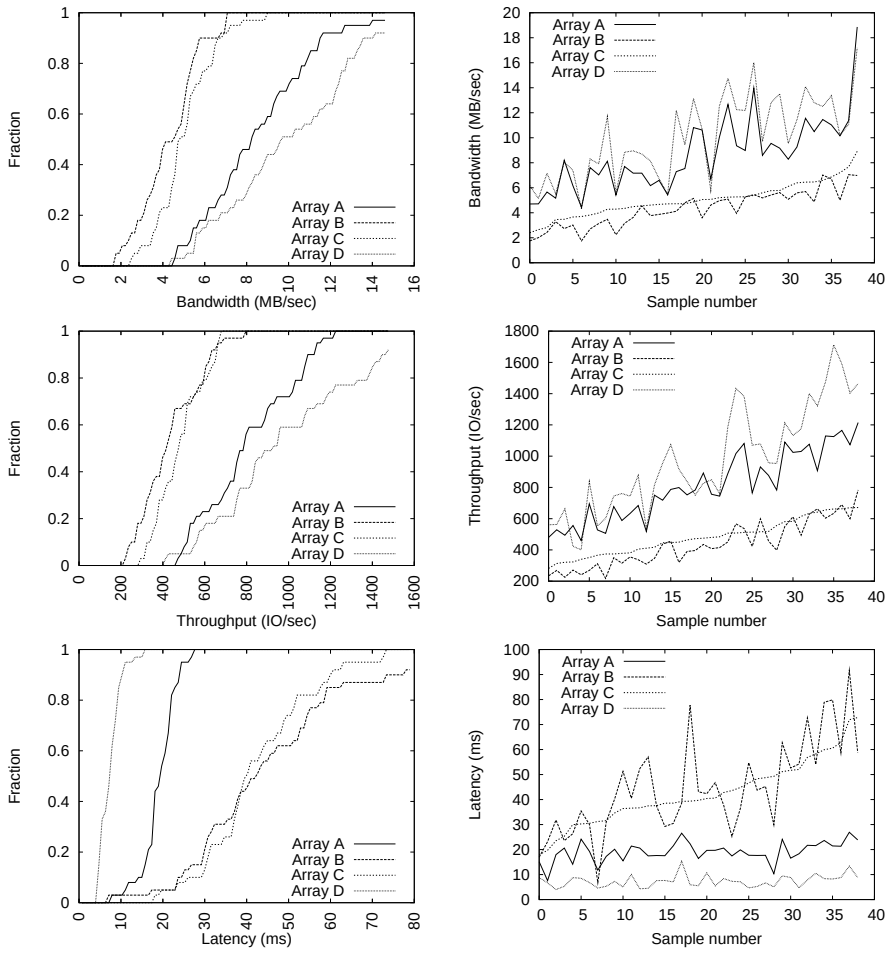

Figure H.1: The cumulative distribution of performance is shown (top). In addition, the performance of each array is shown (bottom), sorted by the performance of Array C.

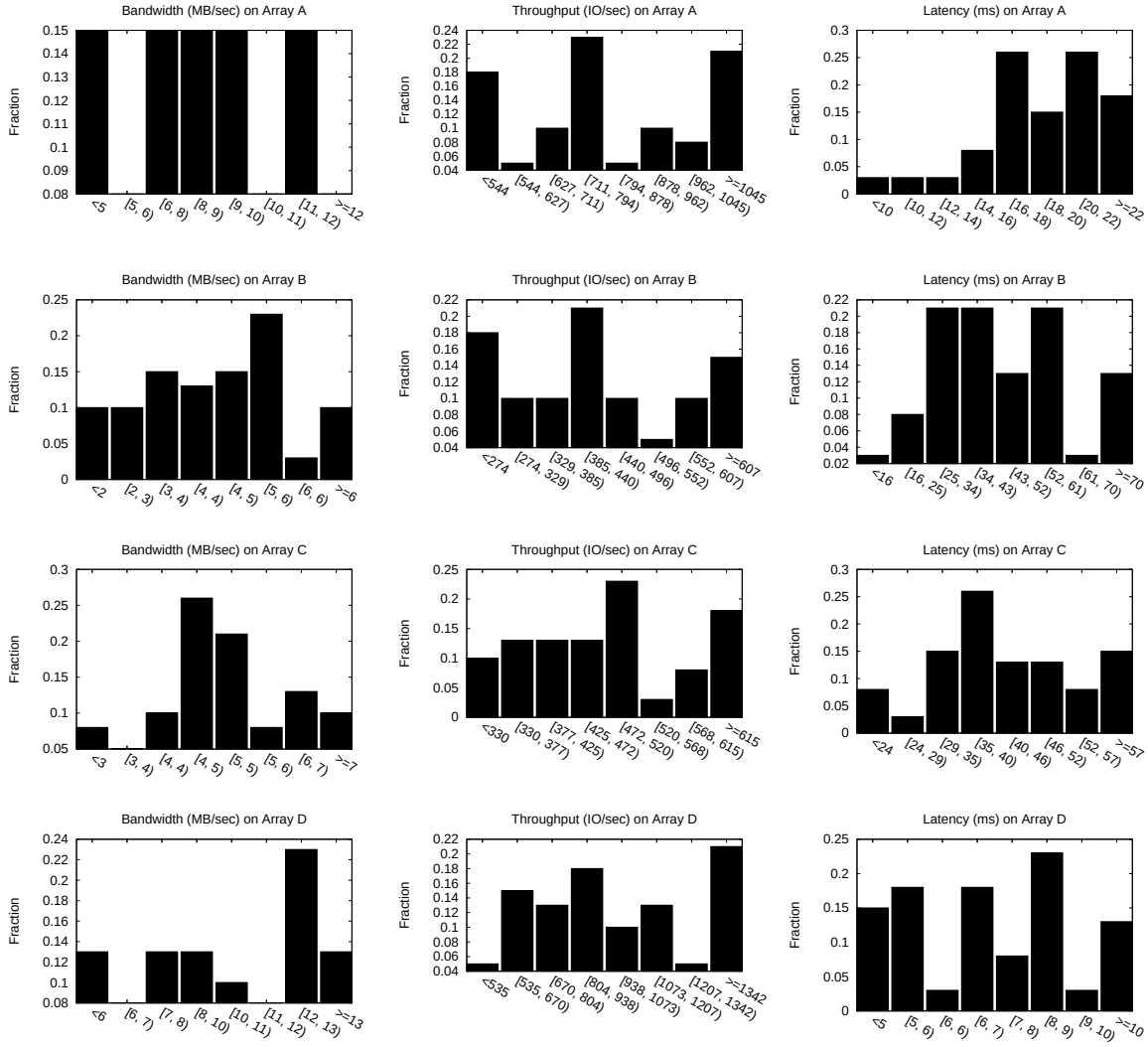

Figure H.2: Probability distributions of performance.

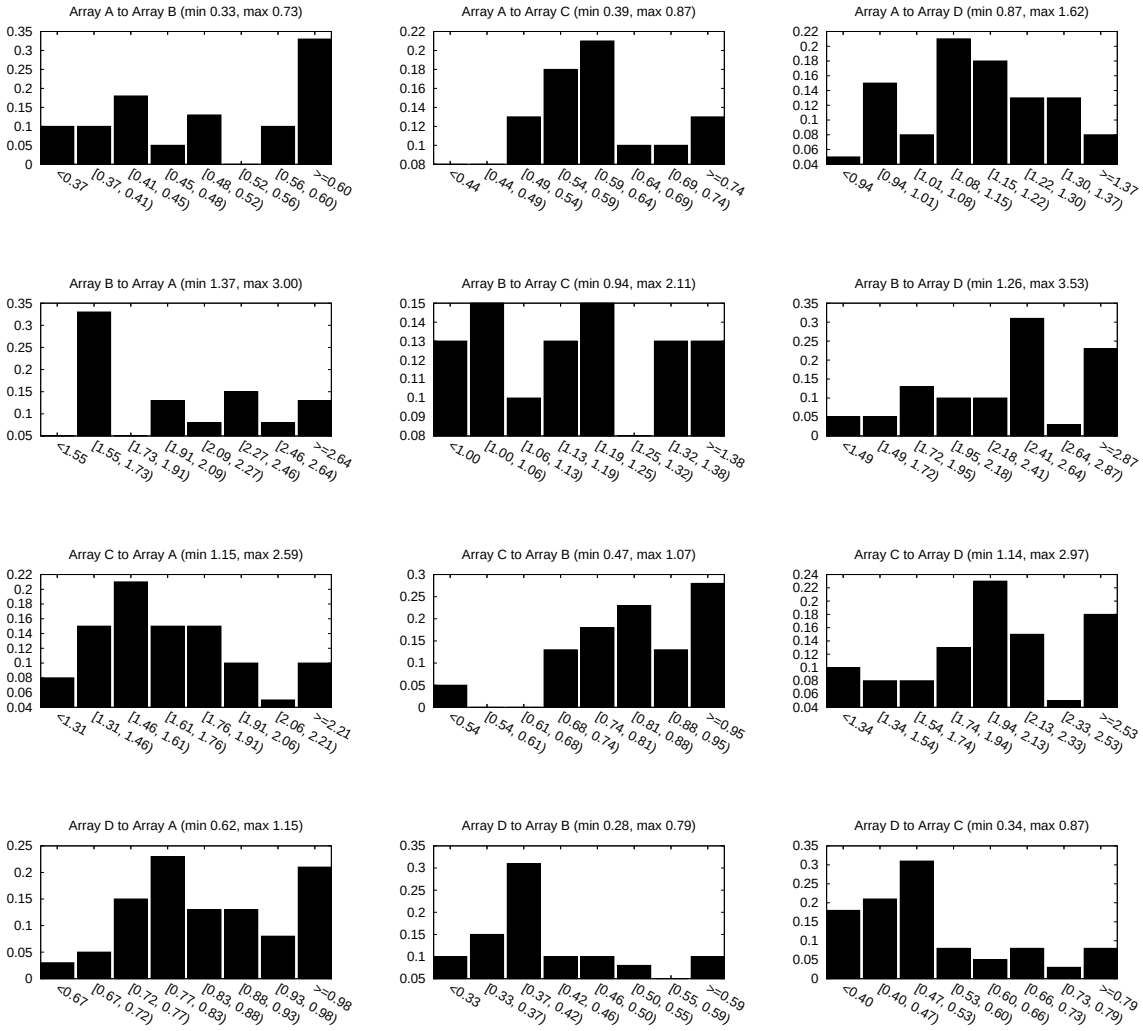

Figure H.3: Each graph shows the probability distribution of the **Bandwidth** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

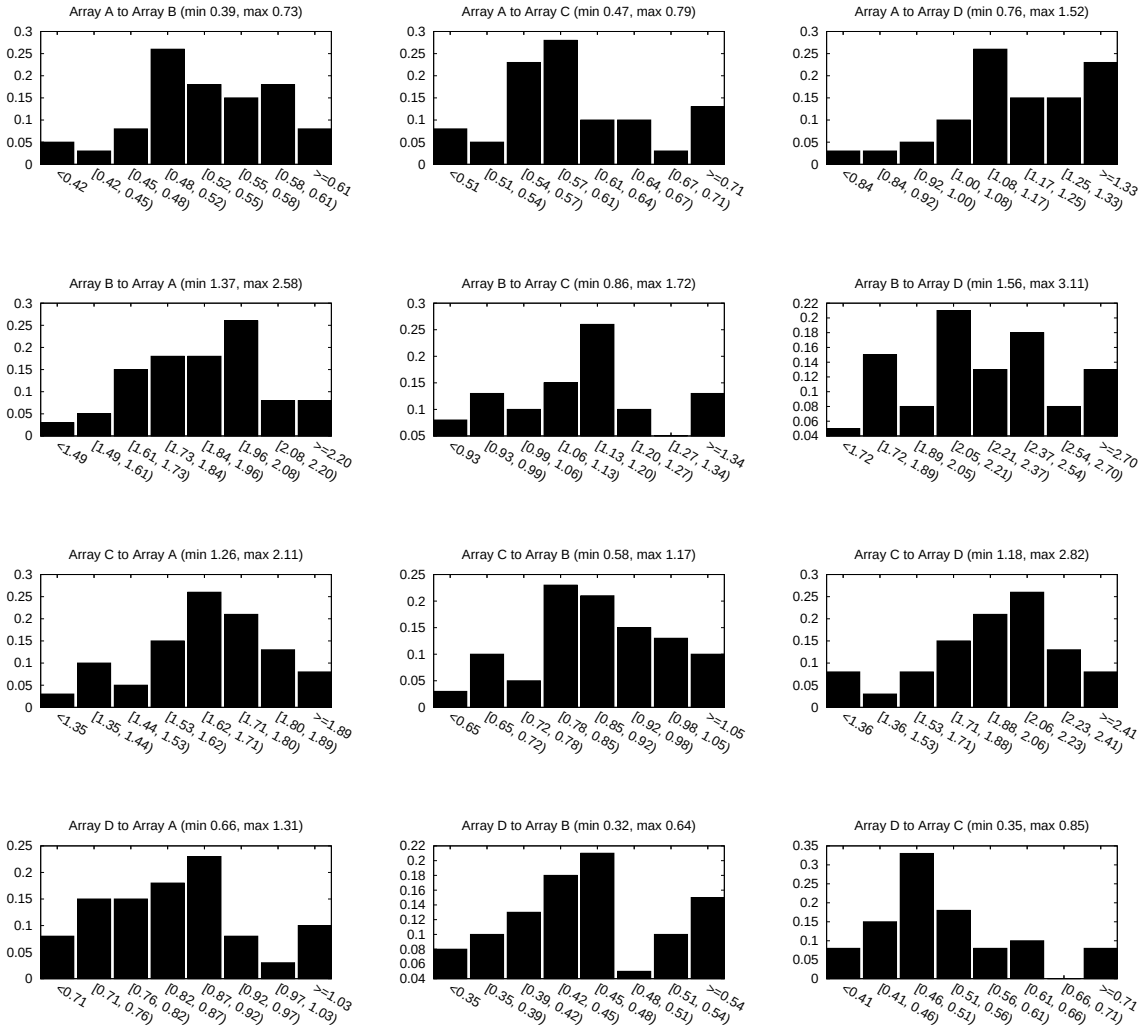

Figure H.4: Each graph shows the probability distribution of the **Throughput** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

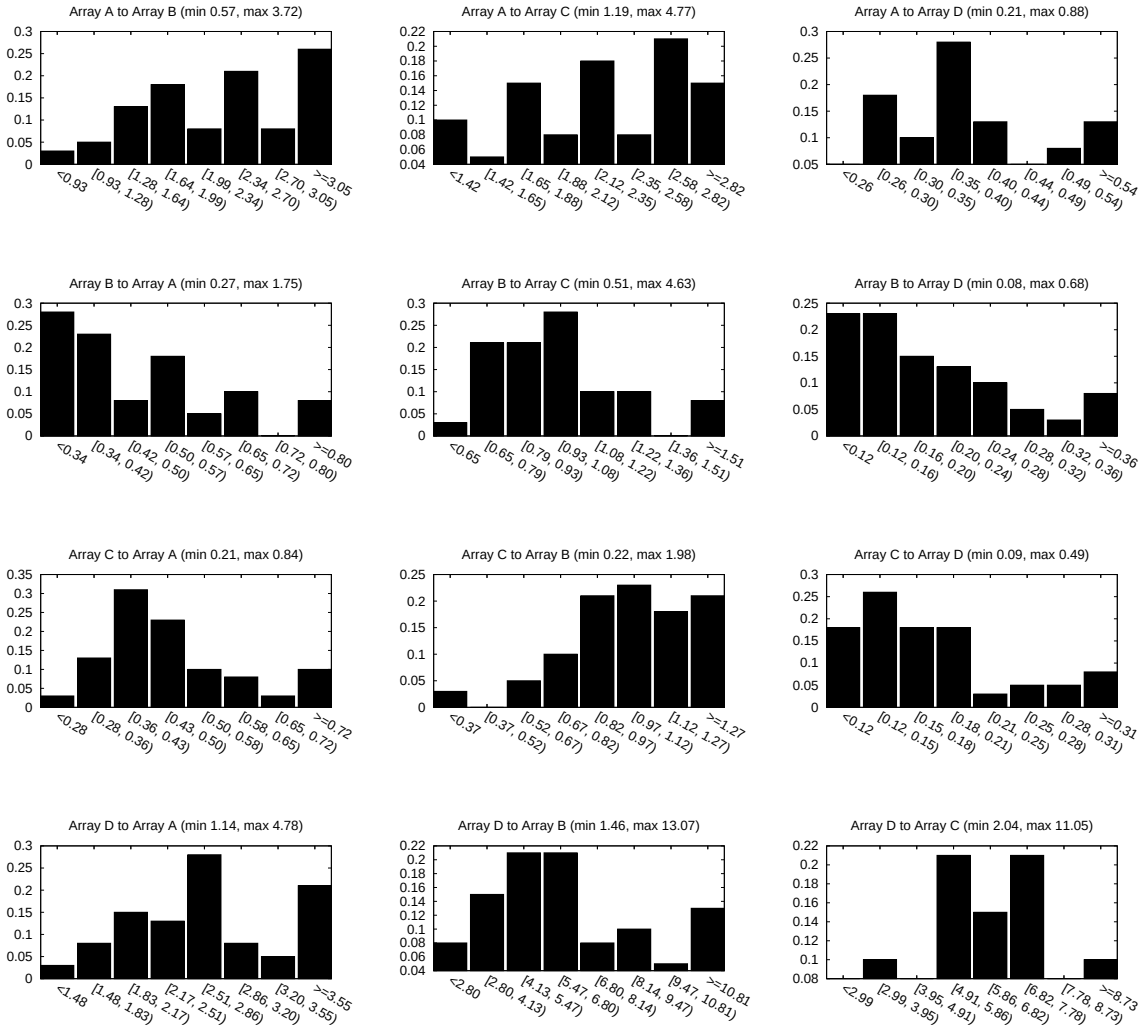

Figure H.5: Each graph shows the probability distribution of the **Latency** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

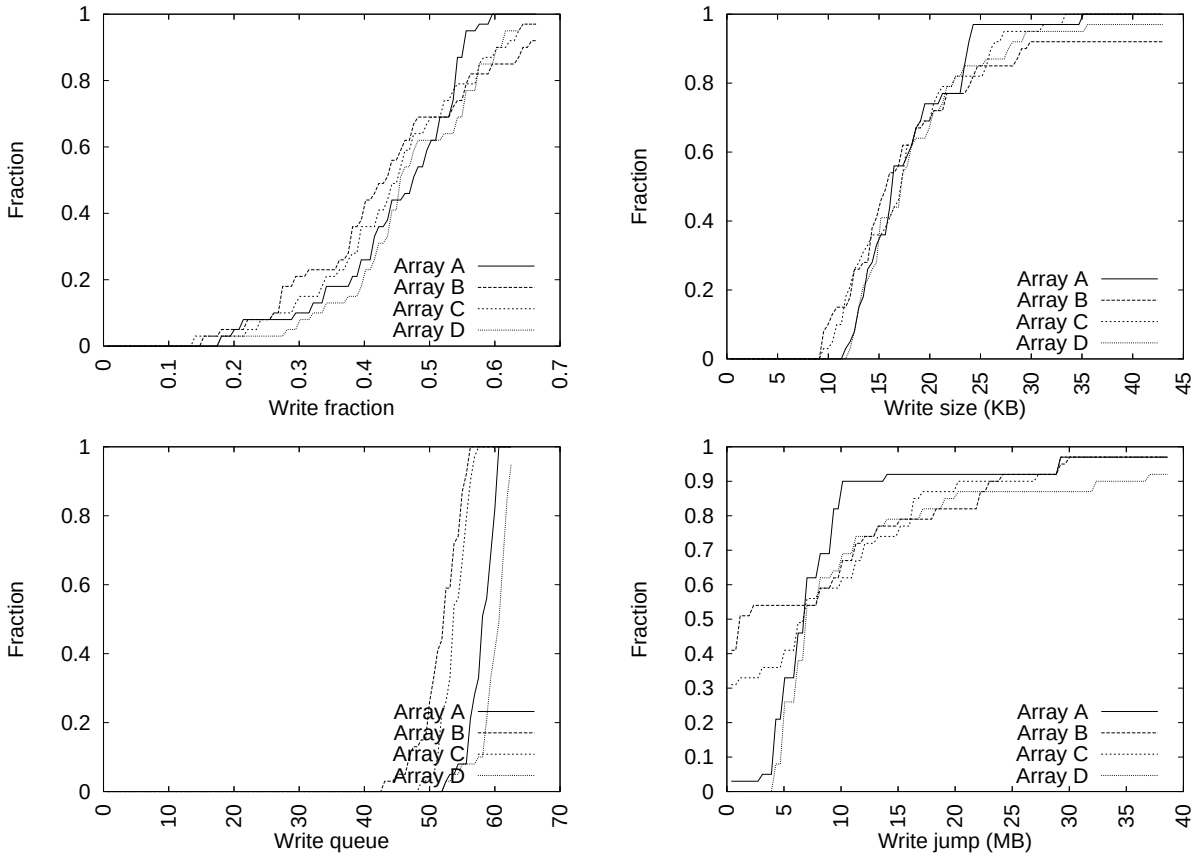

Figure H.6: The cumulative distribution of workload characteristics.

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Write fraction	1.00
Write fraction	0.64	Write fraction	0.40	Write fraction	0.17	Read queue	0.57
Write size	0.17	Write size	0.28	Write size	0.10	Write queue	0.13
Write queue	0.07	Write jump	0.16	Read jump	0.10	Read size	0.09
Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read queue	1.00	Read queue	1.00	Read queue	1.00
Write fraction	0.20	Write size	0.20	Read jump	0.11	Write fraction	0.93
Write size	0.18	Read size	0.16	Write queue	0.06	Write queue	0.64
Read jump	0.16	Write fraction	0.09	Write size	0.04	Write size	0.59
Write queue	0.14	Read jump	0.05	Read size	0.02	Read jump	0.50
Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Throughput	1.00	Bandwidth	1.00	Throughput	1.00	Bandwidth	1.00
Bandwidth	0.97	Throughput	0.35	Read queue	0.74	Latency	0.90
Read queue	0.72	Read queue	0.30	Read jump	0.10	Read latency	0.77
Read latency	0.33	Read latency	0.15	Write queue	0.08	Write size	0.72
Latency	0.30	Read size	0.09	Read size	0.07	Throughput	0.41
Write size	0.24	Write fraction	0.08	Bandwidth	0.05	Read jump	0.36
Read jump	0.18	Write size	0.04	Write jump	0.03	Write queue	0.27
Write queue	0.15	Latency	0.04	Write fraction	0.03	Write fraction	0.21
Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Write fraction	1.00	Write size	1.00	Read latency	1.00	Write fraction	1.00
Throughput	0.79	Throughput	0.60	Throughput	0.98	Latency	0.89
Read queue	0.71	Read queue	0.57	Write latency	0.77	Write queue	0.47
Latency	0.71	Write fraction	0.48	Read queue	0.47	Read jump	0.30
Write size	0.66	Read size	0.47	Bandwidth	0.23	Read queue	0.25
Read latency	0.55	Write queue	0.35	Write fraction	0.23	Read latency	0.16
Write queue	0.50	Bandwidth	0.19	Write jump	0.20	Bandwidth	0.13
Write latency	0.40	Read jump	0.17	Latency	0.18	Read size	0.11

Table H.4: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	5.6	5.5	4.5	6.8
Relative	3.2	3.2	3.9	2.5
Relative Performance	4.2	4.3	4.5	3.8
Relative Fitness	3.2	4.8	1.9	2.8

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	4.7	-	-	-
Array	-	6.3	-	-
Array	-	-	5.0	-
Array	-	-	-	6.3
Relative	**Array**	**Array**	**Array**	**Array**
Array	4.7	2.0	3.0	4.7
Array	2.3	6.3	5.7	2.3
Array	2.7	5.3	5.0	2.3
Array	2.7	2.7	2.7	6.3
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	7.0	3.3	3.7	5.3
Array	5.0	6.7	3.7	4.3
Array	3.3	6.7	5.7	4.0
Array	4.0	5.0	2.3	7.0
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	4.7	2.0	4.0
Array	3.3	1	4.0	3.7
Array	4.7	2.0	1	3.0
Array	2.3	2.3	2.3	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	2.0	-	-	-	5.0	-	-	-	7.0	-	-	-
Array B	-	6.0	-	-	-	7.0	-	-	-	6.0	-	-
Array C	-	-	7.0	-	-	-	3.0	-	-	-	5.0	-
Array D	-	-	-	7.0	-	-	-	3.0	-	-	-	9.0
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	2.0	2.0	5.0	2.0	5.0	3.0	3.0	5.0	7.0	1.0	1.0	7.0
Array B	2.0	6.0	7.0	2.0	3.0	7.0	7.0	3.0	2.0	6.0	3.0	2.0
Array C	4.0	3.0	7.0	2.0	3.0	7.0	3.0	3.0	1.0	6.0	5.0	2.0
Array D	3.0	2.0	4.0	7.0	4.0	3.0	3.0	3.0	1.0	3.0	1.0	9.0
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	6.0	2.0	3.0	8.0	8.0	7.0	7.0	3.0	7.0	1.0	1.0	5.0
Array B	3.0	7.0	4.0	3.0	3.0	6.0	3.0	3.0	9.0	7.0	4.0	7.0
Array C	6.0	7.0	6.0	4.0	3.0	7.0	6.0	5.0	1.0	6.0	5.0	3.0
Array D	7.0	2.0	3.0	7.0	3.0	7.0	3.0	6.0	2.0	6.0	1.0	8.0
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	9.0	2.0	2.0	1	3.0	1.0	2.0	1	2.0	3.0	8.0
Array B	6.0	1	9.0	5.0	2.0	1	2.0	2.0	2.0	1	1.0	4.0
Array C	11.0	2.0	1	3.0	1.0	2.0	1	2.0	2.0	2.0	1	4.0
Array D	3.0	3.0	3.0	1	1.0	3.0	2.0	1	3.0	1.0	2.0	1

Table H.5: Tree sizes (leaf nodes) and their averages.

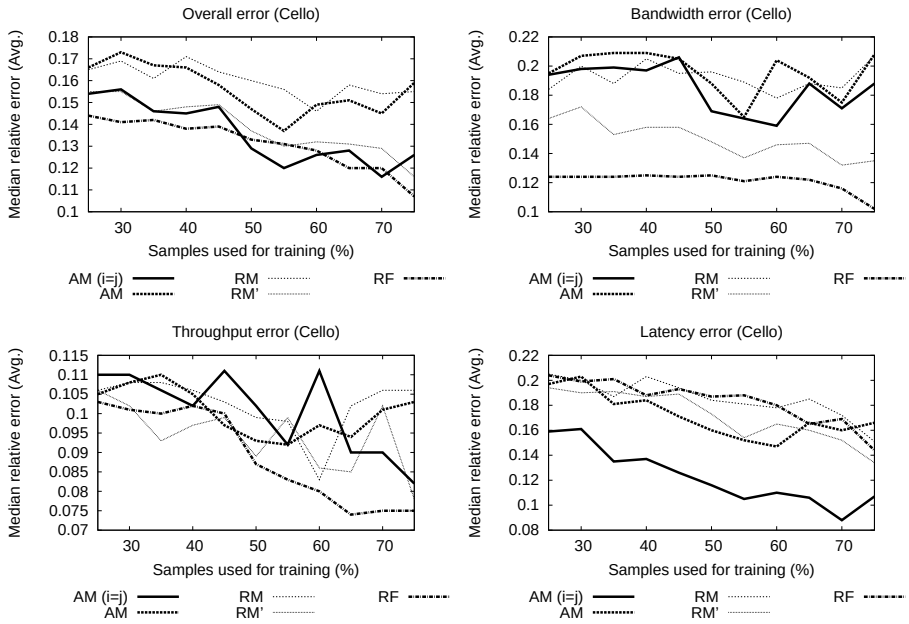

Figure H.7: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

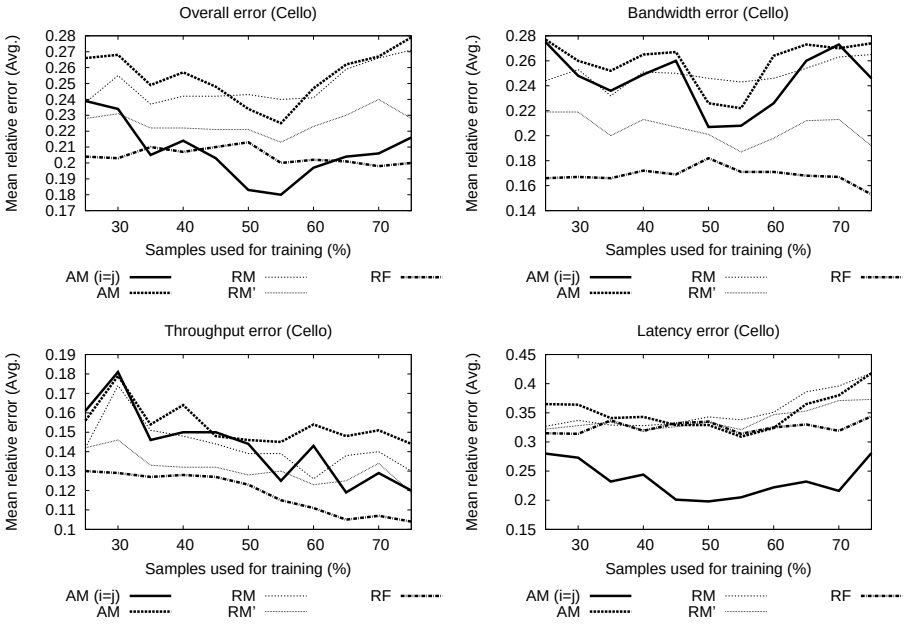

Figure H.8: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

Appendix I

TPC-C model training

Application	Samples	Iters	First sample	Last sample
TPC-C (tpcc)	50	3	0	24
Total used	25			

Table I.1: Multiple training samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

	Array A	Array B	Array C	Array D	MAD	COV	Max. Diff.
Write fraction	0.18	0.21	0.16	0.24	0.0	14.1%	50.0%
Write size (KB)	8.52	8.45	8.61	8.77	0.1	1.4%	3.8%
Read size (KB)	8.14	8.12	8.17	8.12	0.0	0.2%	0.6%
Write jump (MB)	125.28	208.12	101.56	132.96	33.1	28.1%	104.9%
Read jump (MB)	273.16	270.48	277.00	299.40	9.7	4.1%	10.7%
Write queue	18.96	30.82	13.28	13.52	5.8	37.2%	132.1%
Read queue	1.00	1.00	1.00	1.00	0.0	0.1%	0.0%
Bandwidth (MB/sec)	1.69	1.12	1.96	2.40	0.4	25.9%	114.3%
Throughput (IO/sec)	211.60	140.04	243.84	296.92	47.3	25.5%	112.0%
Latency (ms)	5.78	17.29	5.12	1.94	4.9	77.2%	791.2%
Write latency (ms)	20.82	85.17	26.93	2.81	25.6	91.0%	2931.0%
Read latency (ms)	4.15	7.31	2.57	2.15	1.7	50.1%	240.0%

Table I.2: Workload characteristics and performance are measured for each sample, on each storage device. The average value for each measurement is reported in this table. The mean absolute deviation (MAD), coefficient of variation (COV), and maximum relative differences of these averages are also reported; these metrics quantify how the averages change among the storage devices. For example, the mean average deviation of the averages for Read latency (ms) is 1.68, their coeefficient of variation is 50.144%, and the maximum relative difference is 240.00%.

Array A								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	2.6%	0.0	0.1	0.1	0.2	0.2	1.0	0.2
Write size (KB)	0.3%	7.6	8.2	8.5	8.7	8.8	9.3	8.5
Read size (KB)	0.2%	8.0	8.0	8.1	8.2	8.3	8.4	8.1
Write jump (MB)	15.7%	54.0	86.0	97.0	131.0	152.0	542.0	125.3
Read jump (MB)	0.2%	182.0	210.0	277.0	311.0	324.0	333.0	273.2
Write queue	10.1%	4.1	12.7	13.7	17.5	33.0	48.5	19.0
Read queue	0.0%	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Bandwidth (MB/sec)	1.4%	1.3	1.4	1.6	1.8	2.2	2.3	1.7
Throughput (IO/sec)	1.2%	170.0	180.0	194.0	226.0	275.0	296.0	211.6
Latency (ms)	2.0%	3.0	5.2	6.1	6.4	6.8	7.0	5.8
Write latency (ms)	7.8%	14.8	15.6	16.6	19.0	34.0	40.6	20.8
Read latency (ms)	1.1%	2.9	3.3	4.2	4.6	4.9	5.1	4.1

Array B								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	12.6%	0.0	0.2	0.2	0.3	0.3	0.3	0.2
Write size (KB)	0.0%	7.4	8.3	8.4	8.5	8.6	10.1	8.5
Read size (KB)	0.1%	8.0	8.0	8.1	8.2	8.3	8.8	8.1
Write jump (MB)	7.4%	58.0	101.0	163.0	194.0	241.0	1157.0	208.1
Read jump (MB)	1.0%	183.0	218.0	272.0	302.0	319.0	381.0	270.5
Write queue	9.3%	4.8	25.8	31.6	35.6	41.0	43.4	30.8
Read queue	0.1%	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Bandwidth (MB/sec)	2.8%	0.9	1.0	1.1	1.2	1.3	1.4	1.1
Throughput (IO/sec)	2.4%	114.0	125.0	132.0	157.0	159.0	180.0	140.0
Latency (ms)	14.3%	5.6	13.2	17.9	20.7	21.9	24.5	17.3
Write latency (ms)	5.4%	35.3	73.8	82.7	97.3	106.5	112.6	85.2
Read latency (ms)	0.4%	5.5	6.6	7.2	8.0	8.4	8.6	7.3

Array C								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	1.5%	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Write size (KB)	0.2%	7.7	8.4	8.7	8.8	8.9	9.0	8.6
Read size (KB)	0.0%	8.0	8.0	8.1	8.3	8.3	8.4	8.2
Write jump (MB)	14.0%	44.0	63.0	96.0	126.0	137.0	244.0	101.6
Read jump (MB)	0.8%	175.0	242.0	292.0	306.0	316.0	340.0	277.0
Write queue	14.9%	8.5	9.4	10.1	13.3	17.1	34.9	13.3
Read queue	0.1%	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Bandwidth (MB/sec)	1.7%	1.3	1.8	2.0	2.1	2.2	2.6	2.0
Throughput (IO/sec)	1.6%	166.0	211.0	246.0	266.0	274.0	311.0	243.8
Latency (ms)	6.4%	3.5	4.3	4.9	5.8	6.1	8.1	5.1
Write latency (ms)	9.0%	18.6	19.7	21.5	25.7	40.9	67.3	26.9
Read latency (ms)	1.5%	1.8	2.2	2.5	2.7	3.2	3.8	2.6

Array D								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	3.1%	0.1	0.2	0.2	0.2	0.2	1.0	0.2
Write size (KB)	0.2%	7.8	8.4	8.8	9.1	9.2	9.4	8.8
Read size (KB)	0.1%	8.0	8.0	8.1	8.2	8.2	8.3	8.1
Write jump (MB)	27.5%	64.0	86.0	123.0	145.0	191.0	289.0	133.0
Read jump (MB)	0.3%	184.0	287.0	319.0	322.0	327.0	362.0	299.4
Write queue	24.5%	3.8	7.8	8.5	10.8	13.4	61.3	13.5
Read queue	0.0%	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Bandwidth (MB/sec)	2.1%	0.9	2.2	2.5	2.6	2.8	2.9	2.4
Throughput (IO/sec)	2.0%	110.0	278.0	306.0	320.0	338.0	364.0	296.9
Latency (ms)	0.4%	1.5	1.6	1.7	2.0	2.5	3.4	1.9
Write latency (ms)	5.7%	0.7	1.2	1.7	2.9	5.5	11.9	2.8
Read latency (ms)	0.8%	1.6	1.9	2.0	2.2	2.6	3.4	2.1

Table I.3: Workload characteristics and performance are measured for each sample, on each storage device. The minimum value, percentiles, maximum value and average are reported for each measurement. In addition, the relative difference between the average performance of the best and second-to-best iteration is reported. This value quantifies the change in a given measurement across multiple runs of the same sample on the same storage device.

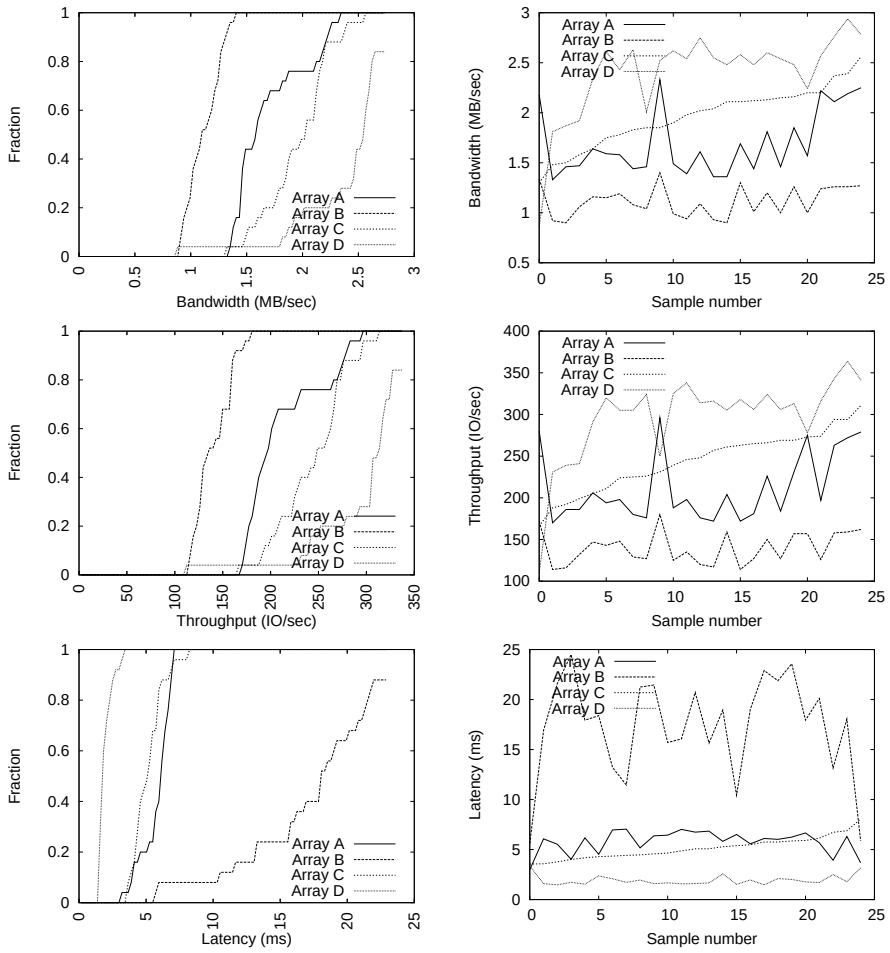

Figure I.1: The cumulative distribution of performance is shown (top). In addition, the performance of each array is shown (bottom), sorted by the performance of Array C.

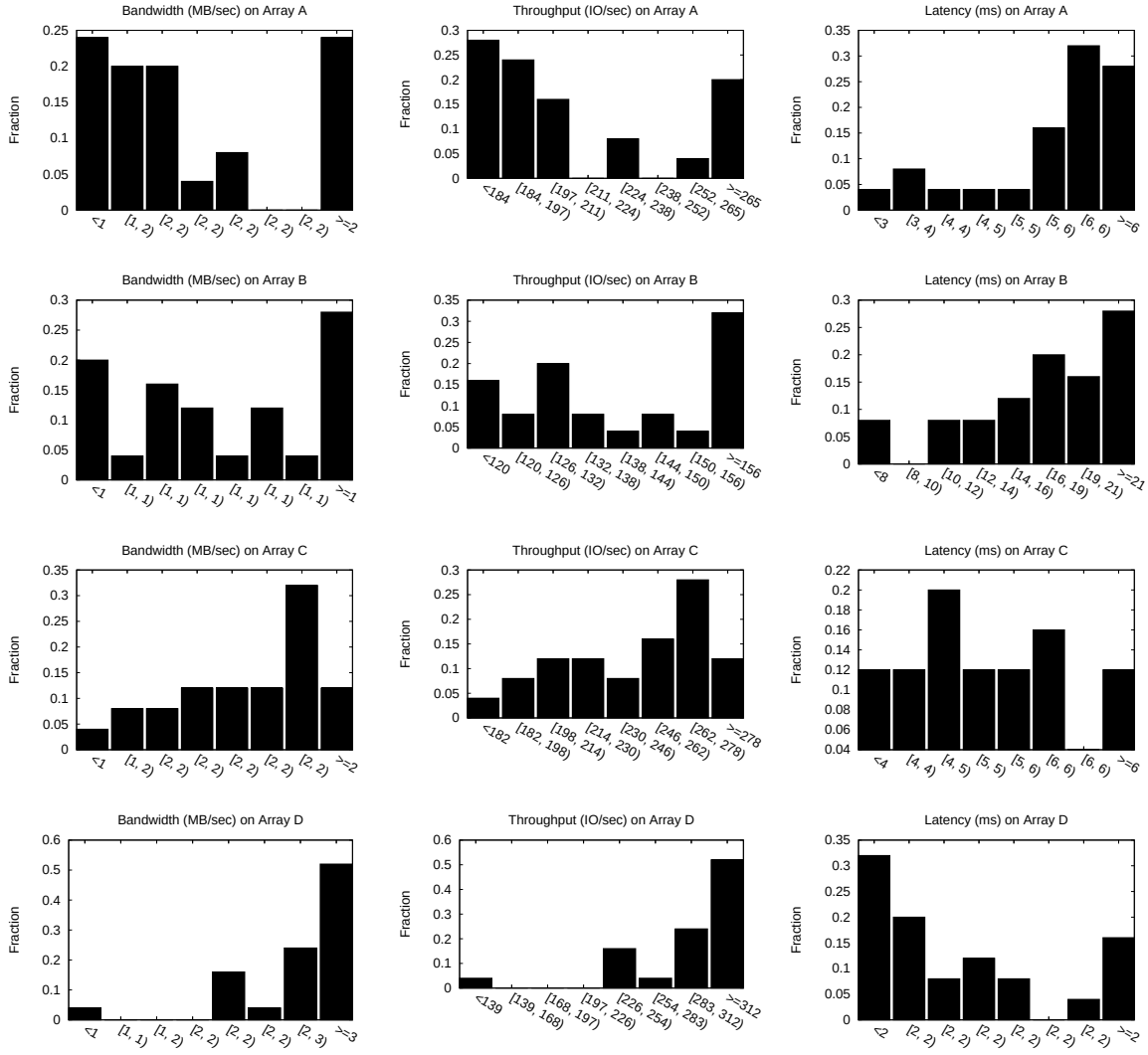

Figure I.2: Probability distributions of performance.

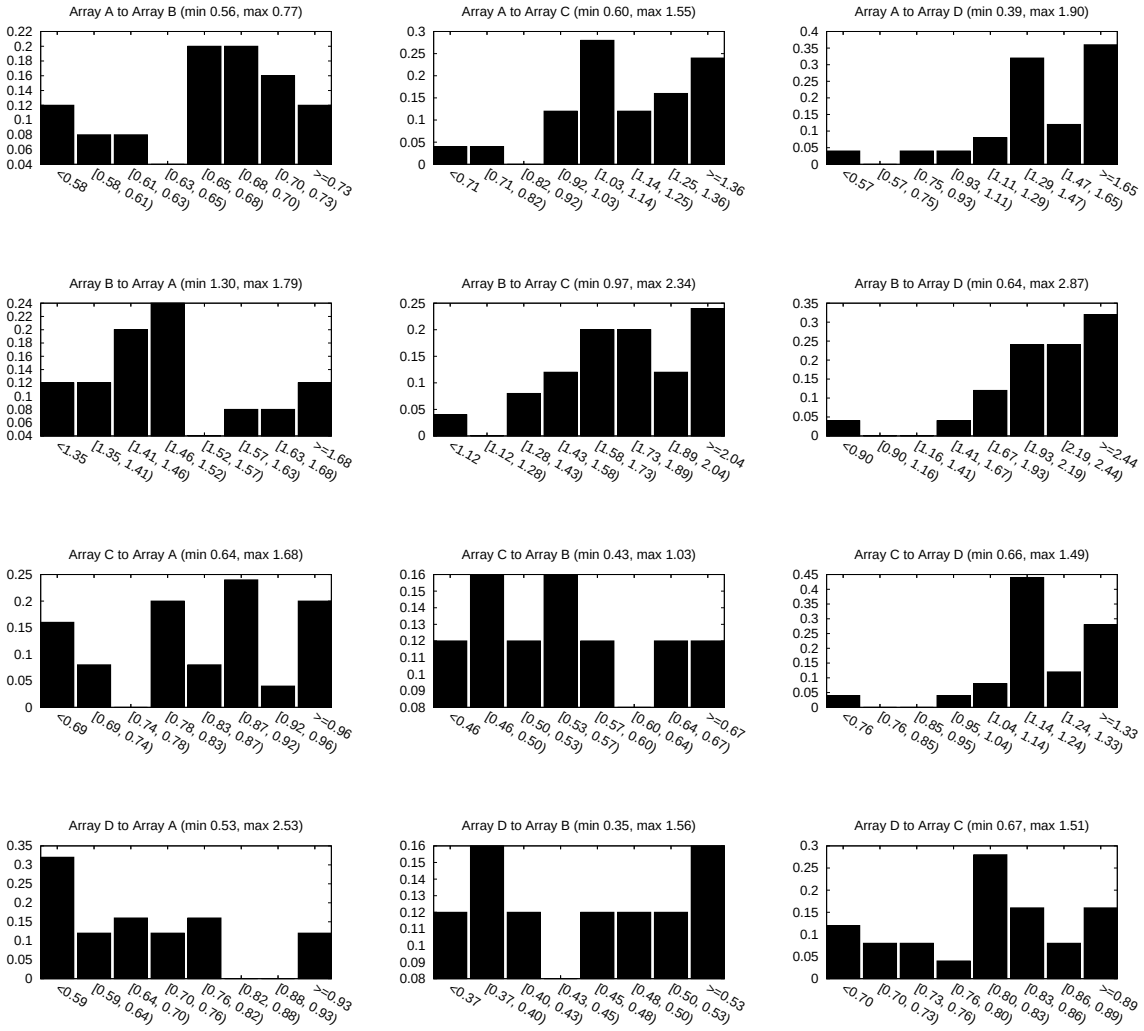

Figure I.3: Each graph shows the probability distribution of the **Bandwidth** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

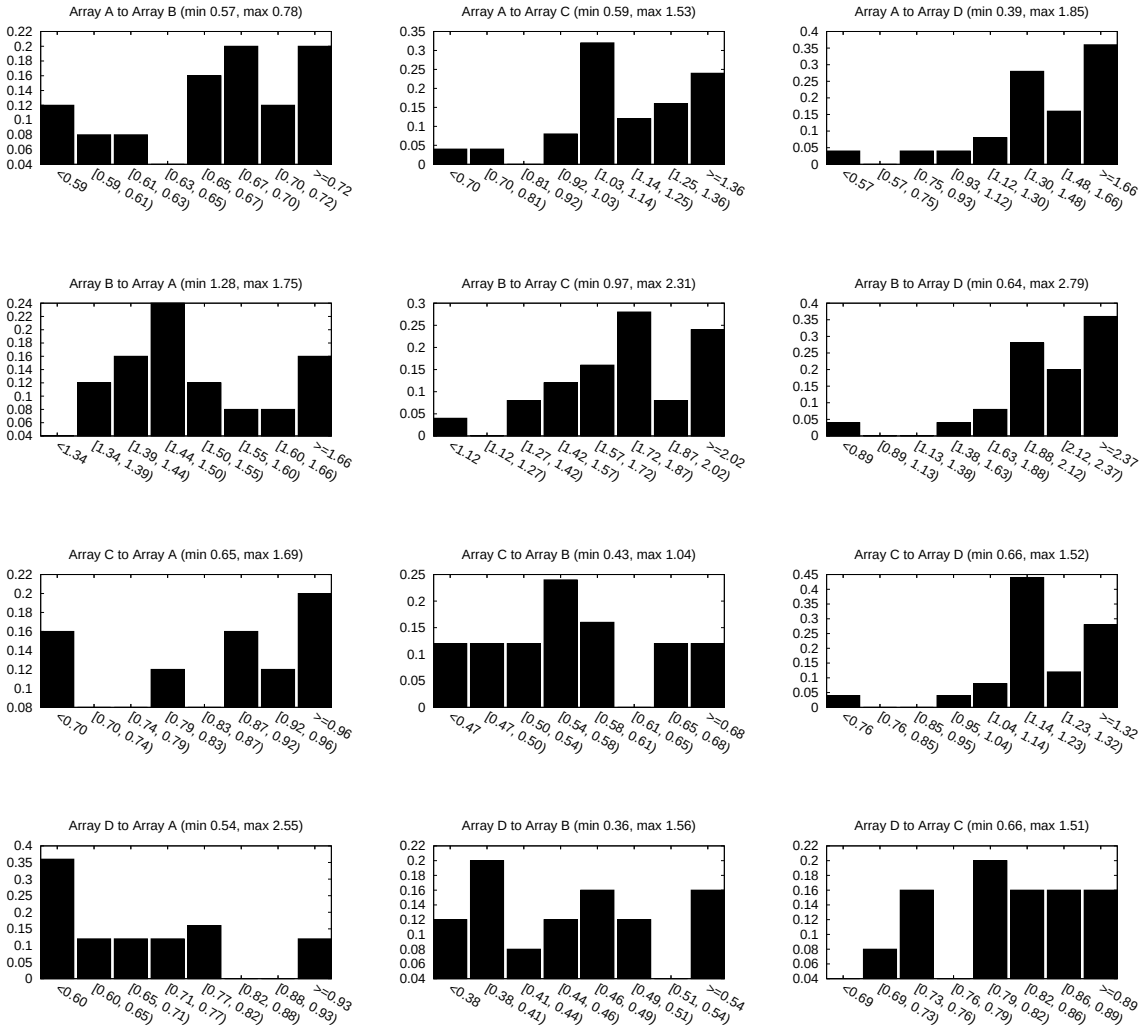

Figure I.4: Each graph shows the probability distribution of the **Throughput** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

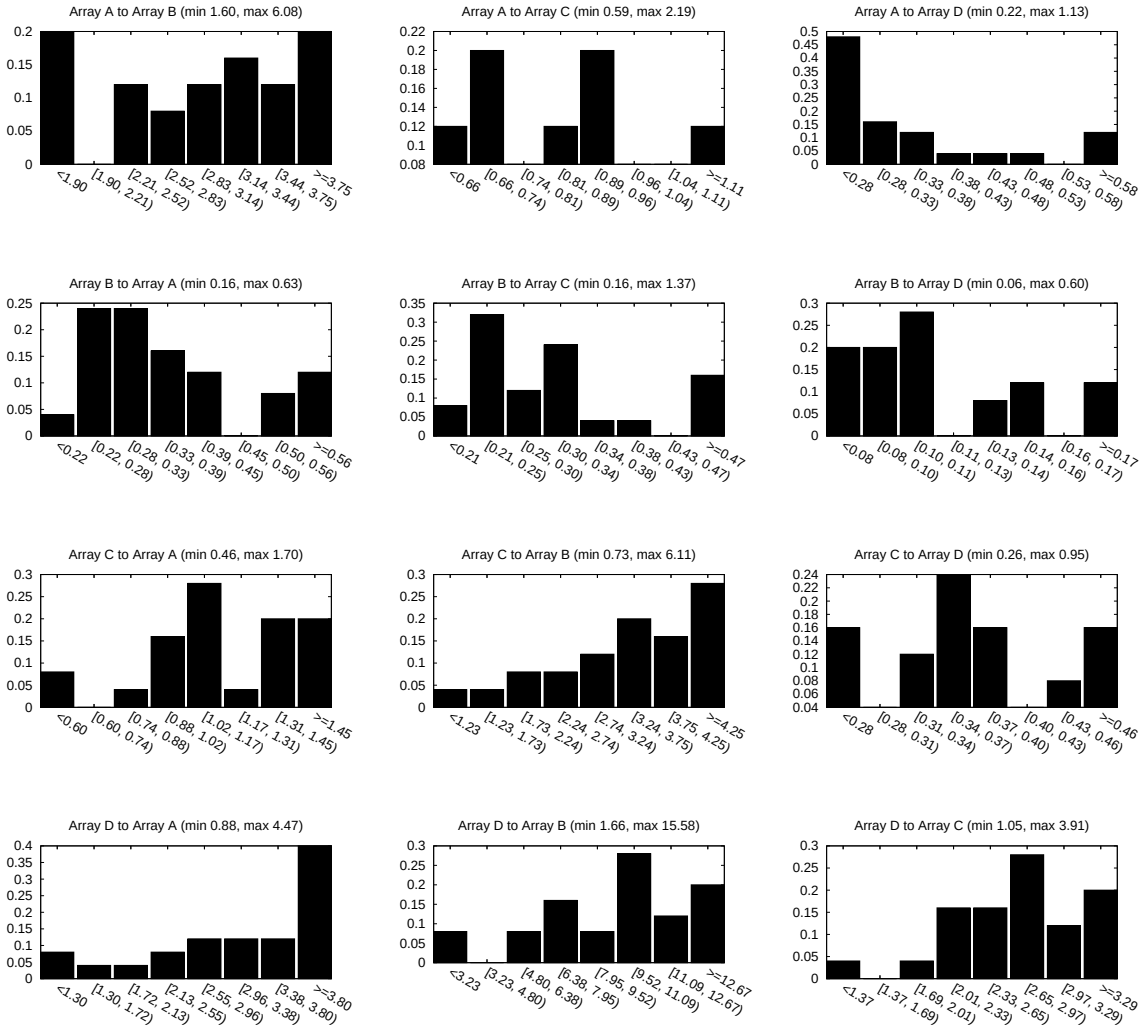

Figure I.5: Each graph shows the probability distribution of the **Latency** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

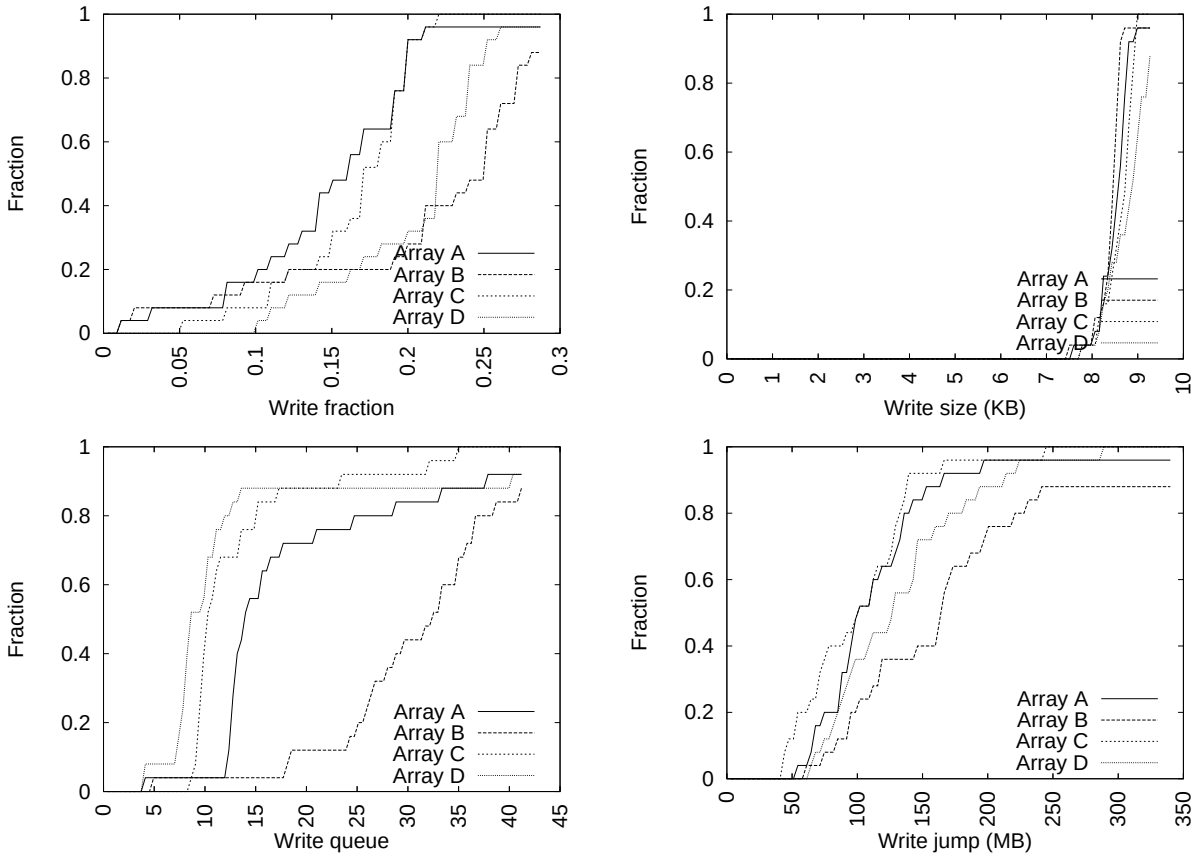

Figure I.6: The cumulative distribution of workload characteristics.

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read jump	1.00	Read jump	1.00	Read jump	1.00	Write queue	1.00
Write queue	0.54	Read size	0.33	Write size	0.20	Write fraction	0.81
Write fraction	0.32	Write size	0.27	Write queue	0.19	Read jump	0.21
Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read jump	1.00	Read jump	1.00	Read jump	1.00	Write queue	1.00
Write size	0.77	Write size	0.50	Write size	0.64	Write jump	0.97
Write queue	0.58	Read size	0.45	Write fraction	0.32	Write fraction	0.82
Write fraction	0.52	Write queue	0.30	Write queue	0.22	Write size	0.66
Write jump	0.40	Write fraction	0.19	Read size	0.20	Read size	0.23
Read size	0.39	Write jump	0.08	Write jump	0.08	Read jump	0.14
Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read jump	1.00	Read jump	1.00	Read jump	1.00	Write queue	1.00
Write size	0.82	Bandwidth	0.69	Bandwidth	0.85	Write size	0.87
Bandwidth	0.79	Write size	0.63	Write size	0.60	Write fraction	0.69
Write fraction	0.46	Read latency	0.26	Read latency	0.43	Write jump	0.67
Write queue	0.44	Write fraction	0.26	Write fraction	0.29	Read latency	0.45
Read latency	0.44	Read size	0.25	Read size	0.28	Read size	0.42
Read size	0.37	Write queue	0.19	Write jump	0.14	Read jump	0.35
Write jump	0.32	Write latency	0.15	Write latency	0.12	Bandwidth	0.34
Latency	0.12	Latency	0.13	Throughput	0.10	Throughput	0.22
Write latency	0.12	Write jump	0.11	Write queue	0.08	Latency	0.21
Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Write fraction	1.00	Read latency	1.00	Read latency	1.00	Latency	1.00
Read latency	0.92	Write size	0.94	Write size	0.86	Write fraction	0.80
Latency	0.84	Write fraction	0.62	Write fraction	0.71	Write queue	0.28
Write size	0.80	Read jump	0.45	Read jump	0.38	Bandwidth	0.28
Bandwidth	0.40	Bandwidth	0.44	Write latency	0.37	Read latency	0.26
Read jump	0.36	Latency	0.33	Read size	0.29	Write size	0.20
Write queue	0.32	Read size	0.32	Latency	0.28	Write latency	0.13
Write latency	0.31	Write jump	0.30	Bandwidth	0.18	Write jump	0.13
Read size	0.23	Write queue	0.23	Write queue	0.16	Read jump	0.09

Table I.4: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	2.6	2.2	2.5	3.0
Relative	2.1	2.2	2.1	1.9
Relative Performance	2.5	2.8	2.6	2.2
Relative Fitness	2.4	2.2	2.7	2.3

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	3.0	-	-	-
Array	-	3.3	-	-
Array	-	-	2.7	-
Array	-	-	-	1.3
Relative	**Array**	**Array**	**Array**	**Array**
Array	3.0	3.0	1.0	1.3
Array	3.7	3.3	2.3	3.0
Array	1.7	2.0	2.7	1.0
Array	2.0	2.7	1.0	1.3
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	4.0	3.7	1.0	1.3
Array	4.0	3.3	1.0	3.0
Array	1.7	2.0	5.0	4.0
Array	2.3	2.7	3.7	4.0
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	2.0	3.3	3.7
Array	2.3	1	1.7	3.3
Array	2.7	3.0	1	3.0
Array	2.0	1.0	1.0	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	4.0	-	-	-	3.0	-	-	-	2.0	-	-	-
Array B	-	2.0	-	-	-	4.0	-	-	-	4.0	-	-
Array C	-	-	2.0	-	-	-	2.0	-	-	-	4.0	-
Array D	-	-	-	1.0	-	-	-	1.0	-	-	-	2.0
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	4.0	3.0	1.0	1.0	3.0	2.0	1.0	1.0	2.0	4.0	1.0	2.0
Array B	4.0	2.0	1.0	2.0	4.0	4.0	5.0	2.0	3.0	4.0	1.0	5.0
Array C	2.0	3.0	2.0	1.0	2.0	2.0	2.0	1.0	1.0	1.0	4.0	1.0
Array D	3.0	4.0	1.0	1.0	2.0	2.0	1.0	1.0	1.0	2.0	1.0	2.0
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	4.0	4.0	1.0	1.0	4.0	4.0	1.0	1.0	4.0	3.0	1.0	2.0
Array B	4.0	2.0	1.0	2.0	4.0	4.0	1.0	3.0	4.0	4.0	1.0	4.0
Array C	2.0	3.0	5.0	4.0	2.0	2.0	5.0	4.0	1.0	1.0	5.0	4.0
Array D	3.0	4.0	5.0	4.0	2.0	2.0	5.0	4.0	2.0	2.0	1.0	4.0
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	2.0	5.0	4.0	1	2.0	4.0	4.0	1	2.0	1.0	3.0
Array B	2.0	1	2.0	2.0	2.0	1	2.0	4.0	3.0	1	1.0	4.0
Array C	2.0	4.0	1	1.0	2.0	4.0	1	5.0	4.0	1.0	1	3.0
Array D	1.0	1.0	1.0	1	1.0	1.0	1.0	1	4.0	1.0	1.0	1

Table I.5: Tree sizes (leaf nodes) and their averages.

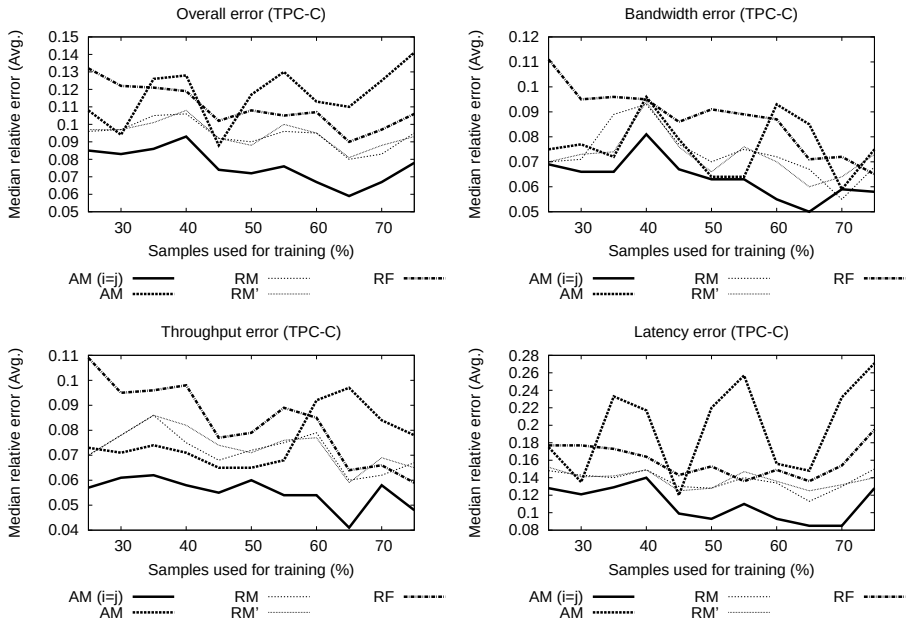

Figure I.7: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

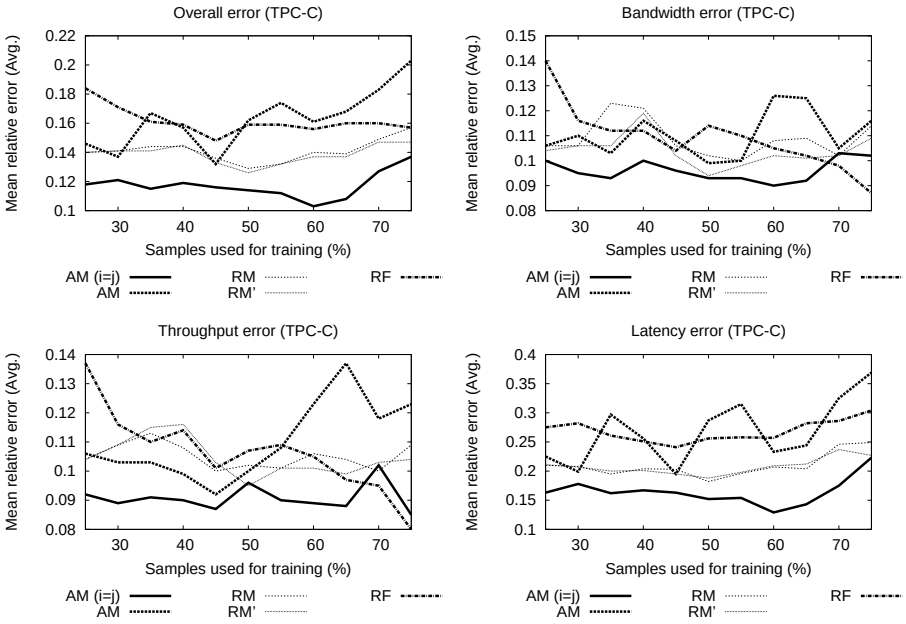

Figure I.8: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

Appendix J

WorkloadMix model training

Application	Samples	Iters	First sample	Last sample
Direct (raw)	200	3	0	99
Buffered (sd)	200	3	0	99
FS (fs)	200	3	0	99
Postmark (phase 1) (pmc)	50	3	0	24
Postmark (phase 2) (pmt)	50	3	0	24
(srt)	78	3	0	38
TPC-C (tpcc)	50	3	0	24
Cache (cache)	70	3	0	34
Total used	449			

Table J.1: Multiple training samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

	Array A	Array B	Array C	Array D	MAD	COV	Max. Diff.
Write fraction	0.38	0.38	0.37	0.38	0.0	0.9%	2.7%
Write size (KB)	82.57	83.25	84.41	82.85	0.6	0.8%	2.2%
Read size (KB)	62.49	62.46	62.21	62.35	0.1	0.2%	0.5%
Write jump (MB)	815.03	818.80	796.41	828.24	9.1	1.4%	4.0%
Read jump (MB)	1856.84	1852.55	1894.78	1849.21	15.7	1.0%	2.5%
Write queue	24.44	20.34	20.33	20.09	1.6	8.5%	21.6%
Read queue	3.82	4.16	3.68	3.92	0.1	4.5%	13.0%
Bandwidth (MB/sec)	23.29	19.41	14.83	28.51	4.4	23.4%	92.2%
Throughput (IO/sec)	440.48	344.63	626.66	920.87	190.6	37.7%	167.2%
Latency (ms)	26.97	27.01	63.01	18.53	14.6	50.7%	240.0%
Write latency (ms)	45.03	42.81	106.23	20.26	26.3	59.5%	424.3%
Read latency (ms)	11.47	22.21	25.84	15.43	5.3	30.0%	125.3%

Table J.2: Workload characteristics and performance are measured for each sample, on each storage device. The average value for each measurement is reported in this table. The mean absolute deviation (MAD), coefficient of variation (COV), and maximum relative differences of these averages are also reported; these metrics quantify how the averages change among the storage devices. For example, the mean average deviation of the averages for Read latency (ms) is 5.29, their coeefficient of variation is 29.994%, and the maximum relative difference is 125.28%.

Array A								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	1.1%	0.0	0.1	0.4	0.6	0.8	1.0	0.4
Write size (KB)	0.6%	0.0	7.6	78.5	146.0	188.8	251.3	82.6
Read size (KB)	0.1%	0.0	8.0	45.1	97.0	141.0	255.3	62.5
Write jump (MB)	0.5%	0.0	1.0	99.0	1259.0	3074.0	5525.0	815.0
Read jump (MB)	0.8%	0.0	314.0	1159.0	3240.0	4759.0	6304.0	1856.8
Write queue	0.7%	0.0	6.2	19.6	42.3	57.9	84.2	24.4
Read queue	1.5%	0.0	1.1	1.8	4.6	10.4	31.7	3.8
Bandwidth (MB/sec)	1.5%	0.5	11.9	20.6	30.4	45.3	103.4	23.3
Throughput (IO/sec)	0.5%	102.0	210.0	277.0	428.0	844.0	4253.0	440.5
Latency (ms)	0.1%	0.4	10.6	20.3	33.5	55.4	138.6	27.0
Write latency (ms)	0.3%	0.0	10.3	43.3	66.0	93.8	165.7	45.0
Read latency (ms)	1.0%	0.0	5.3	7.6	13.9	22.7	89.7	11.5
Array B								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.9%	0.0	0.1	0.4	0.6	0.8	1.0	0.4
Write size (KB)	0.7%	0.0	7.6	80.7	149.4	190.6	251.0	83.2
Read size (KB)	0.3%	0.0	8.0	44.7	97.6	141.5	255.1	62.5
Write jump (MB)	0.2%	0.0	0.0	94.0	1244.0	2927.0	5589.0	818.8
Read jump (MB)	0.3%	0.0	318.0	1184.0	3223.0	4683.0	6115.0	1852.6
Write queue	0.8%	0.0	1.1	17.3	33.2	52.5	64.0	20.3
Read queue	0.7%	0.0	1.1	2.0	5.1	10.9	24.3	4.2
Bandwidth (MB/sec)	1.9%	0.3	9.0	16.8	26.0	39.1	104.7	19.4
Throughput (IO/sec)	1.0%	65.0	165.0	234.0	337.0	495.0	9477.0	344.6
Latency (ms)	1.8%	0.8	12.7	19.1	27.9	52.2	264.0	27.0
Write latency (ms)	0.6%	0.0	2.4	30.4	59.0	120.0	453.3	42.8
Read latency (ms)	1.9%	0.0	9.0	13.0	21.6	41.6	264.1	22.2
Array C								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.9%	0.0	0.1	0.4	0.6	0.8	1.0	0.4
Write size (KB)	1.1%	0.0	7.6	78.5	154.0	193.8	251.0	84.4
Read size (KB)	0.4%	0.0	8.0	44.8	99.1	139.9	255.5	62.2
Write jump (MB)	5.3%	0.0	0.0	52.0	1087.0	3129.0	16383.0	796.4
Read jump (MB)	0.2%	0.0	321.0	1241.0	3226.0	4863.0	6406.0	1894.8
Write queue	1.5%	0.0	1.2	15.3	34.9	53.0	64.0	20.3
Read queue	1.1%	0.0	1.1	1.7	4.7	9.9	22.9	3.7
Bandwidth (MB/sec)	1.4%	0.3	6.0	11.3	15.5	22.2	109.6	14.8
Throughput (IO/sec)	0.1%	34.0	113.0	153.0	248.0	516.0	25519.0	626.7
Latency (ms)	1.8%	0.2	21.8	44.5	72.2	129.4	578.0	63.0
Write latency (ms)	2.4%	0.0	19.9	108.0	138.1	220.9	583.5	106.2
Read latency (ms)	0.2%	0.0	5.1	11.6	25.5	60.5	423.9	25.8
Array D								
	Rel. Diff.	**Min**	**25%**	**50%**	**75%**	**90%**	**Max**	**Mean**
Write fraction	0.9%	0.0	0.1	0.4	0.6	0.8	1.0	0.4
Write size (KB)	0.2%	0.0	7.3	79.1	148.0	189.4	251.0	82.9
Read size (KB)	0.0%	0.0	8.0	45.2	97.6	141.9	255.8	62.3
Write jump (MB)	0.8%	0.0	1.0	103.0	1358.0	3028.0	5519.0	828.2
Read jump (MB)	0.0%	0.0	324.0	1182.0	3188.0	4738.0	6310.0	1849.2
Write queue	0.4%	0.0	1.1	15.4	29.7	58.9	64.0	20.1
Read queue	0.6%	0.0	1.1	2.0	5.0	10.3	29.0	3.9
Bandwidth (MB/sec)	2.6%	0.5	12.5	20.6	38.4	59.7	111.0	28.5
Throughput (IO/sec)	2.1%	92.0	200.0	305.0	530.0	1097.0	27676.0	920.9
Latency (ms)	1.1%	0.1	7.6	12.5	18.8	34.0	211.9	18.5
Write latency (ms)	0.2%	0.0	1.0	10.5	26.5	42.5	214.8	20.3
Read latency (ms)	0.6%	0.0	6.9	11.1	15.8	31.9	139.7	15.4

Table J.3: Workload characteristics and performance are measured for each sample, on each storage device. The minimum value, percentiles, maximum value and average are reported for each measurement. In addition, the relative difference between the average performance of the best and second-to-best iteration is reported. This value quantifies the change in a given measurement across multiple runs of the same sample on the same storage device.

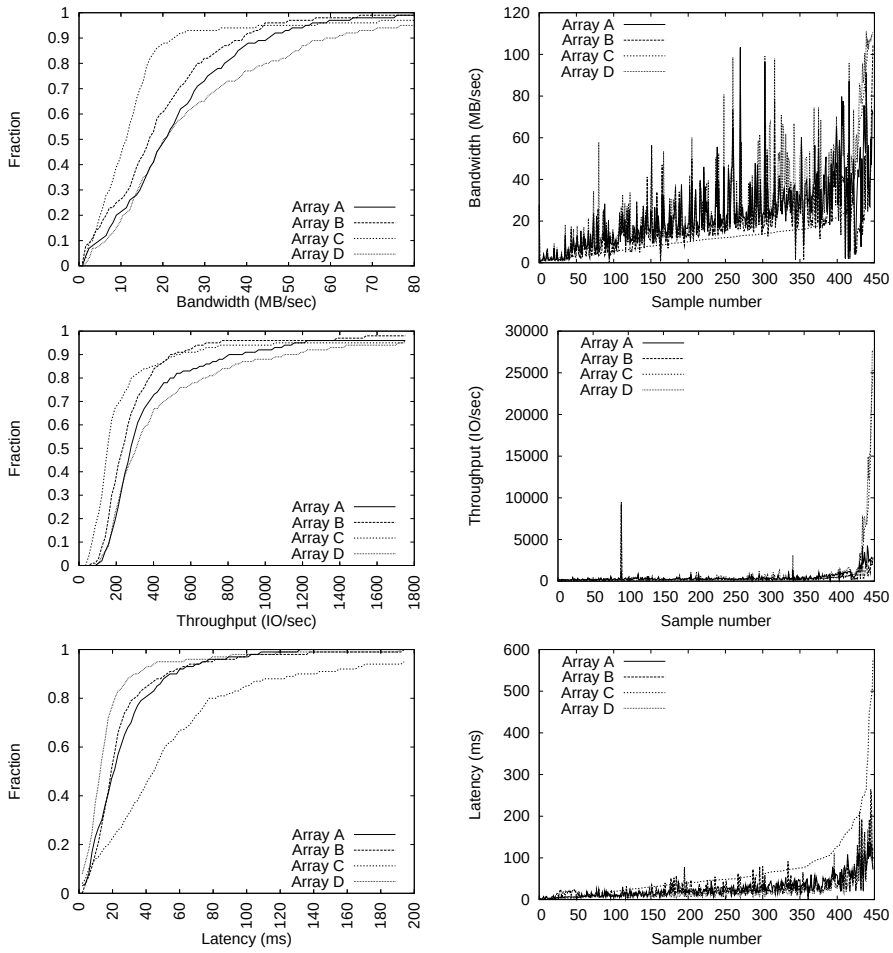

Figure J.1: The cumulative distribution of performance is shown (top). In addition, the performance of each array is shown (bottom), sorted by the performance of Array C.

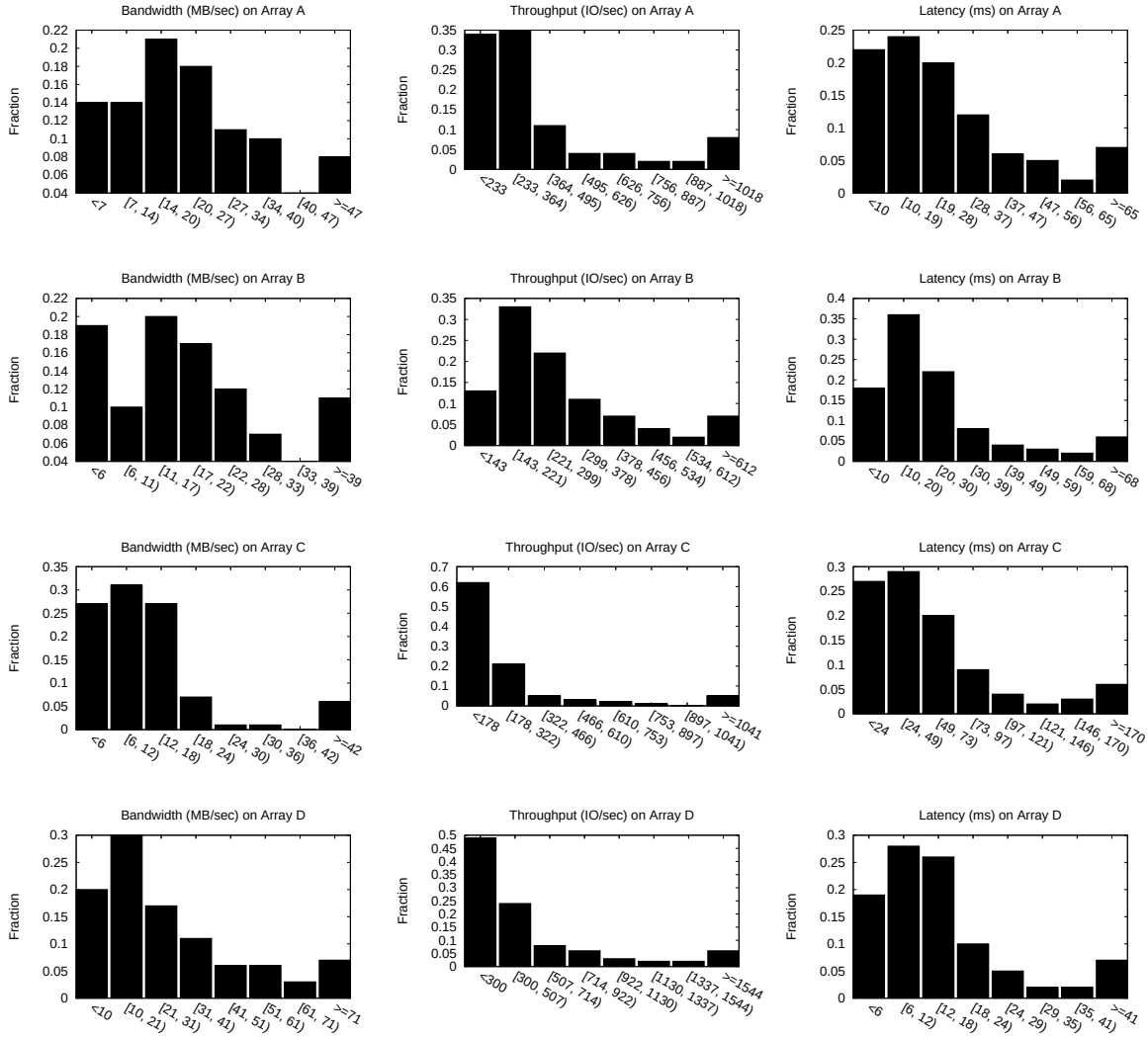

Figure J.2: Probability distributions of performance.

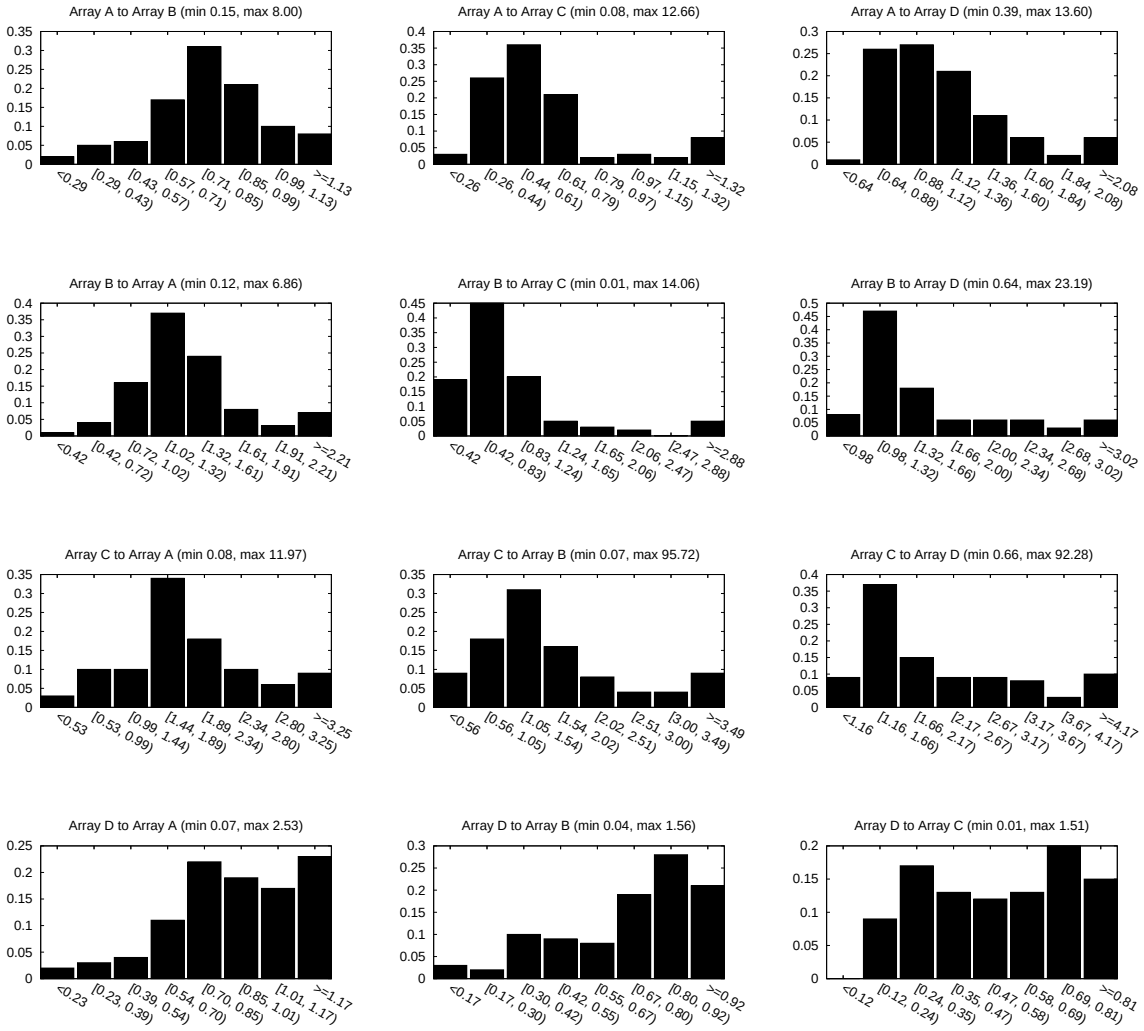

Figure J.3: Each graph shows the probability distribution of the **Bandwidth** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

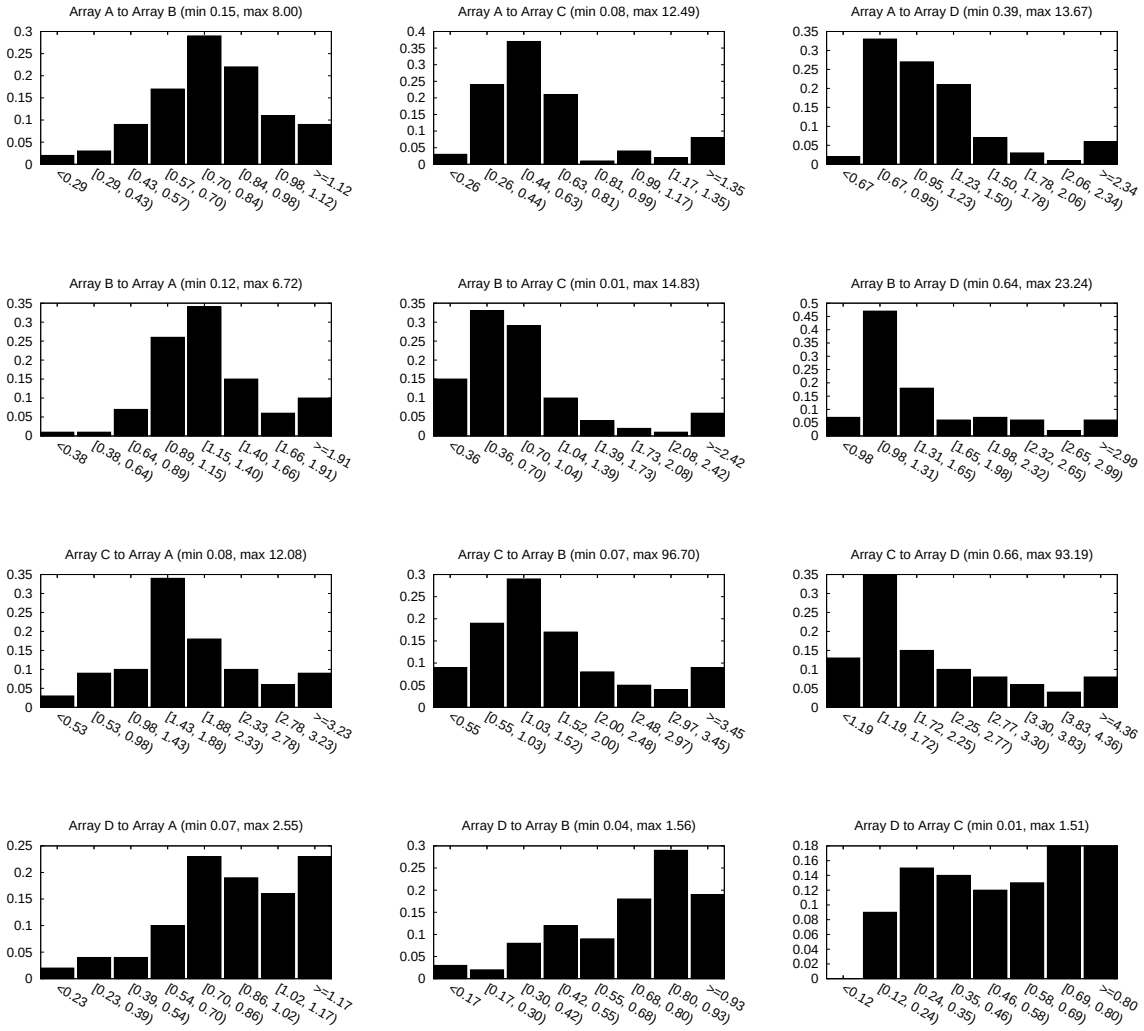

Figure J.4: Each graph shows the probability distribution of the **Throughput** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

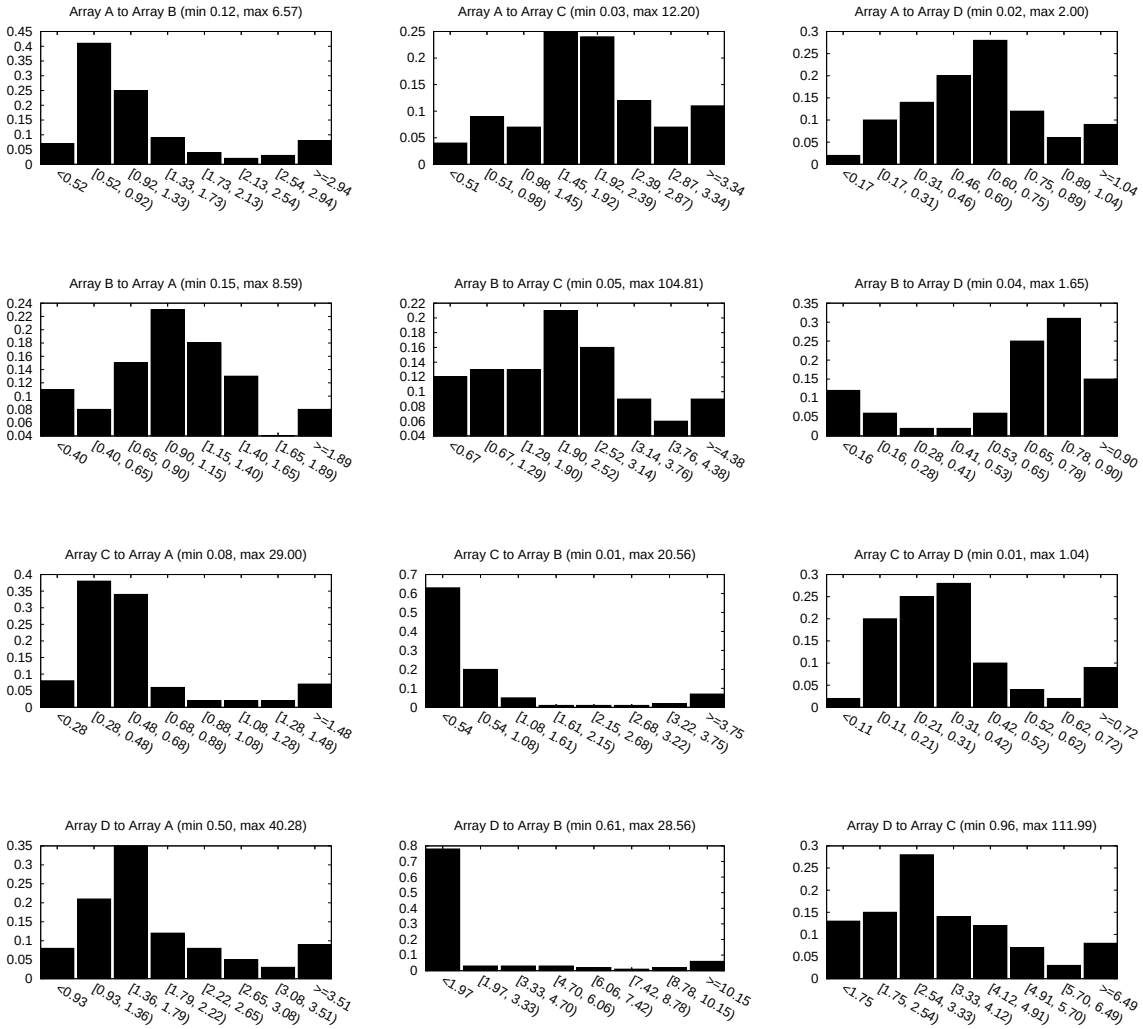

Figure J.5: Each graph shows the probability distribution of the **Latency** relative fitness values for a given device pairing, over all workload samples. A relative fitness value is the ratio of the performance of two devices. Values greater than 1.0 indicate a performance increase as a workload is moved from device A to device B, values less than zero indicate a decrease, and values close to zero indicate little change.

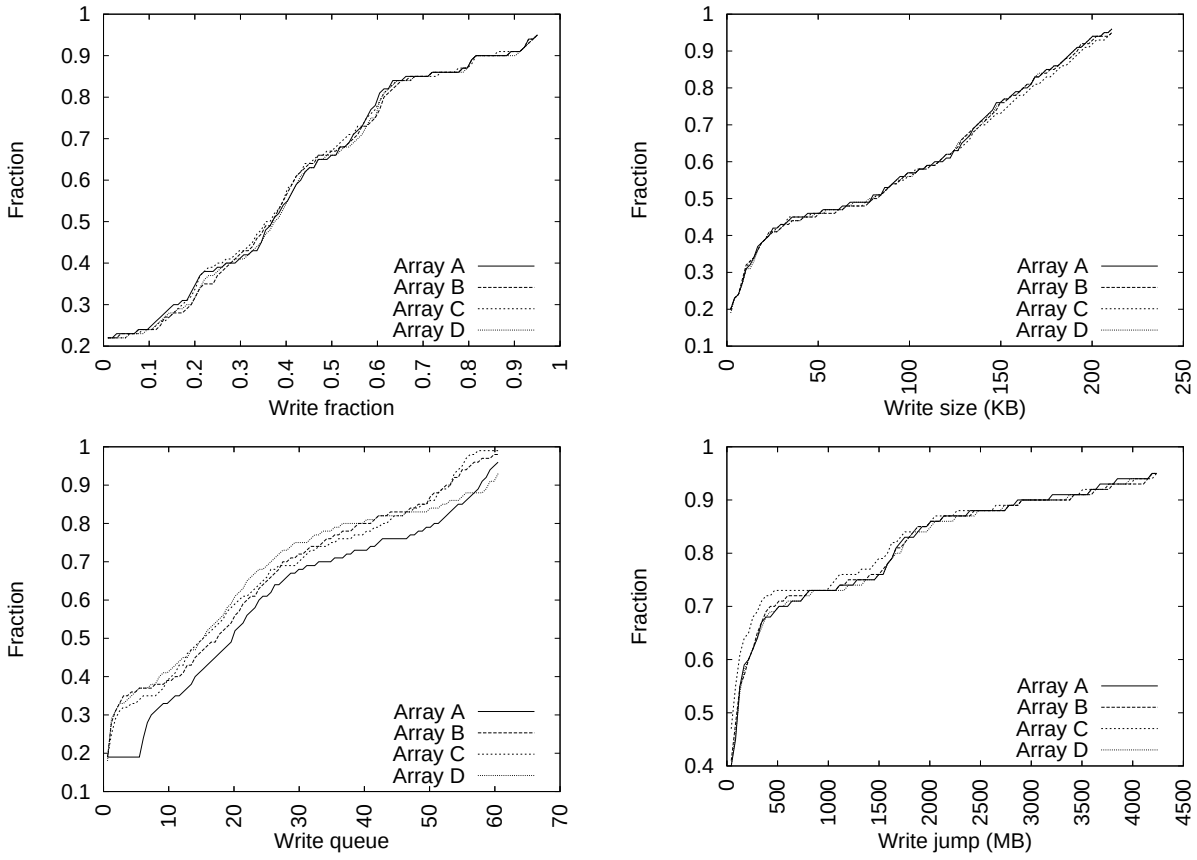

Figure J.6: The cumulative distribution of workload characteristics.

Absolute							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read size	1.00	Read queue	1.00	Write fraction	1.00
Read size	0.88	Read queue	0.87	Read size	0.90	Read queue	0.90
Write fraction	0.79	Write size	0.72	Read jump	0.63	Write queue	0.89
Write size	0.64	Write fraction	0.67	Write size	0.55	Read jump	0.57
Read jump	0.62	Read jump	0.53	Write fraction	0.50	Read size	0.55
Write queue	0.59	Write jump	0.36	Write queue	0.44	Write size	0.49
Write jump	0.31	Write queue	0.27	Write jump	0.40	Write jump	0.11
Relative							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Read queue	1.00	Read size	1.00	Read queue	1.00	Read queue	1.00
Read size	0.93	Read queue	0.82	Read size	0.84	Write fraction	0.85
Write size	0.69	Write size	0.75	Read jump	0.74	Write queue	0.84
Read jump	0.67	Write fraction	0.60	Write size	0.56	Read size	0.74
Write fraction	0.67	Read jump	0.58	Write queue	0.41	Write size	0.60
Write queue	0.50	Write jump	0.32	Write fraction	0.41	Read jump	0.57
Write jump	0.26	Write queue	0.18	Write jump	0.33	Write jump	0.09
Relative Performance							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Bandwidth	1.00	Bandwidth	1.00	Throughput	1.00	Latency	1.00
Latency	0.94	Latency	0.21	Read queue	0.25	Bandwidth	0.21
Throughput	0.93	Write fraction	0.17	Bandwidth	0.17	Read latency	0.21
Write fraction	0.36	Read jump	0.17	Write fraction	0.16	Write fraction	0.16
Read queue	0.33	Read latency	0.16	Read jump	0.14	Write queue	0.16
Read jump	0.33	Throughput	0.14	Read size	0.13	Read jump	0.13
Read latency	0.30	Read size	0.11	Write queue	0.12	Read queue	0.11
Write queue	0.26	Write jump	0.11	Write size	0.11	Read size	0.11
Read size	0.26	Write size	0.09	Latency	0.11	Write size	0.10
Write size	0.22	Read queue	0.08	Write jump	0.07	Throughput	0.08
Write jump	0.17	Write queue	0.08	Read latency	0.05	Write latency	0.08
Write latency	0.12	Write latency	0.05	Write latency	0.04	Write jump	0.05
Relative Fitness							
Overall		**Bandwidth**		**Throughput**		**Latency**	
Predictor	**Score**	**Predictor**	**Score**	**Predictor**	**Score**	**Predictor**	**Score**
Bandwidth	1.00	Read jump	1.00	Read latency	1.00	Latency	1.00
Latency	1.00	Read latency	0.97	Bandwidth	0.96	Write fraction	0.78
Throughput	0.99	Bandwidth	0.96	Throughput	0.94	Bandwidth	0.71
Read jump	0.94	Throughput	0.95	Read jump	0.83	Throughput	0.71
Read latency	0.89	Latency	0.93	Write fraction	0.78	Read jump	0.64
Write fraction	0.89	Write fraction	0.75	Latency	0.65	Write queue	0.49
Read size	0.53	Read queue	0.57	Write queue	0.47	Read size	0.46
Read queue	0.51	Read size	0.50	Read queue	0.46	Read latency	0.42
Write queue	0.50	Write latency	0.44	Read size	0.41	Write size	0.39
Write latency	0.45	Write size	0.36	Write latency	0.36	Write latency	0.37
Write size	0.40	Write queue	0.31	Write size	0.29	Write jump	0.34
Write jump	0.33	Write jump	0.24	Write jump	0.26	Read queue	0.33

Table J.4: The normalized importance measure of each predictor.

Model	Overall	Bandwidth	Throughput	Latency
Absolute	74.5	78.8	69.2	75.5
Relative	68.8	85.6	55.2	65.5
Relative Performance	67.7	71.9	64.3	66.8
Relative Fitness	57.9	58.2	52.6	62.8

Pairwise				
Absolute	**Array**	**Array**	**Array**	**Array**
Array	68.7	-	-	-
Array	-	86.0	-	-
Array	-	-	61.7	-
Array	-	-	-	81.7
Relative	**Array**	**Array**	**Array**	**Array**
Array	68.7	77.3	68.7	76.3
Array	83.3	86.0	34.7	71.7
Array	67.7	61.3	61.7	77.0
Array	74.0	76.0	57.3	81.7
Relative Performance	**Array**	**Array**	**Array**	**Array**
Array	74.0	66.7	31.3	80.0
Array	86.0	75.0	63.0	43.0
Array	52.7	83.0	72.0	76.7
Array	92.7	63.0	74.3	72.3
Relative Fitness	**Array**	**Array**	**Array**	**Array**
Array	1	64.0	65.7	48.3
Array	30.3	1	52.3	67.0
Array	81.7	78.7	1	72.0
Array	43.7	56.3	34.3	1

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	83.0	-	-	-	64.0	-	-	-	59.0	-	-	-
Array B	-	76.0	-	-	-	88.0	-	-	-	94.0	-	-
Array C	-	-	66.0	-	-	-	43.0	-	-	-	76.0	-
Array D	-	-	-	90.0	-	-	-	82.0	-	-	-	73.0
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	83.0	80.0	96.0	88.0	64.0	84.0	60.0	63.0	59.0	68.0	50.0	78.0
Array B	89.0	76.0	79.0	53.0	88.0	88.0	5.0	78.0	73.0	94.0	20.0	84.0
Array C	101.0	91.0	66.0	83.0	42.0	9.0	43.0	62.0	60.0	84.0	76.0	86.0
Array D	88.0	84.0	95.0	90.0	67.0	73.0	32.0	82.0	67.0	71.0	45.0	73.0
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	74.0	62.0	17.0	98.0	76.0	107.0	2.0	41.0	72.0	31.0	75.0	101.0
Array B	91.0	75.0	85.0	56.0	82.0	76.0	64.0	22.0	85.0	74.0	40.0	51.0
Array C	47.0	94.0	73.0	60.0	65.0	66.0	73.0	65.0	46.0	89.0	70.0	105.0
Array D	86.0	66.0	101.0	70.0	91.0	83.0	84.0	74.0	101.0	40.0	38.0	73.0
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1	92.0	98.0	25.0	1	62.0	54.0	54.0	1	38.0	45.0	66.0
Array B	32.0	1	34.0	73.0	39.0	1	34.0	26.0	20.0	1	89.0	102.0
Array C	85.0	43.0	1	60.0	74.0	95.0	1	58.0	86.0	98.0	1	98.0
Array D	55.0	56.0	46.0	1	36.0	76.0	23.0	1	40.0	37.0	34.0	1

Table J.5: Tree sizes (leaf nodes) and their averages.

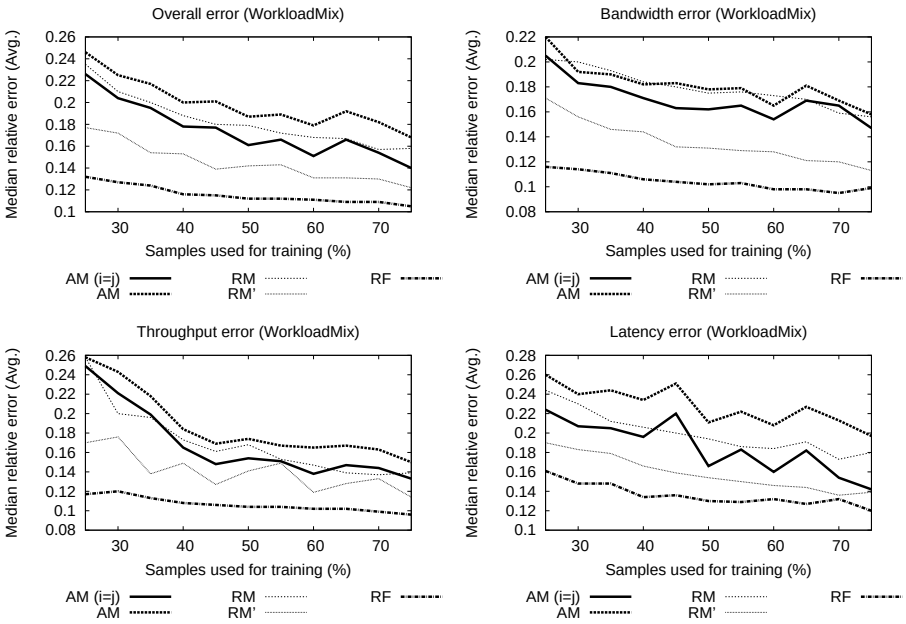

Figure J.7: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Median relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

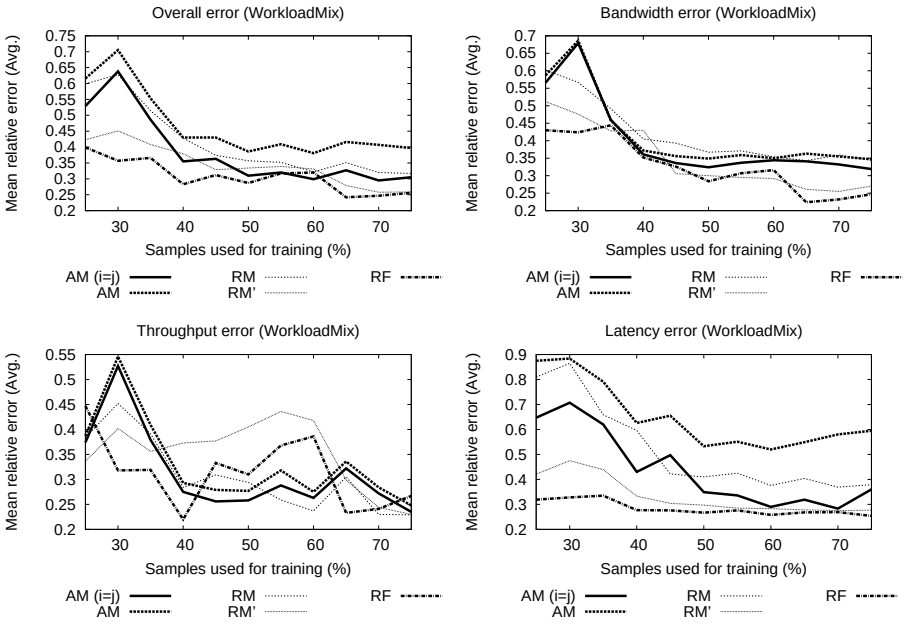

Figure J.8: Error vs. training. The training set size varies from 25% of the collected samples to 75%; the remaining samples are used for testing. For each training set size, the Mean relative error is calculated for each pairing of devices. They are then averaged to produce the values shown.

Appendix K

FitnessDirect model testing on FitnessDirect samples

Application	Samples	Iters	First sample	Last sample
Direct (raw)	200	3	100	199
Total used	100			

Table K.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

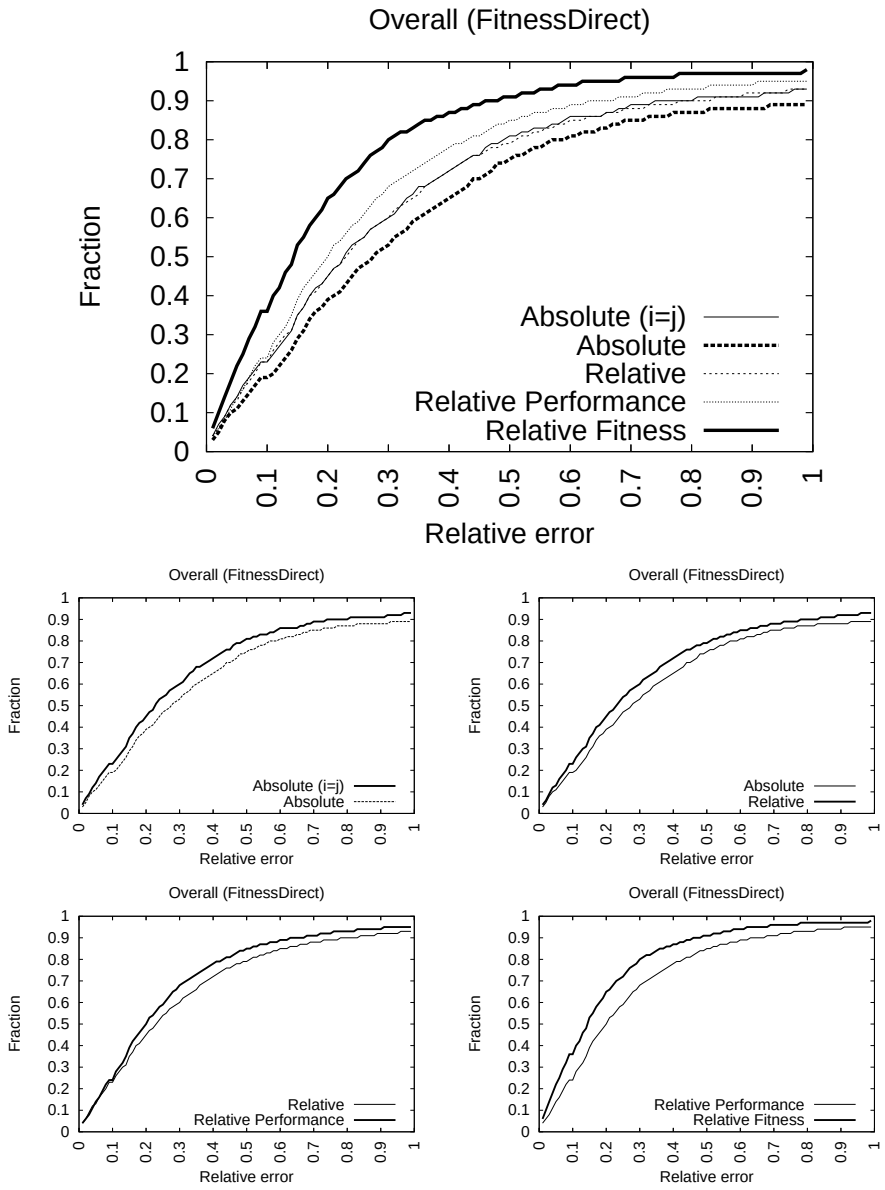

Figure K.1: The cumulative distribution of relative error over all pairwise predictions.

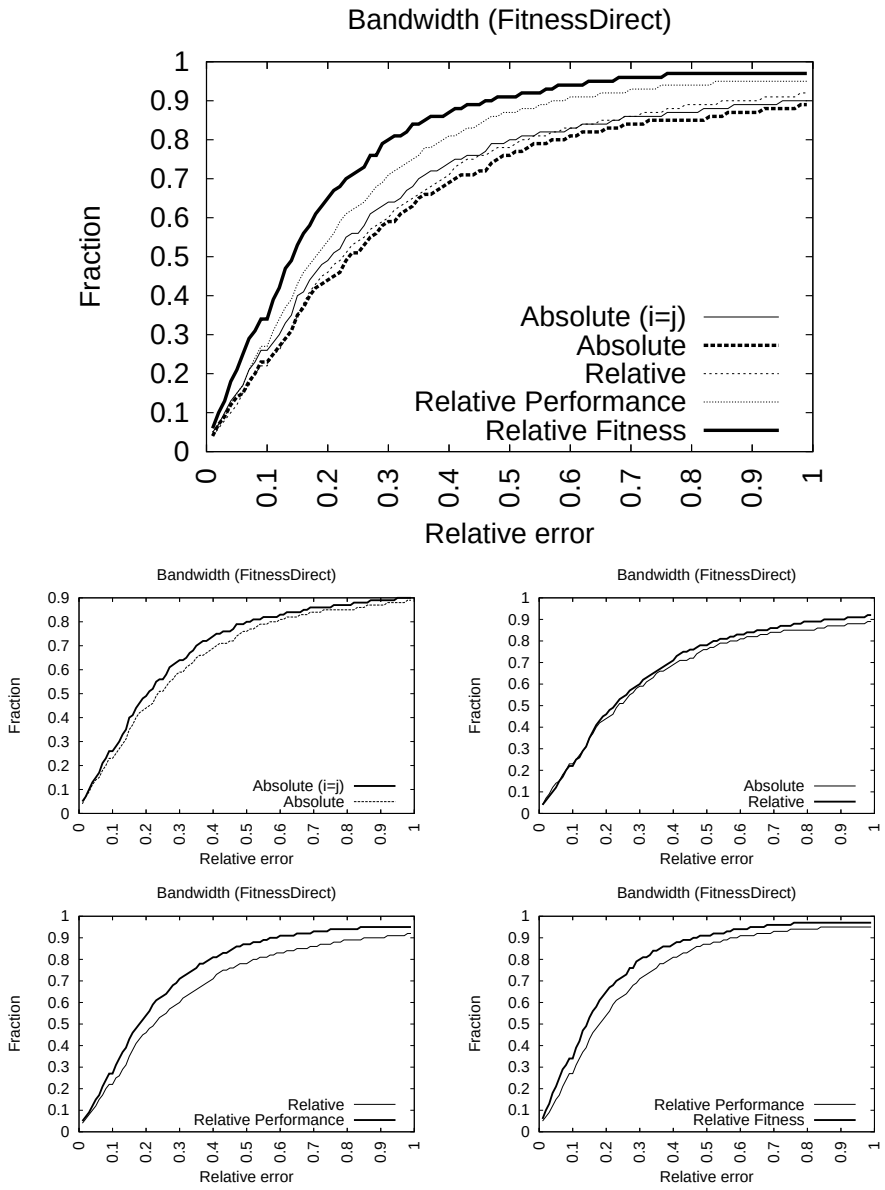

Figure K.2: The cumulative distribution of relative error over all pairwise predictions.

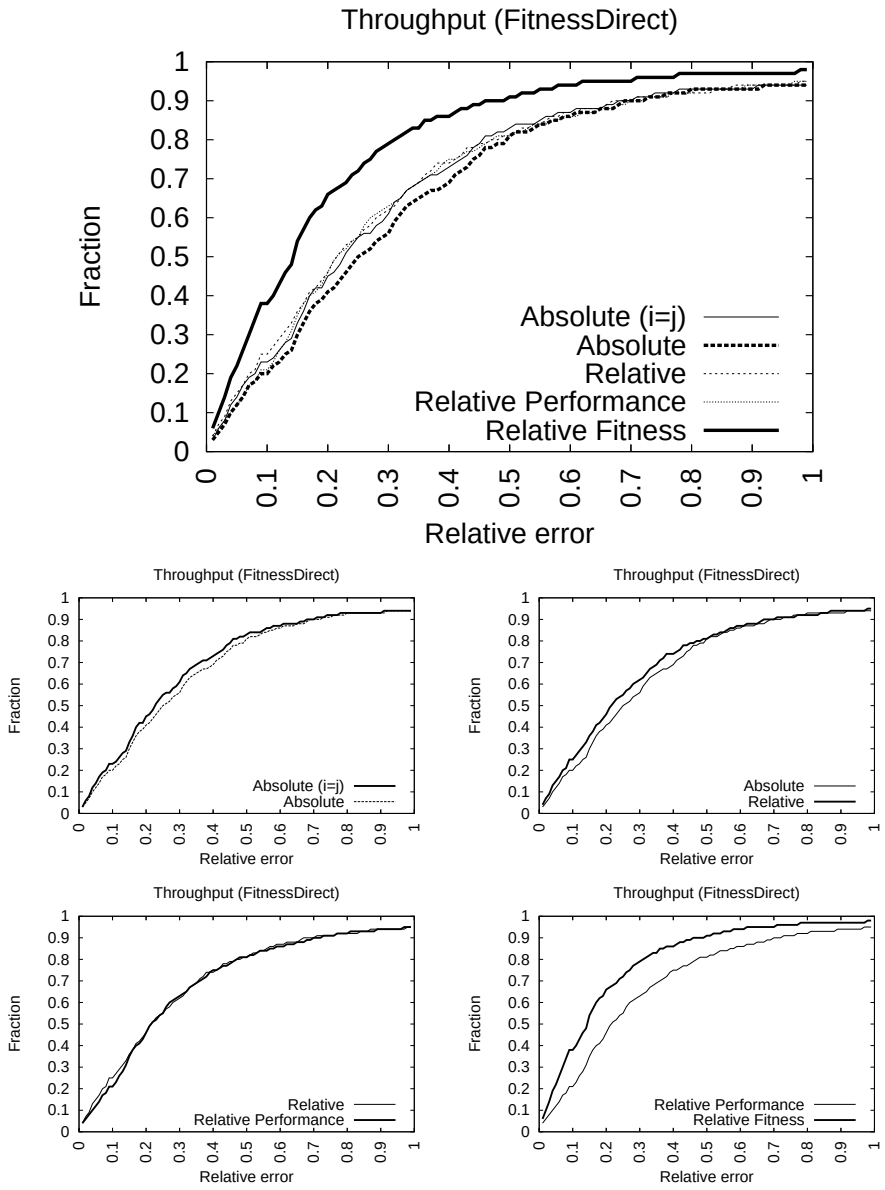

Figure K.3: The cumulative distribution of relative error over all pairwise predictions.

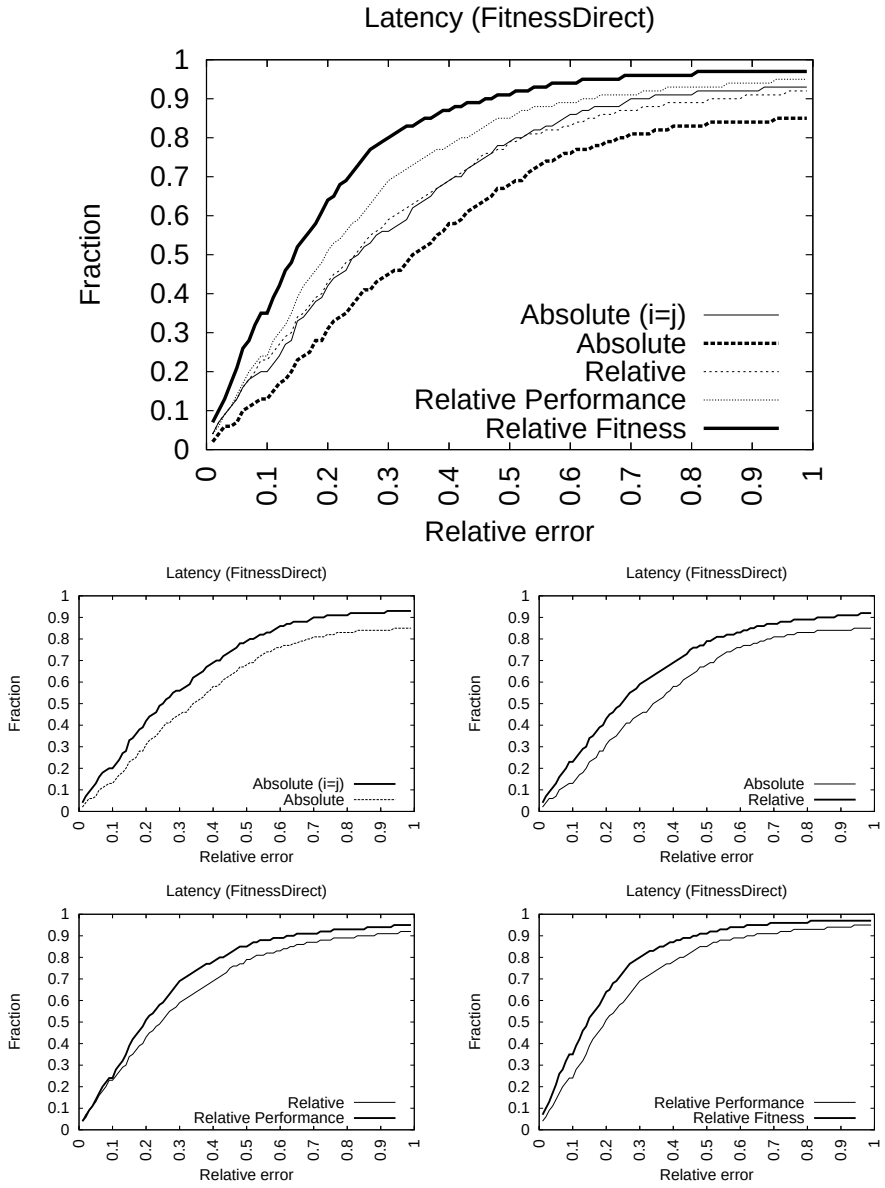

Figure K.4: The cumulative distribution of relative error over all pairwise predictions.

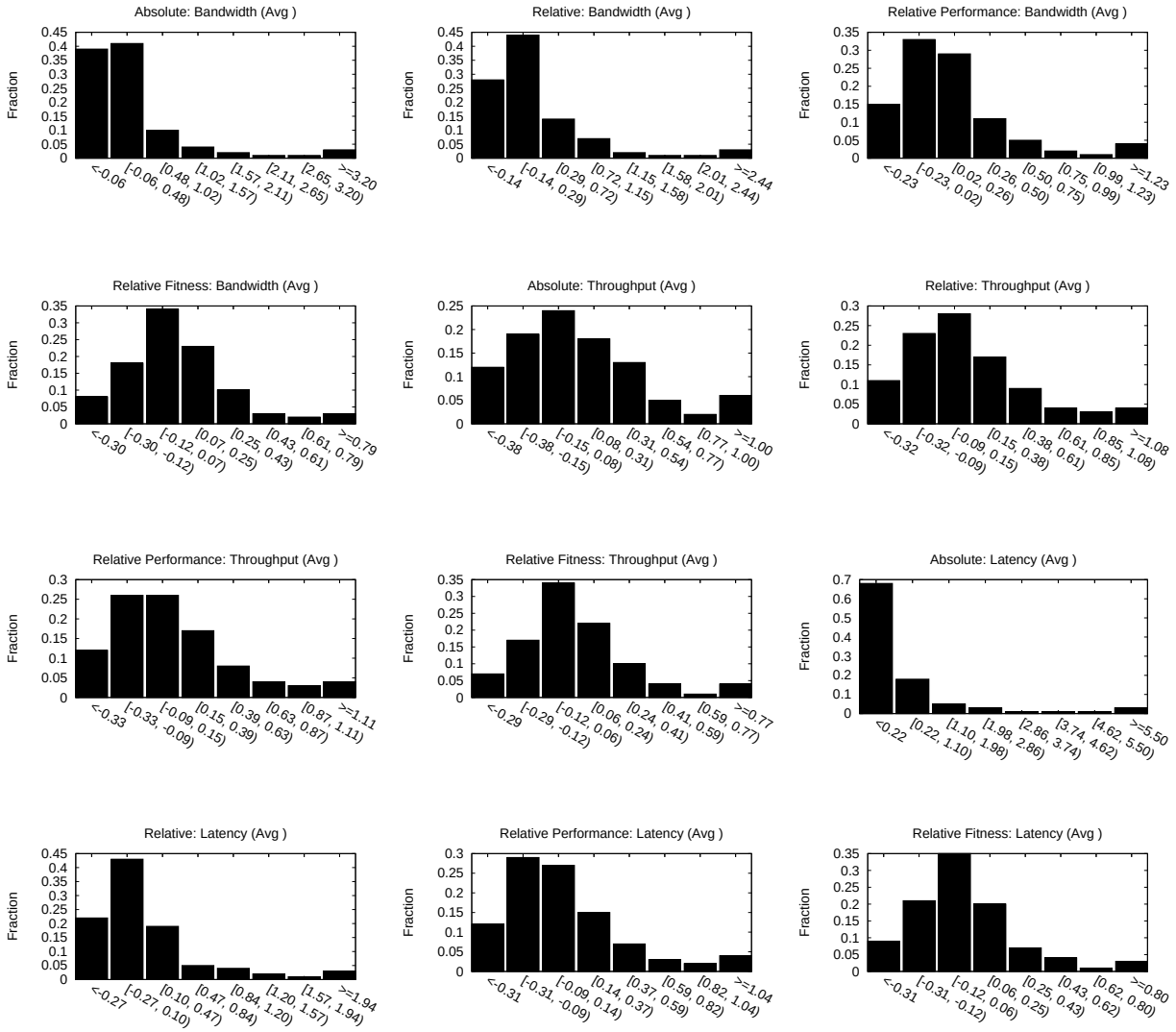

Figure K.5: The probability distribution of relative error over all pairwise predictions.

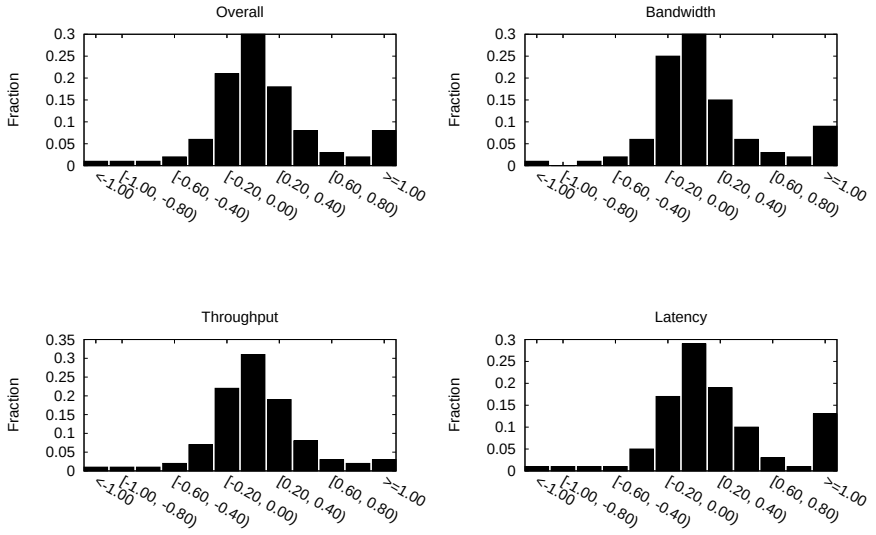

Figure K.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	37 / 15 / 46	32 / 48 / 18	29 / 66 / 3	49 / 47 / 2	28 / 68 / 2
A → C	2 / 4 / 92	39 / 19 / 40	30 / 62 / 6	44 / 49 / 5	42 / 56 / 0
A → D	10 / 11 / 77	29 / 32 / 37	44 / 48 / 6	36 / 58 / 4	38 / 57 / 3
B → A	29 / 14 / 55	34 / 60 / 4	25 / 56 / 17	35 / 55 / 8	19 / 74 / 5
B → C	12 / 2 / 84	55 / 43 / 0	42 / 55 / 1	37 / 60 / 1	33 / 63 / 2
B → D	8 / 0 / 90	36 / 28 / 34	31 / 60 / 7	29 / 63 / 6	28 / 66 / 4
C → A	19 / 15 / 64	40 / 44 / 14	42 / 53 / 3	31 / 63 / 4	29 / 67 / 2
C → B	18 / 9 / 71	28 / 34 / 36	51 / 38 / 9	40 / 54 / 4	40 / 51 / 7
C → D	7 / 9 / 82	33 / 32 / 33	48 / 43 / 7	43 / 53 / 2	43 / 50 / 5
D → A	24 / 16 / 58	29 / 54 / 15	37 / 52 / 9	29 / 62 / 7	22 / 73 / 3
D → B	6 / 4 / 88	39 / 37 / 22	27 / 54 / 17	24 / 68 / 6	32 / 64 / 2
D → C	6 / 2 / 90	58 / 40 / 0	28 / 63 / 7	43 / 51 / 4	35 / 58 / 5
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	14 / 3 / 81	50 / 41 / 7	59 / 39 / 0	28 / 68 / 2	33 / 62 / 3
A → C	3 / 4 / 91	34 / 51 / 13	61 / 35 / 2	30 / 65 / 3	40 / 55 / 3
A → D	0 / 1 / 97	50 / 48 / 0	0 / 0 / 98	25 / 66 / 7	25 / 72 / 1
B → A	22 / 9 / 67	36 / 60 / 2	54 / 39 / 5	25 / 68 / 5	35 / 61 / 2
B → C	9 / 5 / 84	37 / 48 / 13	61 / 37 / 0	30 / 64 / 4	37 / 59 / 2
B → D	0 / 0 / 98	49 / 49 / 0	24 / 74 / 0	31 / 60 / 7	18 / 76 / 4
C → A	18 / 5 / 75	34 / 60 / 4	61 / 37 / 0	29 / 67 / 2	29 / 68 / 1
C → B	12 / 2 / 84	26 / 63 / 9	55 / 40 / 3	42 / 51 / 5	35 / 58 / 5
C → D	0 / 0 / 98	49 / 49 / 0	46 / 51 / 1	33 / 61 / 4	37 / 59 / 2
D → A	19 / 8 / 71	44 / 52 / 2	33 / 60 / 5	36 / 54 / 8	25 / 72 / 1
D → B	2 / 3 / 93	39 / 52 / 7	41 / 51 / 6	29 / 61 / 8	29 / 65 / 4
D → C	8 / 4 / 86	38 / 44 / 16	68 / 29 / 1	34 / 62 / 2	38 / 56 / 4
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	36 / 3 / 59	24 / 71 / 3	36 / 55 / 7	38 / 55 / 5	14 / 81 / 3
A → C	51 / 12 / 35	33 / 62 / 3	41 / 56 / 1	40 / 53 / 5	22 / 75 / 1
A → D	47 / 1 / 50	20 / 64 / 14	24 / 61 / 13	40 / 52 / 6	18 / 80 / 0
B → A	40 / 13 / 45	30 / 61 / 7	48 / 44 / 6	36 / 57 / 5	25 / 69 / 4
B → C	19 / 14 / 65	22 / 35 / 41	46 / 44 / 8	37 / 59 / 2	28 / 68 / 2
B → D	5 / 6 / 87	50 / 47 / 1	36 / 61 / 1	29 / 64 / 5	18 / 77 / 3
C → A	41 / 7 / 50	19 / 49 / 30	31 / 45 / 22	40 / 51 / 7	22 / 70 / 6
C → B	13 / 7 / 78	33 / 63 / 2	45 / 49 / 4	41 / 54 / 3	31 / 66 / 1
C → D	14 / 6 / 78	31 / 36 / 31	46 / 44 / 8	39 / 57 / 2	31 / 64 / 3
D → A	39 / 17 / 42	27 / 62 / 9	42 / 42 / 14	38 / 54 / 6	20 / 77 / 1
D → B	6 / 2 / 90	39 / 45 / 14	30 / 54 / 14	26 / 69 / 3	21 / 73 / 4
D → C	17 / 13 / 68	47 / 42 / 9	38 / 45 / 15	35 / 60 / 3	36 / 59 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table K.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.23	0.21	0.23	0.25
Absolute	0.28	0.24	0.26	0.34
Relative	0.23	0.23	0.22	0.25
Relative Performance	0.20	0.19	0.22	0.20
Relative Fitness	0.14	0.14	0.14	0.14

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.20	0.30	0.31	0.31
Array B	0.28	0.22	0.30	0.27
Array C	0.30	0.25	0.24	0.26
Array D	0.28	0.22	0.28	0.26
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.20	0.24	0.24	0.25
Array B	0.20	0.22	0.28	0.29
Array C	0.20	0.18	0.24	0.25
Array D	0.19	0.20	0.28	0.26
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.04	0.19	0.21	0.21
Array B	0.17	0.04	0.28	0.18
Array C	0.19	0.20	0.04	0.23
Array D	0.16	0.16	0.28	0.04
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.14	0.18	0.13
Array B	0.11	0.0	0.20	0.12
Array C	0.13	0.18	0.0	0.19
Array D	0.12	0.09	0.20	0.0

	Bandwidth				Throughput				Latency			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.26	0.27	0.23	0.18	0.20	0.26	0.23	0.29	0.18	0.44	0.58	0.77
Array B	0.34	0.17	0.27	0.23	0.23	0.22	0.24	0.29	0.27	0.26	0.33	0.33
Array C	0.32	0.19	0.23	0.18	0.27	0.26	0.23	0.29	0.30	0.32	0.28	0.33
Array D	0.32	0.17	0.23	0.22	0.24	0.22	0.24	0.29	0.27	0.31	0.31	0.34
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.26	0.23	0.24	0.18	0.20	0.28	0.19	0.32	0.18	0.21	0.31	0.29
Array B	0.23	0.17	0.30	0.22	0.17	0.22	0.22	0.32	0.16	0.26	0.32	0.31
Array C	0.26	0.17	0.23	0.19	0.18	0.16	0.23	0.32	0.18	0.20	0.28	0.25
Array D	0.19	0.17	0.30	0.22	0.21	0.19	0.21	0.29	0.18	0.24	0.31	0.34
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.04	0.14	0.18	0.16	0.02	0.27	0.27	0.32	0.05	0.16	0.22	0.16
Array B	0.13	0.04	0.27	0.19	0.19	0.03	0.34	0.13	0.18	0.05	0.26	0.22
Array C	0.19	0.21	0.04	0.19	0.24	0.19	0.03	0.28	0.14	0.20	0.07	0.23
Array D	0.16	0.16	0.19	0.03	0.15	0.15	0.34	0.03	0.18	0.17	0.29	0.07
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.15	0.18	0.12	0.0	0.16	0.16	0.12	0.0	0.12	0.19	0.15
Array B	0.12	0.0	0.20	0.12	0.11	0.0	0.20	0.08	0.10	0.0	0.20	0.14
Array C	0.12	0.18	0.0	0.18	0.14	0.18	0.0	0.18	0.12	0.18	0.0	0.19
Array D	0.12	0.09	0.20	0.0	0.11	0.07	0.19	0.0	0.12	0.10	0.18	0.0

Table K.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.47	0.62	0.35	0.45
Absolute	0.71	0.72	0.37	1.06
Relative	0.46	0.56	0.35	0.47
Relative Performance	0.35	0.36	0.35	0.34
Relative Fitness	0.24	0.24	0.24	0.25

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.38	1.23	1.02	1.54
Array B	0.54	0.45	0.70	0.50
Array C	0.53	0.49	0.57	0.47
Array D	0.52	0.45	0.59	0.47
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.38	0.39	0.48	0.50
Array B	0.41	0.45	0.61	0.58
Array C	0.44	0.37	0.57	0.45
Array D	0.39	0.40	0.53	0.47
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.08	0.32	0.42	0.35
Array B	0.31	0.08	0.50	0.25
Array C	0.34	0.38	0.11	0.43
Array D	0.26	0.22	0.41	0.08
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.22	0.25	0.25
Array B	0.23	0.0	0.31	0.18
Array C	0.20	0.31	0.0	0.38
Array D	0.15	0.13	0.31	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.66	0.59	0.72	0.37	0.24	0.40	0.37	0.40	0.25	2.70	1.96	3.84
Array B	1.02	0.40	1.34	0.49	0.28	0.37	0.40	0.40	0.32	0.59	0.37	0.60
Array C	0.98	0.41	0.99	0.38	0.29	0.40	0.37	0.40	0.33	0.66	0.37	0.61
Array D	0.97	0.36	1.03	0.41	0.27	0.37	0.40	0.40	0.31	0.61	0.36	0.61
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.66	0.45	0.75	0.40	0.24	0.37	0.26	0.41	0.25	0.33	0.43	0.68
Array B	0.58	0.40	0.82	0.52	0.30	0.37	0.51	0.41	0.34	0.59	0.49	0.81
Array C	0.70	0.40	0.99	0.39	0.32	0.26	0.37	0.41	0.29	0.44	0.37	0.55
Array D	0.53	0.41	0.82	0.41	0.35	0.32	0.28	0.40	0.28	0.49	0.49	0.61
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.09	0.25	0.50	0.32	0.04	0.45	0.42	0.41	0.10	0.26	0.34	0.32
Array B	0.38	0.08	0.62	0.23	0.32	0.05	0.42	0.17	0.24	0.10	0.46	0.36
Array C	0.46	0.37	0.13	0.27	0.31	0.44	0.05	0.42	0.24	0.34	0.16	0.61
Array D	0.33	0.23	0.35	0.05	0.20	0.20	0.42	0.04	0.25	0.24	0.47	0.13
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.23	0.23	0.20	0.0	0.23	0.23	0.19	0.0	0.20	0.28	0.35
Array B	0.25	0.0	0.32	0.18	0.26	0.0	0.31	0.17	0.19	0.0	0.31	0.19
Array C	0.21	0.34	0.0	0.29	0.21	0.34	0.0	0.34	0.18	0.24	0.0	0.50
Array D	0.14	0.14	0.31	0.0	0.14	0.12	0.31	0.0	0.17	0.14	0.32	0.0

Table K.4: Mean relative error

Appendix L

FitnessBuffered model testing on FitnessBuffered samples

Application	Samples	Iters	First sample	Last sample
Buffered (sd)	200	3	100	199
Total used	100			

Table L.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

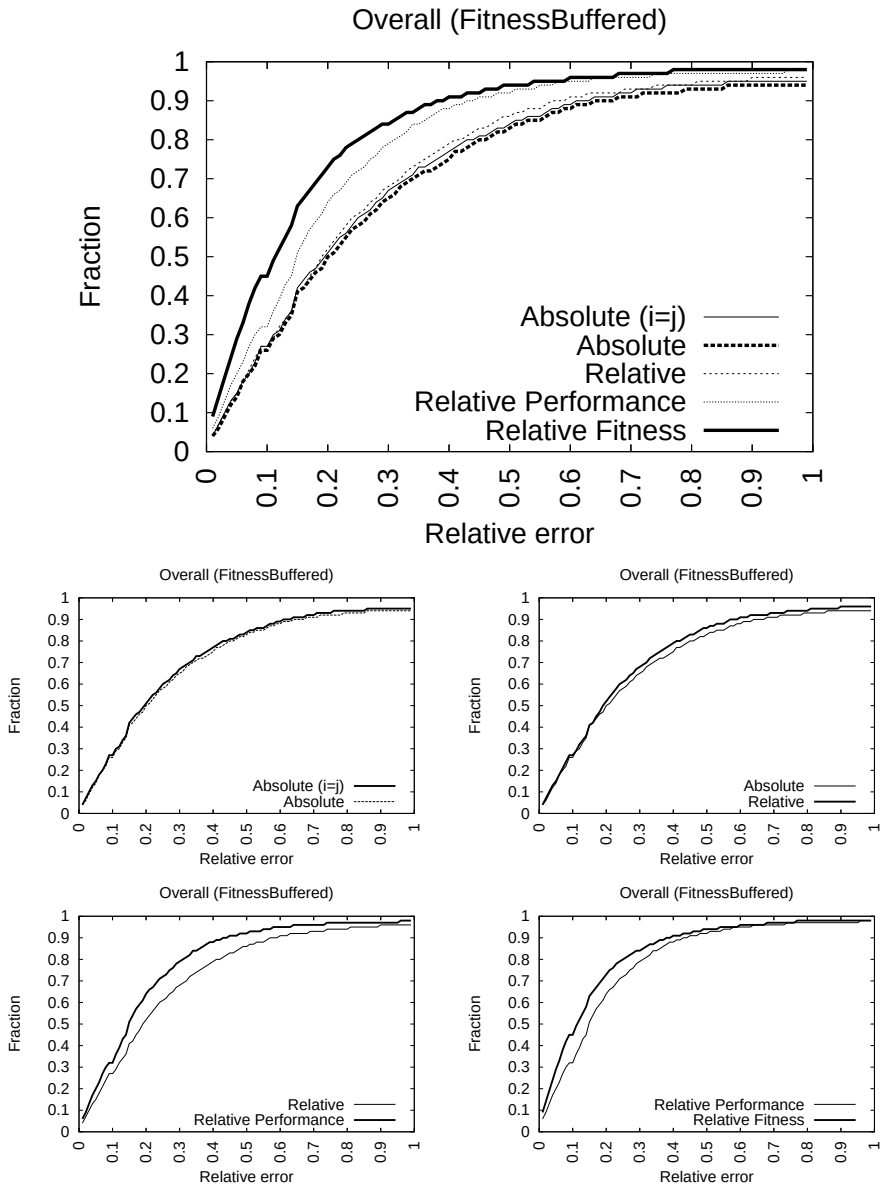

Figure L.1: The cumulative distribution of relative error over all pairwise predictions.

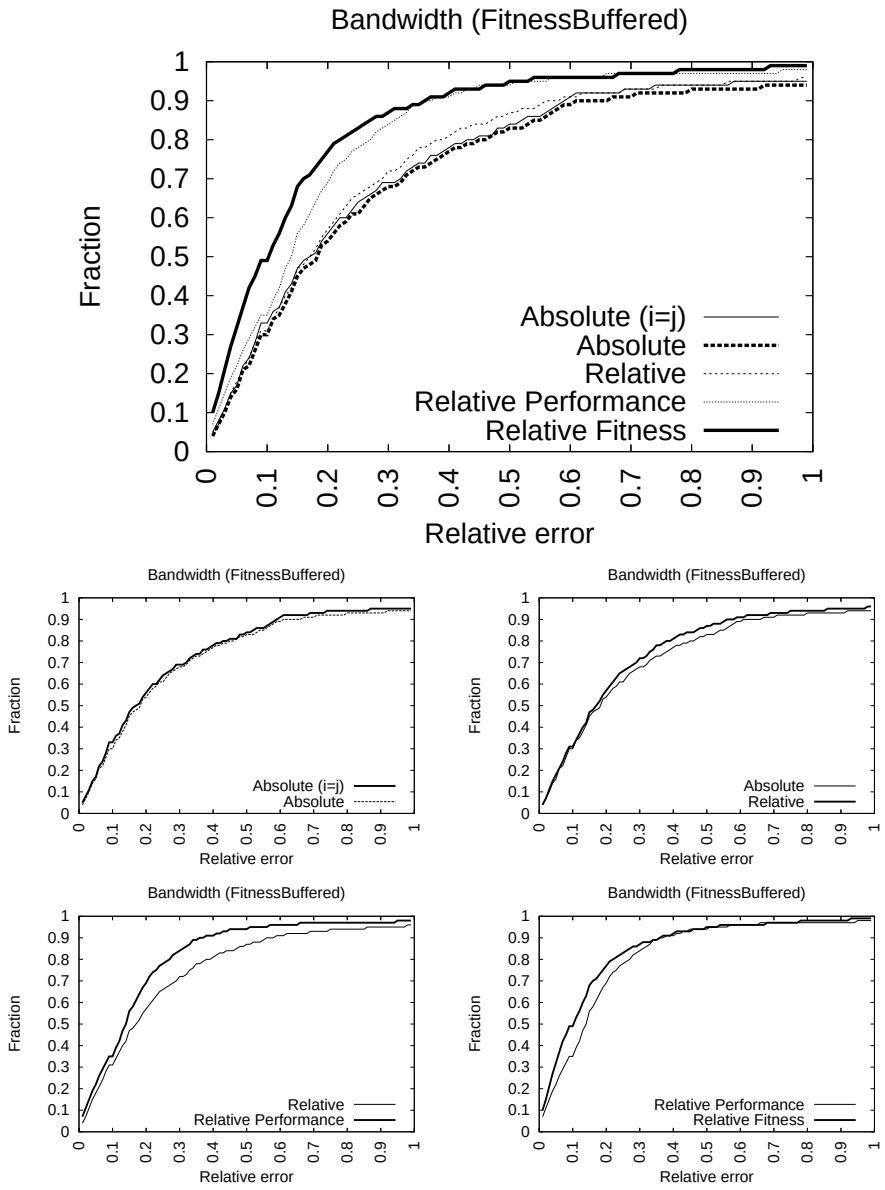

Figure L.2: The cumulative distribution of relative error over all pairwise predictions.

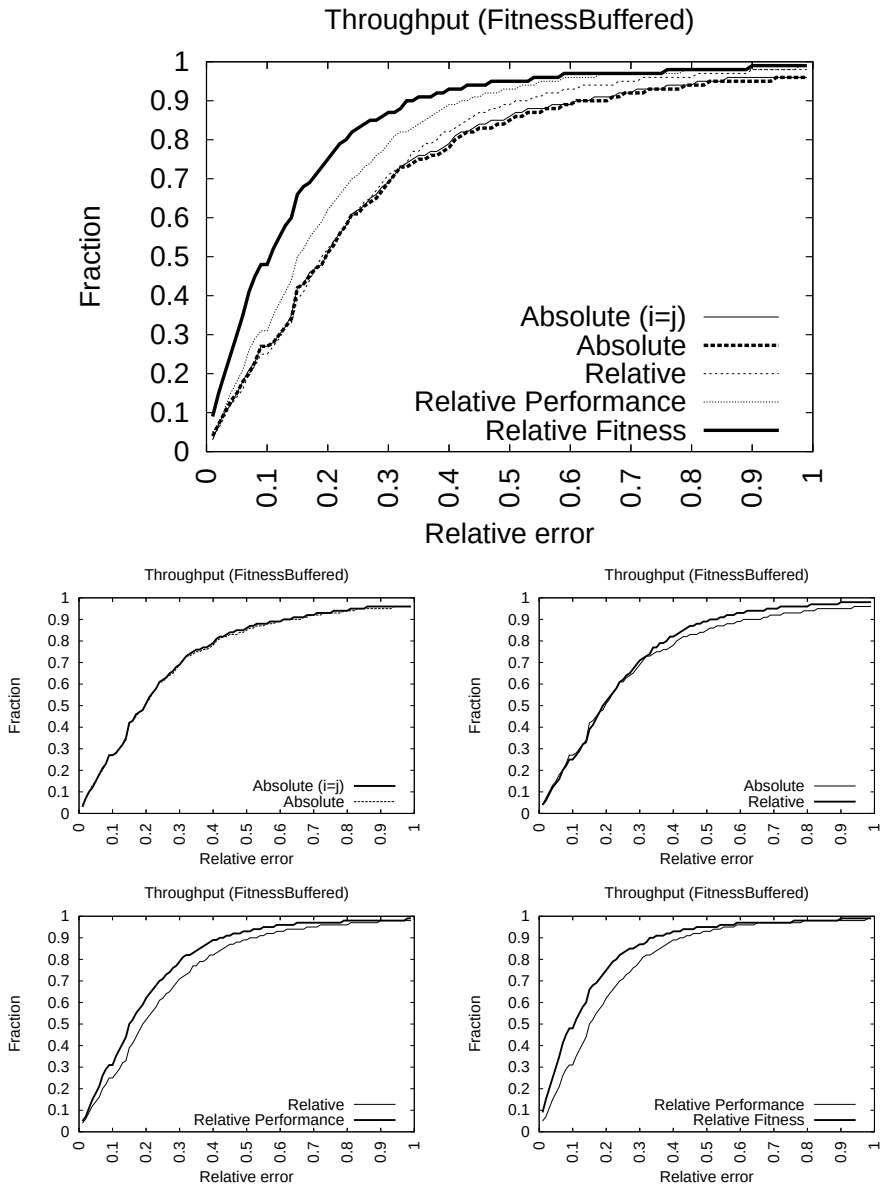

Figure L.3: The cumulative distribution of relative error over all pairwise predictions.

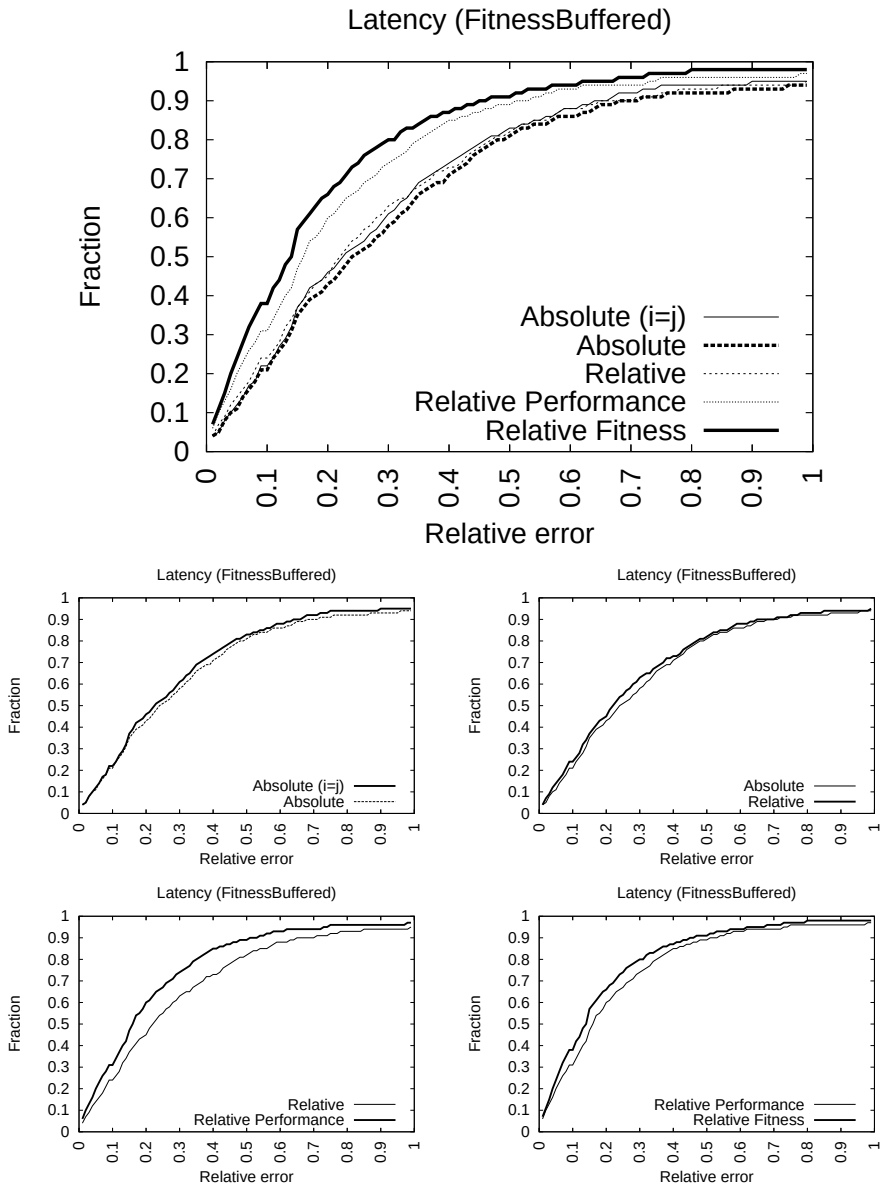

Figure L.4: The cumulative distribution of relative error over all pairwise predictions.

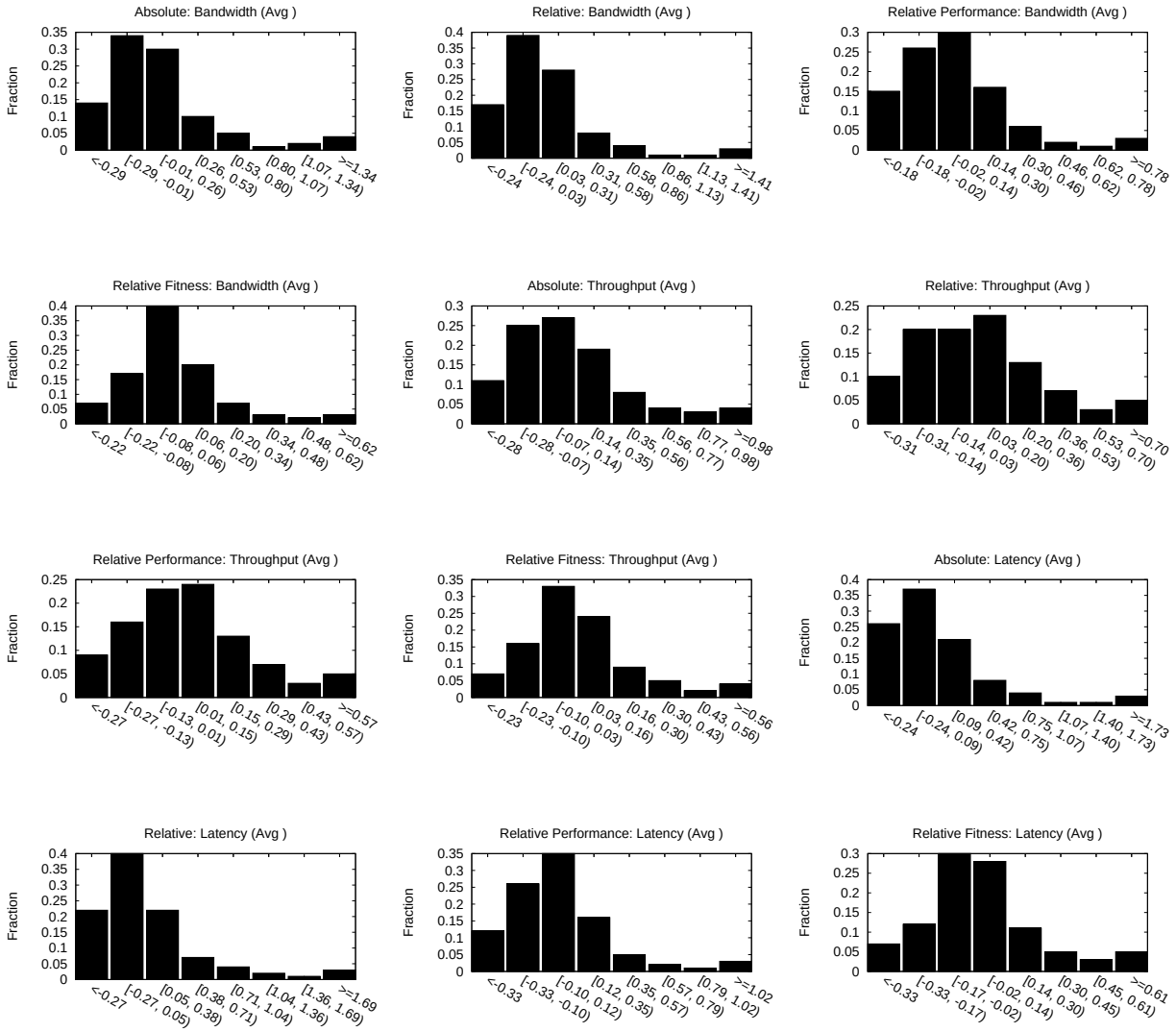

Figure L.5: The probability distribution of relative error over all pairwise predictions.

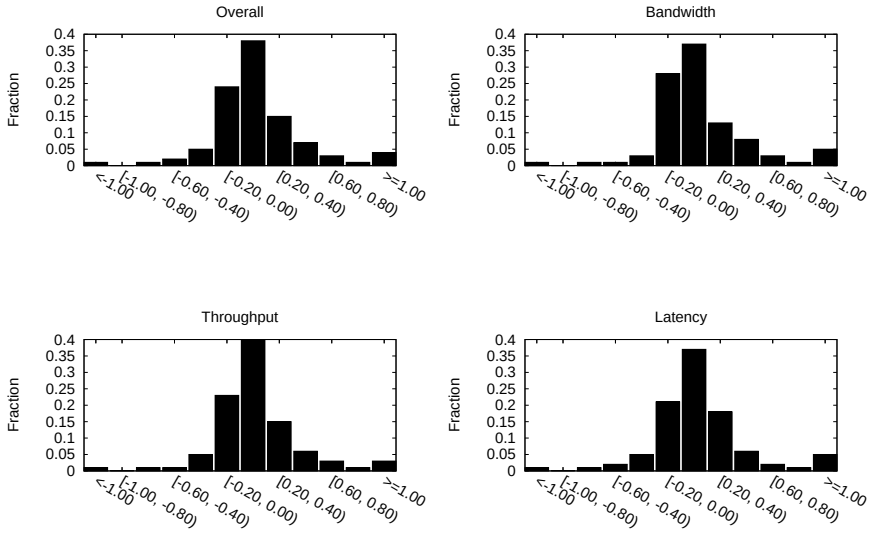

Figure L.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	4 / 4 / 90	24 / 38 / 36	36 / 46 / 16	23 / 59 / 16	24 / 69 / 5
A → C	11 / 7 / 80	33 / 28 / 37	20 / 55 / 23	40 / 55 / 3	37 / 54 / 7
A → D	9 / 3 / 86	45 / 39 / 14	35 / 60 / 3	29 / 61 / 8	29 / 65 / 4
B → A	2 / 0 / 96	16 / 31 / 51	32 / 46 / 20	36 / 56 / 6	26 / 67 / 5
B → C	11 / 6 / 81	28 / 31 / 39	30 / 44 / 24	43 / 52 / 3	41 / 53 / 4
B → D	9 / 5 / 84	38 / 33 / 27	24 / 57 / 17	36 / 53 / 9	17 / 78 / 3
C → A	6 / 4 / 88	36 / 47 / 15	30 / 49 / 19	44 / 46 / 8	26 / 64 / 8
C → B	7 / 6 / 85	28 / 48 / 22	32 / 44 / 22	38 / 53 / 7	36 / 57 / 5
C → D	7 / 5 / 86	31 / 39 / 28	40 / 39 / 19	38 / 53 / 7	40 / 53 / 5
D → A	1 / 2 / 95	20 / 33 / 45	34 / 49 / 15	35 / 53 / 10	30 / 64 / 4
D → B	4 / 2 / 92	30 / 36 / 32	27 / 64 / 7	26 / 64 / 8	23 / 70 / 5
D → C	13 / 8 / 77	29 / 25 / 44	39 / 38 / 21	38 / 54 / 6	45 / 50 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	12 / 4 / 82	21 / 23 / 54	28 / 41 / 29	31 / 58 / 9	22 / 70 / 6
A → C	2 / 4 / 92	61 / 37 / 0	31 / 66 / 1	41 / 50 / 7	31 / 62 / 5
A → D	0 / 0 / 98	37 / 60 / 1	32 / 35 / 31	37 / 56 / 5	27 / 71 / 0
B → A	4 / 7 / 87	54 / 32 / 12	36 / 49 / 13	24 / 67 / 7	23 / 65 / 10
B → C	3 / 3 / 92	61 / 37 / 0	35 / 44 / 19	28 / 64 / 6	25 / 67 / 6
B → D	0 / 0 / 98	42 / 56 / 0	46 / 50 / 2	21 / 68 / 9	15 / 75 / 8
C → A	7 / 7 / 84	45 / 29 / 24	31 / 53 / 14	41 / 53 / 4	36 / 58 / 4
C → B	8 / 8 / 82	46 / 41 / 11	37 / 47 / 14	44 / 51 / 3	46 / 46 / 6
C → D	0 / 0 / 98	39 / 58 / 1	41 / 28 / 29	35 / 58 / 5	28 / 66 / 4
D → A	2 / 5 / 91	57 / 34 / 7	37 / 61 / 0	31 / 62 / 5	28 / 62 / 8
D → B	10 / 4 / 84	37 / 32 / 29	28 / 52 / 18	22 / 65 / 11	19 / 73 / 6
D → C	5 / 4 / 89	61 / 37 / 0	56 / 40 / 2	37 / 59 / 2	43 / 51 / 4
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	10 / 1 / 87	29 / 32 / 37	29 / 44 / 25	34 / 59 / 5	25 / 67 / 6
A → C	8 / 8 / 82	33 / 54 / 11	37 / 43 / 18	37 / 55 / 6	20 / 75 / 3
A → D	9 / 3 / 86	41 / 33 / 24	24 / 55 / 19	39 / 56 / 3	27 / 66 / 5
B → A	7 / 4 / 87	24 / 19 / 55	27 / 62 / 9	44 / 48 / 6	31 / 62 / 5
B → C	7 / 6 / 85	33 / 44 / 21	41 / 47 / 10	42 / 54 / 2	29 / 65 / 4
B → D	9 / 4 / 85	32 / 28 / 38	23 / 61 / 14	31 / 54 / 13	27 / 66 / 5
C → A	10 / 6 / 82	35 / 32 / 31	26 / 52 / 20	39 / 54 / 5	28 / 67 / 3
C → B	4 / 8 / 86	37 / 34 / 27	32 / 56 / 10	52 / 42 / 4	47 / 47 / 4
C → D	10 / 3 / 85	35 / 47 / 16	43 / 45 / 10	36 / 59 / 3	40 / 52 / 6
D → A	11 / 4 / 83	7 / 21 / 70	19 / 61 / 18	38 / 52 / 8	22 / 72 / 4
D → B	2 / 4 / 92	31 / 26 / 41	20 / 54 / 24	31 / 57 / 10	26 / 68 / 4
D → C	8 / 5 / 85	13 / 65 / 20	53 / 35 / 10	40 / 49 / 9	27 / 69 / 2
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table L.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.20	0.17	0.20	0.23
Absolute	0.21	0.19	0.20	0.25
Relative	0.20	0.18	0.20	0.23
Relative Performance	0.15	0.14	0.15	0.16
Relative Fitness	0.11	0.10	0.10	0.13

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.18	0.17	0.23	0.26
Array B	0.19	0.16	0.23	0.26
Array C	0.19	0.16	0.22	0.25
Array D	0.18	0.16	0.24	0.24
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.18	0.16	0.22	0.23
Array B	0.17	0.16	0.21	0.24
Array C	0.20	0.19	0.22	0.20
Array D	0.18	0.17	0.20	0.24
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.03	0.13	0.16	0.16
Array B	0.13	0.03	0.19	0.14
Array C	0.14	0.15	0.04	0.20
Array D	0.13	0.10	0.21	0.03
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.08	0.13	0.12
Array B	0.09	0.0	0.14	0.07
Array C	0.12	0.13	0.0	0.15
Array D	0.10	0.06	0.16	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.17	0.17	0.18	0.22	0.18	0.16	0.22	0.31	0.20	0.24	0.30	0.24
Array B	0.17	0.16	0.19	0.21	0.17	0.13	0.23	0.31	0.22	0.20	0.30	0.24
Array C	0.17	0.19	0.15	0.19	0.17	0.13	0.22	0.31	0.22	0.17	0.29	0.24
Array D	0.16	0.16	0.19	0.19	0.17	0.15	0.23	0.31	0.22	0.18	0.30	0.22
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.17	0.15	0.21	0.24	0.18	0.15	0.25	0.20	0.20	0.18	0.21	0.25
Array B	0.12	0.16	0.18	0.22	0.17	0.13	0.25	0.22	0.24	0.20	0.21	0.29
Array C	0.14	0.19	0.15	0.16	0.18	0.15	0.22	0.21	0.23	0.23	0.29	0.23
Array D	0.13	0.17	0.18	0.19	0.20	0.16	0.25	0.31	0.23	0.20	0.15	0.22
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.03	0.12	0.15	0.16	0.03	0.11	0.16	0.16	0.04	0.17	0.17	0.13
Array B	0.12	0.03	0.15	0.12	0.13	0.03	0.22	0.16	0.16	0.04	0.19	0.17
Array C	0.12	0.15	0.03	0.16	0.14	0.14	0.03	0.22	0.17	0.17	0.04	0.25
Array D	0.12	0.09	0.18	0.03	0.16	0.10	0.26	0.03	0.13	0.11	0.21	0.05
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.07	0.13	0.10	0.0	0.06	0.13	0.12	0.0	0.11	0.12	0.13
Array B	0.08	0.0	0.14	0.07	0.07	0.0	0.13	0.06	0.14	0.0	0.15	0.09
Array C	0.10	0.11	0.0	0.12	0.11	0.12	0.0	0.15	0.14	0.16	0.0	0.17
Array D	0.08	0.06	0.14	0.0	0.10	0.05	0.18	0.0	0.12	0.09	0.16	0.0

Table L.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.33	0.34	0.29	0.35
Absolute	0.34	0.34	0.30	0.39
Relative	0.32	0.32	0.27	0.37
Relative Performance	0.23	0.21	0.23	0.26
Relative Fitness	0.18	0.16	0.17	0.21

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.29	0.38	0.35	0.38
Array B	0.30	0.36	0.34	0.37
Array C	0.31	0.32	0.32	0.37
Array D	0.30	0.35	0.35	0.35
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.29	0.34	0.35	0.35
Array B	0.29	0.36	0.33	0.35
Array C	0.28	0.33	0.32	0.32
Array D	0.28	0.33	0.29	0.35
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.05	0.20	0.25	0.22
Array B	0.21	0.06	0.30	0.25
Array C	0.20	0.21	0.07	0.27
Array D	0.19	0.15	0.31	0.08
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.12	0.24	0.18
Array B	0.16	0.0	0.26	0.16
Array C	0.18	0.20	0.0	0.23
Array D	0.14	0.10	0.24	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.30	0.38	0.31	0.36	0.29	0.21	0.30	0.42	0.29	0.56	0.44	0.36
Array B	0.30	0.46	0.31	0.37	0.28	0.18	0.30	0.42	0.32	0.43	0.42	0.32
Array C	0.29	0.34	0.27	0.34	0.29	0.20	0.30	0.42	0.33	0.44	0.39	0.36
Array D	0.28	0.44	0.32	0.34	0.29	0.20	0.31	0.42	0.32	0.41	0.43	0.30
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.30	0.36	0.38	0.42	0.29	0.19	0.32	0.24	0.29	0.47	0.37	0.39
Array B	0.27	0.46	0.36	0.35	0.27	0.18	0.32	0.30	0.34	0.43	0.32	0.40
Array C	0.24	0.26	0.27	0.30	0.27	0.24	0.30	0.27	0.31	0.48	0.39	0.40
Array D	0.26	0.36	0.31	0.34	0.29	0.20	0.32	0.42	0.31	0.42	0.23	0.30
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.06	0.18	0.27	0.21	0.05	0.13	0.20	0.24	0.05	0.29	0.27	0.21
Array B	0.21	0.06	0.23	0.20	0.22	0.05	0.33	0.24	0.21	0.06	0.34	0.31
Array C	0.15	0.18	0.07	0.23	0.21	0.17	0.05	0.28	0.25	0.28	0.08	0.31
Array D	0.18	0.15	0.32	0.07	0.23	0.12	0.31	0.05	0.16	0.19	0.29	0.12
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.10	0.26	0.15	0.0	0.10	0.26	0.18	0.0	0.16	0.21	0.20
Array B	0.11	0.0	0.25	0.15	0.13	0.0	0.19	0.14	0.24	0.0	0.33	0.18
Array C	0.14	0.17	0.0	0.23	0.19	0.18	0.0	0.24	0.22	0.24	0.0	0.23
Array D	0.11	0.09	0.21	0.0	0.16	0.08	0.23	0.0	0.16	0.13	0.28	0.0

Table L.4: Mean relative error

Appendix M

FitnessFS model testing on FitnessFS samples

Application	Samples	Iters	First sample	Last sample
FS (fs)	200	3	100	199
Total used	100			

Table M.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

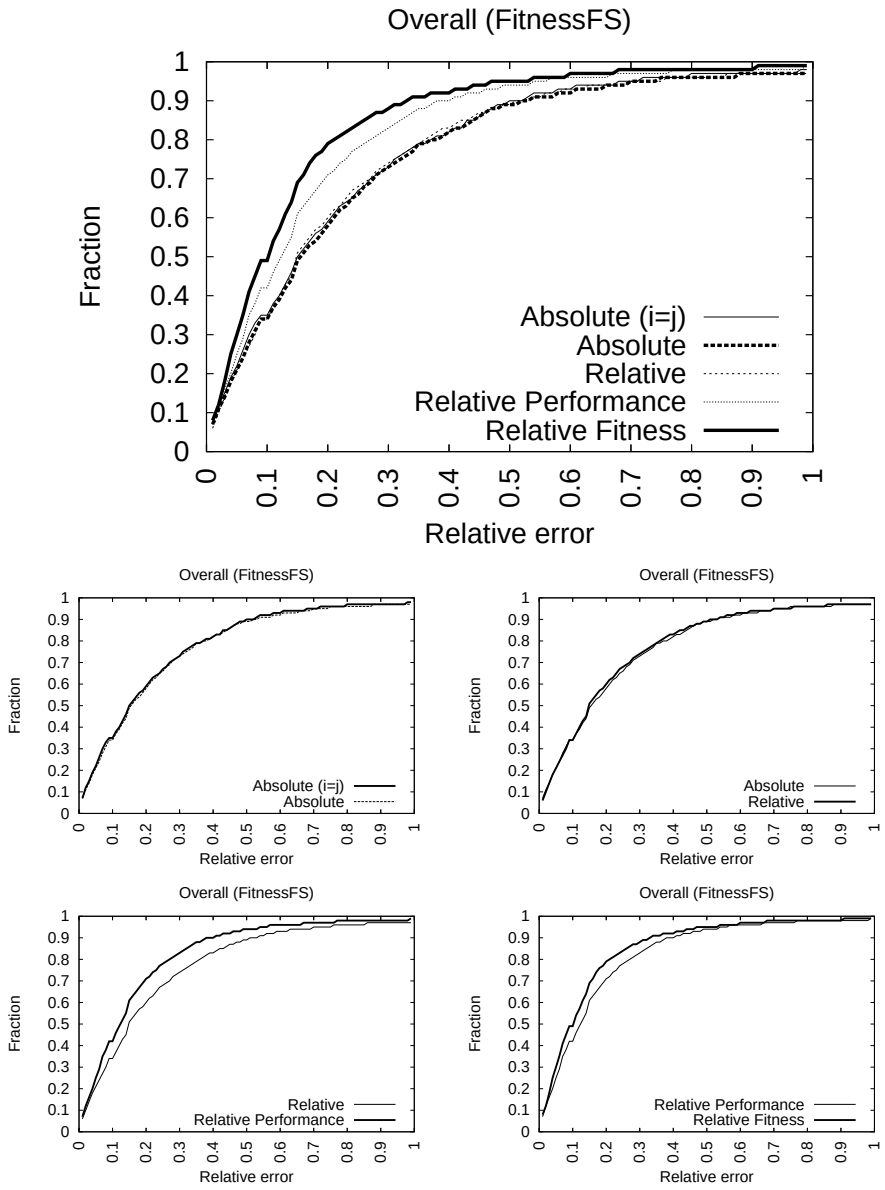

Figure M.1: The cumulative distribution of relative error over all pairwise predictions.

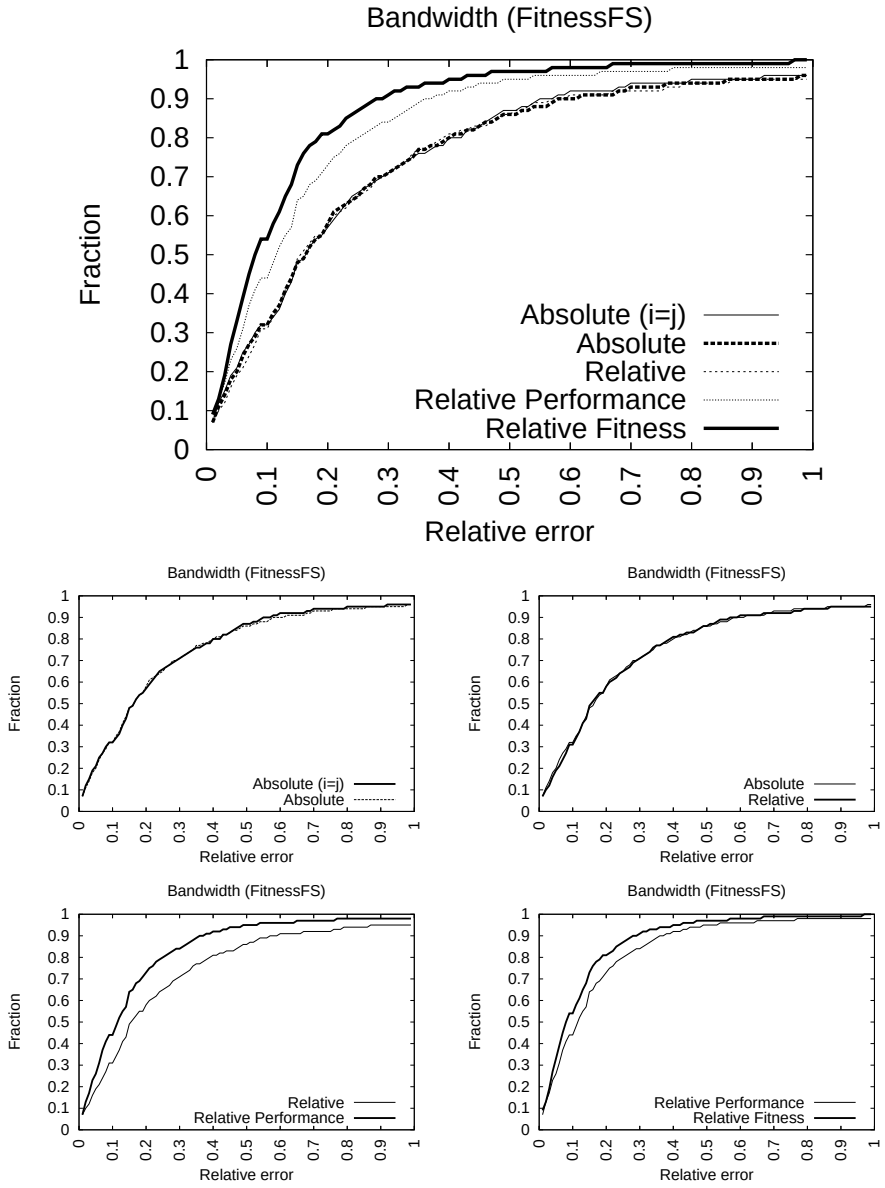

Figure M.2: The cumulative distribution of relative error over all pairwise predictions.

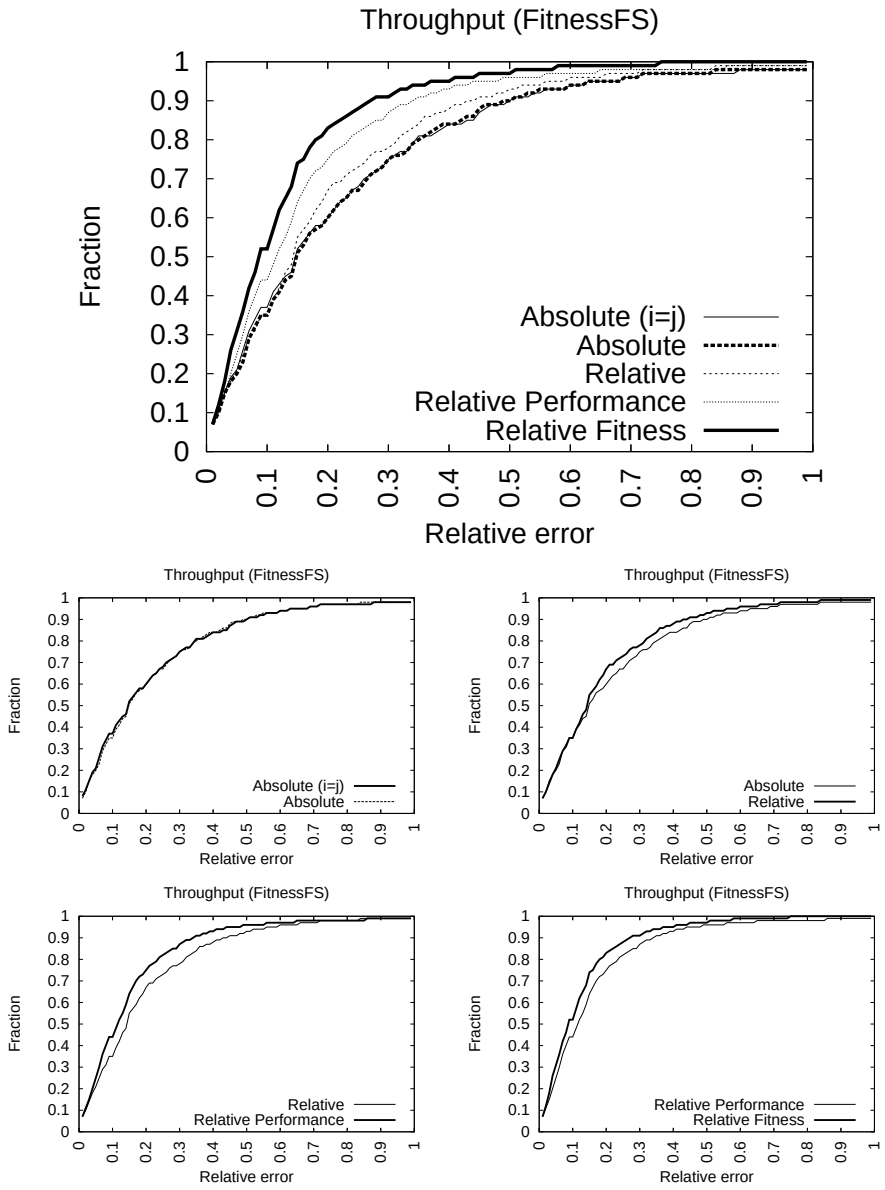

Figure M.3: The cumulative distribution of relative error over all pairwise predictions.

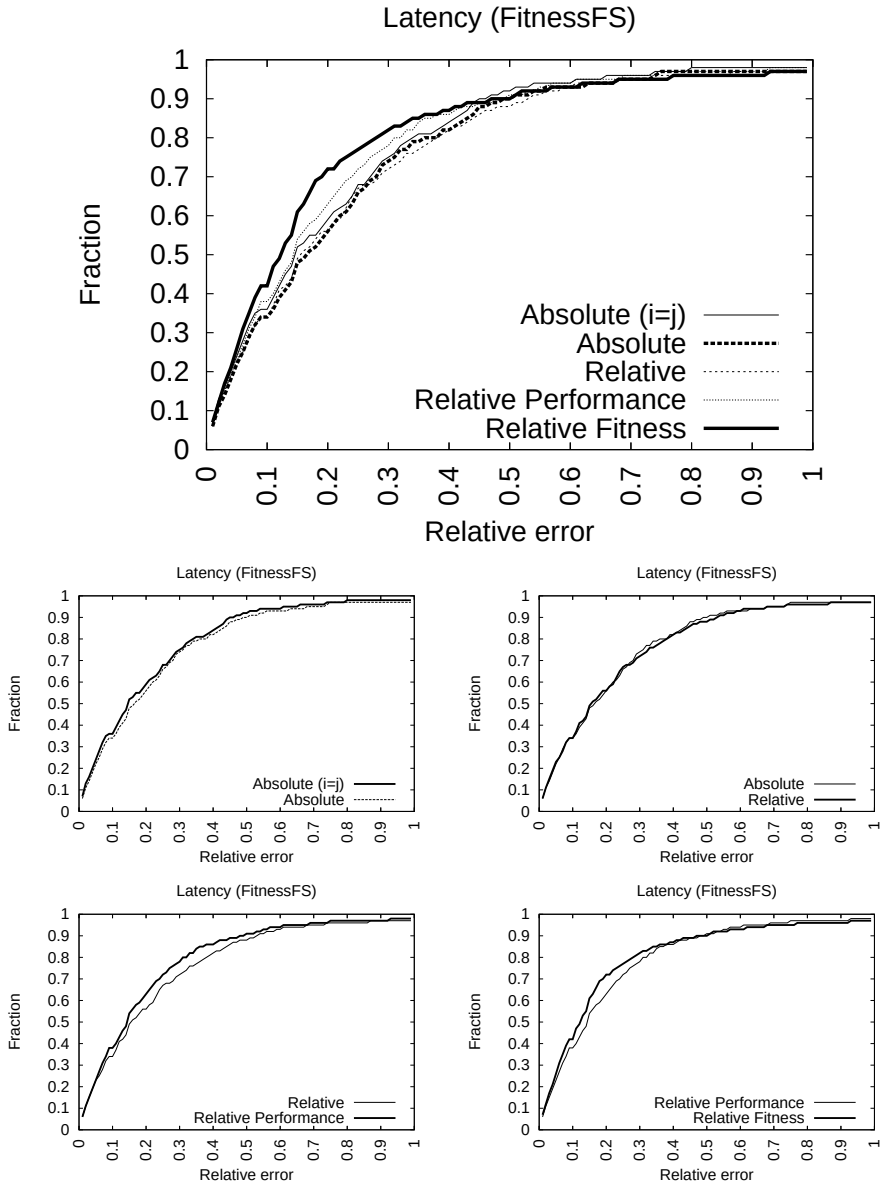

Figure M.4: The cumulative distribution of relative error over all pairwise predictions.

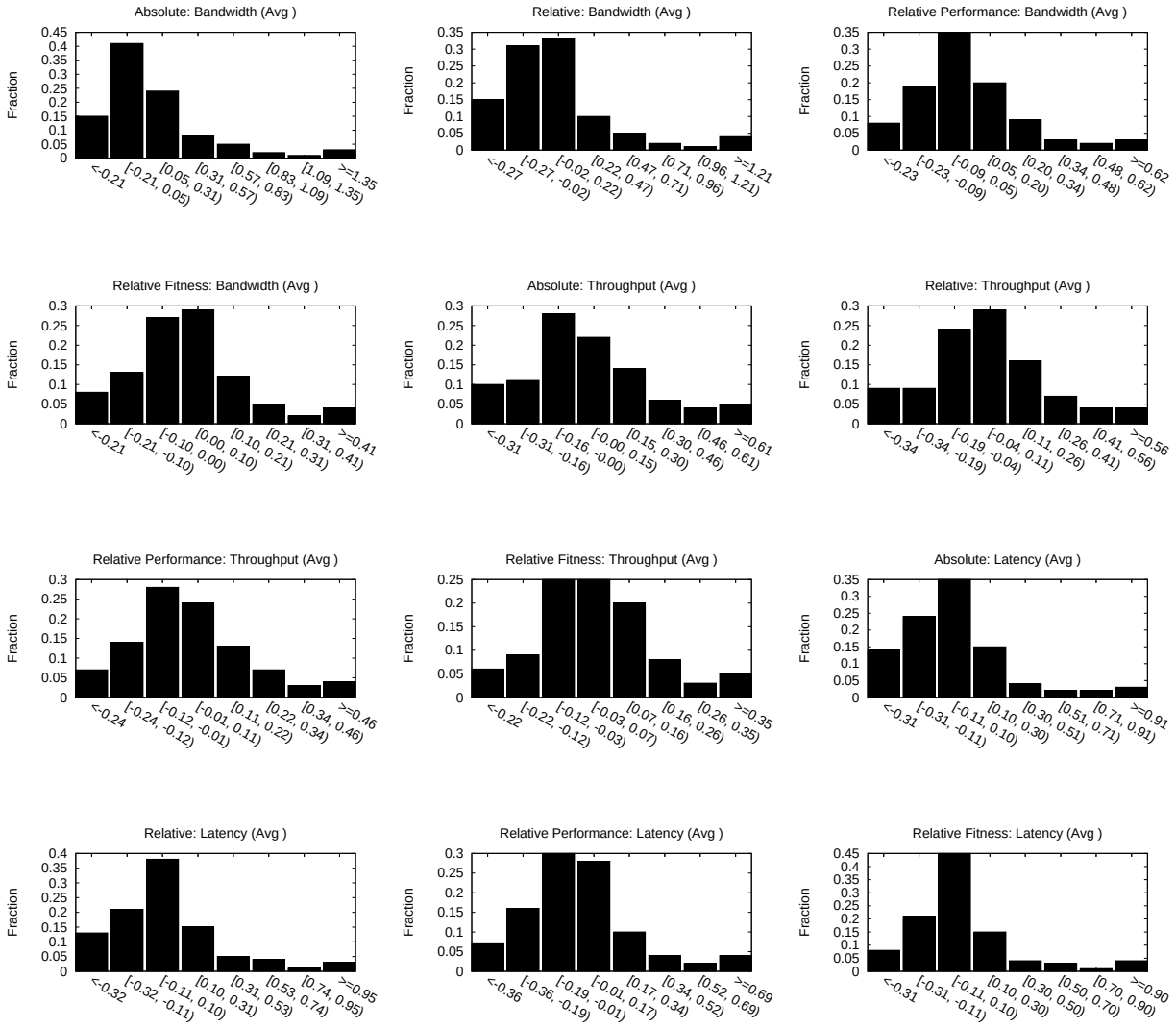

Figure M.5: The probability distribution of relative error over all pairwise predictions.

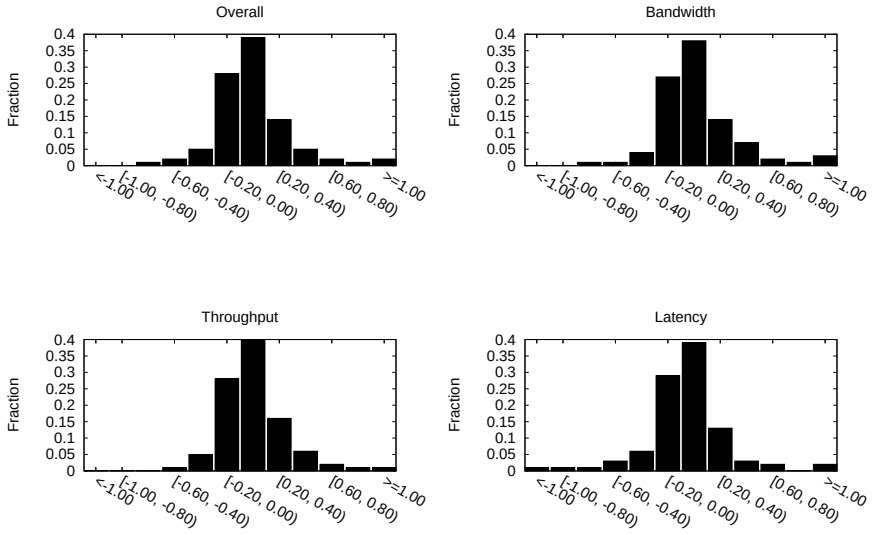

Figure M.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	11 / 7 / 80	22 / 32 / 44	34 / 53 / 11	33 / 57 / 8	31 / 62 / 5
A → C	19 / 6 / 73	35 / 42 / 21	28 / 58 / 12	39 / 50 / 9	30 / 65 / 3
A → D	19 / 19 / 60	41 / 30 / 27	31 / 59 / 8	23 / 64 / 11	25 / 68 / 5
B → A	11 / 14 / 73	29 / 34 / 35	46 / 48 / 4	27 / 64 / 7	41 / 54 / 3
B → C	7 / 5 / 86	29 / 36 / 33	23 / 41 / 34	49 / 44 / 5	38 / 57 / 3
B → D	11 / 21 / 66	47 / 30 / 21	30 / 58 / 10	36 / 53 / 9	22 / 70 / 6
C → A	10 / 14 / 74	49 / 36 / 13	41 / 42 / 15	49 / 44 / 5	47 / 44 / 7
C → B	10 / 13 / 75	39 / 33 / 26	40 / 42 / 16	37 / 54 / 7	32 / 59 / 7
C → D	14 / 16 / 68	52 / 34 / 12	33 / 38 / 27	30 / 58 / 10	28 / 64 / 6
D → A	12 / 13 / 73	57 / 38 / 3	25 / 64 / 9	33 / 53 / 12	31 / 58 / 9
D → B	9 / 9 / 80	37 / 35 / 26	20 / 63 / 15	39 / 47 / 12	22 / 70 / 6
D → C	20 / 5 / 73	43 / 38 / 17	27 / 67 / 4	41 / 50 / 7	26 / 67 / 5
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	2 / 1 / 95	38 / 54 / 6	36 / 46 / 16	39 / 50 / 9	35 / 59 / 4
A → C	5 / 3 / 90	61 / 35 / 2	0 / 0 / 98	27 / 69 / 2	32 / 60 / 6
A → D	0 / 0 / 98	36 / 61 / 1	34 / 58 / 6	30 / 56 / 12	22 / 74 / 2
B → A	18 / 14 / 66	36 / 23 / 39	29 / 55 / 14	31 / 52 / 15	27 / 61 / 10
B → C	3 / 3 / 92	63 / 33 / 2	32 / 58 / 8	38 / 53 / 7	38 / 54 / 6
B → D	0 / 0 / 98	35 / 63 / 0	28 / 62 / 8	39 / 50 / 9	17 / 79 / 2
C → A	20 / 12 / 66	28 / 25 / 45	38 / 39 / 21	47 / 41 / 10	41 / 52 / 5
C → B	5 / 2 / 91	35 / 60 / 3	41 / 31 / 26	36 / 56 / 6	43 / 51 / 4
C → D	0 / 0 / 98	33 / 63 / 2	47 / 46 / 5	39 / 49 / 10	23 / 73 / 2
D → A	19 / 14 / 65	36 / 18 / 44	22 / 63 / 13	42 / 47 / 9	34 / 56 / 8
D → B	1 / 1 / 96	51 / 46 / 1	31 / 58 / 9	29 / 60 / 9	26 / 65 / 7
D → C	7 / 2 / 89	60 / 36 / 2	28 / 63 / 7	44 / 45 / 9	42 / 50 / 6
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	5 / 4 / 89	17 / 25 / 56	48 / 41 / 9	49 / 41 / 8	51 / 43 / 4
A → C	21 / 5 / 72	24 / 27 / 47	39 / 38 / 21	31 / 60 / 7	38 / 53 / 7
A → D	16 / 8 / 74	18 / 33 / 47	29 / 39 / 30	40 / 54 / 4	34 / 60 / 4
B → A	5 / 0 / 93	34 / 37 / 27	34 / 51 / 13	30 / 63 / 5	27 / 71 / 0
B → C	14 / 6 / 78	32 / 20 / 46	24 / 42 / 32	51 / 42 / 5	55 / 39 / 4
B → D	8 / 9 / 81	28 / 29 / 41	23 / 41 / 34	38 / 52 / 8	27 / 65 / 6
C → A	9 / 4 / 85	28 / 44 / 26	34 / 51 / 13	34 / 56 / 8	28 / 70 / 0
C → B	4 / 3 / 91	38 / 39 / 21	42 / 37 / 19	43 / 51 / 4	48 / 44 / 6
C → D	12 / 6 / 80	17 / 22 / 59	28 / 34 / 36	42 / 51 / 5	48 / 45 / 5
D → A	8 / 3 / 87	31 / 45 / 22	34 / 54 / 10	30 / 57 / 11	27 / 68 / 3
D → B	7 / 4 / 87	42 / 35 / 21	27 / 53 / 18	37 / 53 / 8	30 / 62 / 6
D → C	27 / 7 / 64	37 / 38 / 23	34 / 47 / 17	50 / 41 / 7	47 / 46 / 5
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table M.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.15	0.17	0.15	0.15
Absolute	0.16	0.17	0.15	0.17
Relative	0.15	0.16	0.14	0.16
Relative Performance	0.12	0.11	0.11	0.14
Relative Fitness	0.10	0.09	0.09	0.12

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.17	0.13	0.16	0.21
Array B	0.17	0.12	0.13	0.17
Array C	0.17	0.12	0.13	0.21
Array D	0.17	0.13	0.15	0.21
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.17	0.12	0.17	0.17
Array B	0.15	0.12	0.16	0.14
Array C	0.15	0.13	0.13	0.14
Array D	0.17	0.14	0.17	0.21
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.03	0.10	0.14	0.13
Array B	0.12	0.02	0.12	0.09
Array C	0.14	0.12	0.02	0.14
Array D	0.12	0.09	0.13	0.05
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.09	0.10	0.09
Array B	0.09	0.0	0.12	0.08
Array C	0.11	0.10	0.0	0.12
Array D	0.09	0.07	0.14	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.15	0.15	0.21	0.17	0.10	0.10	0.13	0.27	0.25	0.12	0.17	0.15
Array B	0.14	0.14	0.15	0.15	0.12	0.10	0.12	0.27	0.27	0.12	0.13	0.14
Array C	0.13	0.14	0.14	0.18	0.13	0.10	0.12	0.27	0.27	0.12	0.13	0.14
Array D	0.15	0.15	0.24	0.20	0.12	0.10	0.13	0.27	0.27	0.14	0.14	0.13
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.15	0.14	0.20	0.20	0.10	0.10	0.17	0.15	0.25	0.12	0.16	0.15
Array B	0.13	0.14	0.15	0.17	0.12	0.10	0.17	0.13	0.24	0.12	0.16	0.13
Array C	0.14	0.15	0.14	0.18	0.13	0.10	0.12	0.13	0.23	0.15	0.13	0.14
Array D	0.21	0.14	0.21	0.20	0.15	0.15	0.17	0.27	0.22	0.13	0.16	0.13
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.03	0.10	0.11	0.14	0.02	0.08	0.17	0.12	0.03	0.13	0.17	0.14
Array B	0.11	0.02	0.10	0.09	0.08	0.02	0.11	0.09	0.23	0.03	0.13	0.09
Array C	0.13	0.14	0.02	0.16	0.10	0.11	0.01	0.14	0.20	0.14	0.04	0.14
Array D	0.10	0.07	0.11	0.04	0.10	0.09	0.12	0.21	0.15	0.10	0.15	0.03
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.06	0.10	0.07	0.0	0.07	0.10	0.10	0.0	0.16	0.10	0.09
Array B	0.07	0.0	0.11	0.08	0.07	0.0	0.10	0.08	0.13	0.0	0.15	0.07
Array C	0.11	0.08	0.0	0.11	0.11	0.10	0.0	0.12	0.13	0.14	0.0	0.15
Array D	0.08	0.07	0.12	0.0	0.09	0.05	0.12	0.0	0.10	0.08	0.16	0.0

Table M.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.25	0.29	0.23	0.22
Absolute	0.26	0.31	0.23	0.25
Relative	0.25	0.29	0.20	0.25
Relative Performance	0.19	0.18	0.16	0.22
Relative Fitness	0.16	0.13	0.13	0.21

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.21	0.24	0.31	0.29
Array B	0.21	0.23	0.28	0.28
Array C	0.23	0.23	0.27	0.30
Array D	0.21	0.26	0.30	0.28
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.21	0.22	0.27	0.26
Array B	0.22	0.23	0.27	0.27
Array C	0.25	0.22	0.27	0.27
Array D	0.24	0.24	0.28	0.28
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.06	0.16	0.22	0.19
Array B	0.19	0.06	0.21	0.18
Array C	0.20	0.22	0.05	0.21
Array D	0.18	0.13	0.20	0.13
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.16	0.16	0.12
Array B	0.15	0.0	0.20	0.12
Array C	0.18	0.19	0.0	0.17
Array D	0.14	0.10	0.20	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.21	0.32	0.40	0.30	0.17	0.19	0.25	0.31	0.27	0.22	0.28	0.24
Array B	0.19	0.31	0.36	0.31	0.17	0.18	0.24	0.31	0.29	0.20	0.24	0.20
Array C	0.20	0.28	0.33	0.35	0.17	0.20	0.25	0.31	0.30	0.22	0.22	0.23
Array D	0.19	0.37	0.40	0.31	0.17	0.18	0.25	0.31	0.28	0.22	0.26	0.20
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.21	0.27	0.31	0.33	0.17	0.14	0.23	0.23	0.27	0.23	0.28	0.24
Array B	0.21	0.31	0.27	0.33	0.17	0.18	0.23	0.29	0.27	0.20	0.31	0.20
Array C	0.26	0.28	0.33	0.35	0.17	0.18	0.25	0.20	0.31	0.20	0.22	0.27
Array D	0.29	0.28	0.34	0.31	0.18	0.20	0.23	0.31	0.24	0.23	0.27	0.20
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.07	0.17	0.19	0.19	0.03	0.13	0.23	0.17	0.07	0.19	0.23	0.22
Array B	0.17	0.09	0.19	0.16	0.12	0.04	0.19	0.20	0.28	0.05	0.24	0.18
Array C	0.17	0.24	0.06	0.25	0.17	0.18	0.03	0.18	0.27	0.23	0.06	0.20
Array D	0.15	0.12	0.19	0.06	0.13	0.12	0.16	0.25	0.25	0.14	0.24	0.09
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.12	0.14	0.11	0.0	0.11	0.13	0.12	0.0	0.24	0.21	0.14
Array B	0.11	0.0	0.17	0.10	0.10	0.0	0.14	0.10	0.24	0.0	0.29	0.14
Array C	0.17	0.15	0.0	0.15	0.16	0.18	0.0	0.16	0.21	0.24	0.0	0.21
Array D	0.10	0.10	0.16	0.0	0.11	0.08	0.16	0.0	0.19	0.13	0.27	0.0

Table M.4: Mean relative error

Appendix N

FitnessCache model testing on FitnessCache samples

Application	Samples	Iters	First sample	Last sample
Cache (cache)	70	3	35	69
Total used	35			

Table N.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

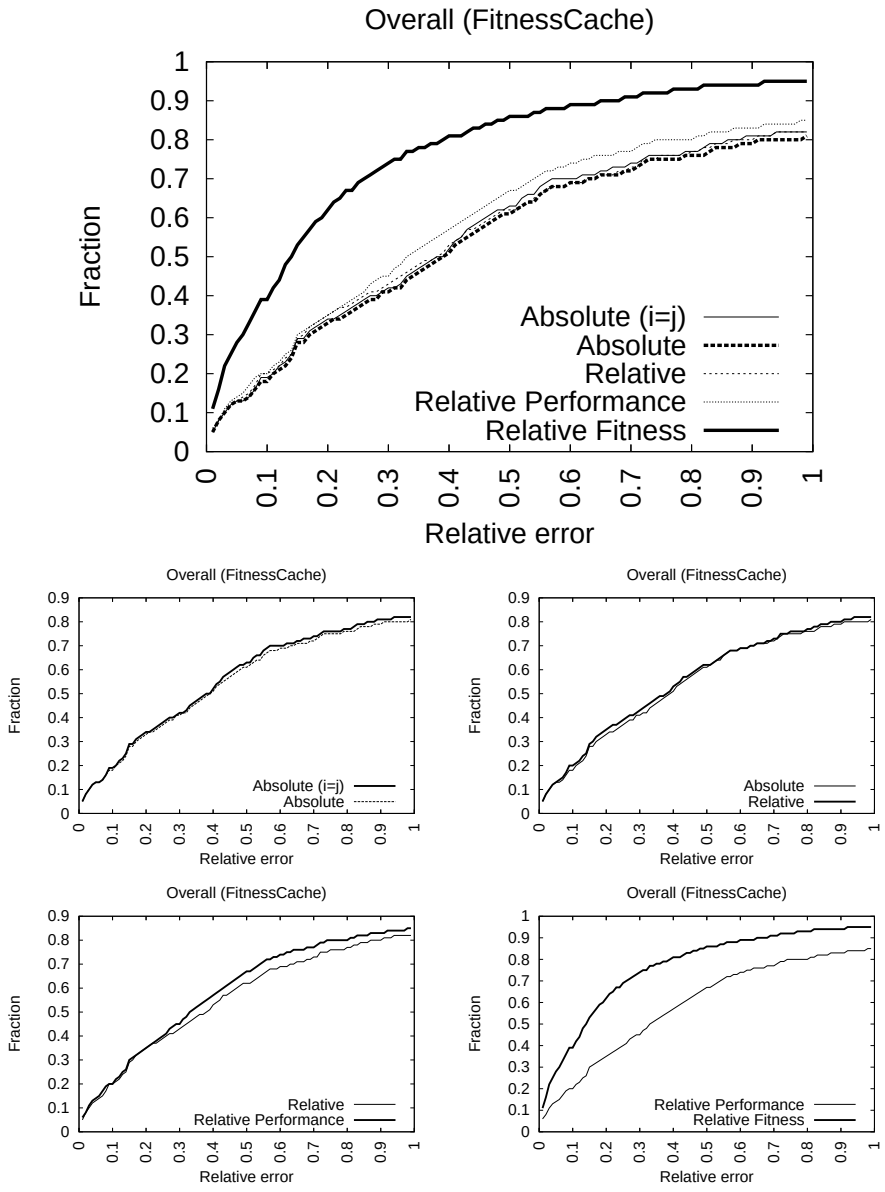

Figure N.1: The cumulative distribution of relative error over all pairwise predictions.

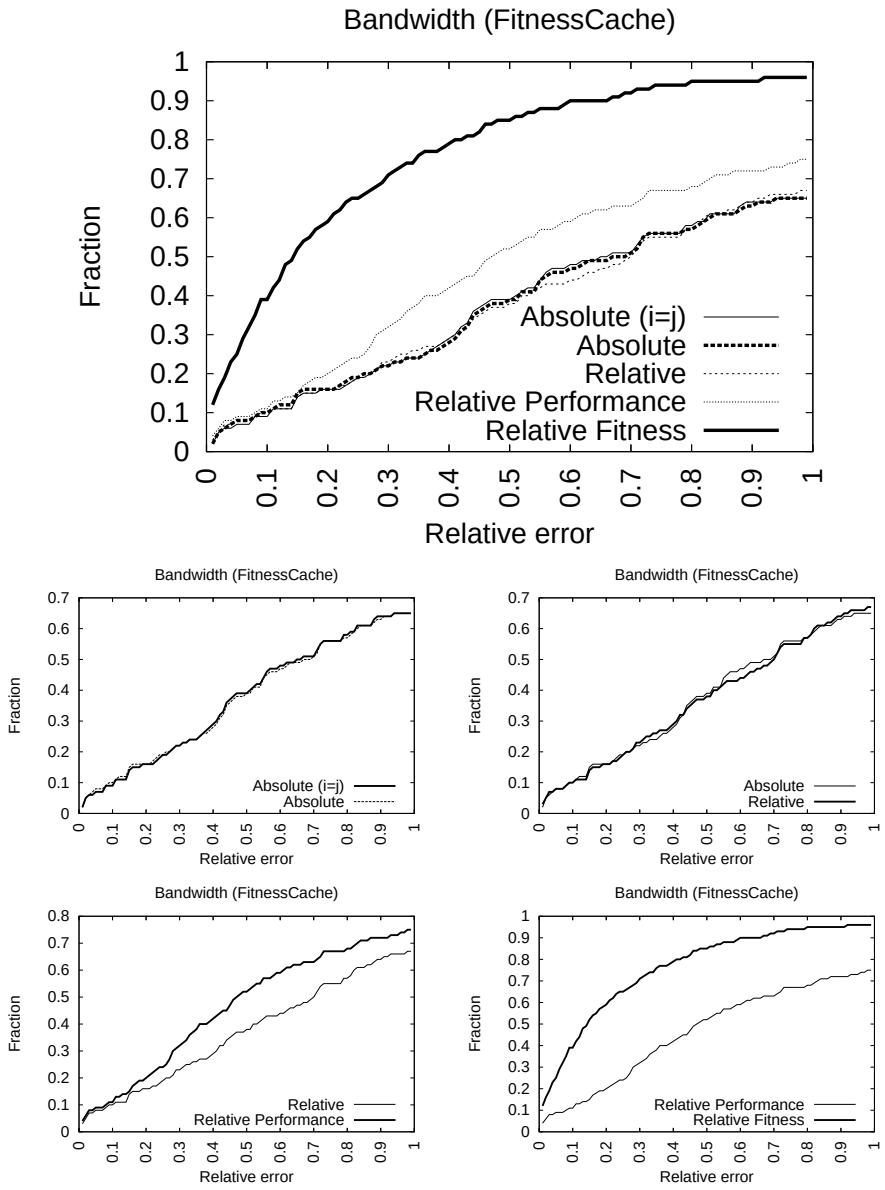

Figure N.2: The cumulative distribution of relative error over all pairwise predictions.

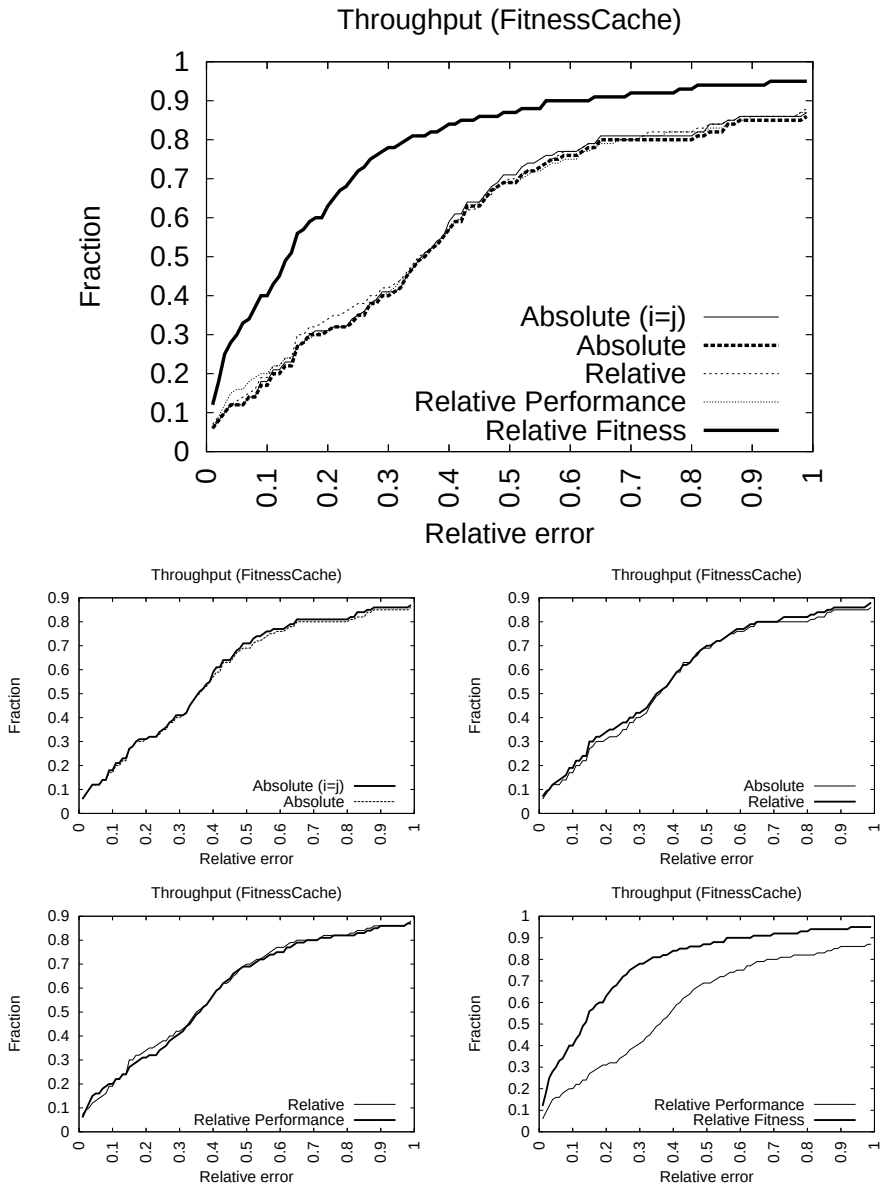

Figure N.3: The cumulative distribution of relative error over all pairwise predictions.

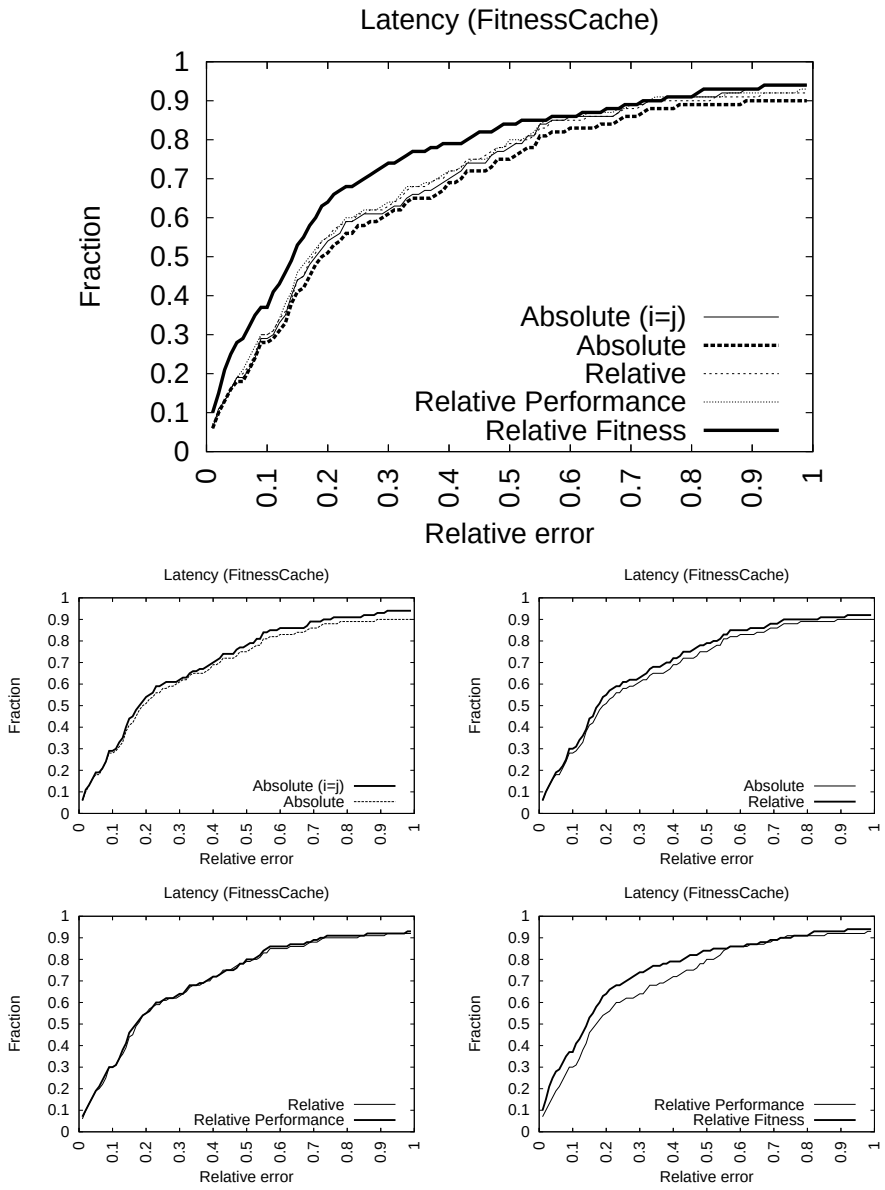

Figure N.4: The cumulative distribution of relative error over all pairwise predictions.

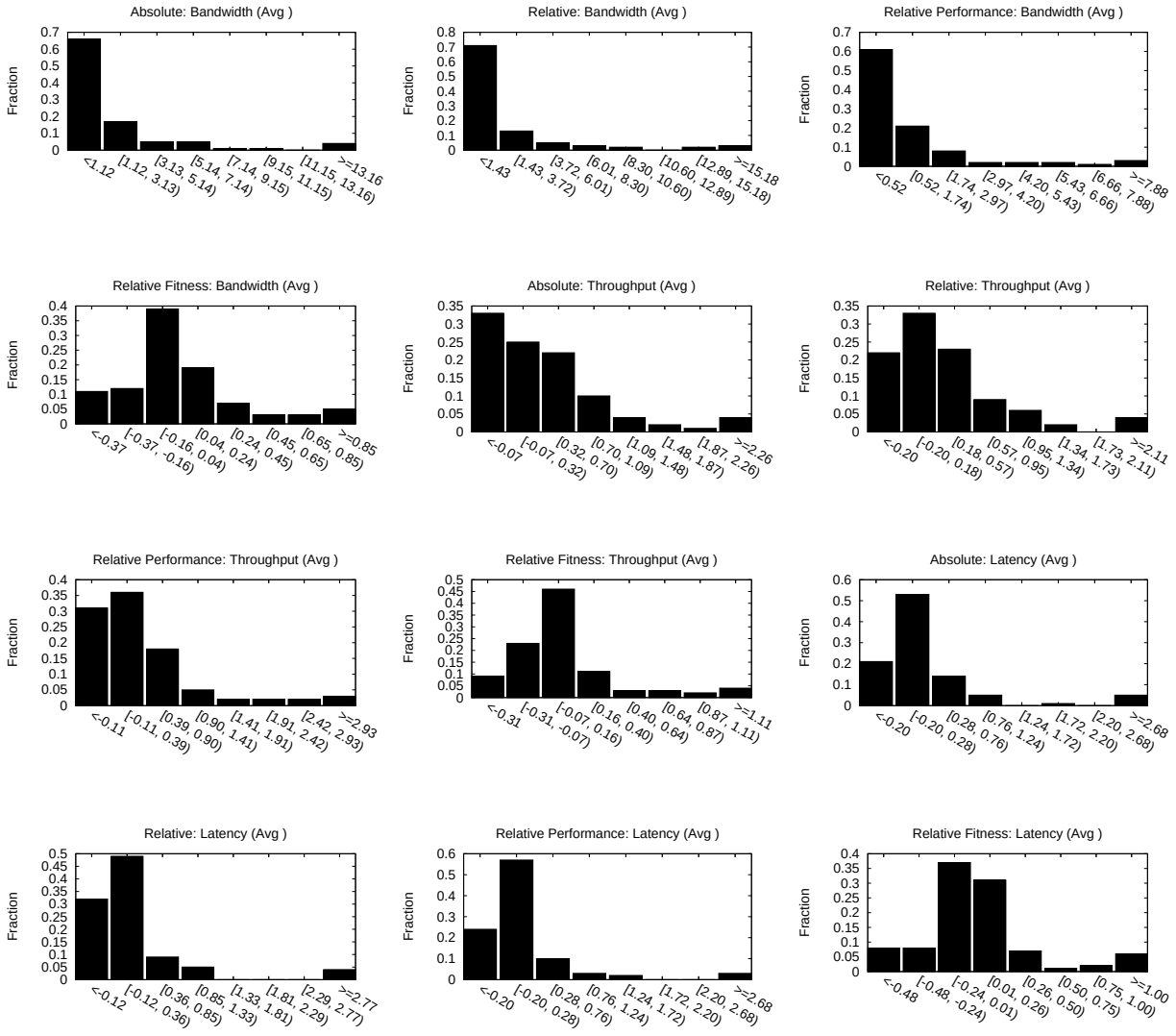

Figure N.5: The probability distribution of relative error over all pairwise predictions.

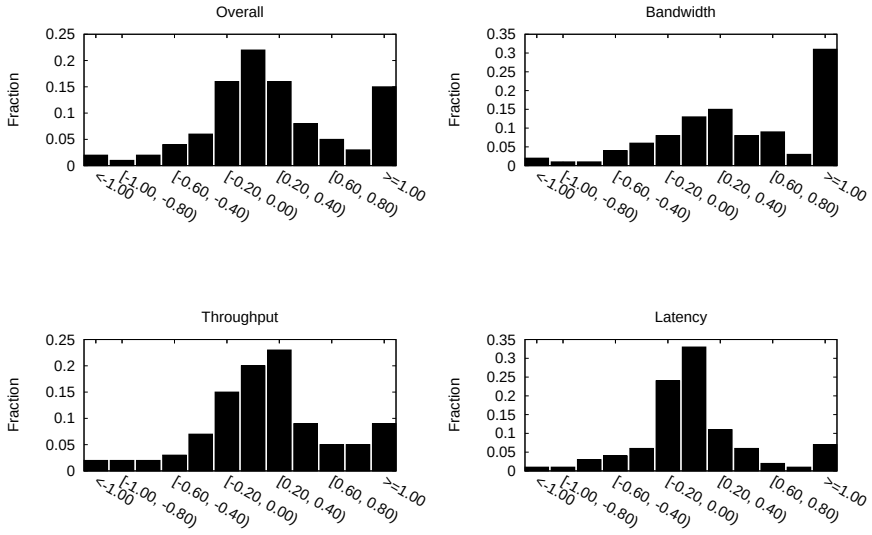

Figure N.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	1 / 1 / 31	18 / 15 / 0	7 / 26 / 0	3 / 30 / 0	2 / 31 / 0
A → C	0 / 0 / 33	0 / 0 / 33	2 / 0 / 31	7 / 26 / 0	8 / 25 / 0
A → D	0 / 0 / 33	2 / 2 / 29	10 / 15 / 8	9 / 24 / 0	10 / 23 / 0
B → A	1 / 0 / 32	14 / 17 / 2	19 / 13 / 1	12 / 21 / 0	12 / 20 / 1
B → C	0 / 0 / 33	0 / 0 / 33	5 / 9 / 19	11 / 22 / 0	14 / 19 / 0
B → D	0 / 0 / 33	2 / 2 / 29	6 / 17 / 10	7 / 25 / 1	7 / 26 / 0
C → A	1 / 0 / 32	0 / 0 / 33	14 / 16 / 3	6 / 26 / 1	4 / 28 / 1
C → B	1 / 2 / 30	18 / 15 / 0	7 / 26 / 0	2 / 31 / 0	3 / 30 / 0
C → D	0 / 0 / 33	0 / 0 / 33	3 / 23 / 7	10 / 21 / 2	4 / 28 / 1
D → A	1 / 0 / 32	1 / 7 / 25	11 / 9 / 13	2 / 31 / 0	5 / 28 / 0
D → B	1 / 2 / 30	8 / 17 / 8	11 / 20 / 2	5 / 28 / 0	4 / 28 / 1
D → C	0 / 0 / 33	0 / 0 / 33	10 / 18 / 5	7 / 24 / 2	8 / 22 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	1 / 0 / 32	0 / 2 / 31	4 / 7 / 22	7 / 24 / 2	5 / 27 / 1
A → C	0 / 0 / 33	1 / 6 / 26	23 / 9 / 1	3 / 30 / 0	7 / 25 / 1
A → D	0 / 2 / 31	0 / 0 / 33	6 / 12 / 15	9 / 23 / 1	8 / 25 / 0
B → A	1 / 0 / 32	5 / 7 / 21	10 / 10 / 13	9 / 20 / 4	10 / 21 / 2
B → C	0 / 0 / 33	14 / 18 / 1	9 / 17 / 7	17 / 16 / 0	17 / 16 / 0
B → D	0 / 2 / 31	3 / 2 / 28	25 / 7 / 1	5 / 28 / 0	8 / 25 / 0
C → A	2 / 0 / 31	5 / 3 / 25	4 / 8 / 21	10 / 20 / 3	11 / 20 / 2
C → B	1 / 1 / 31	2 / 6 / 25	15 / 16 / 2	13 / 18 / 2	11 / 22 / 0
C → D	0 / 2 / 31	0 / 0 / 33	4 / 10 / 19	7 / 26 / 0	7 / 25 / 1
D → A	3 / 0 / 30	3 / 3 / 27	7 / 8 / 18	9 / 23 / 1	9 / 23 / 1
D → B	3 / 1 / 29	15 / 10 / 8	16 / 15 / 2	7 / 24 / 2	9 / 23 / 1
D → C	0 / 0 / 33	0 / 0 / 33	5 / 8 / 20	8 / 22 / 3	9 / 23 / 1
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	3 / 1 / 29	4 / 5 / 24	8 / 3 / 22	11 / 18 / 4	9 / 22 / 2
A → C	6 / 1 / 26	7 / 7 / 19	4 / 11 / 18	8 / 25 / 0	5 / 27 / 1
A → D	1 / 0 / 32	3 / 2 / 28	5 / 3 / 25	12 / 17 / 4	13 / 16 / 4
B → A	0 / 0 / 33	0 / 0 / 33	7 / 17 / 9	8 / 24 / 1	8 / 24 / 1
B → C	5 / 1 / 27	2 / 5 / 26	3 / 11 / 19	15 / 16 / 2	13 / 20 / 0
B → D	1 / 0 / 32	0 / 1 / 32	0 / 4 / 29	12 / 17 / 4	9 / 20 / 4
C → A	0 / 0 / 33	4 / 8 / 21	2 / 0 / 31	14 / 18 / 1	12 / 21 / 0
C → B	2 / 3 / 28	3 / 2 / 28	6 / 8 / 19	17 / 15 / 1	18 / 15 / 0
C → D	0 / 0 / 33	0 / 0 / 33	5 / 7 / 21	15 / 15 / 3	16 / 14 / 3
D → A	2 / 2 / 29	3 / 7 / 23	4 / 2 / 27	9 / 22 / 2	9 / 21 / 3
D → B	4 / 4 / 25	5 / 3 / 25	5 / 8 / 20	20 / 9 / 4	21 / 9 / 3
D → C	1 / 1 / 31	3 / 3 / 27	16 / 9 / 8	13 / 19 / 1	17 / 14 / 2
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table N.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.39	0.65	0.36	0.18
Absolute	0.40	0.67	0.36	0.20
Relative	0.38	0.70	0.36	0.18
Relative Performance	0.34	0.47	0.36	0.17
Relative Fitness	0.14	0.14	0.13	0.14

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.34	0.35	0.55	0.41
Array B	0.34	0.33	0.53	0.41
Array C	0.34	0.33	0.50	0.41
Array D	0.34	0.33	0.47	0.42
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.34	0.29	0.46	0.42
Array B	0.33	0.33	0.46	0.42
Array C	0.34	0.27	0.50	0.41
Array D	0.33	0.32	0.50	0.42
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.16	0.25	0.55	0.37
Array B	0.32	0.16	0.44	0.42
Array C	0.33	0.28	0.25	0.25
Array D	0.31	0.31	0.44	0.19
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.08	0.18	0.13
Array B	0.11	0.0	0.33	0.09
Array C	0.14	0.17	0.0	0.12
Array D	0.10	0.14	0.13	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.42	1.37	0.63	0.62	0.28	0.32	0.43	0.45	0.25	0.13	0.47	0.13
Array B	0.42	1.37	0.63	0.62	0.28	0.32	0.43	0.45	0.25	0.13	0.47	0.13
Array C	0.42	0.91	0.63	0.62	0.29	0.33	0.43	0.45	0.25	0.13	0.40	0.13
Array D	0.42	0.88	0.63	0.62	0.29	0.33	0.43	0.47	0.31	0.13	0.39	0.13
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.42	0.79	0.63	0.62	0.28	0.29	0.27	0.45	0.25	0.11	0.43	0.13
Array B	0.82	1.37	0.63	0.62	0.23	0.32	0.43	0.45	0.25	0.13	0.40	0.13
Array C	0.42	0.79	0.63	0.62	0.30	0.27	0.43	0.45	0.22	0.13	0.40	0.13
Array D	0.39	0.83	0.63	0.62	0.29	0.38	0.43	0.47	0.21	0.14	0.40	0.13
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.19	0.46	0.63	0.45	0.16	0.26	0.83	0.41	0.10	0.12	0.40	0.12
Array B	0.55	0.25	0.47	0.36	0.28	0.23	0.40	0.72	0.14	0.07	0.33	0.11
Array C	0.49	0.53	0.28	0.25	0.27	0.28	0.19	0.35	0.22	0.13	0.24	0.14
Array D	0.45	0.58	0.30	0.23	0.27	0.35	0.40	0.32	0.19	0.11	0.49	0.07
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.07	0.26	0.23	0.0	0.08	0.10	0.10	0.0	0.06	0.13	0.10
Array B	0.14	0.0	0.33	0.06	0.09	0.0	0.31	0.13	0.08	0.0	0.33	0.07
Array C	0.08	0.16	0.0	0.12	0.13	0.17	0.0	0.12	0.15	0.16	0.0	0.12
Array D	0.07	0.08	0.11	0.0	0.08	0.07	0.12	0.0	0.14	0.16	0.21	0.0

Table N.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	1.00	2.11	0.50	0.38
Absolute	1.03	2.10	0.52	0.46
Relative	1.12	2.43	0.49	0.43
Relative Performance	0.87	1.37	0.71	0.55
Relative Fitness	0.27	0.26	0.25	0.29

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.56	1.14	1.13	1.32
Array B	0.60	1.14	1.10	1.32
Array C	0.60	1.11	1.01	1.28
Array D	0.61	1.07	1.02	1.28
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.56	1.81	1.11	1.37
Array B	0.70	1.14	0.97	1.26
Array C	0.58	1.80	1.01	1.28
Array D	0.58	0.96	1.02	1.28
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.42	0.54	1.92	0.90
Array B	0.71	0.28	1.24	0.98
Array C	0.50	0.52	0.47	0.58
Array D	0.53	0.71	1.38	0.54
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.15	0.25	0.28
Array B	0.20	0.0	0.54	0.29
Array C	0.21	0.25	0.0	0.19
Array D	0.22	0.26	0.34	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.99	2.90	1.68	2.81	0.37	0.32	0.75	0.57	0.32	0.19	0.94	0.58
Array B	1.09	2.95	1.68	2.81	0.39	0.31	0.75	0.57	0.32	0.17	0.87	0.58
Array C	1.09	2.86	1.68	2.81	0.40	0.32	0.75	0.57	0.32	0.16	0.58	0.45
Array D	1.09	2.70	1.68	2.81	0.42	0.36	0.75	0.58	0.33	0.16	0.63	0.45
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.99	4.97	1.68	2.81	0.37	0.31	0.67	0.57	0.32	0.14	0.97	0.73
Array B	1.41	2.95	1.68	2.81	0.37	0.31	0.57	0.53	0.32	0.17	0.64	0.45
Array C	1.09	4.97	1.68	2.81	0.39	0.29	0.75	0.57	0.27	0.15	0.58	0.45
Array D	1.05	2.20	1.68	2.81	0.40	0.51	0.75	0.58	0.29	0.18	0.61	0.45
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.82	1.12	2.56	1.40	0.23	0.27	0.97	0.43	0.21	0.22	2.24	0.87
Array B	1.59	0.51	2.48	1.02	0.30	0.24	0.70	1.55	0.24	0.09	0.53	0.36
Array C	0.93	1.05	0.71	0.92	0.26	0.34	0.24	0.40	0.31	0.18	0.45	0.41
Array D	0.99	1.39	0.96	0.90	0.28	0.58	2.43	0.37	0.33	0.16	0.74	0.36
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.15	0.31	0.31	0.0	0.15	0.17	0.23	0.0	0.16	0.27	0.30
Array B	0.31	0.0	0.53	0.18	0.15	0.0	0.62	0.39	0.14	0.0	0.47	0.31
Array C	0.19	0.20	0.0	0.16	0.20	0.27	0.0	0.16	0.24	0.28	0.0	0.25
Array D	0.17	0.24	0.29	0.0	0.16	0.27	0.29	0.0	0.32	0.26	0.43	0.0

Table N.4: Mean relative error

Appendix O

Postmark model testing on Postmark samples

Application	Samples	Iters	First sample	Last sample
Postmark (phase 1) (pmc)	50	3	25	49
Postmark (phase 2) (pmt)	50	3	25	49
Total used	50			

Table O.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

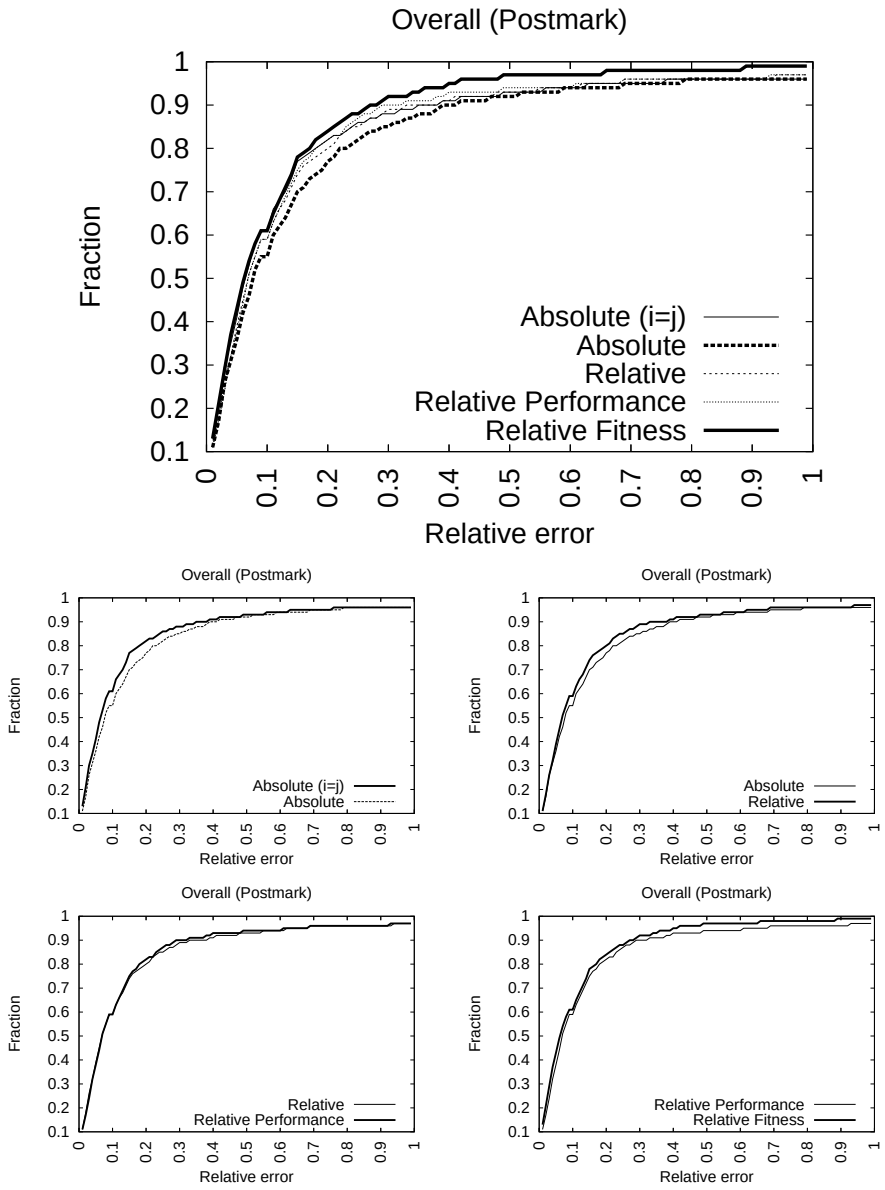

Figure O.1: The cumulative distribution of relative error over all pairwise predictions.

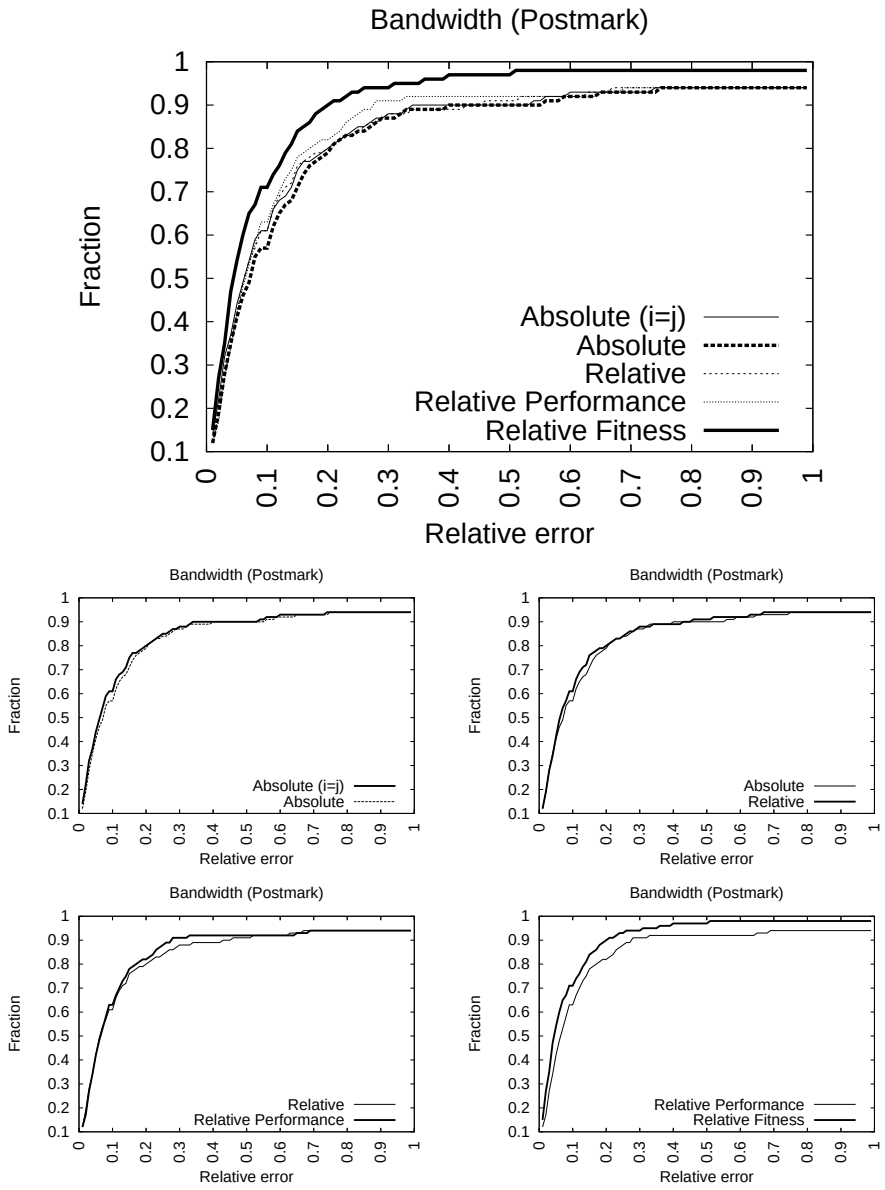

Figure O.2: The cumulative distribution of relative error over all pairwise predictions.

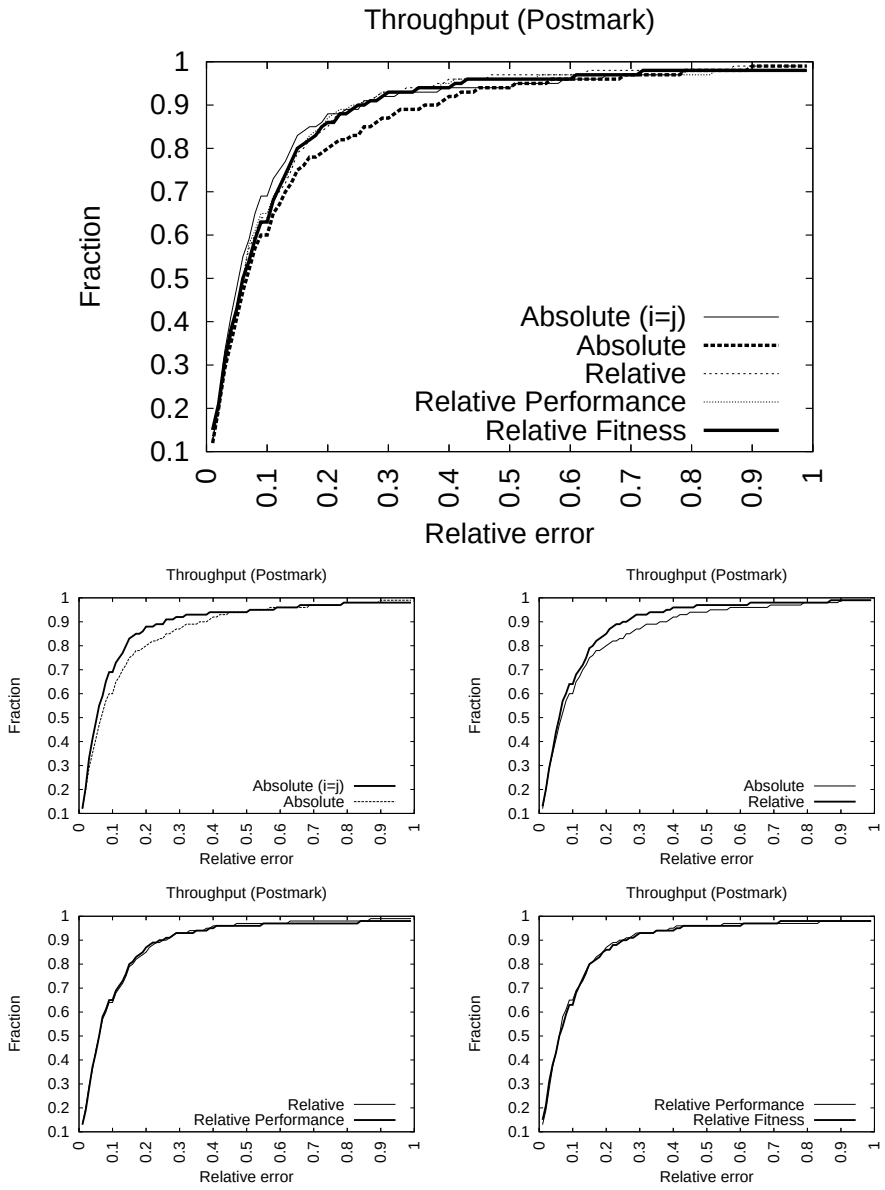

Figure O.3: The cumulative distribution of relative error over all pairwise predictions.

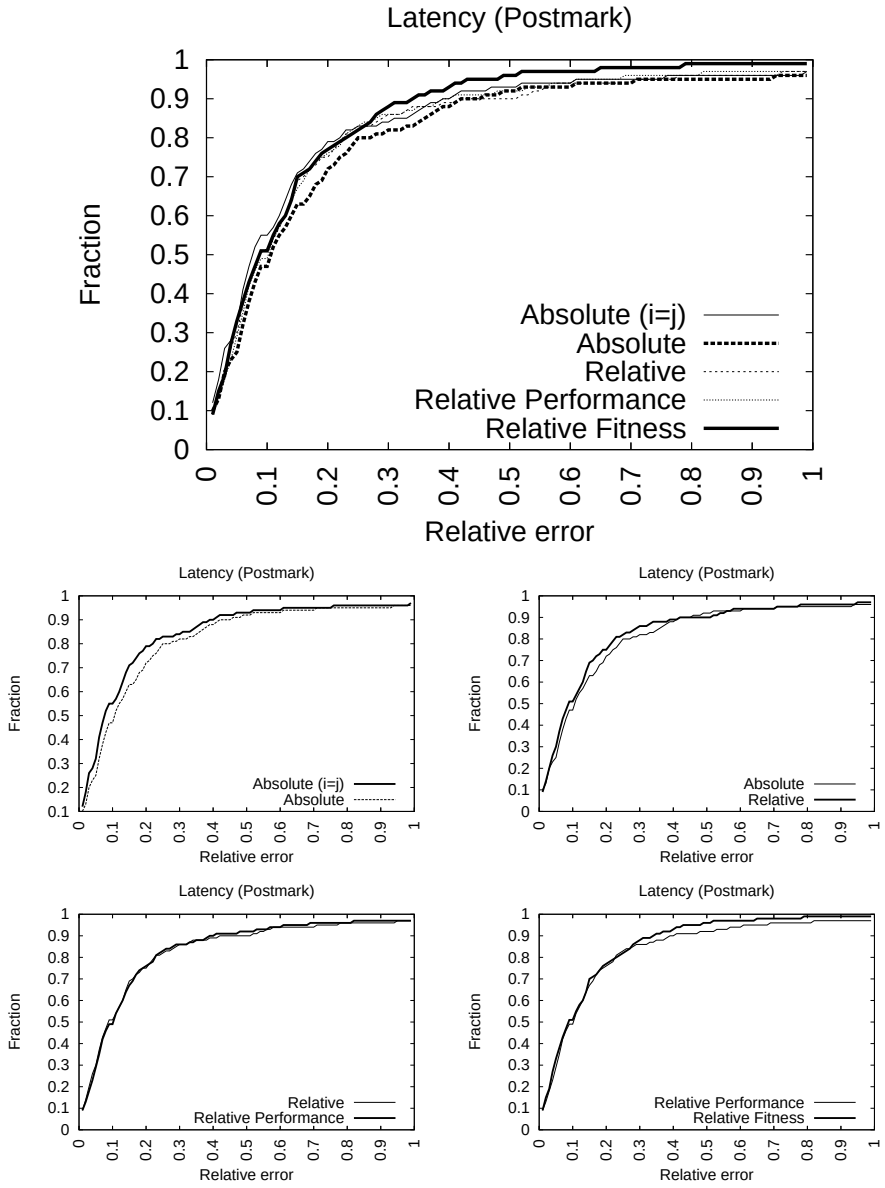

Figure O.4: The cumulative distribution of relative error over all pairwise predictions.

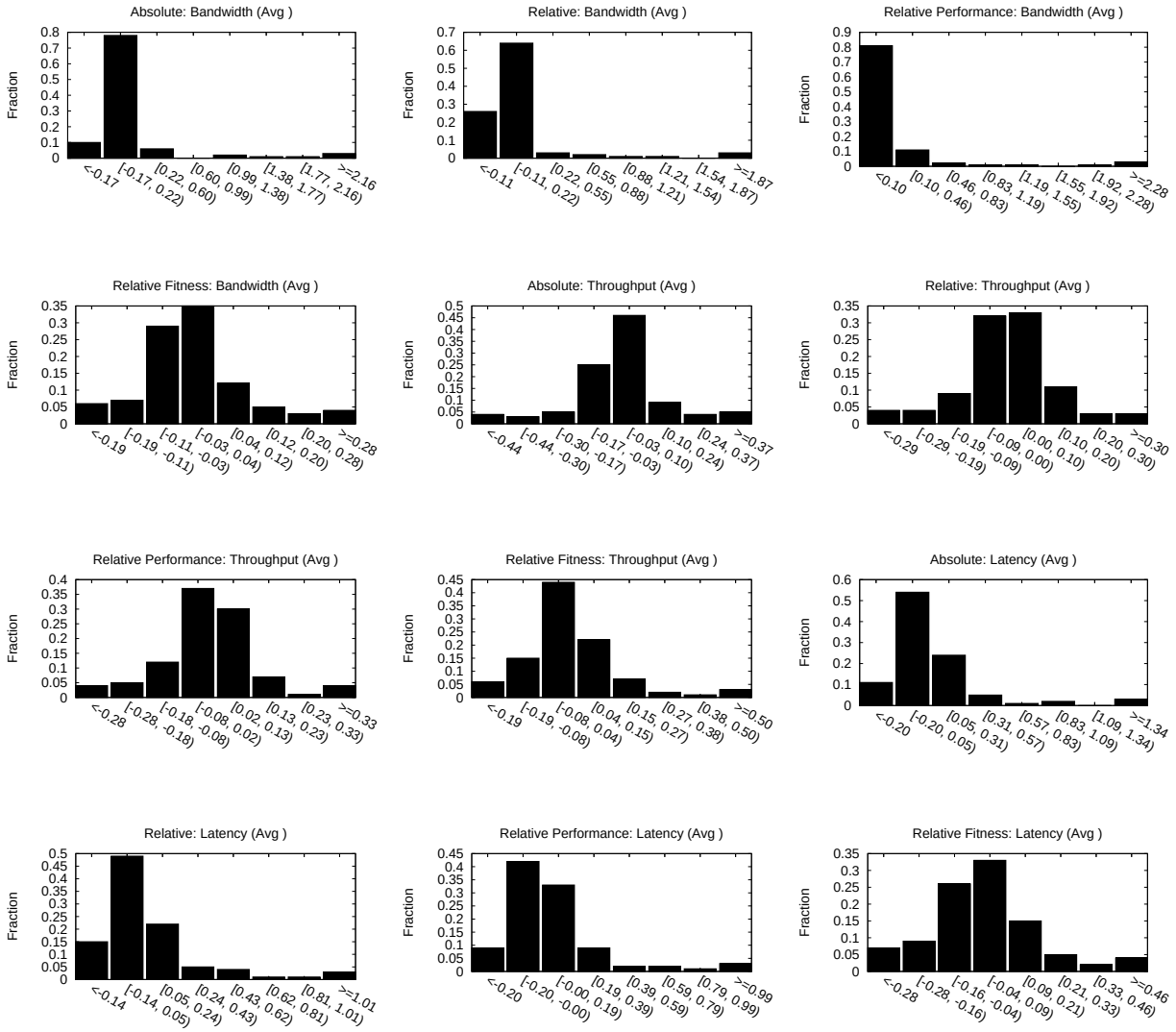

Figure O.5: The probability distribution of relative error over all pairwise predictions.

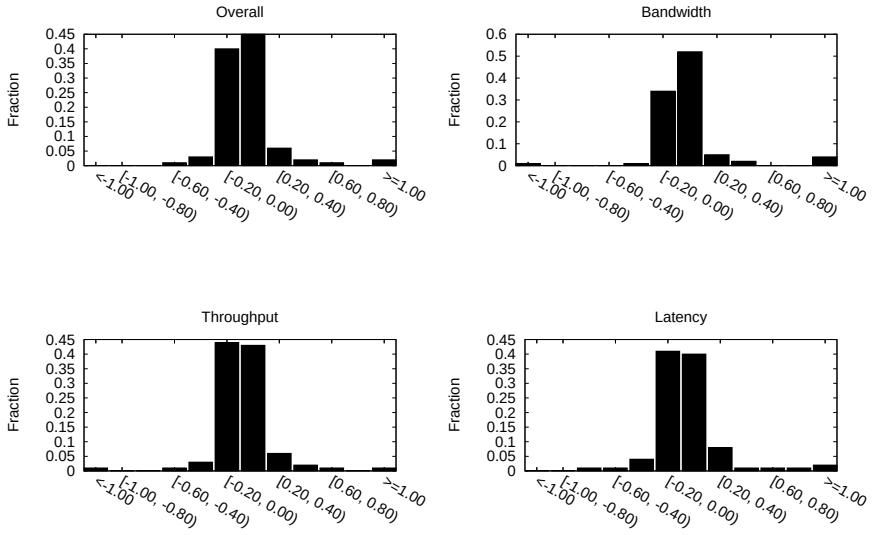

Figure O.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	7 / 2 / 39	12 / 26 / 10	16 / 16 / 16	19 / 22 / 7	9 / 34 / 5
A → C	6 / 5 / 37	12 / 8 / 28	9 / 14 / 25	17 / 24 / 7	16 / 22 / 10
A → D	3 / 3 / 42	12 / 4 / 32	0 / 0 / 48	17 / 24 / 7	17 / 24 / 7
B → A	7 / 3 / 38	9 / 4 / 35	12 / 3 / 33	10 / 30 / 8	10 / 28 / 10
B → C	8 / 6 / 34	9 / 10 / 29	13 / 9 / 26	12 / 27 / 9	14 / 26 / 8
B → D	3 / 3 / 42	20 / 7 / 21	0 / 0 / 48	16 / 24 / 8	19 / 22 / 7
C → A	13 / 5 / 30	15 / 14 / 19	10 / 23 / 15	7 / 31 / 10	6 / 34 / 8
C → B	9 / 4 / 35	16 / 25 / 7	15 / 11 / 22	15 / 29 / 4	10 / 33 / 5
C → D	9 / 4 / 35	16 / 12 / 20	7 / 10 / 31	21 / 23 / 4	22 / 23 / 3
D → A	6 / 3 / 39	21 / 18 / 9	18 / 11 / 19	18 / 26 / 4	20 / 21 / 7
D → B	6 / 5 / 37	22 / 21 / 5	7 / 18 / 23	21 / 23 / 4	14 / 28 / 6
D → C	11 / 7 / 30	12 / 16 / 20	12 / 13 / 23	18 / 26 / 4	15 / 22 / 11
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	6 / 3 / 39	16 / 12 / 20	21 / 15 / 12	15 / 24 / 9	22 / 24 / 2
A → C	20 / 6 / 22	12 / 23 / 13	21 / 15 / 12	20 / 22 / 6	19 / 26 / 3
A → D	15 / 2 / 31	10 / 24 / 14	7 / 12 / 29	14 / 26 / 8	10 / 30 / 8
B → A	0 / 0 / 48	8 / 19 / 21	16 / 11 / 21	22 / 17 / 9	21 / 18 / 9
B → C	15 / 7 / 26	17 / 19 / 12	16 / 18 / 14	19 / 24 / 5	23 / 21 / 4
B → D	11 / 1 / 36	8 / 20 / 20	7 / 2 / 39	17 / 26 / 5	15 / 30 / 3
C → A	0 / 0 / 48	0 / 6 / 42	0 / 0 / 48	32 / 10 / 6	31 / 13 / 4
C → B	19 / 4 / 25	11 / 22 / 15	9 / 10 / 29	19 / 20 / 9	20 / 23 / 5
C → D	13 / 3 / 32	9 / 22 / 17	6 / 8 / 34	18 / 24 / 6	15 / 28 / 5
D → A	0 / 0 / 48	0 / 0 / 48	1 / 3 / 44	21 / 16 / 11	20 / 17 / 11
D → B	3 / 4 / 41	10 / 8 / 30	10 / 8 / 30	22 / 22 / 4	25 / 18 / 5
D → C	20 / 8 / 20	16 / 28 / 4	2 / 15 / 31	25 / 17 / 6	20 / 23 / 5
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	7 / 4 / 37	16 / 25 / 7	9 / 11 / 28	20 / 24 / 4	20 / 24 / 4
A → C	14 / 6 / 28	27 / 17 / 4	14 / 24 / 10	12 / 30 / 6	17 / 27 / 4
A → D	5 / 5 / 38	12 / 10 / 26	7 / 10 / 31	26 / 18 / 4	29 / 16 / 3
B → A	8 / 2 / 38	7 / 14 / 27	11 / 12 / 25	23 / 20 / 5	20 / 21 / 7
B → C	17 / 8 / 23	17 / 24 / 7	19 / 14 / 15	20 / 26 / 2	21 / 19 / 8
B → D	9 / 4 / 35	15 / 12 / 21	12 / 21 / 15	17 / 27 / 4	15 / 30 / 3
C → A	10 / 2 / 36	8 / 16 / 24	17 / 8 / 23	19 / 27 / 2	21 / 24 / 3
C → B	7 / 5 / 36	12 / 19 / 17	13 / 10 / 25	24 / 20 / 4	21 / 26 / 1
C → D	10 / 4 / 34	17 / 20 / 11	5 / 7 / 36	23 / 21 / 4	24 / 23 / 1
D → A	8 / 1 / 39	10 / 22 / 16	26 / 10 / 12	22 / 22 / 4	21 / 24 / 3
D → B	4 / 7 / 37	13 / 20 / 15	13 / 16 / 19	15 / 28 / 5	14 / 32 / 2
D → C	18 / 5 / 25	21 / 25 / 2	15 / 12 / 21	21 / 23 / 4	20 / 26 / 2
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table O.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.07	0.07	0.06	0.08
Absolute	0.08	0.08	0.07	0.10
Relative	0.07	0.07	0.06	0.09
Relative Performance	0.07	0.07	0.06	0.10
Relative Fitness	0.07	0.05	0.07	0.09

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.06	0.09	0.09	0.08
Array B	0.06	0.08	0.08	0.07
Array C	0.08	0.11	0.07	0.09
Array D	0.07	0.08	0.08	0.06
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.06	0.07	0.08	0.07
Array B	0.06	0.08	0.08	0.07
Array C	0.06	0.07	0.07	0.09
Array D	0.06	0.07	0.08	0.06
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.03	0.07	0.08	0.06
Array B	0.07	0.04	0.08	0.07
Array C	0.07	0.07	0.03	0.09
Array D	0.07	0.07	0.07	0.04
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.07	0.07	0.07
Array B	0.06	0.0	0.07	0.06
Array C	0.07	0.07	0.0	0.07
Array D	0.06	0.06	0.07	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.07	0.13	0.05	0.06	0.04	0.05	0.10	0.11	0.07	0.13	0.09	0.07
Array B	0.06	0.09	0.06	0.06	0.04	0.05	0.09	0.09	0.10	0.11	0.10	0.08
Array C	0.09	0.11	0.04	0.08	0.04	0.09	0.07	0.10	0.13	0.13	0.08	0.07
Array D	0.07	0.10	0.07	0.06	0.04	0.05	0.09	0.08	0.11	0.10	0.09	0.06
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.07	0.06	0.07	0.06	0.04	0.06	0.08	0.09	0.07	0.10	0.11	0.07
Array B	0.07	0.09	0.06	0.06	0.04	0.05	0.08	0.08	0.10	0.11	0.13	0.07
Array C	0.07	0.06	0.04	0.09	0.04	0.05	0.07	0.08	0.11	0.11	0.08	0.10
Array D	0.08	0.06	0.07	0.06	0.04	0.06	0.11	0.08	0.08	0.09	0.07	0.06
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.04	0.05	0.06	0.06	0.01	0.06	0.10	0.07	0.04	0.11	0.11	0.06
Array B	0.10	0.05	0.06	0.06	0.04	0.04	0.10	0.08	0.10	0.04	0.12	0.07
Array C	0.07	0.07	0.03	0.09	0.04	0.06	0.02	0.07	0.13	0.10	0.05	0.08
Array D	0.09	0.05	0.08	0.05	0.04	0.06	0.07	0.05	0.13	0.09	0.09	0.04
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.05	0.04	0.04	0.0	0.05	0.10	0.08	0.0	0.11	0.08	0.13
Array B	0.04	0.0	0.04	0.07	0.04	0.0	0.07	0.06	0.11	0.0	0.10	0.05
Array C	0.04	0.04	0.0	0.06	0.09	0.07	0.0	0.06	0.10	0.12	0.0	0.08
Array D	0.06	0.06	0.06	0.0	0.04	0.05	0.08	0.0	0.12	0.06	0.10	0.0

Table O.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.23	0.33	0.12	0.23
Absolute	0.24	0.34	0.14	0.25
Relative	0.22	0.31	0.12	0.24
Relative Performance	0.22	0.32	0.13	0.22
Relative Fitness	0.13	0.11	0.13	0.16

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.15	0.39	0.19	0.34
Array B	0.17	0.37	0.19	0.25
Array C	0.18	0.39	0.17	0.24
Array D	0.17	0.22	0.20	0.22
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.15	0.27	0.23	0.34
Array B	0.16	0.37	0.20	0.23
Array C	0.15	0.24	0.17	0.23
Array D	0.24	0.21	0.18	0.22
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.08	0.18	0.23	0.41
Array B	0.14	0.20	0.24	0.19
Array C	0.13	0.23	0.15	0.23
Array D	0.23	0.22	0.26	0.15
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.11	0.11	0.18
Array B	0.13	0.0	0.17	0.10
Array C	0.10	0.15	0.0	0.12
Array D	0.12	0.10	0.17	0.0

	Bandwidth				Throughput				Latency			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.17	0.69	0.22	0.62	0.08	0.10	0.16	0.23	0.22	0.36	0.18	0.17
Array B	0.17	0.68	0.22	0.27	0.08	0.10	0.14	0.22	0.27	0.34	0.22	0.26
Array C	0.22	0.69	0.22	0.29	0.08	0.14	0.15	0.23	0.25	0.34	0.13	0.20
Array D	0.17	0.35	0.22	0.27	0.08	0.10	0.16	0.16	0.26	0.22	0.23	0.25
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.17	0.31	0.29	0.68	0.08	0.10	0.16	0.16	0.22	0.39	0.23	0.18
Array B	0.18	0.68	0.21	0.26	0.07	0.10	0.17	0.13	0.22	0.34	0.23	0.30
Array C	0.22	0.29	0.22	0.29	0.07	0.10	0.15	0.13	0.16	0.32	0.13	0.27
Array D	0.49	0.24	0.21	0.27	0.08	0.10	0.16	0.16	0.15	0.30	0.17	0.25
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.13	0.28	0.28	0.68	0.04	0.11	0.17	0.28	0.07	0.16	0.26	0.25
Array B	0.19	0.27	0.33	0.26	0.07	0.07	0.16	0.13	0.16	0.26	0.23	0.17
Array C	0.18	0.29	0.30	0.29	0.07	0.10	0.05	0.14	0.15	0.30	0.09	0.26
Array D	0.44	0.28	0.39	0.24	0.07	0.10	0.12	0.10	0.17	0.28	0.26	0.11
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.09	0.08	0.11	0.0	0.09	0.13	0.23	0.0	0.15	0.12	0.21
Array B	0.12	0.0	0.14	0.11	0.12	0.0	0.18	0.11	0.15	0.0	0.19	0.08
Array C	0.06	0.13	0.0	0.10	0.11	0.12	0.0	0.10	0.13	0.20	0.0	0.17
Array D	0.13	0.11	0.13	0.0	0.09	0.10	0.16	0.0	0.15	0.09	0.21	0.0

Table O.4: Mean relative error

Appendix P

Cello model testing on Cello samples

Application	Samples	Iters	First sample	Last sample
(srt)	78	3	39	77
Total used	39			

Table P.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

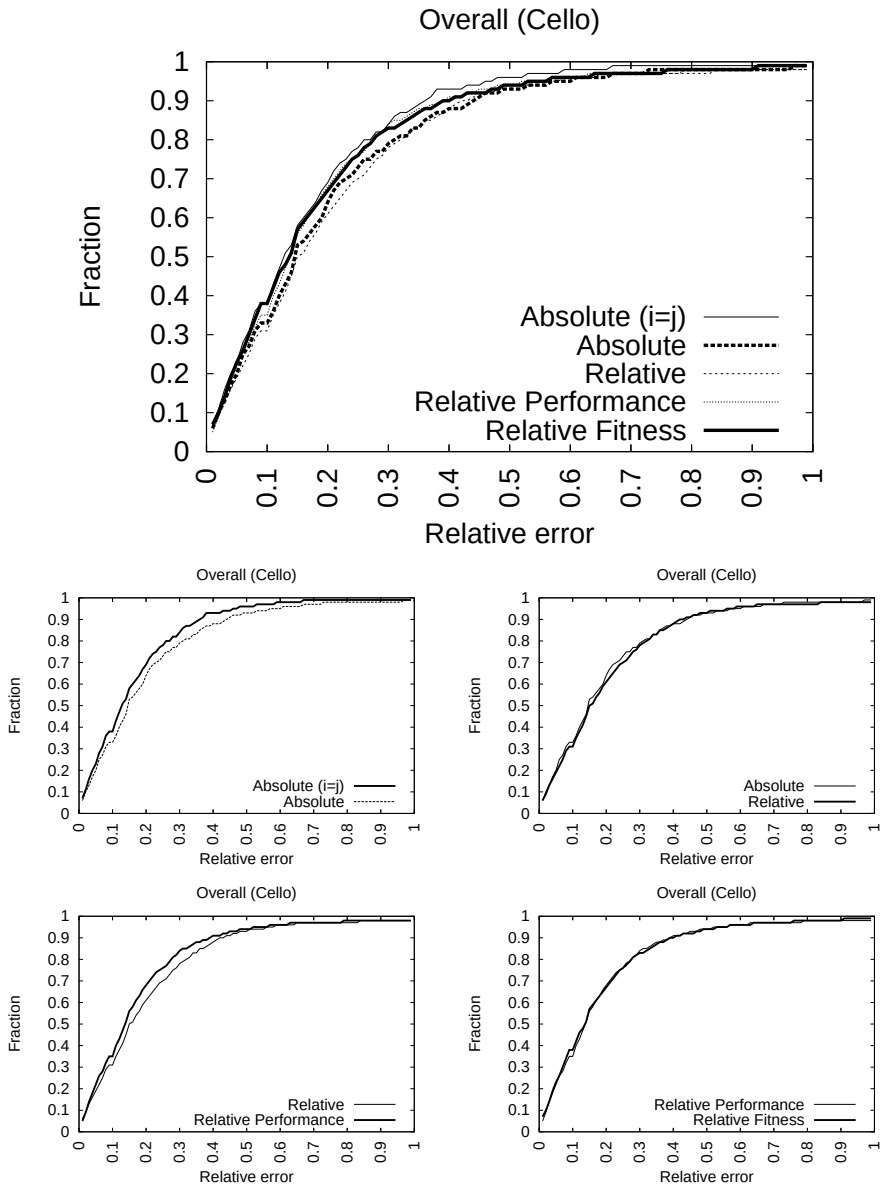

Figure P.1: The cumulative distribution of relative error over all pairwise predictions.

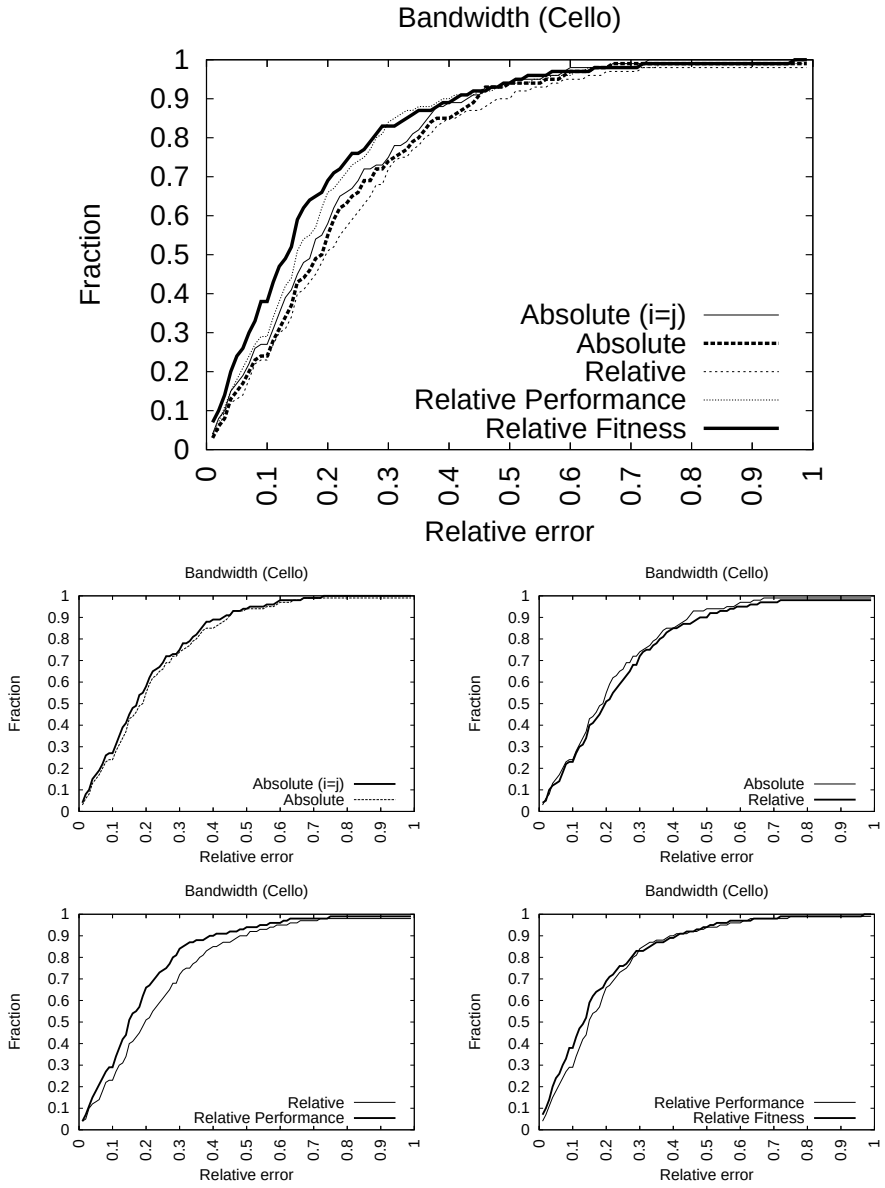

Figure P.2: The cumulative distribution of relative error over all pairwise predictions.

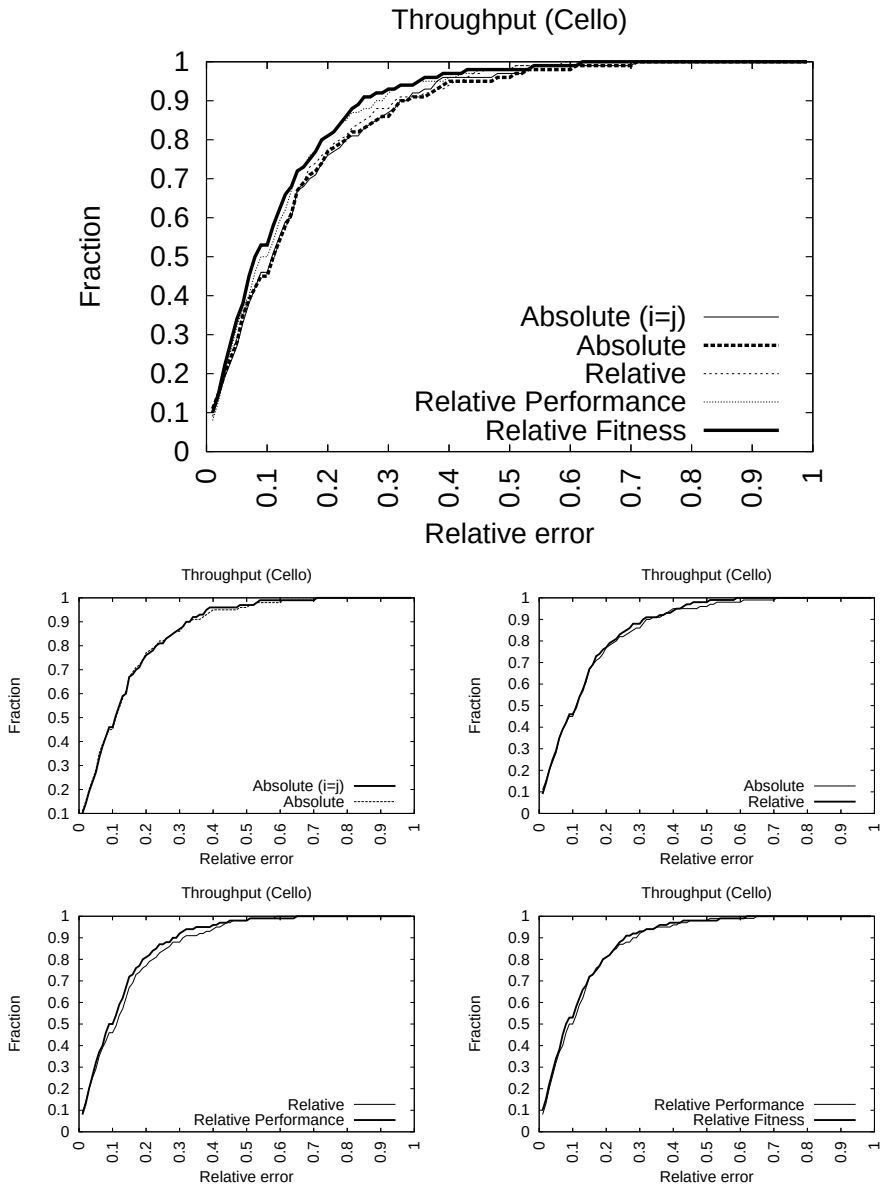

Figure P.3: The cumulative distribution of relative error over all pairwise predictions.

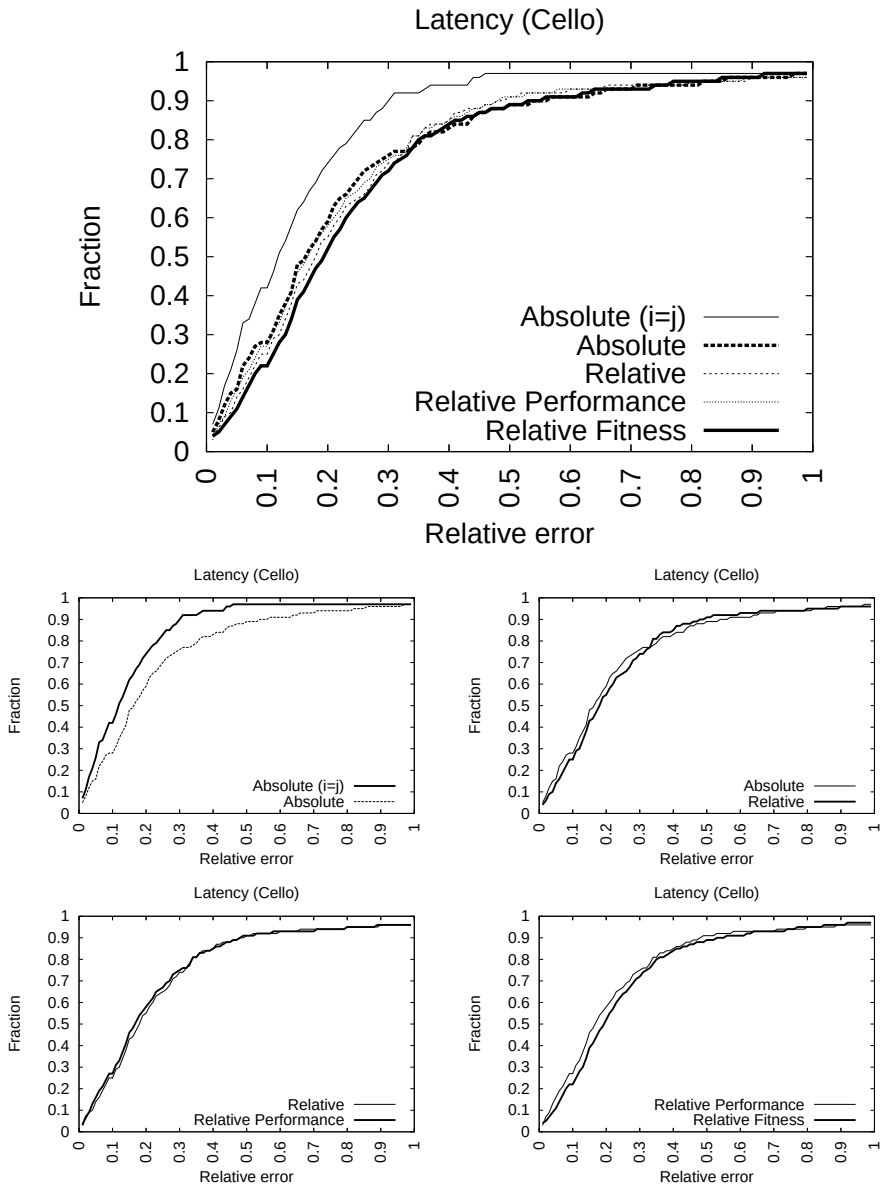

Figure P.4: The cumulative distribution of relative error over all pairwise predictions.

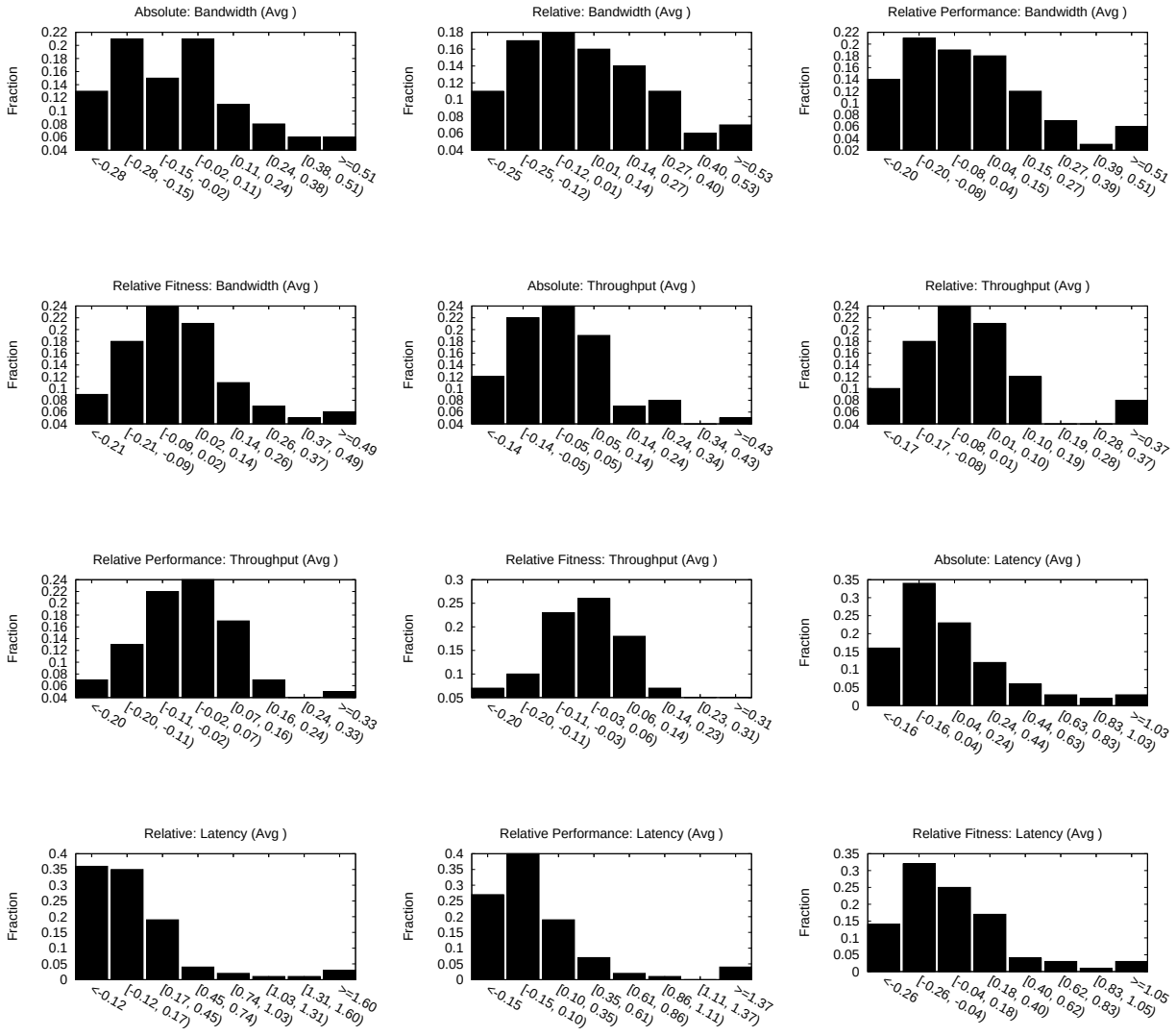

Figure P.5: The probability distribution of relative error over all pairwise predictions.

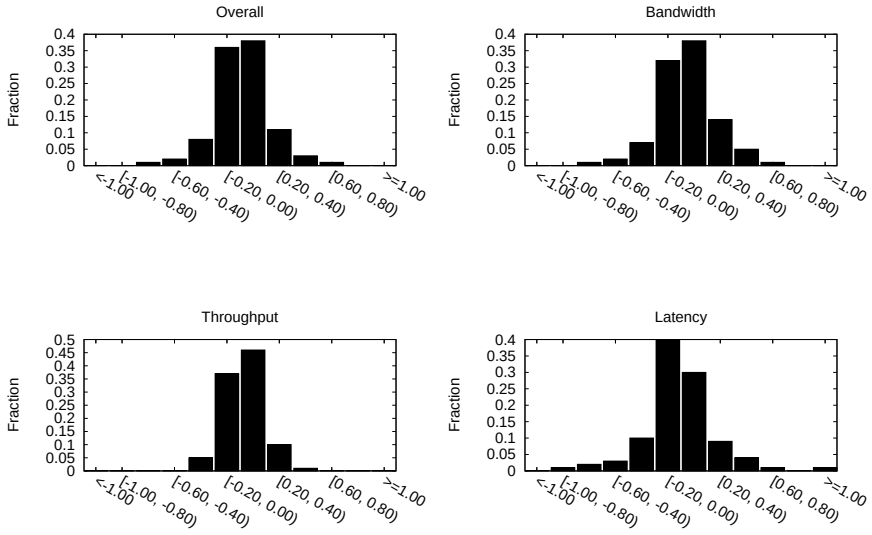

Figure P.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	6 / 2 / 29	19 / 17 / 1	2 / 3 / 32	14 / 23 / 0	16 / 20 / 1
A → C	7 / 11 / 19	17 / 18 / 2	20 / 14 / 3	14 / 22 / 1	17 / 19 / 1
A → D	12 / 3 / 22	21 / 15 / 1	10 / 24 / 3	16 / 18 / 3	14 / 23 / 0
B → A	0 / 0 / 37	16 / 19 / 2	16 / 21 / 0	12 / 23 / 2	11 / 23 / 3
B → C	6 / 6 / 25	17 / 15 / 5	10 / 26 / 1	19 / 17 / 1	14 / 19 / 4
B → D	12 / 4 / 21	22 / 14 / 1	7 / 15 / 15	13 / 21 / 3	15 / 21 / 1
C → A	0 / 0 / 37	9 / 12 / 16	12 / 24 / 1	20 / 12 / 5	16 / 20 / 1
C → B	3 / 3 / 31	22 / 15 / 0	11 / 26 / 0	14 / 20 / 3	11 / 26 / 0
C → D	11 / 7 / 19	23 / 13 / 1	13 / 23 / 1	18 / 19 / 0	20 / 17 / 0
D → A	0 / 0 / 37	0 / 0 / 37	14 / 23 / 0	15 / 20 / 2	12 / 24 / 1
D → B	8 / 2 / 27	17 / 19 / 1	5 / 4 / 28	16 / 19 / 2	15 / 22 / 0
D → C	6 / 7 / 24	16 / 17 / 4	20 / 11 / 6	17 / 18 / 2	18 / 16 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	5 / 4 / 28	20 / 17 / 0	13 / 22 / 2	13 / 23 / 1	12 / 19 / 6
A → C	3 / 3 / 31	4 / 1 / 32	17 / 10 / 10	15 / 18 / 4	19 / 16 / 2
A → D	0 / 4 / 33	15 / 13 / 9	16 / 6 / 15	12 / 23 / 2	13 / 20 / 4
B → A	4 / 3 / 30	17 / 12 / 8	14 / 16 / 7	15 / 20 / 2	15 / 20 / 2
B → C	2 / 3 / 32	14 / 3 / 20	4 / 12 / 21	13 / 20 / 4	14 / 20 / 3
B → D	0 / 3 / 34	11 / 25 / 1	15 / 13 / 9	18 / 16 / 3	13 / 22 / 2
C → A	5 / 3 / 29	16 / 14 / 7	1 / 4 / 32	19 / 14 / 4	18 / 17 / 2
C → B	6 / 0 / 31	5 / 16 / 16	3 / 7 / 27	14 / 18 / 5	8 / 25 / 4
C → D	1 / 3 / 33	11 / 25 / 1	15 / 14 / 8	19 / 16 / 2	13 / 21 / 3
D → A	3 / 2 / 32	13 / 16 / 8	18 / 12 / 7	15 / 21 / 1	13 / 22 / 2
D → B	8 / 4 / 25	16 / 21 / 0	14 / 14 / 9	20 / 14 / 3	11 / 20 / 6
D → C	2 / 4 / 31	6 / 2 / 29	0 / 0 / 37	25 / 10 / 2	25 / 9 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	23 / 1 / 13	19 / 18 / 0	0 / 0 / 37	19 / 17 / 1	19 / 17 / 1
A → C	13 / 1 / 23	23 / 13 / 1	0 / 0 / 37	10 / 26 / 1	18 / 18 / 1
A → D	3 / 3 / 31	10 / 16 / 11	16 / 17 / 4	24 / 11 / 2	22 / 14 / 1
B → A	8 / 5 / 24	16 / 11 / 10	14 / 9 / 14	22 / 9 / 6	21 / 13 / 3
B → C	9 / 4 / 24	22 / 14 / 1	17 / 7 / 13	14 / 22 / 1	17 / 19 / 1
B → D	5 / 6 / 26	19 / 16 / 2	7 / 16 / 14	23 / 14 / 0	23 / 14 / 0
C → A	9 / 5 / 23	17 / 19 / 1	0 / 0 / 37	20 / 12 / 5	19 / 14 / 4
C → B	17 / 0 / 20	21 / 15 / 1	14 / 17 / 6	21 / 13 / 3	22 / 12 / 3
C → D	7 / 4 / 26	19 / 17 / 1	17 / 14 / 6	22 / 13 / 2	24 / 13 / 0
D → A	12 / 3 / 22	20 / 17 / 0	14 / 22 / 1	13 / 19 / 5	16 / 19 / 2
D → B	22 / 2 / 13	17 / 17 / 3	14 / 12 / 11	17 / 19 / 1	18 / 19 / 0
D → C	17 / 1 / 19	19 / 18 / 0	0 / 0 / 37	18 / 18 / 1	22 / 15 / 0
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table P.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.12	0.18	0.10	0.11
Absolute	0.15	0.20	0.10	0.17
Relative	0.16	0.20	0.11	0.19
Relative Performance	0.13	0.15	0.09	0.17
Relative Fitness	0.13	0.13	0.09	0.20

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.11	0.17	0.13	0.15
Array B	0.13	0.11	0.15	0.14
Array C	0.12	0.15	0.14	0.15
Array D	0.12	0.18	0.14	0.14
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.11	0.17	0.16	0.15
Array B	0.13	0.11	0.17	0.17
Array C	0.13	0.15	0.14	0.17
Array D	0.13	0.18	0.16	0.14
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.04	0.16	0.16	0.12
Array B	0.12	0.06	0.13	0.14
Array C	0.12	0.12	0.04	0.16
Array D	0.10	0.17	0.16	0.06
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.12	0.11	0.11
Array B	0.11	0.0	0.11	0.13
Array C	0.12	0.10	0.0	0.18
Array D	0.09	0.17	0.20	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.20	0.21	0.14	0.20	0.09	0.08	0.09	0.12	0.11	0.21	0.17	0.14
Array B	0.20	0.18	0.17	0.20	0.08	0.07	0.10	0.12	0.11	0.08	0.19	0.13
Array C	0.20	0.18	0.17	0.20	0.09	0.09	0.10	0.12	0.12	0.17	0.15	0.15
Array D	0.20	0.22	0.15	0.13	0.09	0.10	0.06	0.15	0.11	0.21	0.21	0.13
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.20	0.23	0.15	0.23	0.09	0.09	0.09	0.11	0.11	0.23	0.26	0.13
Array B	0.13	0.18	0.20	0.23	0.12	0.07	0.11	0.13	0.14	0.08	0.20	0.15
Array C	0.16	0.23	0.17	0.23	0.11	0.06	0.10	0.13	0.13	0.20	0.15	0.15
Array D	0.20	0.23	0.15	0.13	0.09	0.09	0.08	0.15	0.13	0.22	0.26	0.13
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.07	0.24	0.12	0.12	0.04	0.08	0.11	0.11	0.03	0.23	0.26	0.12
Array B	0.16	0.04	0.11	0.16	0.08	0.06	0.09	0.11	0.12	0.04	0.19	0.10
Array C	0.13	0.13	0.05	0.19	0.08	0.06	0.03	0.10	0.13	0.17	0.05	0.17
Array D	0.10	0.19	0.13	0.06	0.09	0.08	0.08	0.05	0.11	0.21	0.26	0.05
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.17	0.15	0.11	0.0	0.06	0.08	0.07	0.0	0.25	0.12	0.14
Array B	0.08	0.0	0.12	0.10	0.09	0.0	0.06	0.10	0.14	0.0	0.21	0.19
Array C	0.14	0.10	0.0	0.15	0.08	0.06	0.0	0.14	0.15	0.21	0.0	0.20
Array D	0.09	0.17	0.14	0.0	0.08	0.08	0.15	0.0	0.11	0.25	0.26	0.0

Table P.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.18	0.21	0.14	0.20
Absolute	0.23	0.23	0.15	0.33
Relative	0.24	0.25	0.14	0.34
Relative Performance	0.22	0.20	0.13	0.33
Relative Fitness	0.21	0.18	0.12	0.33

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.17	0.26	0.28	0.20
Array B	0.18	0.15	0.26	0.20
Array C	0.18	0.23	0.23	0.20
Array D	0.19	0.32	0.33	0.19
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.17	0.26	0.32	0.19
Array B	0.20	0.15	0.33	0.21
Array C	0.19	0.23	0.23	0.21
Array D	0.19	0.29	0.31	0.19
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.08	0.27	0.32	0.16
Array B	0.17	0.08	0.27	0.18
Array C	0.16	0.18	0.15	0.19
Array D	0.15	0.28	0.32	0.08
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.22	0.26	0.17
Array B	0.15	0.0	0.25	0.19
Array C	0.17	0.19	0.0	0.21
Array D	0.16	0.25	0.33	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.22	0.27	0.19	0.23	0.12	0.13	0.11	0.18	0.16	0.38	0.53	0.17
Array B	0.22	0.21	0.21	0.22	0.14	0.12	0.11	0.21	0.17	0.11	0.45	0.17
Array C	0.22	0.24	0.21	0.21	0.14	0.15	0.11	0.21	0.18	0.29	0.36	0.17
Array D	0.22	0.32	0.19	0.19	0.15	0.15	0.09	0.23	0.22	0.48	0.72	0.16
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.22	0.30	0.23	0.25	0.12	0.13	0.11	0.17	0.16	0.35	0.63	0.14
Array B	0.22	0.21	0.27	0.25	0.14	0.12	0.13	0.19	0.22	0.11	0.58	0.18
Array C	0.21	0.28	0.21	0.25	0.13	0.11	0.11	0.19	0.22	0.31	0.36	0.18
Array D	0.22	0.30	0.18	0.19	0.13	0.13	0.11	0.23	0.22	0.43	0.63	0.16
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.11	0.34	0.20	0.16	0.05	0.13	0.13	0.18	0.07	0.35	0.63	0.14
Array B	0.16	0.07	0.13	0.21	0.10	0.09	0.11	0.17	0.24	0.08	0.59	0.15
Array C	0.14	0.19	0.07	0.21	0.10	0.10	0.04	0.17	0.22	0.25	0.34	0.19
Array D	0.16	0.30	0.21	0.07	0.13	0.12	0.11	0.09	0.18	0.43	0.63	0.07
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.24	0.16	0.17	0.0	0.08	0.11	0.13	0.0	0.35	0.50	0.20
Array B	0.14	0.0	0.21	0.15	0.09	0.0	0.08	0.15	0.23	0.0	0.46	0.26
Array C	0.18	0.16	0.0	0.21	0.12	0.08	0.0	0.17	0.19	0.33	0.0	0.26
Array D	0.14	0.26	0.16	0.0	0.13	0.14	0.17	0.0	0.21	0.35	0.67	0.0

Table P.4: Mean relative error

Appendix Q

TPC-C model testing on TPC-C samples

Application	Samples	Iters	First sample	Last sample
TPC-C (tpcc)	50	3	25	49
Total used	25			

Table Q.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

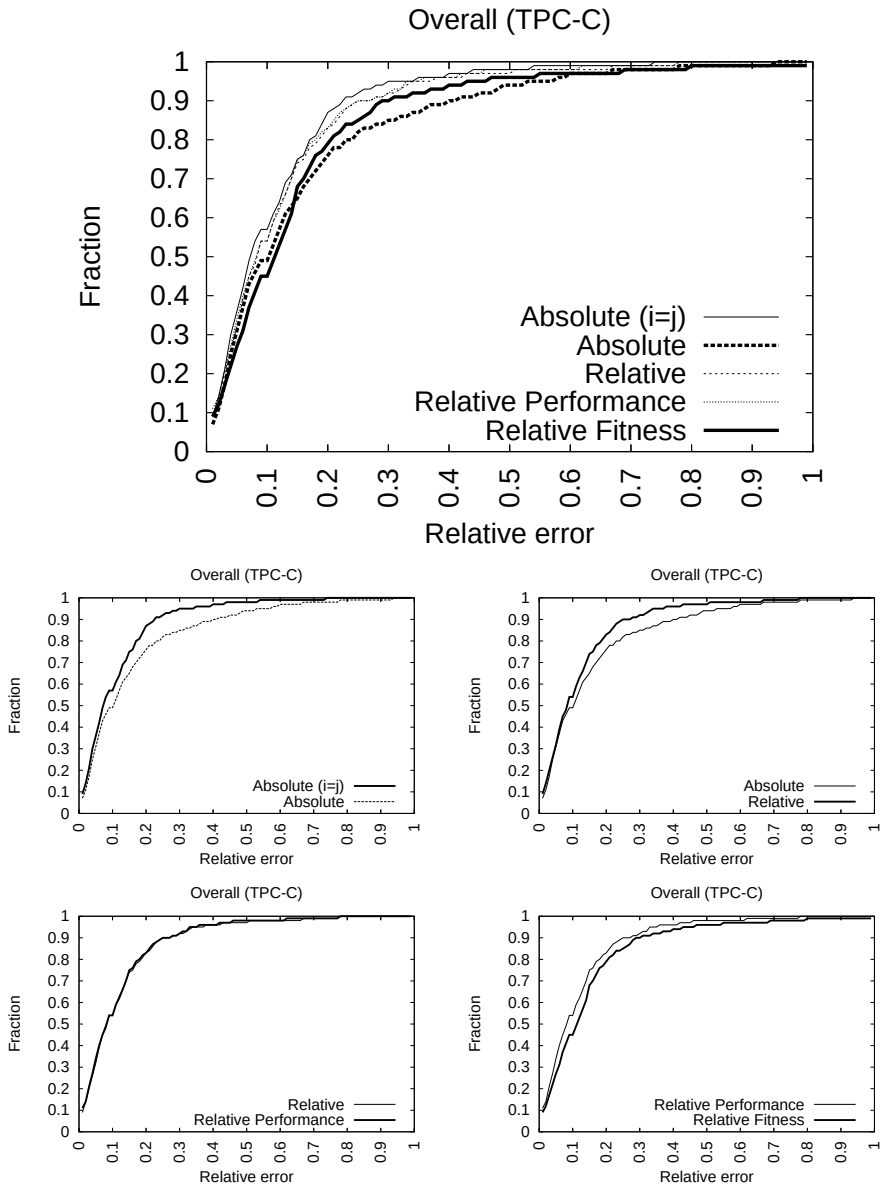

Figure Q.1: The cumulative distribution of relative error over all pairwise predictions.

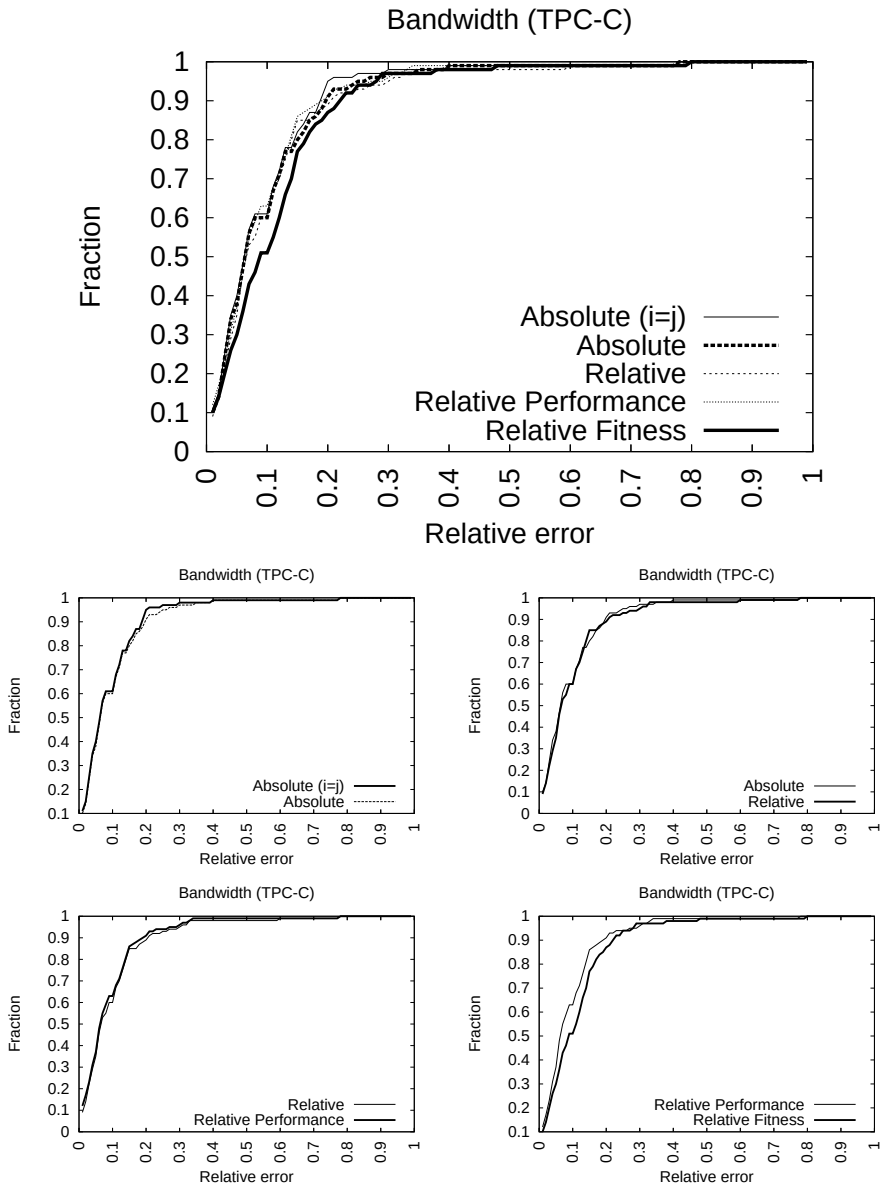

Figure Q.2: The cumulative distribution of relative error over all pairwise predictions.

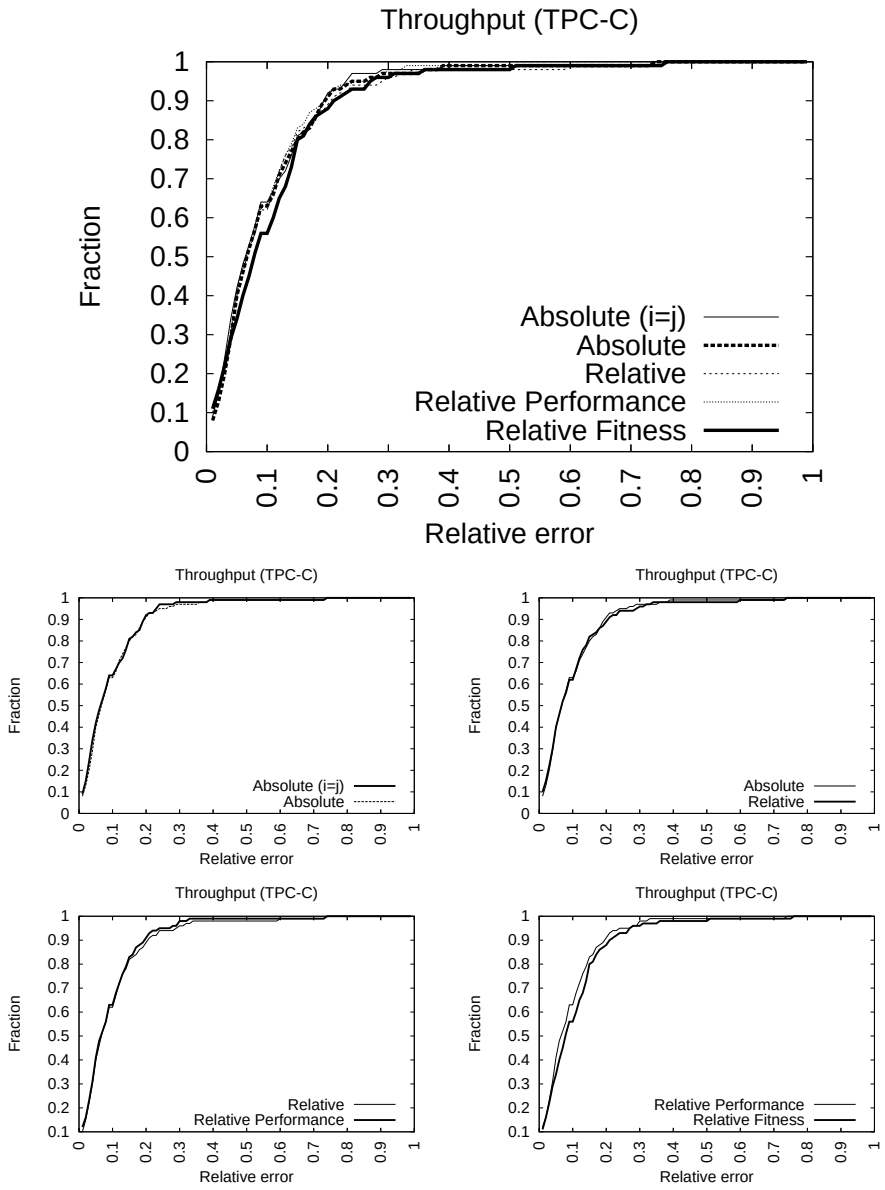

Figure Q.3: The cumulative distribution of relative error over all pairwise predictions.

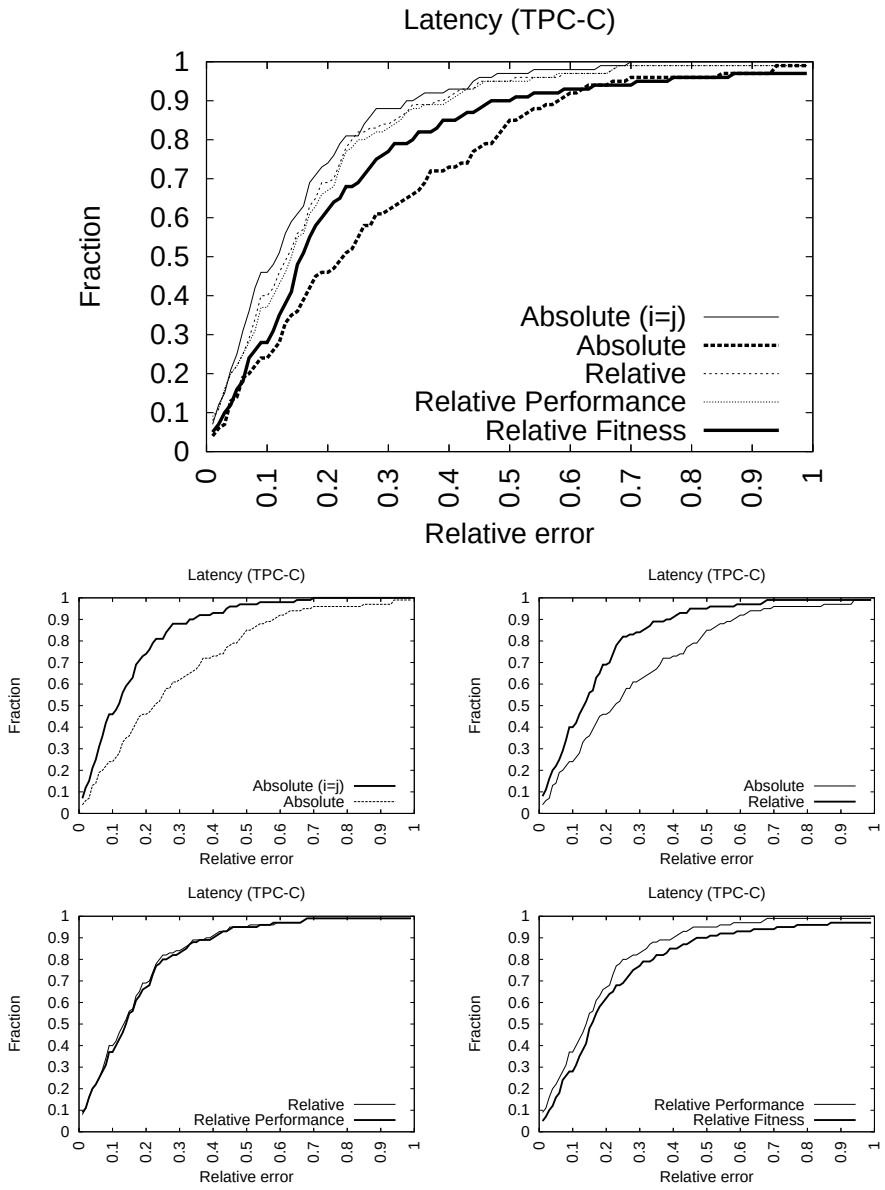

Figure Q.4: The cumulative distribution of relative error over all pairwise predictions.

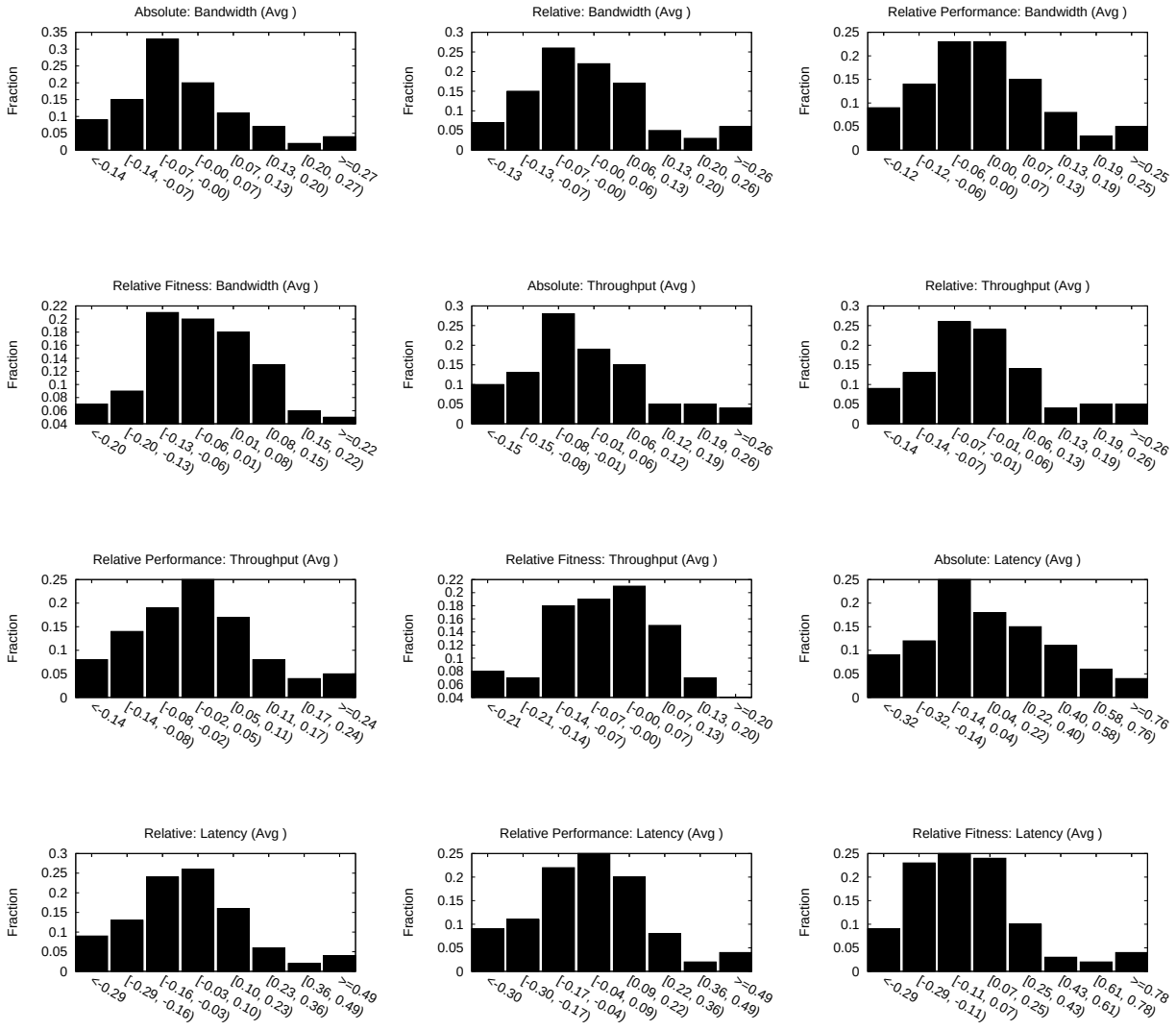

Figure Q.5: The probability distribution of relative error over all pairwise predictions.

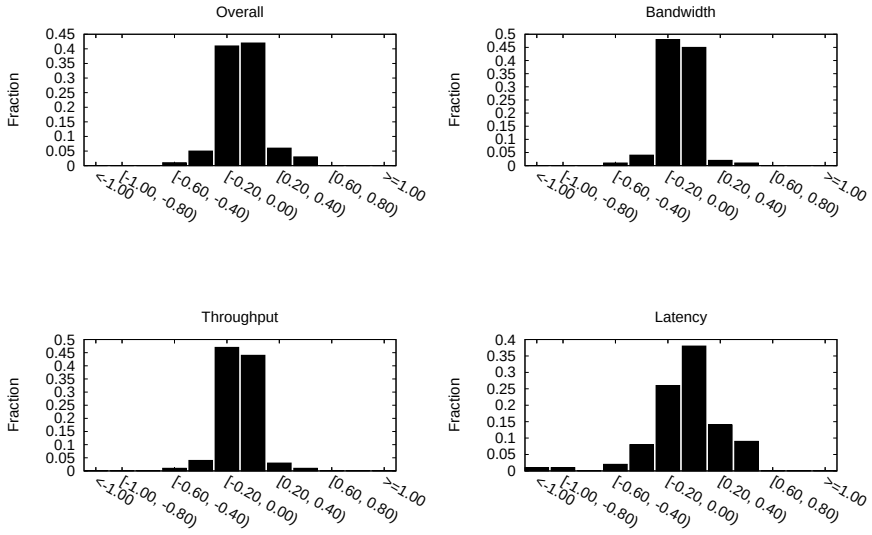

Figure Q.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	1 / 4 / 18	3 / 5 / 15	4 / 4 / 15	10 / 8 / 5	9 / 10 / 4
A → C	1 / 0 / 22	13 / 9 / 1	0 / 0 / 23	9 / 12 / 2	14 / 7 / 2
A → D	0 / 0 / 23	0 / 0 / 23	0 / 0 / 23	14 / 6 / 3	14 / 6 / 3
B → A	5 / 1 / 17	4 / 9 / 10	7 / 6 / 10	8 / 14 / 1	6 / 15 / 2
B → C	4 / 0 / 19	11 / 12 / 0	0 / 0 / 23	8 / 10 / 5	11 / 11 / 1
B → D	0 / 0 / 23	13 / 8 / 2	0 / 0 / 23	13 / 8 / 2	12 / 10 / 1
C → A	3 / 1 / 19	7 / 4 / 12	0 / 0 / 23	7 / 13 / 3	10 / 12 / 1
C → B	1 / 3 / 19	2 / 7 / 14	0 / 0 / 23	10 / 8 / 5	5 / 11 / 7
C → D	0 / 0 / 23	0 / 0 / 23	3 / 3 / 17	10 / 9 / 4	12 / 9 / 2
D → A	4 / 3 / 16	11 / 6 / 6	0 / 0 / 23	14 / 9 / 0	13 / 7 / 3
D → B	2 / 1 / 20	3 / 7 / 13	0 / 0 / 23	17 / 4 / 2	16 / 6 / 1
D → C	1 / 2 / 20	15 / 8 / 0	12 / 11 / 0	11 / 9 / 3	15 / 7 / 1
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	2 / 6 / 15	5 / 4 / 14	2 / 2 / 19	8 / 9 / 6	9 / 11 / 3
A → C	1 / 0 / 22	14 / 9 / 0	0 / 0 / 23	8 / 11 / 4	12 / 9 / 2
A → D	0 / 0 / 23	0 / 0 / 23	0 / 0 / 23	13 / 6 / 4	13 / 6 / 4
B → A	7 / 1 / 15	4 / 12 / 7	8 / 6 / 9	6 / 14 / 3	5 / 15 / 3
B → C	5 / 0 / 18	11 / 11 / 1	9 / 11 / 3	8 / 12 / 3	8 / 13 / 2
B → D	0 / 0 / 23	10 / 4 / 9	4 / 2 / 17	12 / 8 / 3	12 / 5 / 6
C → A	5 / 1 / 17	7 / 7 / 9	0 / 0 / 23	7 / 13 / 3	9 / 13 / 1
C → B	3 / 6 / 14	4 / 4 / 15	0 / 0 / 23	11 / 10 / 2	10 / 10 / 3
C → D	0 / 0 / 23	0 / 0 / 23	11 / 5 / 7	11 / 11 / 1	11 / 10 / 2
D → A	5 / 1 / 17	14 / 9 / 0	0 / 0 / 23	11 / 10 / 2	12 / 9 / 2
D → B	6 / 4 / 13	2 / 9 / 12	0 / 0 / 23	18 / 3 / 2	16 / 7 / 0
D → C	2 / 1 / 20	15 / 8 / 0	12 / 11 / 0	13 / 9 / 1	15 / 8 / 0
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	13 / 3 / 7	8 / 14 / 1	10 / 10 / 3	14 / 9 / 0	8 / 15 / 0
A → C	7 / 1 / 15	4 / 5 / 14	0 / 0 / 23	10 / 13 / 0	10 / 13 / 0
A → D	12 / 0 / 11	4 / 19 / 0	0 / 0 / 23	17 / 5 / 1	4 / 19 / 0
B → A	2 / 0 / 21	9 / 13 / 1	2 / 5 / 16	13 / 8 / 2	8 / 13 / 2
B → C	19 / 1 / 3	4 / 19 / 0	0 / 0 / 23	15 / 4 / 4	8 / 15 / 0
B → D	14 / 1 / 8	4 / 19 / 0	1 / 7 / 15	14 / 9 / 0	6 / 16 / 1
C → A	4 / 0 / 19	7 / 16 / 0	0 / 0 / 23	12 / 11 / 0	9 / 12 / 2
C → B	16 / 4 / 3	4 / 19 / 0	0 / 0 / 23	18 / 5 / 0	13 / 10 / 0
C → D	9 / 2 / 12	3 / 20 / 0	15 / 8 / 0	10 / 11 / 2	8 / 15 / 0
D → A	4 / 0 / 19	7 / 16 / 0	16 / 7 / 0	14 / 8 / 1	13 / 8 / 2
D → B	16 / 4 / 3	7 / 13 / 3	0 / 0 / 23	14 / 7 / 2	7 / 13 / 3
D → C	6 / 3 / 14	6 / 5 / 12	0 / 0 / 23	6 / 16 / 1	11 / 12 / 0
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table Q.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.08	0.07	0.07	0.11
Absolute	0.10	0.07	0.07	0.23
Relative	0.09	0.07	0.07	0.13
Relative Performance	0.09	0.07	0.07	0.13
Relative Fitness	0.11	0.09	0.08	0.16

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.07	0.07	0.09	0.11
Array B	0.10	0.07	0.16	0.11
Array C	0.09	0.07	0.08	0.09
Array D	0.10	0.10	0.07	0.08
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.07	0.05	0.11	0.08
Array B	0.09	0.07	0.10	0.10
Array C	0.09	0.05	0.08	0.08
Array D	0.09	0.06	0.11	0.08
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.04	0.06	0.11	0.08
Array B	0.08	0.04	0.11	0.10
Array C	0.09	0.05	0.03	0.10
Array D	0.10	0.06	0.09	0.03
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.07	0.10	0.12
Array B	0.07	0.0	0.11	0.13
Array C	0.07	0.07	0.0	0.11
Array D	0.14	0.13	0.12	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.06	0.05	0.06	0.07	0.07	0.05	0.05	0.06	0.07	0.28	0.17	0.35
Array B	0.09	0.07	0.07	0.07	0.10	0.07	0.08	0.06	0.08	0.08	0.46	0.36
Array C	0.06	0.05	0.06	0.07	0.07	0.05	0.05	0.06	0.12	0.18	0.11	0.25
Array D	0.06	0.07	0.05	0.07	0.09	0.07	0.05	0.06	0.10	0.18	0.12	0.12
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.06	0.04	0.09	0.07	0.07	0.04	0.10	0.06	0.07	0.15	0.17	0.08
Array B	0.09	0.07	0.09	0.07	0.09	0.07	0.07	0.07	0.07	0.08	0.17	0.16
Array C	0.07	0.04	0.06	0.07	0.09	0.05	0.05	0.06	0.09	0.17	0.11	0.08
Array D	0.07	0.05	0.09	0.07	0.10	0.05	0.10	0.06	0.09	0.15	0.17	0.12
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.04	0.04	0.09	0.07	0.06	0.04	0.10	0.06	0.03	0.13	0.17	0.08
Array B	0.08	0.04	0.09	0.07	0.08	0.03	0.10	0.06	0.06	0.04	0.17	0.15
Array C	0.07	0.04	0.03	0.06	0.09	0.05	0.03	0.07	0.09	0.17	0.04	0.10
Array D	0.07	0.05	0.06	0.03	0.10	0.05	0.06	0.03	0.11	0.15	0.17	0.03
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.06	0.10	0.12	0.0	0.04	0.08	0.09	0.0	0.17	0.14	0.13
Array B	0.07	0.0	0.08	0.10	0.05	0.0	0.07	0.09	0.13	0.0	0.17	0.15
Array C	0.06	0.04	0.0	0.12	0.06	0.06	0.0	0.07	0.16	0.21	0.0	0.14
Array D	0.12	0.12	0.11	0.0	0.12	0.10	0.11	0.0	0.17	0.15	0.12	0.0

Table Q.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.11	0.09	0.10	0.15
Absolute	0.16	0.10	0.10	0.29
Relative	0.13	0.10	0.10	0.18
Relative Performance	0.13	0.09	0.09	0.19
Relative Fitness	0.16	0.11	0.11	0.26

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.09	0.15	0.16	0.20
Array B	0.13	0.12	0.26	0.21
Array C	0.12	0.16	0.11	0.17
Array D	0.12	0.17	0.11	0.14
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.09	0.09	0.13	0.12
Array B	0.14	0.12	0.14	0.15
Array C	0.12	0.14	0.11	0.12
Array D	0.13	0.15	0.13	0.14
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.06	0.09	0.13	0.12
Array B	0.10	0.06	0.13	0.15
Array C	0.12	0.14	0.04	0.12
Array D	0.14	0.15	0.12	0.05
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.13	0.13	0.21
Array B	0.10	0.0	0.18	0.18
Array C	0.12	0.21	0.0	0.12
Array D	0.19	0.23	0.13	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.08	0.07	0.10	0.12	0.09	0.07	0.10	0.12	0.10	0.31	0.27	0.36
Array B	0.13	0.08	0.11	0.12	0.14	0.09	0.13	0.12	0.13	0.17	0.53	0.38
Array C	0.08	0.07	0.09	0.12	0.09	0.07	0.09	0.12	0.19	0.33	0.14	0.29
Array D	0.08	0.09	0.08	0.12	0.10	0.09	0.08	0.12	0.17	0.32	0.16	0.18
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.08	0.06	0.11	0.12	0.09	0.05	0.11	0.12	0.10	0.16	0.18	0.13
Array B	0.13	0.08	0.11	0.12	0.13	0.09	0.12	0.11	0.15	0.17	0.18	0.20
Array C	0.10	0.06	0.09	0.12	0.10	0.06	0.09	0.12	0.15	0.30	0.14	0.11
Array D	0.11	0.07	0.11	0.12	0.13	0.07	0.11	0.12	0.15	0.30	0.18	0.18
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.07	0.05	0.11	0.12	0.08	0.05	0.11	0.12	0.04	0.18	0.18	0.13
Array B	0.08	0.05	0.11	0.12	0.08	0.04	0.11	0.13	0.15	0.08	0.18	0.20
Array C	0.10	0.06	0.04	0.10	0.10	0.06	0.04	0.11	0.15	0.30	0.06	0.15
Array D	0.11	0.07	0.09	0.06	0.13	0.07	0.08	0.05	0.18	0.30	0.18	0.04
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.07	0.11	0.23	0.0	0.06	0.09	0.22	0.0	0.28	0.18	0.19
Array B	0.07	0.0	0.10	0.13	0.06	0.0	0.09	0.13	0.16	0.0	0.35	0.26
Array C	0.09	0.06	0.0	0.12	0.09	0.08	0.0	0.08	0.17	0.49	0.0	0.14
Array D	0.15	0.14	0.12	0.0	0.14	0.13	0.12	0.0	0.27	0.42	0.16	0.0

Table Q.4: Mean relative error

Appendix R

WorkloadMix model testing on FitnessDirect samples

Application	Samples	Iters	First sample	Last sample
Direct (raw)	200	3	100	199
Total used	100			

Table R.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

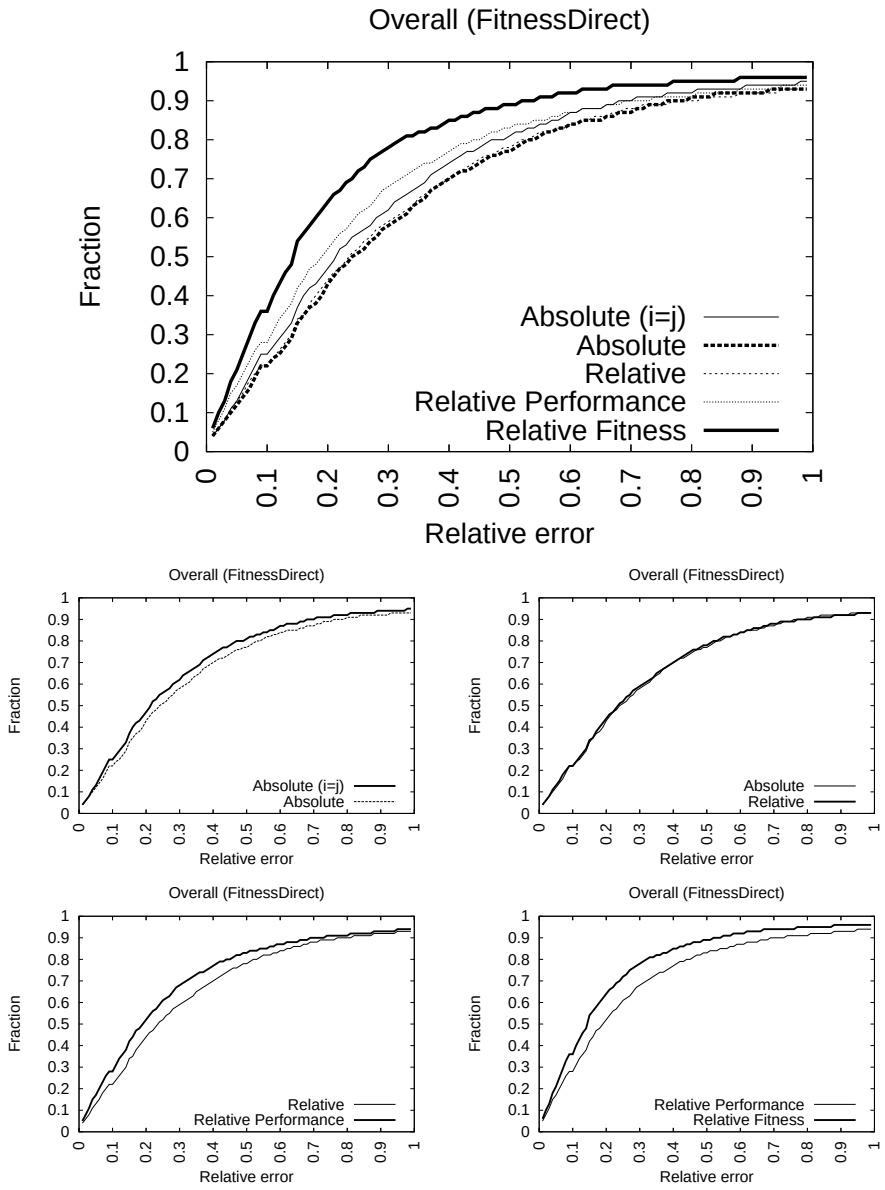

Figure R.1: The cumulative distribution of relative error over all pairwise predictions.

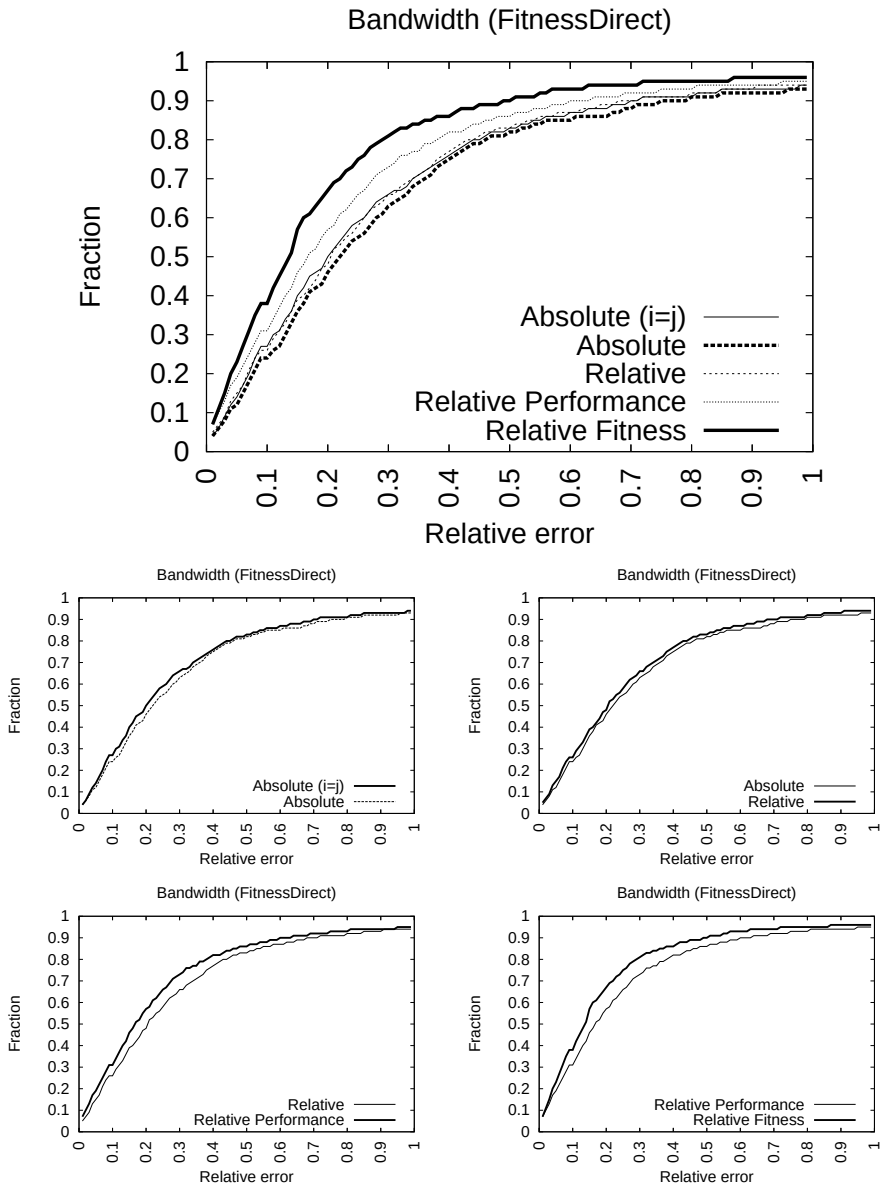

Figure R.2: The cumulative distribution of relative error over all pairwise predictions.

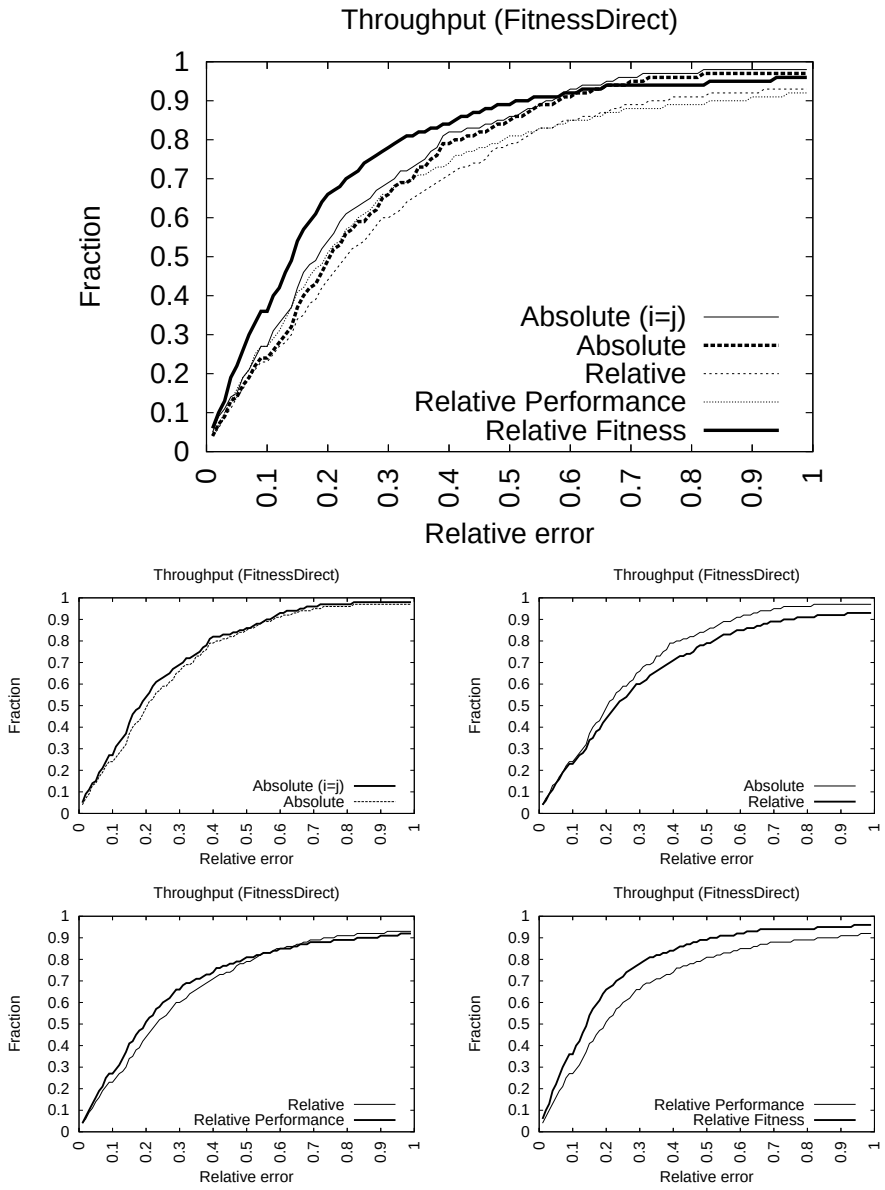

Figure R.3: The cumulative distribution of relative error over all pairwise predictions.

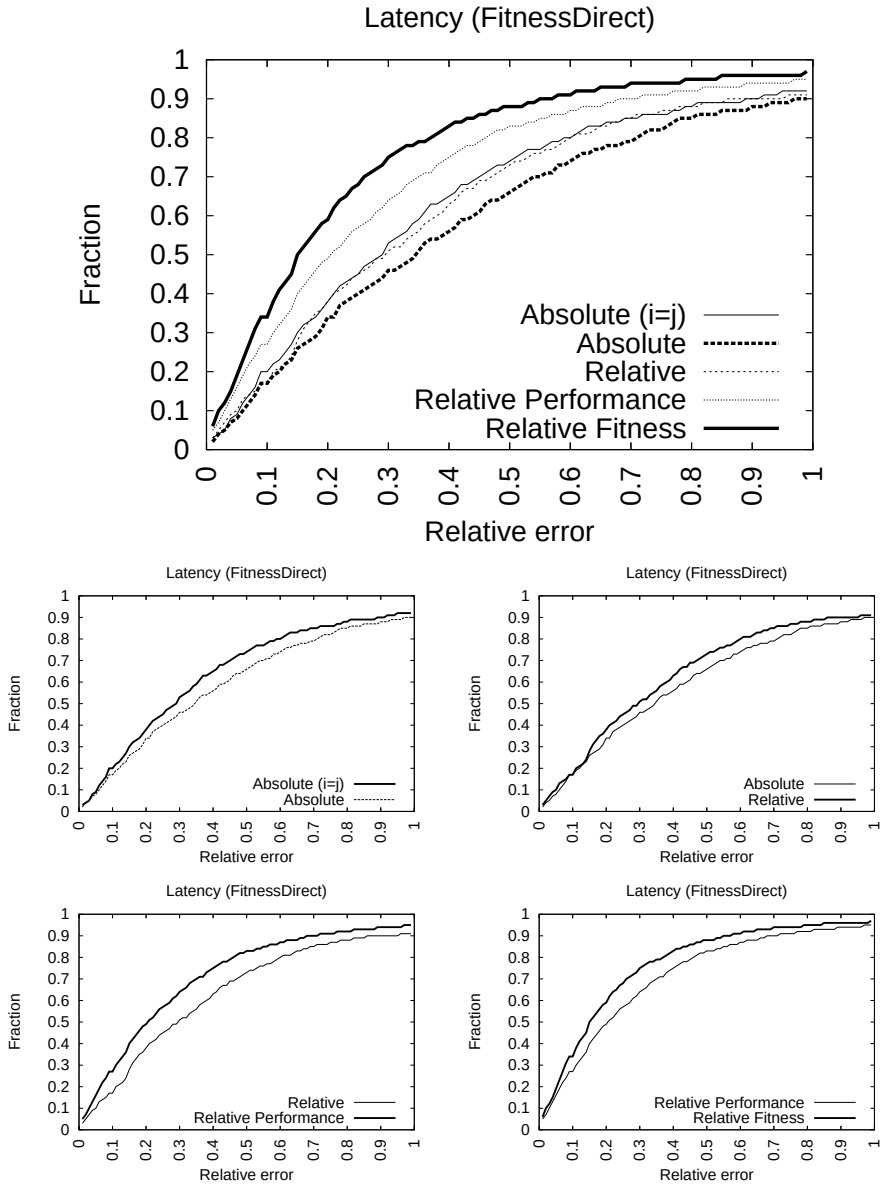

Figure R.4: The cumulative distribution of relative error over all pairwise predictions.

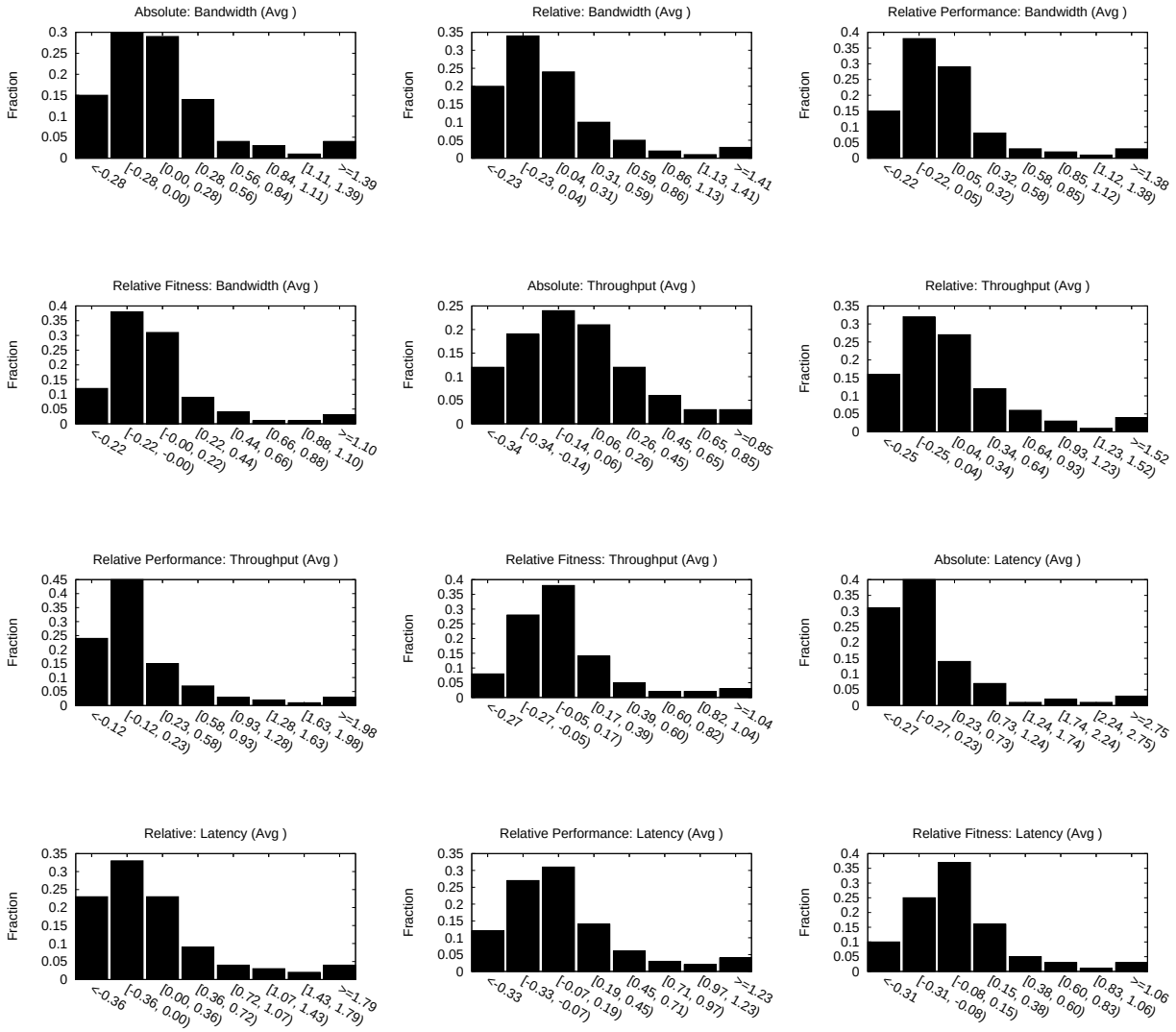

Figure R.5: The probability distribution of relative error over all pairwise predictions.

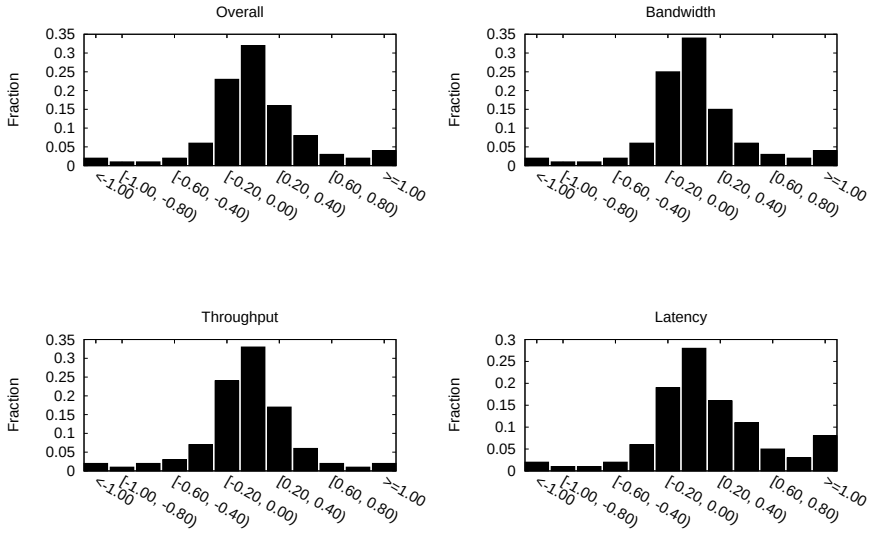

Figure R.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	12 / 10 / 76	33 / 36 / 29	40 / 52 / 6	38 / 56 / 4	31 / 63 / 4
A → C	29 / 12 / 57	33 / 51 / 14	38 / 57 / 3	46 / 49 / 3	36 / 60 / 2
A → D	23 / 9 / 66	44 / 36 / 18	38 / 51 / 9	32 / 58 / 8	28 / 68 / 2
B → A	12 / 8 / 78	35 / 34 / 29	37 / 56 / 5	29 / 61 / 8	27 / 68 / 3
B → C	12 / 3 / 83	43 / 39 / 16	34 / 50 / 14	49 / 47 / 2	43 / 51 / 4
B → D	2 / 5 / 91	26 / 37 / 35	38 / 46 / 14	29 / 60 / 9	28 / 66 / 4
C → A	5 / 5 / 88	35 / 28 / 35	33 / 51 / 14	32 / 60 / 6	32 / 60 / 6
C → B	13 / 6 / 79	35 / 51 / 12	42 / 46 / 10	47 / 46 / 5	43 / 55 / 0
C → D	16 / 9 / 73	35 / 44 / 19	36 / 46 / 16	46 / 47 / 5	47 / 48 / 3
D → A	11 / 9 / 78	37 / 31 / 30	30 / 63 / 5	36 / 53 / 9	29 / 62 / 7
D → B	4 / 3 / 91	41 / 40 / 17	32 / 58 / 8	39 / 50 / 9	23 / 72 / 3
D → C	11 / 5 / 82	34 / 43 / 21	42 / 48 / 8	47 / 50 / 1	43 / 50 / 5
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	24 / 20 / 54	43 / 39 / 16	36 / 49 / 13	35 / 57 / 6	33 / 63 / 2
A → C	2 / 2 / 94	30 / 32 / 36	83 / 15 / 0	14 / 82 / 2	44 / 51 / 3
A → D	25 / 18 / 55	48 / 36 / 14	37 / 52 / 9	35 / 58 / 5	36 / 57 / 5
B → A	35 / 8 / 55	45 / 50 / 3	40 / 53 / 5	43 / 53 / 2	38 / 60 / 0
B → C	4 / 3 / 91	88 / 9 / 1	15 / 83 / 0	43 / 50 / 5	44 / 50 / 4
B → D	4 / 6 / 88	37 / 42 / 19	52 / 39 / 7	30 / 64 / 4	33 / 59 / 6
C → A	32 / 8 / 58	43 / 53 / 2	45 / 46 / 7	31 / 64 / 3	25 / 70 / 3
C → B	18 / 15 / 65	58 / 36 / 4	40 / 50 / 8	35 / 59 / 4	40 / 52 / 6
C → D	13 / 14 / 71	43 / 46 / 9	48 / 47 / 3	41 / 50 / 7	42 / 52 / 4
D → A	33 / 8 / 57	35 / 59 / 4	30 / 63 / 5	42 / 52 / 4	30 / 66 / 2
D → B	4 / 7 / 87	50 / 40 / 8	32 / 58 / 8	37 / 60 / 1	34 / 58 / 6
D → C	5 / 3 / 90	53 / 41 / 4	36 / 56 / 6	43 / 50 / 5	43 / 50 / 5
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	32 / 17 / 49	49 / 41 / 8	32 / 63 / 3	38 / 53 / 7	26 / 68 / 4
A → C	46 / 14 / 38	32 / 59 / 7	31 / 59 / 8	41 / 52 / 5	21 / 75 / 2
A → D	27 / 8 / 63	28 / 54 / 16	28 / 62 / 8	38 / 56 / 4	21 / 75 / 2
B → A	37 / 21 / 40	38 / 54 / 6	45 / 45 / 8	42 / 52 / 4	35 / 61 / 2
B → C	17 / 11 / 70	46 / 35 / 17	38 / 58 / 2	33 / 59 / 6	30 / 65 / 3
B → D	7 / 7 / 84	36 / 42 / 20	28 / 66 / 4	32 / 61 / 5	20 / 74 / 4
C → A	28 / 16 / 54	37 / 52 / 9	38 / 55 / 5	52 / 43 / 3	36 / 59 / 3
C → B	19 / 12 / 67	49 / 40 / 9	37 / 60 / 1	46 / 47 / 5	31 / 64 / 3
C → D	14 / 8 / 76	32 / 39 / 27	36 / 49 / 13	36 / 60 / 2	29 / 68 / 1
D → A	35 / 21 / 42	36 / 50 / 12	39 / 54 / 5	38 / 52 / 8	27 / 68 / 3
D → B	9 / 4 / 85	40 / 46 / 12	41 / 53 / 4	32 / 61 / 5	26 / 69 / 3
D → C	16 / 9 / 73	53 / 36 / 9	36 / 52 / 10	49 / 48 / 1	35 / 60 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table R.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.22	0.21	0.19	0.29
Absolute	0.25	0.23	0.21	0.35
Relative	0.24	0.21	0.23	0.30
Relative Performance	0.19	0.17	0.20	0.21
Relative Fitness	0.14	0.13	0.14	0.16

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.20	0.22	0.33	0.28
Array B	0.24	0.19	0.27	0.24
Array C	0.23	0.22	0.24	0.25
Array D	0.24	0.21	0.27	0.25
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.20	0.22	0.27	0.26
Array B	0.21	0.19	0.42	0.20
Array C	0.21	0.21	0.24	0.23
Array D	0.23	0.20	0.31	0.25
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.01	0.13	0.31	0.17
Array B	0.17	0.01	0.25	0.19
Array C	0.18	0.20	0.01	0.24
Array D	0.15	0.16	0.25	0.01
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.12	0.19	0.12
Array B	0.13	0.0	0.20	0.10
Array C	0.12	0.17	0.0	0.17
Array D	0.12	0.10	0.17	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.21	0.21	0.32	0.27	0.17	0.19	0.22	0.22	0.22	0.34	0.58	0.53
Array B	0.21	0.19	0.24	0.17	0.25	0.15	0.23	0.20	0.29	0.30	0.33	0.39
Array C	0.20	0.21	0.21	0.23	0.21	0.19	0.22	0.21	0.30	0.30	0.31	0.40
Array D	0.20	0.20	0.24	0.18	0.25	0.16	0.23	0.21	0.28	0.34	0.34	0.39
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.21	0.21	0.25	0.23	0.17	0.19	0.24	0.24	0.22	0.33	0.32	0.34
Array B	0.19	0.19	0.25	0.17	0.20	0.15	0.91	0.17	0.24	0.30	0.38	0.34
Array C	0.22	0.18	0.21	0.23	0.20	0.26	0.22	0.20	0.21	0.23	0.31	0.30
Array D	0.21	0.16	0.21	0.18	0.23	0.20	0.33	0.21	0.26	0.23	0.38	0.39
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.01	0.12	0.17	0.16	0.01	0.13	0.92	0.17	0.01	0.15	0.23	0.22
Array B	0.16	0.01	0.24	0.16	0.16	0.01	0.20	0.23	0.18	0.01	0.30	0.18
Array C	0.17	0.19	0.01	0.22	0.20	0.23	0.02	0.23	0.16	0.16	0.02	0.26
Array D	0.14	0.10	0.25	0.01	0.15	0.14	0.22	0.01	0.16	0.19	0.30	0.01
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.12	0.20	0.12	0.0	0.12	0.19	0.10	0.0	0.13	0.16	0.13
Array B	0.10	0.0	0.21	0.09	0.14	0.0	0.21	0.12	0.14	0.0	0.19	0.10
Array C	0.10	0.16	0.0	0.20	0.11	0.15	0.0	0.16	0.18	0.21	0.0	0.14
Array D	0.12	0.08	0.16	0.0	0.12	0.10	0.19	0.0	0.14	0.14	0.17	0.0

Table R.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.39	0.40	0.26	0.52
Absolute	0.45	0.42	0.28	0.63
Relative	0.44	0.41	0.40	0.50
Relative Performance	0.49	0.36	0.75	0.35
Relative Fitness	0.31	0.38	0.25	0.30

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.28	0.34	0.71	0.60
Array B	0.35	0.30	0.51	0.53
Array C	0.30	0.34	0.47	0.52
Array D	0.34	0.30	0.50	0.53
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.28	0.39	0.49	0.41
Array B	0.32	0.30	0.92	0.35
Array C	0.33	0.40	0.47	0.39
Array D	0.34	0.30	0.58	0.53
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.02	0.33	0.69	0.29
Array B	0.34	0.02	1.83	0.52
Array C	0.27	0.34	0.03	0.36
Array D	0.26	0.21	0.42	0.03
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.24	0.32	0.26
Array B	0.23	0.0	0.88	0.17
Array C	0.25	0.32	0.0	0.35
Array D	0.19	0.17	0.35	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.32	0.27	0.80	0.37	0.21	0.23	0.32	0.25	0.30	0.52	1.02	1.19
Array B	0.35	0.26	0.73	0.32	0.33	0.23	0.34	0.27	0.36	0.40	0.45	1.00
Array C	0.32	0.28	0.71	0.33	0.26	0.24	0.32	0.25	0.33	0.51	0.40	0.99
Array D	0.36	0.26	0.71	0.33	0.32	0.23	0.35	0.28	0.35	0.41	0.44	0.98
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.32	0.24	0.66	0.35	0.21	0.24	0.33	0.34	0.30	0.70	0.50	0.56
Array B	0.36	0.26	0.68	0.29	0.27	0.23	1.53	0.25	0.32	0.40	0.54	0.51
Array C	0.43	0.31	0.71	0.30	0.27	0.31	0.32	0.29	0.30	0.58	0.40	0.59
Array D	0.36	0.29	0.64	0.33	0.30	0.25	0.45	0.28	0.36	0.35	0.66	0.98
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.02	0.29	0.46	0.26	0.01	0.23	1.22	0.28	0.02	0.48	0.38	0.32
Array B	0.36	0.02	0.93	0.31	0.35	0.01	4.18	1.00	0.32	0.03	0.39	0.24
Array C	0.28	0.29	0.03	0.30	0.29	0.39	0.03	0.32	0.24	0.32	0.05	0.45
Array D	0.25	0.15	0.44	0.01	0.22	0.17	0.39	0.01	0.31	0.32	0.44	0.06
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.16	0.32	0.18	0.0	0.16	0.37	0.19	0.0	0.42	0.26	0.41
Array B	0.14	0.0	2.04	0.15	0.34	0.0	0.29	0.18	0.22	0.0	0.31	0.17
Array C	0.19	0.33	0.0	0.30	0.22	0.31	0.0	0.30	0.34	0.31	0.0	0.46
Array D	0.18	0.14	0.41	0.0	0.19	0.15	0.31	0.0	0.19	0.23	0.33	0.0

Table R.4: Mean relative error

Appendix S

WorkloadMix model testing on FitnessBuffered samples

Application	Samples	Iters	First sample	Last sample
Buffered (sd)	200	3	100	199
Total used	100			

Table S.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

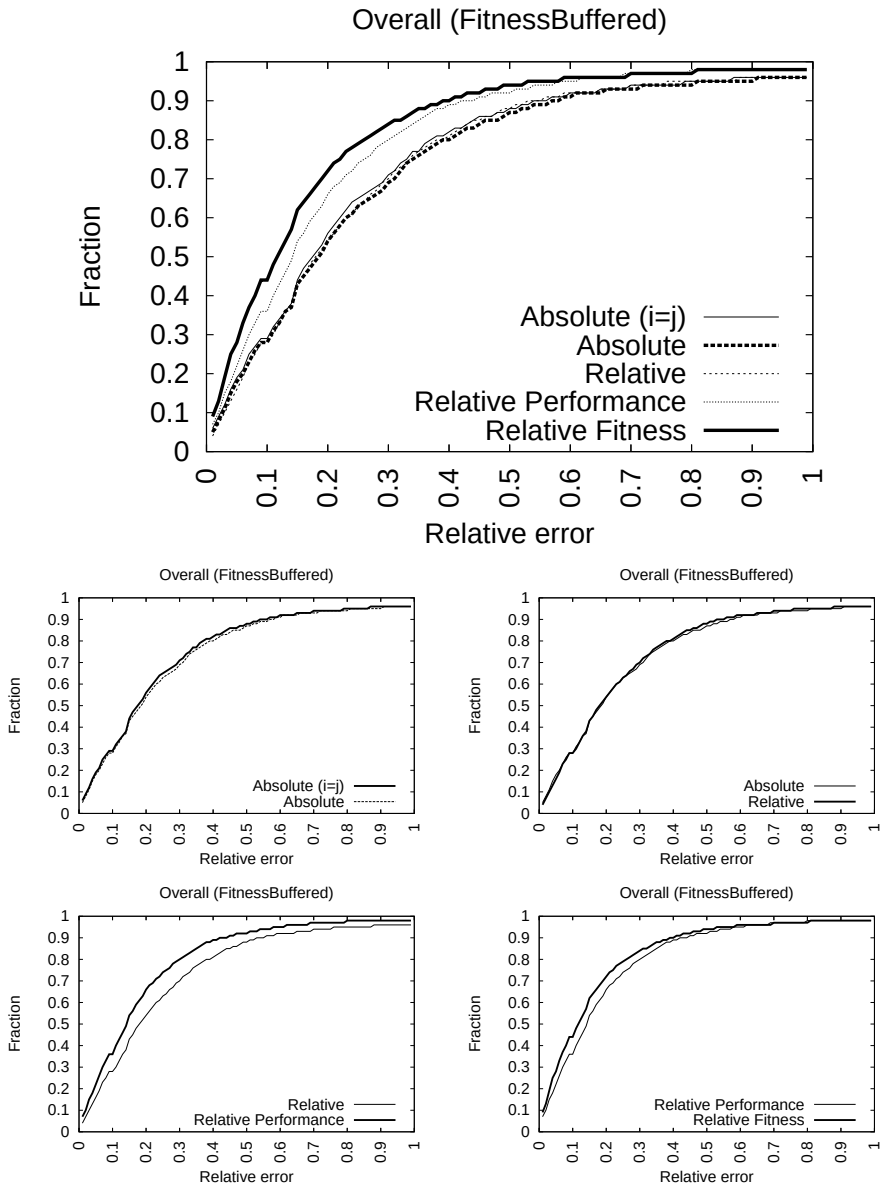

Figure S.1: The cumulative distribution of relative error over all pairwise predictions.

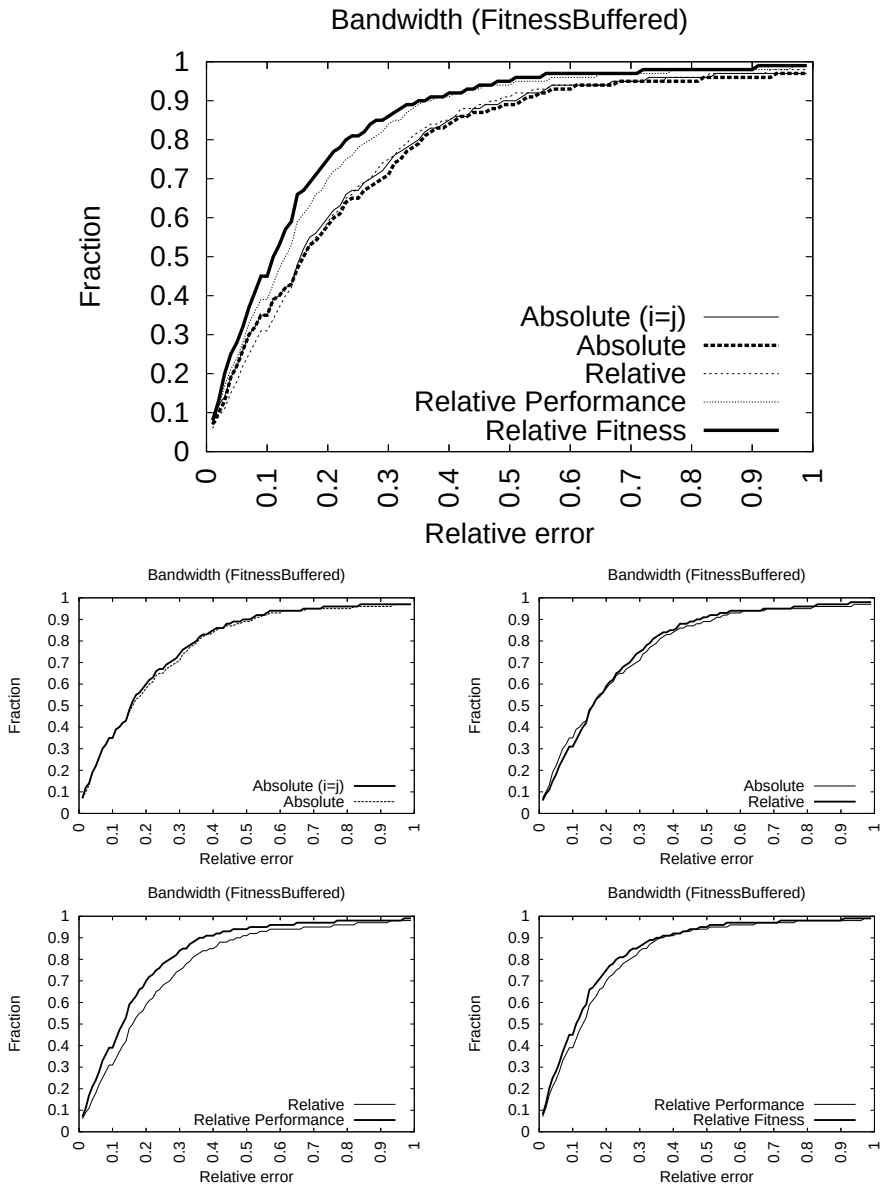

Figure S.2: The cumulative distribution of relative error over all pairwise predictions.

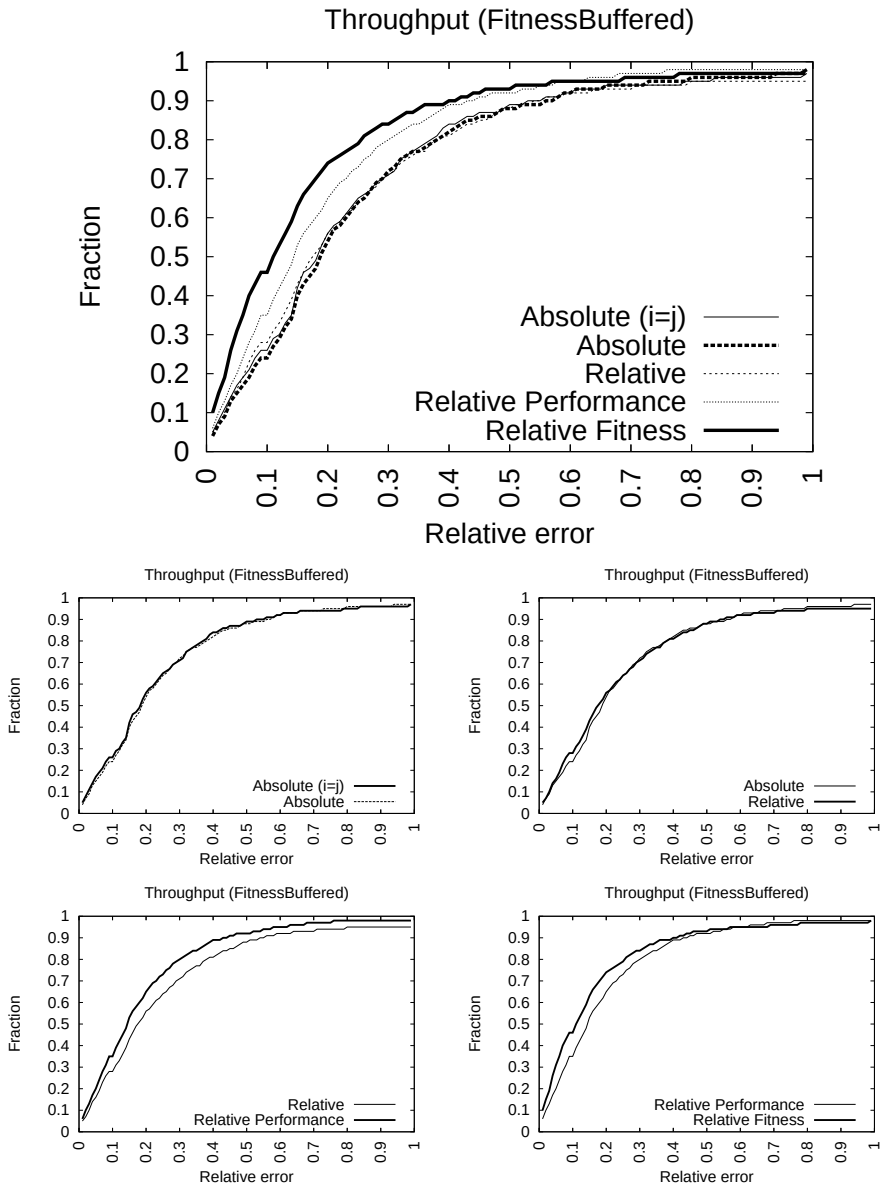

Figure S.3: The cumulative distribution of relative error over all pairwise predictions.

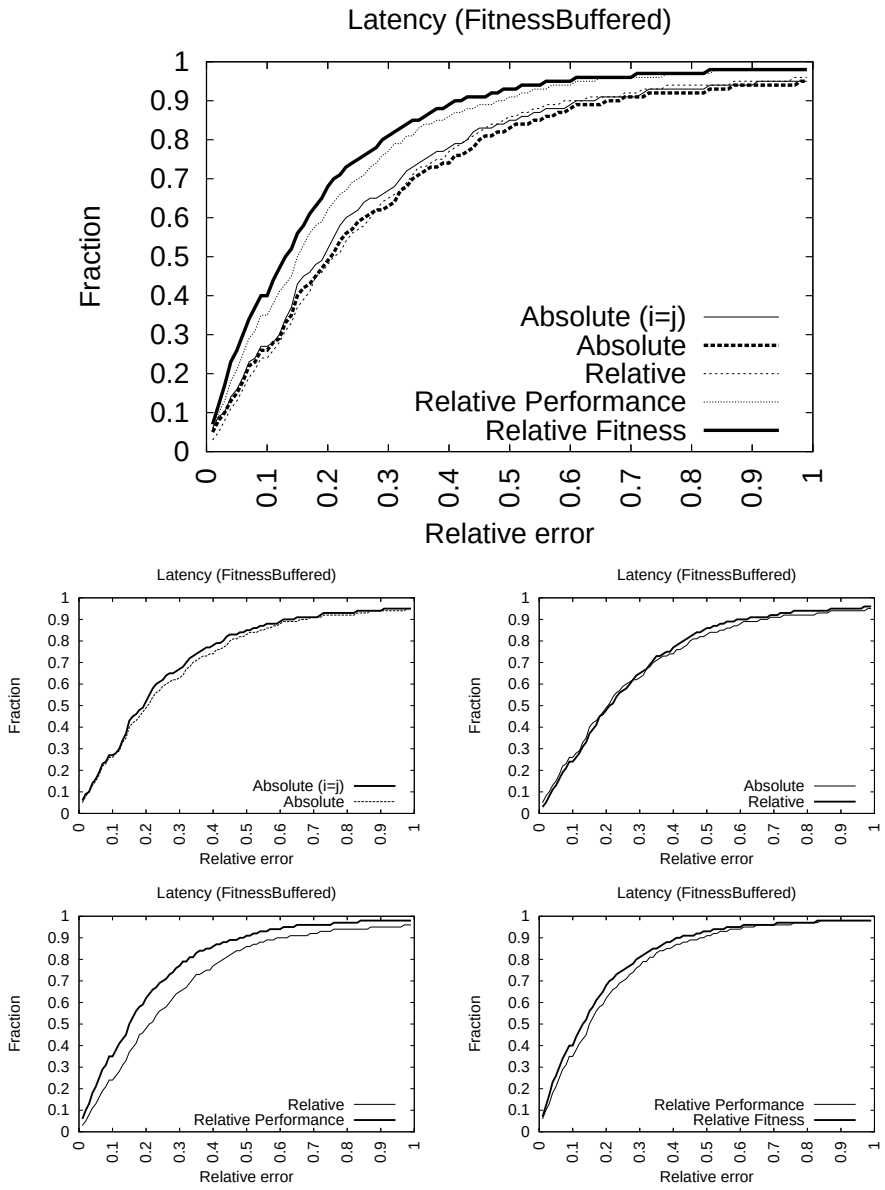

Figure S.4: The cumulative distribution of relative error over all pairwise predictions.

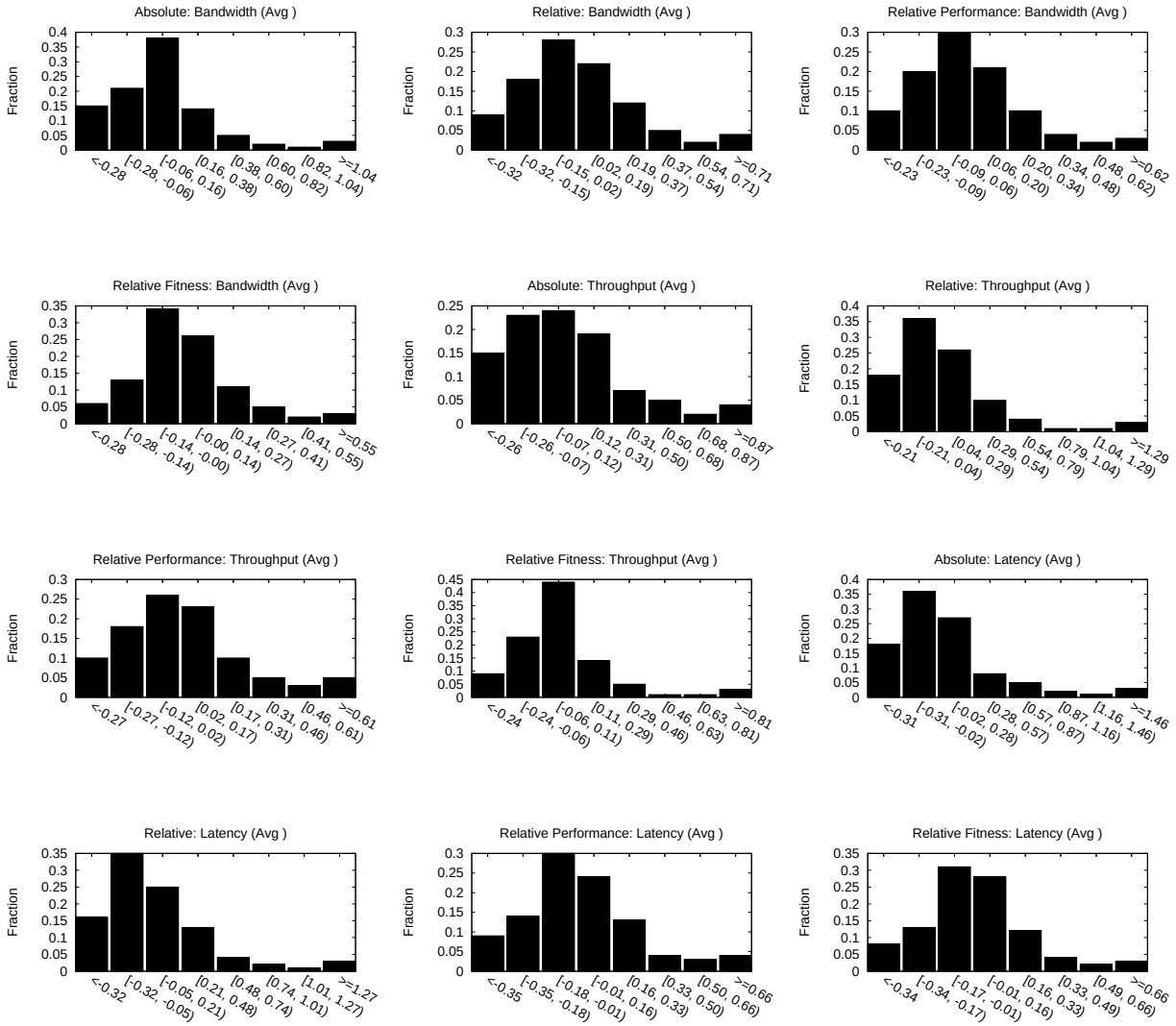

Figure S.5: The probability distribution of relative error over all pairwise predictions.

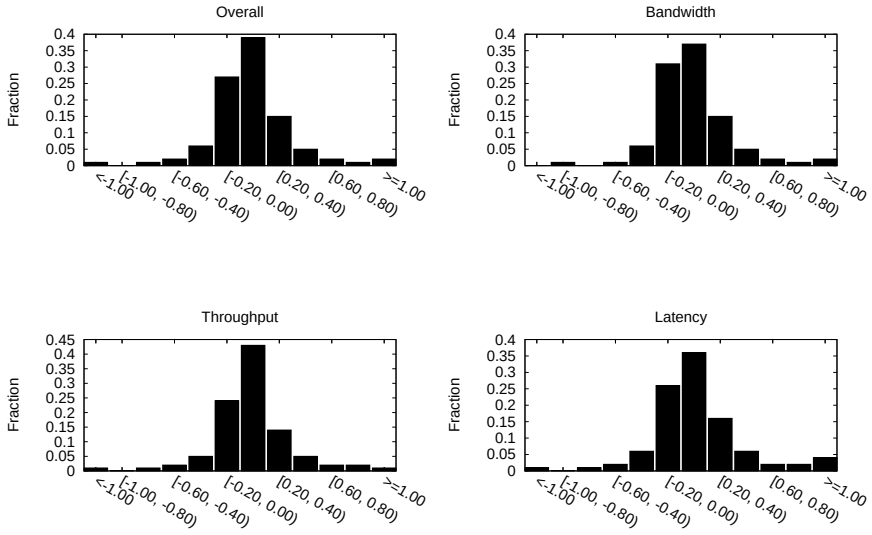

Figure S.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	7 / 4 / 87	34 / 20 / 44	43 / 49 / 6	31 / 52 / 15	38 / 57 / 3
A → C	20 / 9 / 69	39 / 48 / 11	36 / 47 / 15	42 / 50 / 6	40 / 52 / 6
A → D	10 / 6 / 82	36 / 46 / 16	24 / 52 / 22	40 / 51 / 7	22 / 69 / 7
B → A	8 / 8 / 82	46 / 39 / 13	34 / 59 / 5	39 / 52 / 7	32 / 60 / 6
B → C	16 / 6 / 76	40 / 44 / 14	37 / 56 / 5	43 / 50 / 5	38 / 54 / 6
B → D	3 / 12 / 83	37 / 49 / 12	26 / 62 / 10	36 / 49 / 13	30 / 63 / 5
C → A	14 / 10 / 74	32 / 46 / 20	45 / 41 / 12	35 / 56 / 7	34 / 58 / 6
C → B	7 / 10 / 81	50 / 31 / 17	39 / 50 / 9	53 / 38 / 7	52 / 39 / 7
C → D	16 / 10 / 72	33 / 47 / 18	33 / 54 / 11	43 / 44 / 11	34 / 58 / 6
D → A	5 / 12 / 81	37 / 35 / 26	32 / 59 / 7	39 / 51 / 8	33 / 60 / 5
D → B	7 / 4 / 87	38 / 31 / 29	30 / 61 / 7	38 / 48 / 12	36 / 56 / 6
D → C	17 / 9 / 72	40 / 43 / 15	37 / 52 / 9	44 / 47 / 7	41 / 51 / 6
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	7 / 3 / 88	34 / 45 / 19	44 / 47 / 7	27 / 66 / 5	26 / 69 / 3
A → C	12 / 10 / 76	38 / 54 / 6	61 / 37 / 0	32 / 63 / 3	32 / 58 / 8
A → D	5 / 3 / 90	31 / 51 / 16	48 / 38 / 12	33 / 61 / 4	30 / 66 / 2
B → A	14 / 8 / 76	43 / 48 / 7	35 / 53 / 10	36 / 57 / 5	15 / 79 / 4
B → C	5 / 12 / 81	63 / 29 / 6	27 / 65 / 6	40 / 53 / 5	31 / 63 / 4
B → D	7 / 6 / 85	38 / 46 / 14	33 / 56 / 9	42 / 52 / 4	28 / 66 / 4
C → A	24 / 14 / 60	45 / 45 / 8	31 / 56 / 11	41 / 49 / 8	36 / 58 / 4
C → B	13 / 3 / 82	46 / 47 / 5	38 / 57 / 3	45 / 45 / 8	43 / 50 / 5
C → D	12 / 12 / 74	41 / 46 / 11	37 / 53 / 8	47 / 41 / 10	39 / 51 / 8
D → A	11 / 9 / 78	42 / 45 / 11	30 / 56 / 12	29 / 60 / 9	23 / 71 / 4
D → B	3 / 3 / 92	43 / 39 / 16	35 / 49 / 14	29 / 58 / 11	29 / 65 / 4
D → C	8 / 10 / 80	36 / 31 / 31	33 / 55 / 10	51 / 43 / 4	40 / 52 / 6
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	6 / 6 / 86	38 / 50 / 10	41 / 44 / 13	26 / 67 / 5	29 / 64 / 5
A → C	18 / 8 / 72	39 / 45 / 14	28 / 65 / 5	44 / 49 / 5	30 / 63 / 5
A → D	9 / 6 / 83	33 / 41 / 24	28 / 54 / 16	52 / 44 / 2	40 / 53 / 5
B → A	9 / 5 / 84	45 / 43 / 10	29 / 59 / 10	42 / 45 / 11	31 / 62 / 5
B → C	15 / 6 / 77	43 / 41 / 14	38 / 56 / 4	38 / 55 / 5	32 / 59 / 7
B → D	6 / 2 / 90	35 / 51 / 12	28 / 58 / 12	31 / 56 / 11	25 / 68 / 5
C → A	11 / 6 / 81	43 / 37 / 18	33 / 54 / 11	44 / 48 / 6	36 / 58 / 4
C → B	6 / 11 / 81	35 / 39 / 24	51 / 39 / 8	41 / 51 / 6	40 / 51 / 7
C → D	9 / 9 / 80	40 / 34 / 24	41 / 42 / 15	38 / 52 / 8	40 / 51 / 7
D → A	9 / 5 / 84	40 / 39 / 19	31 / 60 / 7	47 / 50 / 1	26 / 65 / 7
D → B	4 / 7 / 87	41 / 44 / 13	32 / 56 / 10	38 / 56 / 4	29 / 61 / 8
D → C	16 / 9 / 73	47 / 43 / 8	40 / 49 / 9	45 / 51 / 2	31 / 64 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table S.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.18	0.16	0.19	0.20
Absolute	0.19	0.17	0.19	0.21
Relative	0.18	0.16	0.18	0.22
Relative Performance	0.14	0.12	0.14	0.15
Relative Fitness	0.11	0.11	0.10	0.13

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.18	0.15	0.22	0.21
Array B	0.18	0.15	0.21	0.20
Array C	0.19	0.16	0.19	0.21
Array D	0.17	0.16	0.21	0.20
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.18	0.14	0.21	0.17
Array B	0.17	0.15	0.24	0.21
Array C	0.19	0.16	0.19	0.21
Array D	0.18	0.15	0.21	0.20
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.01	0.13	0.20	0.13
Array B	0.12	0.01	0.16	0.12
Array C	0.15	0.15	0.01	0.16
Array D	0.12	0.10	0.17	0.01
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.09	0.14	0.11
Array B	0.11	0.0	0.14	0.09
Array C	0.11	0.14	0.0	0.14
Array D	0.09	0.07	0.18	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.15	0.12	0.20	0.20	0.20	0.15	0.20	0.22	0.19	0.20	0.24	0.20
Array B	0.14	0.12	0.20	0.17	0.20	0.14	0.20	0.20	0.19	0.20	0.22	0.21
Array C	0.16	0.10	0.18	0.23	0.20	0.16	0.21	0.21	0.20	0.18	0.18	0.21
Array D	0.14	0.12	0.19	0.17	0.20	0.14	0.21	0.21	0.19	0.20	0.24	0.19
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.15	0.14	0.18	0.17	0.20	0.11	0.17	0.15	0.19	0.18	0.27	0.21
Array B	0.16	0.12	0.19	0.19	0.14	0.14	0.29	0.22	0.20	0.20	0.29	0.20
Array C	0.14	0.15	0.18	0.18	0.21	0.17	0.21	0.20	0.25	0.16	0.18	0.24
Array D	0.15	0.17	0.20	0.17	0.19	0.11	0.21	0.21	0.21	0.15	0.22	0.19
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.01	0.14	0.13	0.11	0.01	0.11	0.26	0.16	0.01	0.19	0.19	0.12
Array B	0.11	0.01	0.14	0.10	0.12	0.01	0.15	0.13	0.12	0.01	0.18	0.12
Array C	0.15	0.13	0.01	0.13	0.15	0.13	0.01	0.15	0.15	0.20	0.01	0.18
Array D	0.11	0.09	0.14	0.01	0.14	0.11	0.19	0.01	0.11	0.10	0.19	0.01
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.09	0.14	0.10	0.0	0.07	0.16	0.10	0.0	0.14	0.12	0.13
Array B	0.10	0.0	0.15	0.10	0.10	0.0	0.12	0.09	0.13	0.0	0.15	0.08
Array C	0.09	0.13	0.0	0.12	0.12	0.11	0.0	0.16	0.13	0.17	0.0	0.14
Array D	0.09	0.07	0.15	0.0	0.07	0.07	0.18	0.0	0.10	0.08	0.18	0.0

Table S.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.28	0.24	0.26	0.33
Absolute	0.29	0.25	0.27	0.35
Relative	0.29	0.23	0.30	0.33
Relative Performance	0.22	0.19	0.22	0.24
Relative Fitness	0.18	0.17	0.19	0.20

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.25	0.32	0.35	0.29
Array B	0.26	0.28	0.33	0.28
Array C	0.27	0.29	0.30	0.30
Array D	0.25	0.27	0.34	0.28
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.25	0.24	0.32	0.27
Array B	0.28	0.28	0.33	0.27
Array C	0.27	0.26	0.30	0.36
Array D	0.28	0.28	0.27	0.28
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.02	0.23	0.27	0.20
Array B	0.18	0.02	0.25	0.20
Array C	0.20	0.22	0.02	0.25
Array D	0.16	0.17	0.25	0.02
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.13	0.23	0.18
Array B	0.15	0.0	0.20	0.17
Array C	0.19	0.23	0.0	0.24
Array D	0.14	0.13	0.23	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.25	0.20	0.32	0.25	0.27	0.23	0.27	0.32	0.24	0.52	0.45	0.30
Array B	0.25	0.20	0.32	0.22	0.29	0.21	0.26	0.32	0.23	0.44	0.40	0.30
Array C	0.28	0.20	0.26	0.27	0.27	0.25	0.27	0.31	0.25	0.41	0.36	0.33
Array D	0.23	0.21	0.31	0.25	0.27	0.21	0.28	0.30	0.24	0.38	0.42	0.28
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.25	0.22	0.27	0.22	0.27	0.18	0.30	0.29	0.24	0.34	0.39	0.31
Array B	0.27	0.20	0.26	0.23	0.30	0.21	0.33	0.29	0.28	0.44	0.42	0.28
Array C	0.19	0.21	0.26	0.24	0.34	0.22	0.27	0.44	0.29	0.36	0.36	0.40
Array D	0.25	0.21	0.24	0.25	0.32	0.30	0.27	0.30	0.28	0.35	0.30	0.28
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.01	0.18	0.26	0.16	0.02	0.16	0.32	0.25	0.02	0.35	0.24	0.18
Array B	0.15	0.01	0.22	0.19	0.22	0.01	0.22	0.24	0.18	0.03	0.32	0.16
Array C	0.19	0.19	0.02	0.20	0.22	0.17	0.01	0.27	0.19	0.30	0.03	0.26
Array D	0.13	0.13	0.24	0.01	0.19	0.14	0.21	0.01	0.17	0.25	0.30	0.04
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.12	0.23	0.14	0.0	0.10	0.23	0.17	0.0	0.18	0.24	0.23
Array B	0.12	0.0	0.19	0.13	0.15	0.0	0.19	0.23	0.17	0.0	0.22	0.14
Array C	0.14	0.23	0.0	0.25	0.22	0.23	0.0	0.26	0.22	0.23	0.0	0.21
Array D	0.12	0.11	0.21	0.0	0.14	0.12	0.22	0.0	0.16	0.16	0.25	0.0

Table S.4: Mean relative error

Appendix T

WorkloadMix model testing on FitnessFS samples

Application	Samples	Iters	First sample	Last sample
FS (fs)	200	3	100	199
Total used	100			

Table T.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

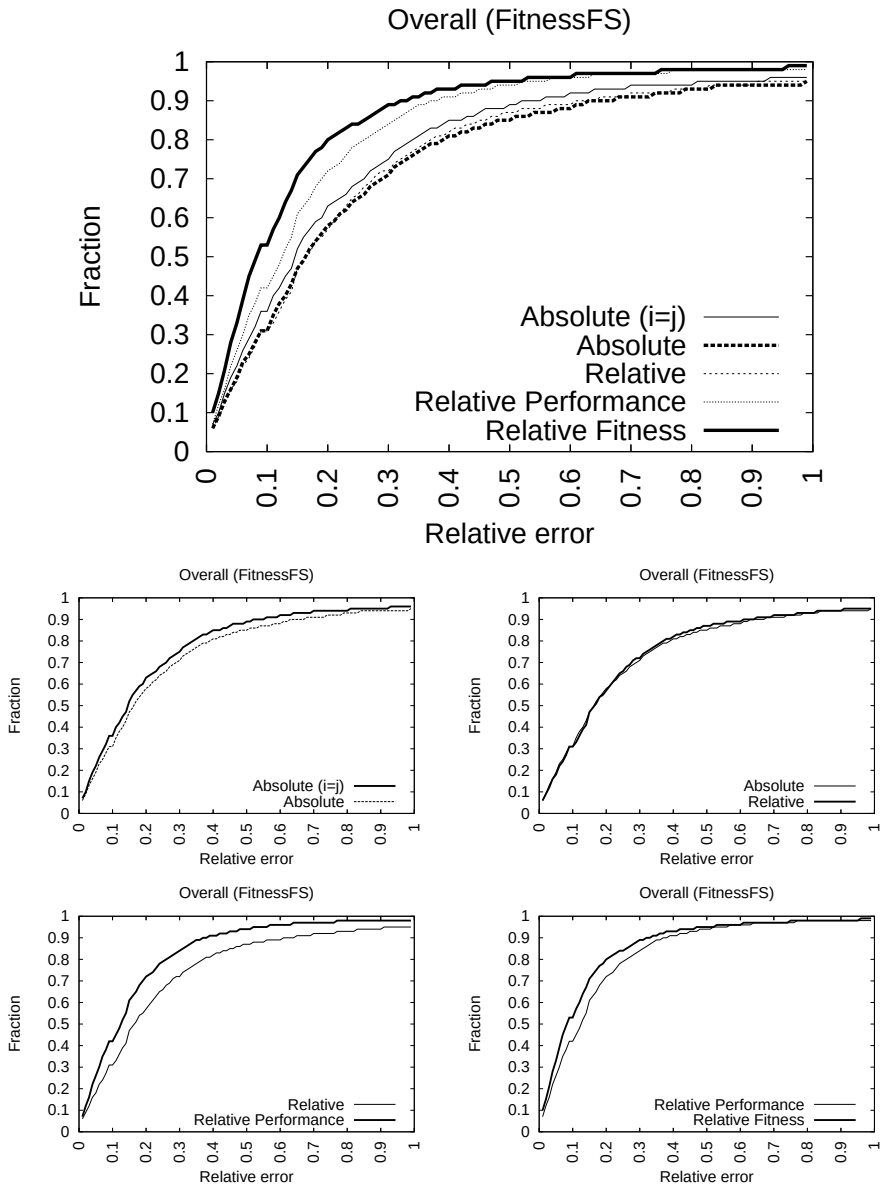

Figure T.1: The cumulative distribution of relative error over all pairwise predictions.

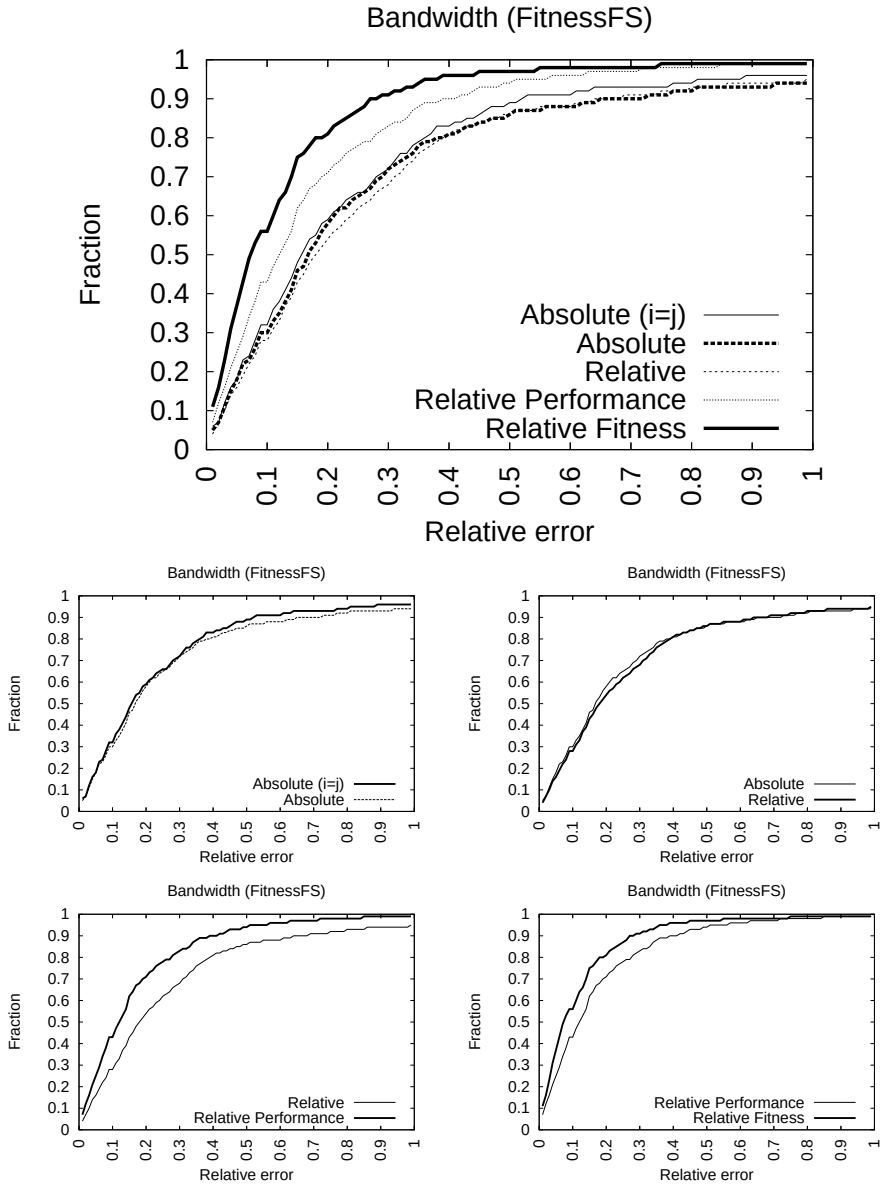

Figure T.2: The cumulative distribution of relative error over all pairwise predictions.

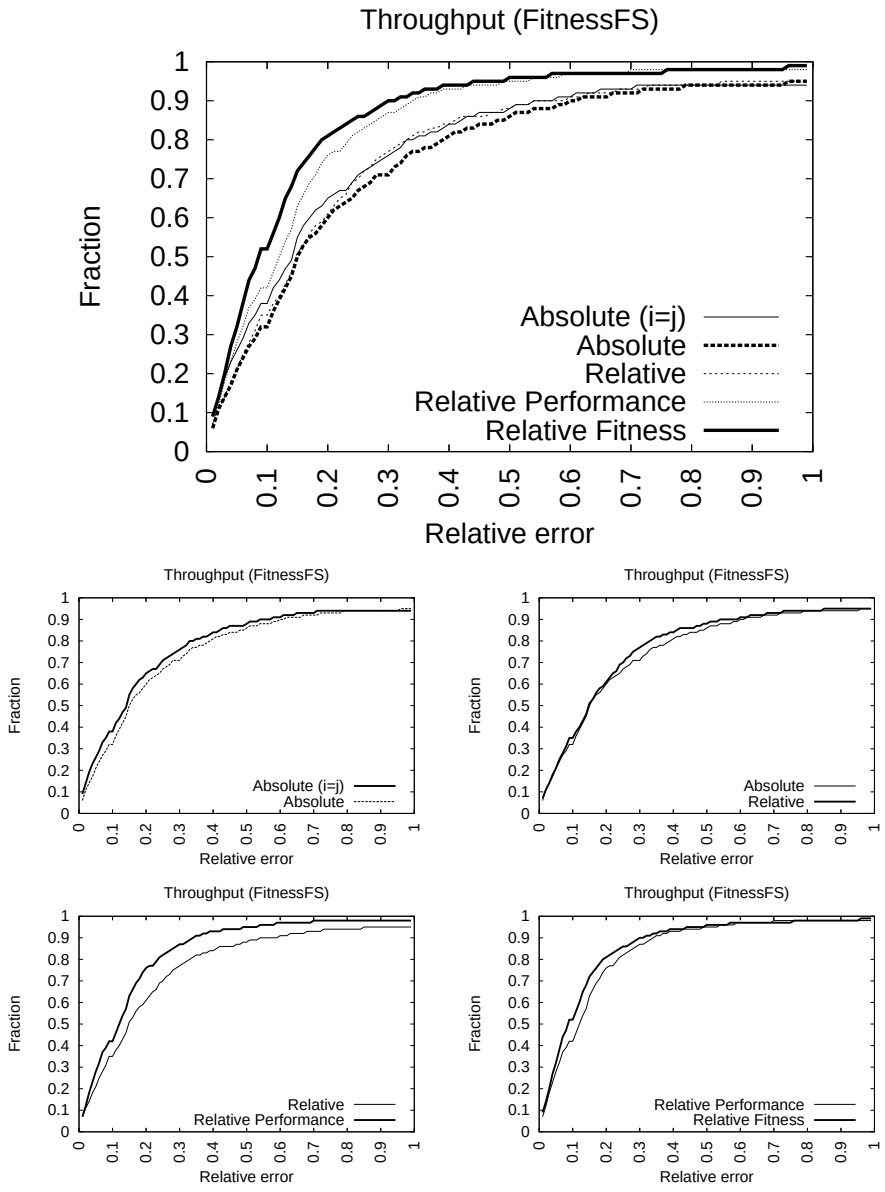

Figure T.3: The cumulative distribution of relative error over all pairwise predictions.

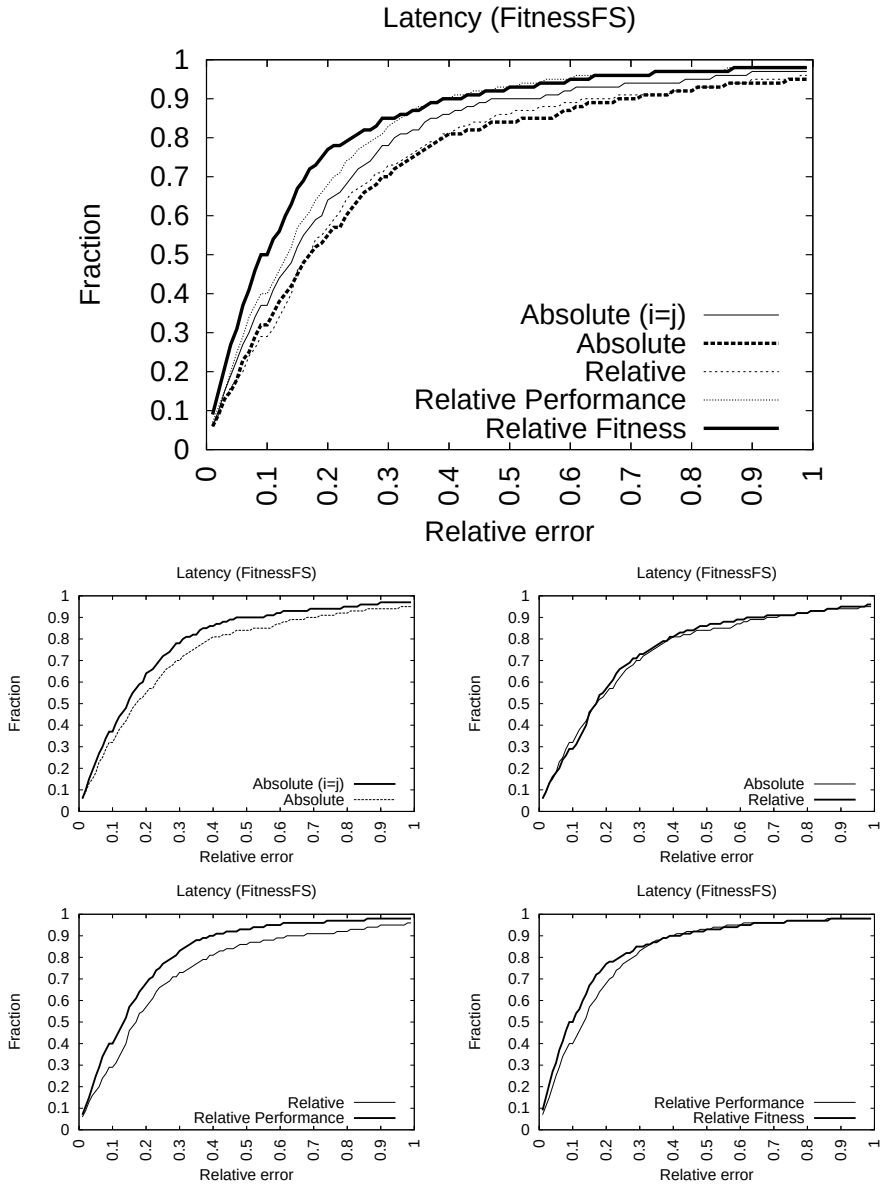

Figure T.4: The cumulative distribution of relative error over all pairwise predictions.

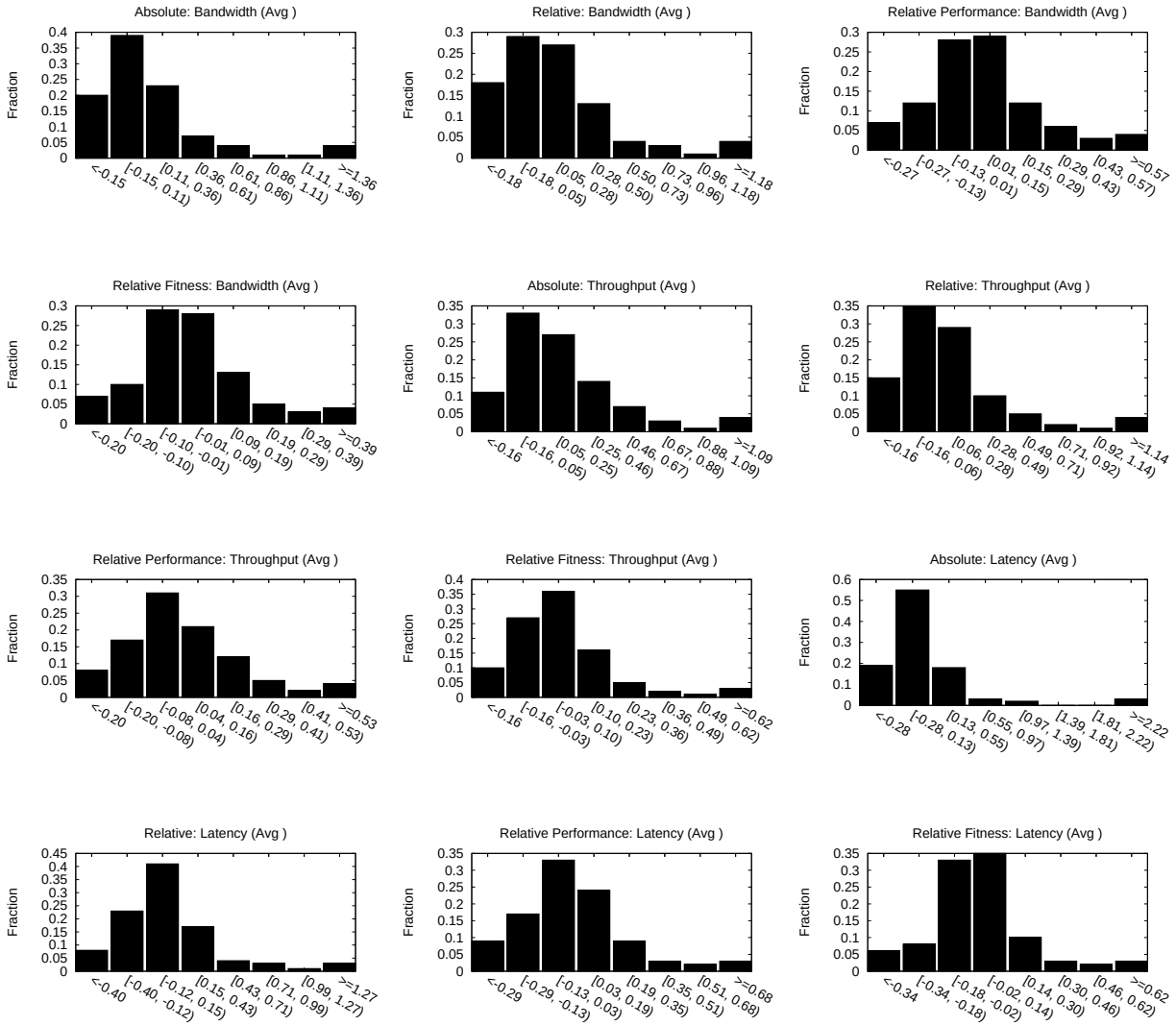

Figure T.5: The probability distribution of relative error over all pairwise predictions.

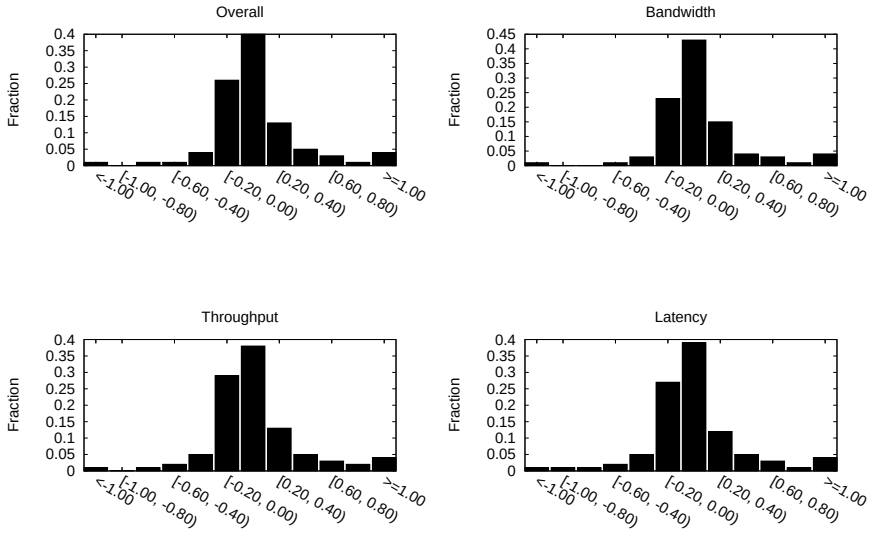

Figure T.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	18 / 9 / 71	32 / 34 / 32	28 / 61 / 9	36 / 54 / 8	26 / 69 / 3
A → C	21 / 10 / 67	53 / 38 / 7	31 / 62 / 5	34 / 58 / 6	28 / 65 / 5
A → D	17 / 20 / 61	46 / 28 / 24	27 / 62 / 9	33 / 61 / 4	31 / 65 / 2
B → A	8 / 8 / 82	35 / 45 / 18	36 / 49 / 13	24 / 62 / 12	16 / 76 / 6
B → C	12 / 11 / 75	54 / 32 / 12	26 / 66 / 6	36 / 55 / 7	35 / 59 / 4
B → D	10 / 17 / 71	50 / 32 / 16	31 / 60 / 7	39 / 55 / 4	34 / 59 / 5
C → A	15 / 7 / 76	34 / 40 / 24	36 / 52 / 10	31 / 64 / 3	19 / 77 / 2
C → B	16 / 10 / 72	49 / 37 / 12	43 / 48 / 7	36 / 55 / 7	34 / 58 / 6
C → D	16 / 19 / 63	36 / 38 / 24	34 / 55 / 9	35 / 58 / 5	32 / 58 / 8
D → A	20 / 5 / 73	32 / 37 / 29	19 / 70 / 9	25 / 60 / 13	15 / 79 / 4
D → B	22 / 6 / 70	38 / 44 / 16	26 / 62 / 10	31 / 56 / 11	17 / 71 / 10
D → C	20 / 6 / 72	45 / 42 / 11	27 / 63 / 8	35 / 54 / 9	23 / 70 / 5
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	9 / 14 / 75	43 / 26 / 29	30 / 54 / 14	34 / 49 / 15	37 / 51 / 10
A → C	22 / 17 / 59	39 / 54 / 5	64 / 34 / 0	32 / 63 / 3	38 / 58 / 2
A → D	13 / 3 / 82	36 / 58 / 4	44 / 50 / 4	26 / 61 / 11	26 / 70 / 2
B → A	37 / 10 / 51	46 / 48 / 4	25 / 64 / 9	48 / 41 / 9	26 / 64 / 8
B → C	7 / 8 / 83	47 / 35 / 16	35 / 52 / 11	43 / 50 / 5	39 / 49 / 10
B → D	4 / 7 / 87	29 / 49 / 20	41 / 55 / 2	41 / 53 / 4	32 / 61 / 5
C → A	48 / 10 / 40	42 / 51 / 5	26 / 56 / 16	37 / 48 / 13	27 / 68 / 3
C → B	12 / 5 / 81	56 / 40 / 2	28 / 67 / 3	48 / 40 / 10	42 / 48 / 8
C → D	10 / 7 / 81	46 / 43 / 9	46 / 49 / 3	40 / 56 / 2	29 / 62 / 7
D → A	41 / 12 / 45	41 / 49 / 8	38 / 48 / 12	35 / 55 / 8	21 / 71 / 6
D → B	15 / 10 / 73	35 / 37 / 26	33 / 54 / 11	38 / 52 / 8	32 / 59 / 7
D → C	10 / 7 / 81	30 / 42 / 26	45 / 50 / 3	48 / 44 / 6	45 / 48 / 5
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	27 / 15 / 56	39 / 52 / 7	39 / 57 / 2	38 / 55 / 5	32 / 62 / 4
A → C	31 / 8 / 59	38 / 45 / 15	31 / 57 / 10	47 / 45 / 6	41 / 53 / 4
A → D	10 / 7 / 81	39 / 33 / 26	33 / 57 / 8	40 / 52 / 6	34 / 58 / 6
B → A	22 / 8 / 68	32 / 40 / 26	42 / 45 / 11	36 / 59 / 3	25 / 66 / 7
B → C	16 / 6 / 76	61 / 29 / 8	30 / 64 / 4	44 / 47 / 7	45 / 49 / 4
B → D	5 / 4 / 89	30 / 46 / 22	30 / 53 / 15	40 / 48 / 10	28 / 66 / 4
C → A	27 / 8 / 63	39 / 32 / 27	31 / 50 / 17	35 / 57 / 6	25 / 63 / 10
C → B	21 / 7 / 70	44 / 38 / 16	39 / 42 / 17	35 / 56 / 7	26 / 68 / 4
C → D	5 / 4 / 89	27 / 30 / 41	37 / 37 / 24	44 / 49 / 5	39 / 54 / 5
D → A	26 / 8 / 64	40 / 44 / 14	33 / 62 / 3	39 / 54 / 5	26 / 68 / 4
D → B	20 / 7 / 71	45 / 42 / 11	22 / 66 / 10	36 / 59 / 3	28 / 64 / 6
D → C	19 / 9 / 70	39 / 42 / 17	41 / 48 / 9	33 / 59 / 6	33 / 59 / 6
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table T.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.15	0.16	0.14	0.14
Absolute	0.17	0.17	0.16	0.17
Relative	0.17	0.18	0.15	0.17
Relative Performance	0.12	0.12	0.11	0.13
Relative Fitness	0.09	0.08	0.09	0.10

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.14	0.13	0.17	0.18
Array B	0.19	0.12	0.16	0.18
Array C	0.21	0.14	0.14	0.19
Array D	0.22	0.14	0.16	0.18

Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.14	0.13	0.17	0.18
Array B	0.16	0.12	0.21	0.17
Array C	0.18	0.17	0.14	0.18
Array D	0.17	0.16	0.16	0.18

Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.01	0.10	0.15	0.12
Array B	0.11	0.01	0.14	0.11
Array C	0.13	0.13	0.01	0.14
Array D	0.11	0.09	0.12	0.01

Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.07	0.10	0.09
Array B	0.08	0.0	0.11	0.09
Array C	0.08	0.09	0.0	0.11
Array D	0.08	0.06	0.11	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.15	0.14	0.18	0.18	0.13	0.10	0.13	0.27	0.16	0.14	0.20	0.16
Array B	0.15	0.12	0.17	0.18	0.15	0.10	0.13	0.21	0.23	0.13	0.14	0.16
Array C	0.19	0.15	0.17	0.20	0.20	0.12	0.14	0.21	0.23	0.17	0.11	0.16
Array D	0.21	0.16	0.19	0.21	0.20	0.12	0.15	0.19	0.23	0.17	0.12	0.16

	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.15	0.14	0.23	0.18	0.13	0.11	0.12	0.18	0.16	0.14	0.16	0.17
Array B	0.16	0.12	0.21	0.18	0.15	0.10	0.18	0.17	0.16	0.13	0.30	0.16
Array C	0.17	0.18	0.17	0.18	0.15	0.18	0.14	0.24	0.20	0.15	0.11	0.16
Array D	0.22	0.18	0.19	0.21	0.12	0.12	0.13	0.19	0.18	0.18	0.13	0.16

	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.01	0.08	0.17	0.10	0.01	0.09	0.16	0.17	0.01	0.12	0.12	0.11
Array B	0.12	0.01	0.12	0.10	0.07	0.01	0.14	0.13	0.19	0.01	0.13	0.10
Array C	0.11	0.14	0.01	0.15	0.12	0.10	0.01	0.14	0.17	0.15	0.01	0.13
Array D	0.11	0.09	0.12	0.01	0.11	0.08	0.10	0.01	0.12	0.10	0.13	0.01

	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.06	0.09	0.08	0.0	0.06	0.09	0.10	0.0	0.09	0.11	0.08
Array B	0.06	0.0	0.12	0.08	0.07	0.0	0.09	0.11	0.11	0.0	0.12	0.08
Array C	0.07	0.09	0.0	0.11	0.07	0.10	0.0	0.11	0.09	0.07	0.0	0.11
Array D	0.07	0.06	0.10	0.0	0.08	0.06	0.12	0.0	0.10	0.08	0.09	0.0

Table T.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.28	0.27	0.27	0.30
Absolute	0.36	0.31	0.30	0.48
Relative	0.32	0.30	0.29	0.36
Relative Performance	0.19	0.18	0.17	0.22
Relative Fitness	0.16	0.13	0.15	0.20

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.24	0.56	0.34	0.41
Array B	0.32	0.28	0.27	0.30
Array C	0.38	0.28	0.26	0.37
Array D	0.37	0.50	0.27	0.33
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.24	0.27	0.26	0.33
Array B	0.26	0.28	0.33	0.29
Array C	0.29	0.29	0.26	0.38
Array D	0.35	0.41	0.34	0.33
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.01	0.17	0.21	0.19
Array B	0.19	0.01	0.23	0.18
Array C	0.20	0.20	0.02	0.20
Array D	0.15	0.21	0.19	0.01
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.13	0.17	0.13
Array B	0.14	0.0	0.19	0.16
Array C	0.14	0.18	0.0	0.18
Array D	0.11	0.24	0.15	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.32	0.27	0.27	0.23	0.22	0.15	0.32	0.40	0.19	1.25	0.44	0.59
Array B	0.40	0.26	0.24	0.21	0.29	0.16	0.30	0.35	0.26	0.43	0.28	0.33
Array C	0.51	0.26	0.26	0.24	0.33	0.18	0.33	0.40	0.29	0.41	0.20	0.47
Array D	0.53	0.29	0.28	0.25	0.30	0.23	0.29	0.36	0.27	0.99	0.24	0.38
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.32	0.25	0.31	0.29	0.22	0.20	0.20	0.39	0.19	0.37	0.27	0.30
Array B	0.29	0.26	0.29	0.26	0.29	0.16	0.30	0.33	0.21	0.43	0.40	0.27
Array C	0.27	0.28	0.26	0.25	0.27	0.24	0.33	0.53	0.34	0.35	0.20	0.37
Array D	0.51	0.23	0.40	0.25	0.25	0.26	0.21	0.36	0.29	0.74	0.41	0.38
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.01	0.14	0.20	0.17	0.01	0.14	0.23	0.24	0.01	0.23	0.19	0.16
Array B	0.17	0.01	0.21	0.20	0.15	0.01	0.22	0.18	0.25	0.02	0.26	0.15
Array C	0.19	0.21	0.02	0.20	0.16	0.14	0.01	0.23	0.24	0.26	0.03	0.16
Array D	0.13	0.13	0.19	0.01	0.12	0.12	0.16	0.01	0.20	0.38	0.21	0.01
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.09	0.15	0.11	0.0	0.10	0.15	0.12	0.0	0.19	0.22	0.15
Array B	0.11	0.0	0.19	0.12	0.16	0.0	0.14	0.21	0.16	0.0	0.25	0.15
Array C	0.12	0.18	0.0	0.17	0.14	0.17	0.0	0.21	0.17	0.20	0.0	0.17
Array D	0.09	0.11	0.13	0.0	0.09	0.13	0.15	0.0	0.14	0.49	0.16	0.0

Table T.4: Mean relative error

Appendix U

WorkloadMix model testing on FitnessCache samples

Application	Samples	Iters	First sample	Last sample
Cache (cache)	70	3	35	69
Total used	35			

Table U.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

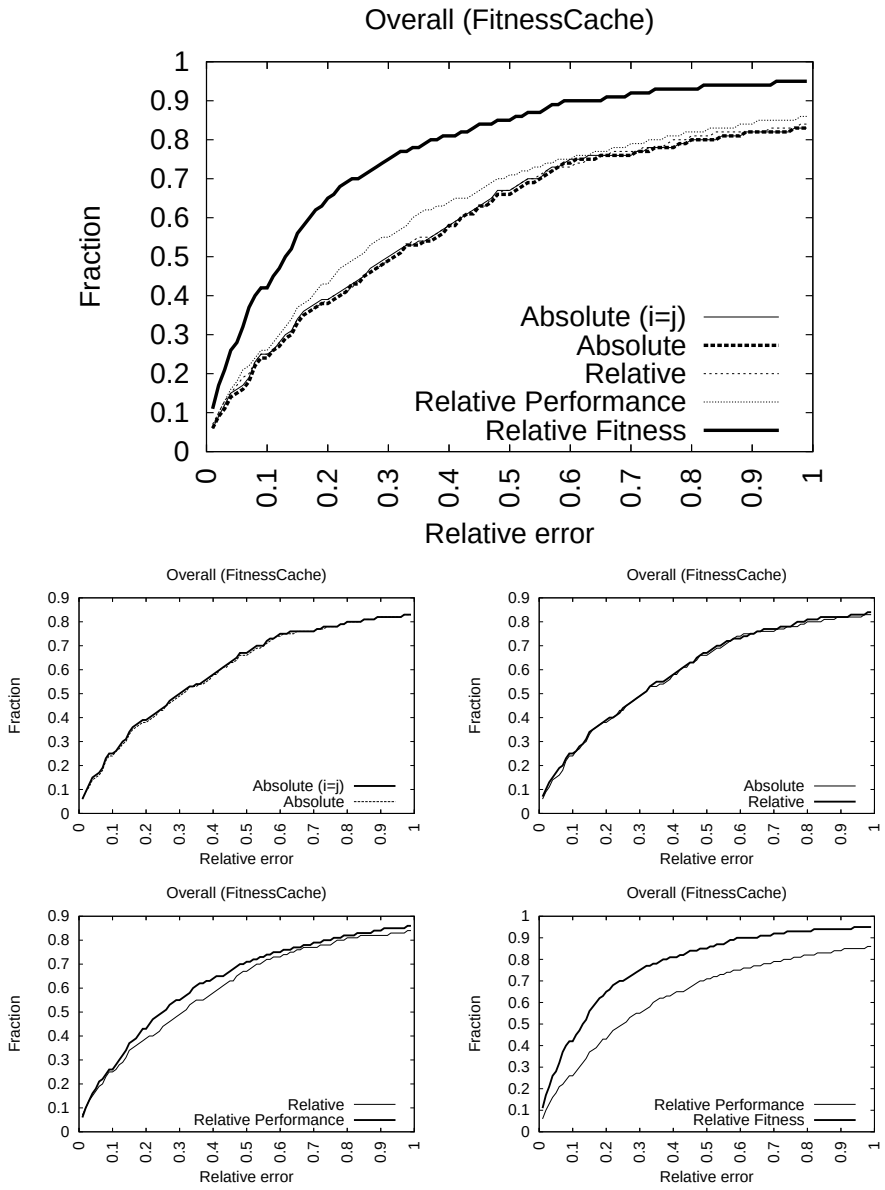

Figure U.1: The cumulative distribution of relative error over all pairwise predictions.

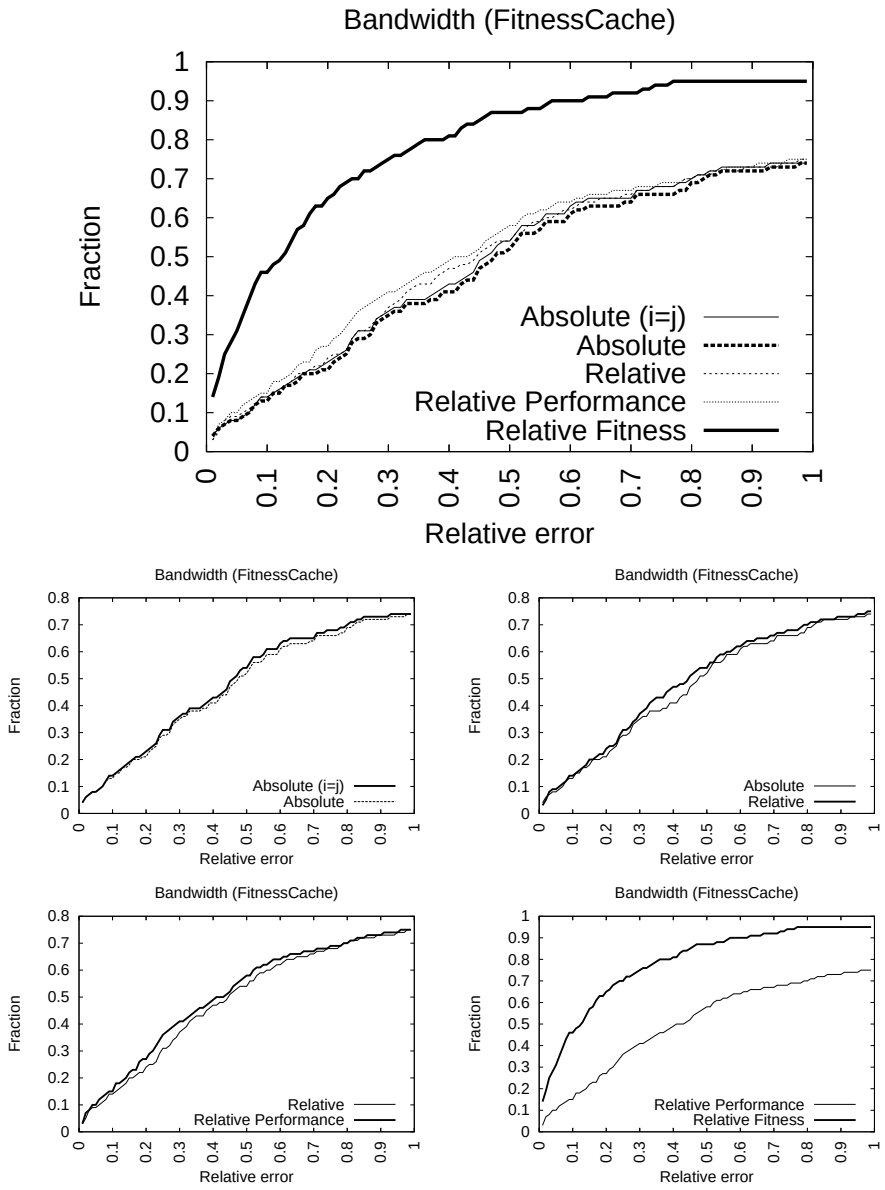

Figure U.2: The cumulative distribution of relative error over all pairwise predictions.

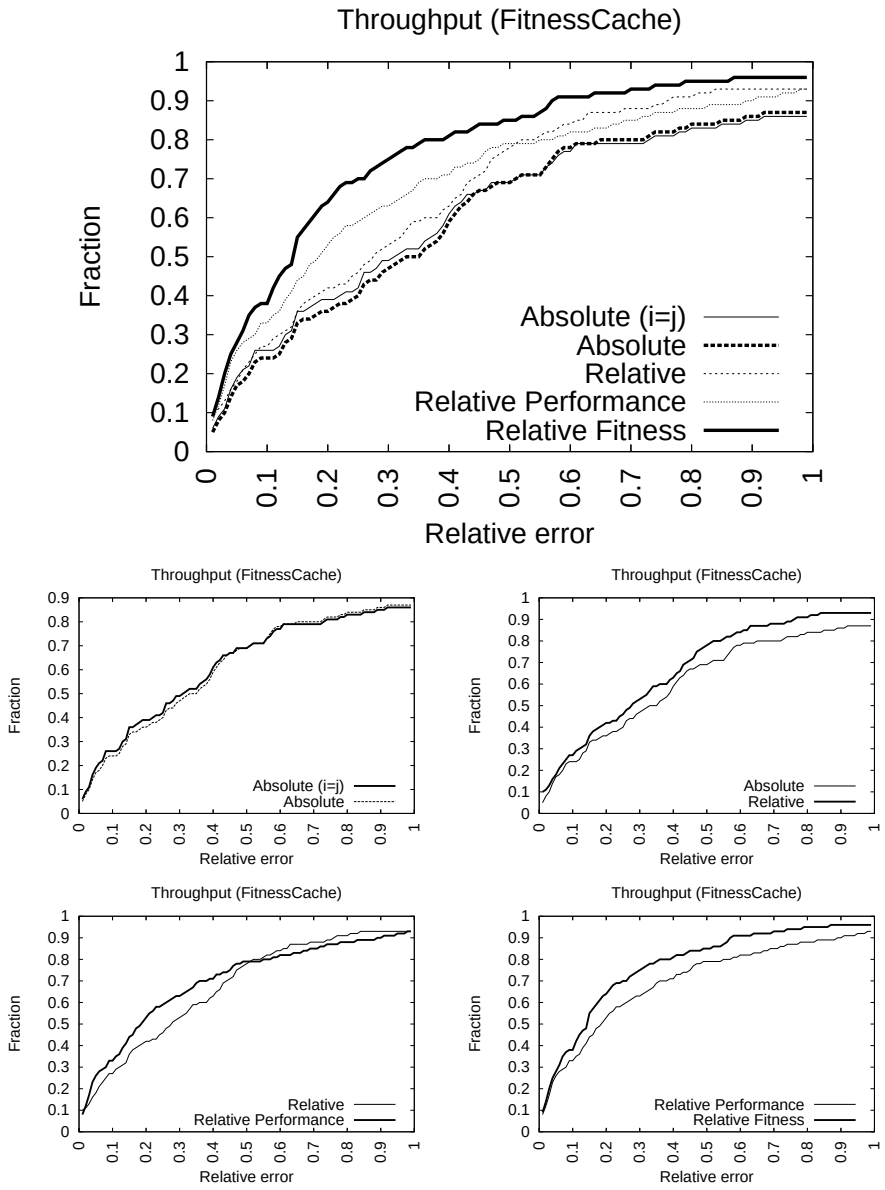

Figure U.3: The cumulative distribution of relative error over all pairwise predictions.

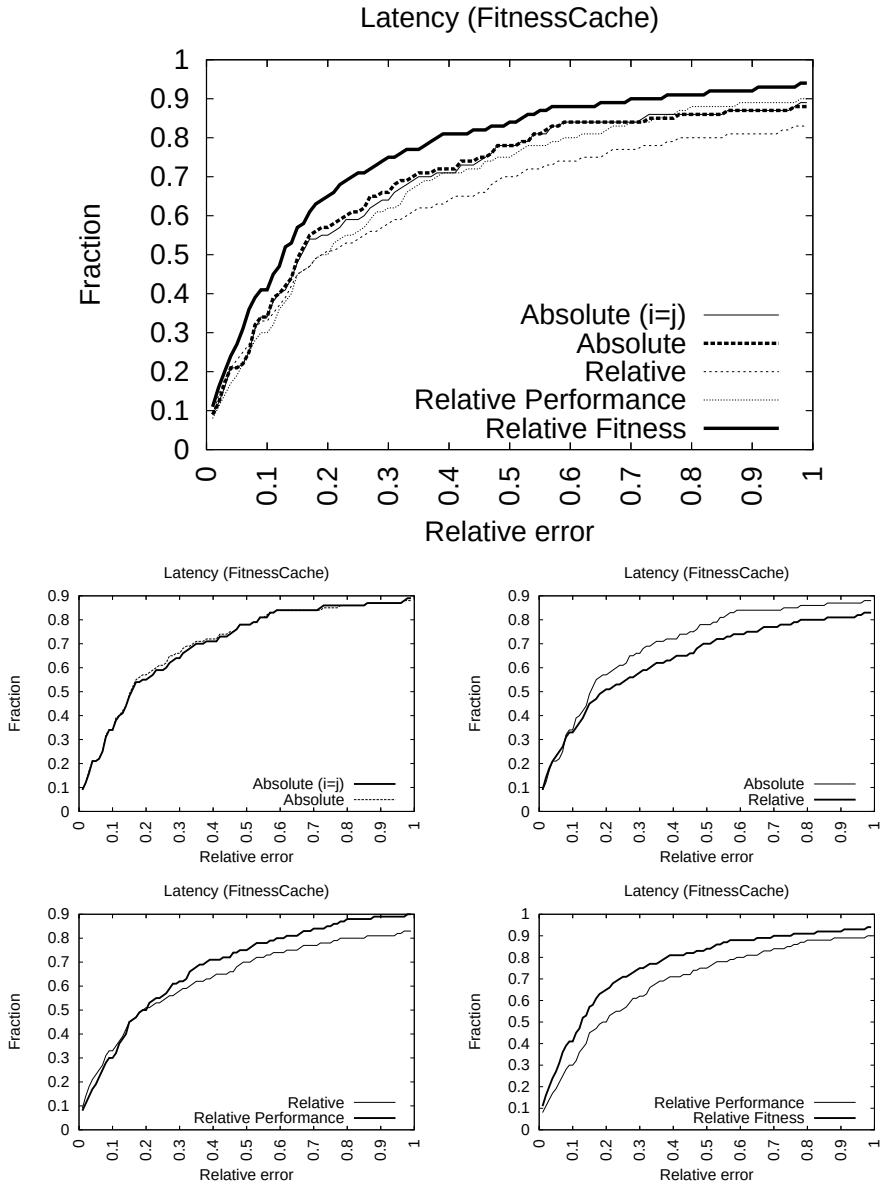

Figure U.4: The cumulative distribution of relative error over all pairwise predictions.

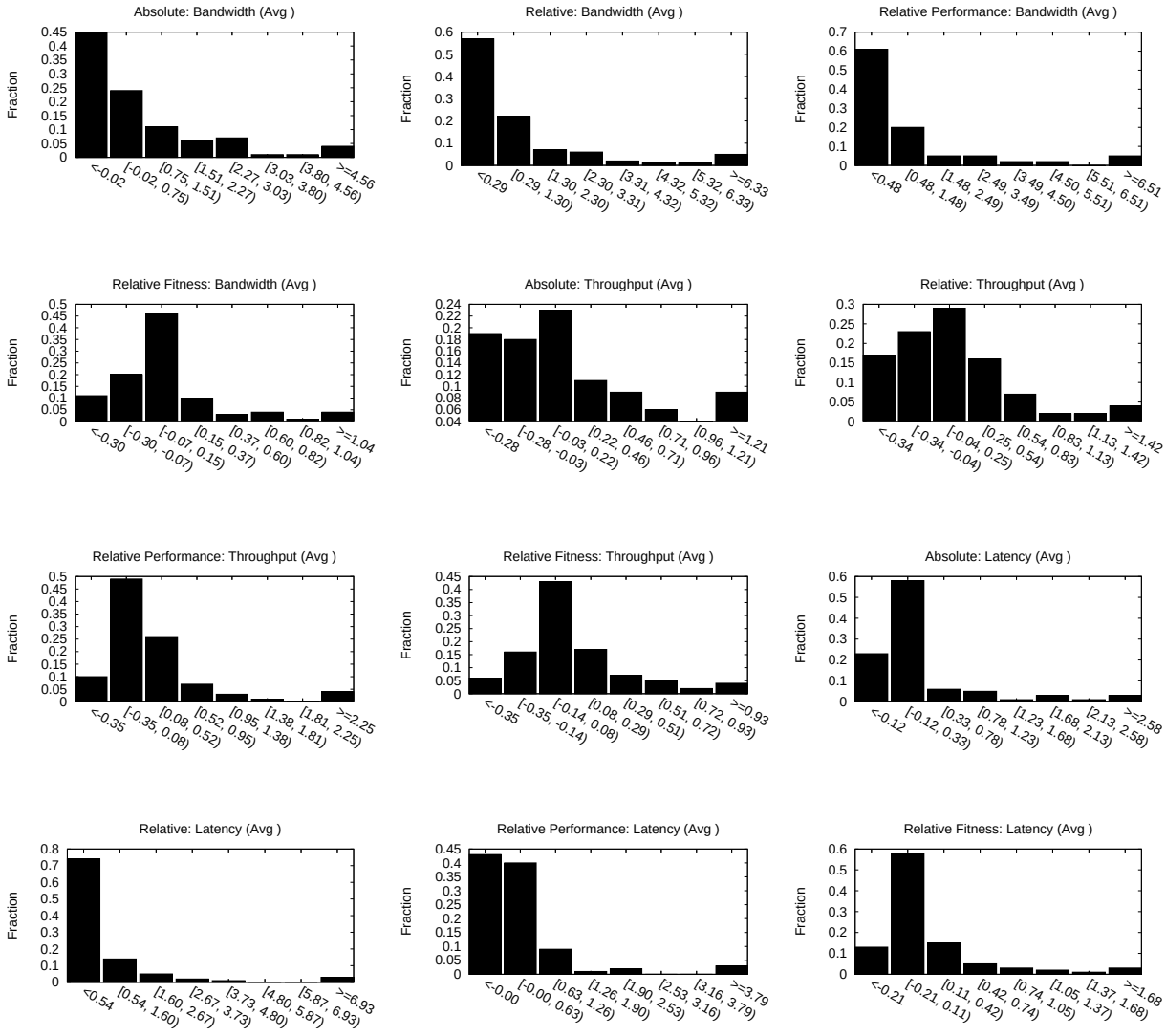

Figure U.5: The probability distribution of relative error over all pairwise predictions.

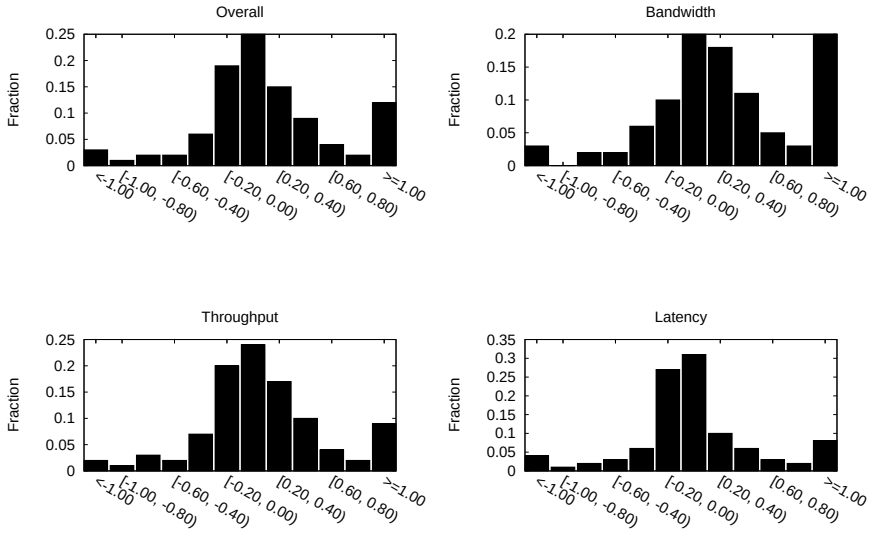

Figure U.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	0 / 0 / 33	17 / 7 / 9	12 / 12 / 9	9 / 24 / 0	7 / 26 / 0
A → C	0 / 0 / 33	9 / 18 / 6	26 / 5 / 2	5 / 28 / 0	12 / 20 / 1
A → D	1 / 0 / 32	14 / 8 / 11	10 / 20 / 3	11 / 21 / 1	9 / 23 / 1
B → A	1 / 0 / 32	8 / 15 / 10	11 / 22 / 0	8 / 24 / 1	5 / 28 / 0
B → C	0 / 0 / 33	9 / 12 / 12	11 / 10 / 12	12 / 19 / 2	9 / 23 / 1
B → D	1 / 1 / 31	11 / 10 / 12	10 / 13 / 10	9 / 23 / 1	8 / 24 / 1
C → A	1 / 0 / 32	7 / 14 / 12	15 / 18 / 0	8 / 25 / 0	7 / 26 / 0
C → B	2 / 0 / 31	11 / 19 / 3	13 / 18 / 2	8 / 25 / 0	11 / 21 / 1
C → D	1 / 2 / 30	9 / 6 / 18	12 / 19 / 2	11 / 18 / 4	4 / 28 / 1
D → A	1 / 0 / 32	12 / 12 / 9	6 / 27 / 0	5 / 27 / 1	3 / 29 / 1
D → B	1 / 0 / 32	9 / 6 / 18	15 / 16 / 2	4 / 28 / 1	3 / 29 / 1
D → C	0 / 0 / 33	4 / 10 / 19	16 / 13 / 4	8 / 21 / 4	8 / 22 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	2 / 1 / 30	9 / 18 / 6	11 / 18 / 4	10 / 19 / 4	10 / 22 / 1
A → C	0 / 1 / 32	7 / 17 / 9	24 / 9 / 0	10 / 23 / 0	8 / 24 / 1
A → D	0 / 0 / 33	3 / 14 / 16	7 / 16 / 10	17 / 14 / 2	9 / 24 / 0
B → A	0 / 0 / 33	21 / 11 / 1	9 / 17 / 7	18 / 10 / 5	16 / 17 / 0
B → C	0 / 0 / 33	19 / 14 / 0	16 / 17 / 0	12 / 20 / 1	13 / 19 / 1
B → D	0 / 0 / 33	9 / 19 / 5	17 / 15 / 1	10 / 20 / 3	7 / 26 / 0
C → A	2 / 0 / 31	12 / 17 / 4	15 / 11 / 7	11 / 20 / 2	10 / 21 / 2
C → B	3 / 3 / 27	22 / 9 / 2	14 / 19 / 0	21 / 11 / 1	17 / 13 / 3
C → D	0 / 0 / 33	3 / 14 / 16	14 / 16 / 3	9 / 22 / 2	7 / 24 / 2
D → A	3 / 0 / 30	14 / 15 / 4	7 / 24 / 2	15 / 15 / 3	13 / 19 / 1
D → B	2 / 2 / 29	16 / 13 / 4	13 / 18 / 2	12 / 17 / 4	7 / 24 / 2
D → C	0 / 0 / 33	10 / 13 / 10	12 / 15 / 6	13 / 18 / 2	13 / 17 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	0 / 1 / 32	12 / 10 / 11	16 / 17 / 0	9 / 24 / 0	11 / 17 / 5
A → C	1 / 0 / 32	17 / 14 / 2	10 / 20 / 3	12 / 20 / 1	9 / 23 / 1
A → D	1 / 0 / 32	9 / 14 / 10	7 / 9 / 17	13 / 14 / 6	13 / 19 / 1
B → A	0 / 1 / 32	8 / 9 / 16	16 / 13 / 4	12 / 21 / 0	15 / 16 / 2
B → C	1 / 0 / 32	26 / 6 / 1	6 / 27 / 0	4 / 29 / 0	8 / 25 / 0
B → D	1 / 0 / 32	10 / 11 / 12	19 / 13 / 1	8 / 22 / 3	9 / 20 / 4
C → A	1 / 1 / 31	6 / 10 / 17	22 / 8 / 3	11 / 22 / 0	15 / 17 / 1
C → B	0 / 4 / 29	9 / 7 / 17	13 / 10 / 10	11 / 19 / 3	14 / 18 / 1
C → D	0 / 0 / 33	3 / 3 / 27	5 / 15 / 13	18 / 13 / 2	15 / 16 / 2
D → A	1 / 1 / 31	11 / 7 / 15	8 / 17 / 8	15 / 16 / 2	13 / 18 / 2
D → B	1 / 5 / 27	12 / 10 / 11	18 / 15 / 0	13 / 14 / 6	19 / 14 / 0
D → C	0 / 0 / 33	14 / 11 / 8	12 / 21 / 0	7 / 25 / 1	13 / 18 / 2
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table U.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.31	0.46	0.31	0.16
Absolute	0.31	0.48	0.33	0.16
Relative	0.31	0.45	0.28	0.19
Relative Performance	0.25	0.41	0.19	0.19
Relative Fitness	0.12	0.12	0.14	0.12

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.31	0.23	0.39	0.27
Array B	0.29	0.23	0.39	0.27
Array C	0.32	0.23	0.39	0.27
Array D	0.33	0.23	0.39	0.27
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.31	0.18	0.31	0.29
Array B	0.33	0.23	0.53	0.25
Array C	0.26	0.28	0.39	0.30
Array D	0.33	0.20	0.42	0.27
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.02	0.25	0.47	0.17
Array B	0.21	0.02	0.41	0.18
Array C	0.34	0.25	0.05	0.14
Array D	0.15	0.21	0.36	0.02
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.08	0.18	0.12
Array B	0.11	0.0	0.17	0.08
Array C	0.13	0.17	0.0	0.10
Array D	0.09	0.08	0.22	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.55	0.47	0.39	0.42	0.14	0.25	0.39	0.37	0.16	0.11	0.35	0.09
Array B	0.60	0.47	0.39	0.42	0.14	0.19	0.39	0.37	0.13	0.13	0.35	0.09
Array C	0.60	0.50	0.39	0.42	0.24	0.29	0.39	0.37	0.16	0.13	0.35	0.09
Array D	0.60	0.47	0.39	0.37	0.26	0.23	0.39	0.37	0.16	0.13	0.35	0.09
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.55	0.52	0.21	0.39	0.14	0.10	0.26	0.28	0.16	0.12	0.66	0.05
Array B	0.43	0.47	0.29	0.45	0.27	0.19	0.43	0.29	0.25	0.13	1.57	0.07
Array C	0.46	0.48	0.39	0.38	0.15	0.41	0.39	0.32	0.19	0.11	0.35	0.09
Array D	0.51	0.50	0.25	0.37	0.23	0.16	0.26	0.37	0.16	0.10	0.53	0.09
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.03	0.38	0.63	0.27	0.01	0.09	0.47	0.14	0.02	0.21	0.32	0.06
Array B	0.34	0.03	0.23	0.25	0.09	0.01	0.33	0.18	0.21	0.02	0.67	0.11
Array C	0.51	0.46	0.10	0.18	0.19	0.20	0.02	0.19	0.32	0.13	0.03	0.05
Array D	0.33	0.39	0.36	0.03	0.05	0.12	0.16	0.01	0.12	0.12	0.46	0.01
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.08	0.17	0.15	0.0	0.10	0.17	0.11	0.0	0.07	0.17	0.09
Array B	0.08	0.0	0.16	0.08	0.10	0.0	0.17	0.14	0.11	0.0	0.12	0.04
Array C	0.21	0.20	0.0	0.13	0.10	0.21	0.0	0.09	0.12	0.11	0.0	0.10
Array D	0.06	0.04	0.11	0.0	0.11	0.05	0.25	0.0	0.10	0.12	0.32	0.0

Table U.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.63	1.02	0.44	0.42
Absolute	0.75	1.02	0.44	0.80
Relative	0.84	1.25	0.39	0.88
Relative Performance	1.06	1.21	1.38	0.59
Relative Fitness	1.13	1.21	1.86	0.31

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.72	0.52	1.29	0.77
Array B	0.70	0.53	1.29	0.75
Array C	0.71	0.54	0.59	0.62
Array D	0.71	0.52	0.59	0.66
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.72	0.49	0.73	0.93
Array B	0.97	0.53	1.97	0.93
Array C	0.64	0.58	0.59	0.62
Array D	0.87	0.57	0.77	0.66
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.13	0.55	1.08	0.81
Array B	0.49	0.12	1.46	0.96
Array C	0.68	2.73	0.19	2.38
Array D	0.46	0.53	0.59	0.29
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.18	0.41	0.25
Array B	0.34	0.0	0.28	0.20
Array C	0.49	7.77	0.0	2.88
Array D	0.21	0.18	0.35	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1.18	1.02	0.73	1.18	0.35	0.38	0.41	0.59	0.63	0.17	2.73	0.55
Array B	1.19	1.02	0.73	1.12	0.35	0.40	0.41	0.59	0.56	0.17	2.73	0.55
Array C	1.19	1.12	0.73	1.01	0.37	0.37	0.41	0.59	0.58	0.14	0.62	0.25
Array D	1.18	1.05	0.73	1.14	0.38	0.37	0.41	0.59	0.58	0.14	0.62	0.25
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	1.18	1.09	0.80	1.54	0.35	0.23	0.34	0.40	0.63	0.16	1.06	0.84
Array B	2.05	1.02	0.86	1.68	0.47	0.40	0.50	0.30	0.38	0.17	4.57	0.82
Array C	1.28	1.13	0.73	1.14	0.20	0.45	0.41	0.39	0.44	0.17	0.62	0.32
Array D	1.71	1.04	0.71	1.14	0.36	0.48	0.58	0.59	0.56	0.19	1.01	0.25
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.28	1.08	2.07	1.69	0.03	0.32	0.63	0.26	0.09	0.24	0.55	0.48
Array B	0.88	0.26	0.81	1.56	0.19	0.04	0.63	0.94	0.41	0.05	2.94	0.38
Array C	1.21	0.71	0.34	1.66	0.25	7.28	0.09	5.30	0.60	0.20	0.16	0.20
Array D	0.91	1.14	0.81	0.69	0.14	0.21	0.41	0.06	0.32	0.24	0.54	0.11
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.20	0.28	0.27	0.0	0.19	0.26	0.20	0.0	0.16	0.67	0.27
Array B	0.19	0.0	0.27	0.18	0.25	0.0	0.27	0.20	0.58	0.0	0.29	0.22
Array C	1.02	11.41	0.0	0.15	0.17	11.75	0.0	8.34	0.28	0.15	0.0	0.15
Array D	0.15	0.13	0.28	0.0	0.15	0.17	0.37	0.0	0.34	0.24	0.39	0.0

Table U.4: Mean relative error

Appendix V

WorkloadMix model testing on Postmark samples

Application	Samples	Iters	First sample	Last sample
Postmark (phase 1) (pmc)	50	3	25	49
Postmark (phase 2) (pmt)	50	3	25	49
Total used	50			

Table V.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

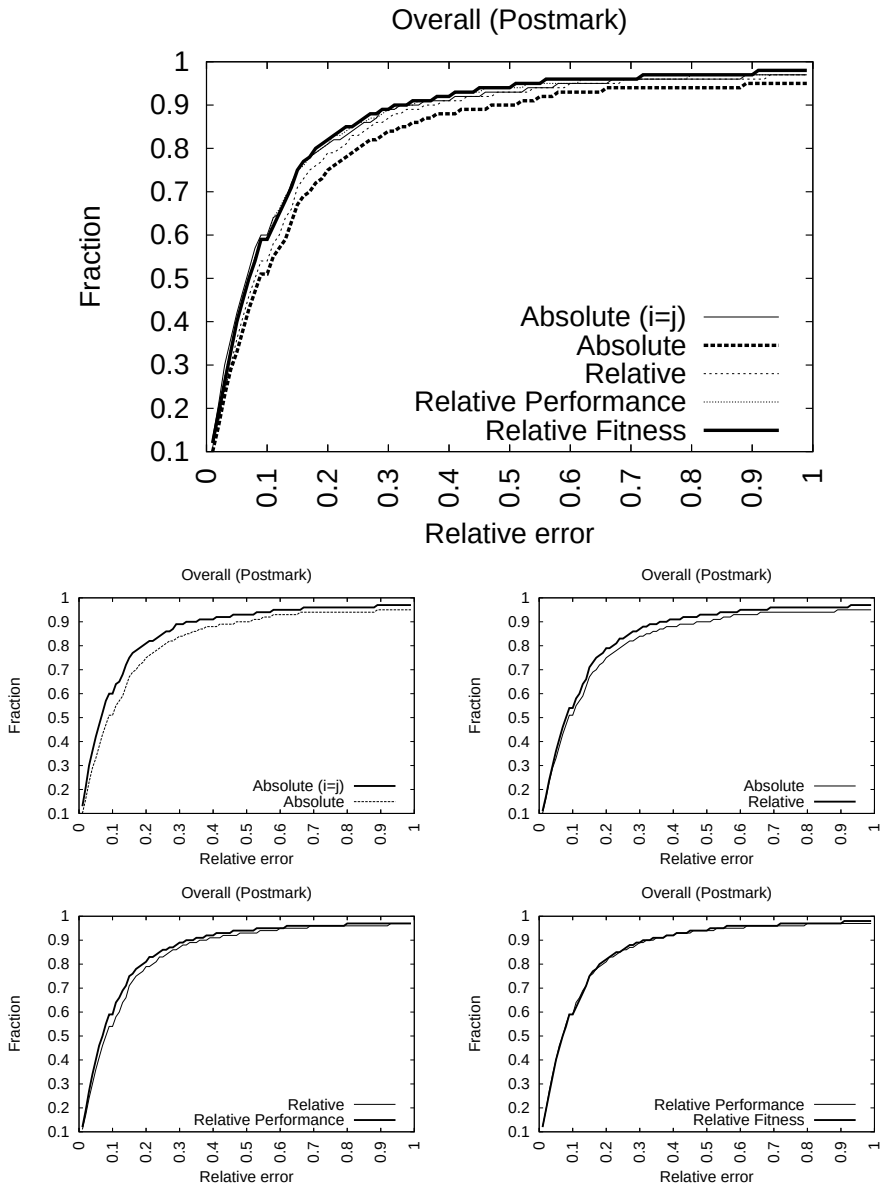

Figure V.1: The cumulative distribution of relative error over all pairwise predictions.

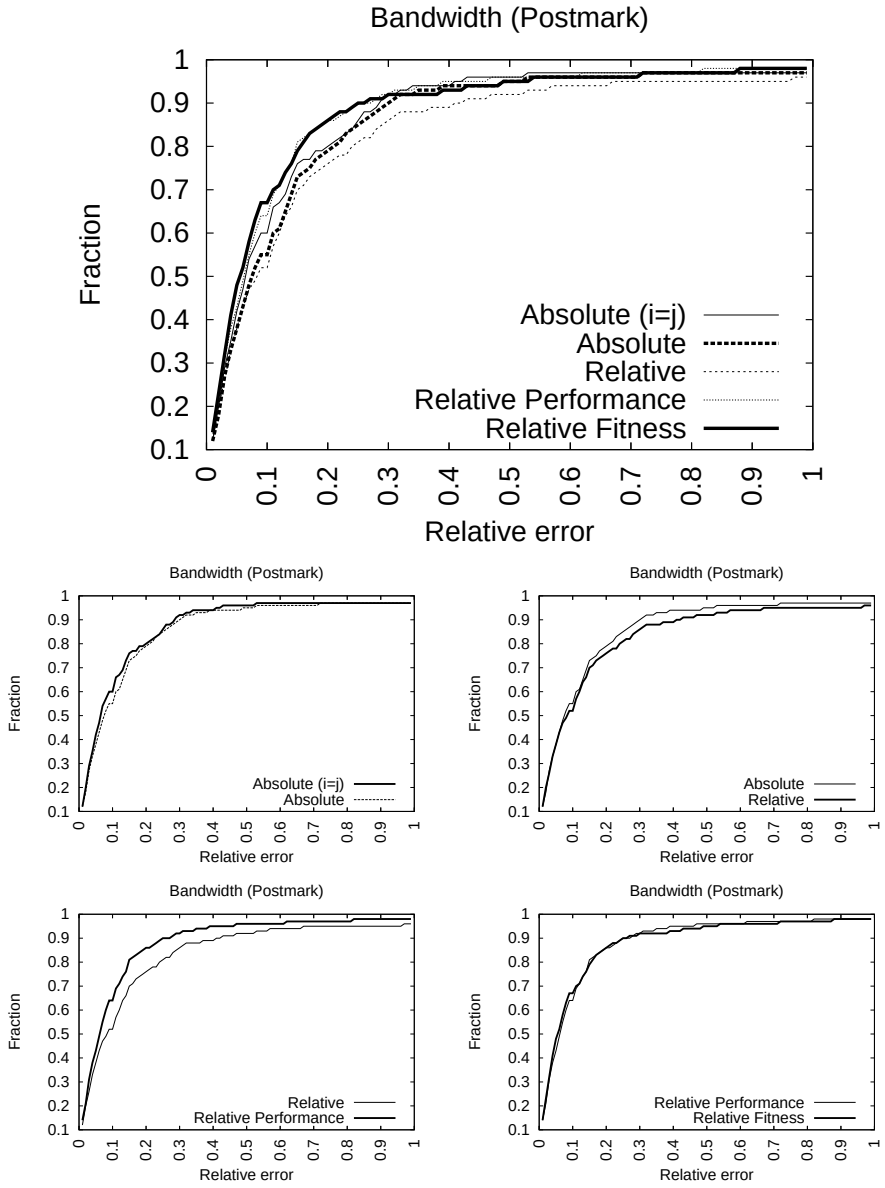

Figure V.2: The cumulative distribution of relative error over all pairwise predictions.

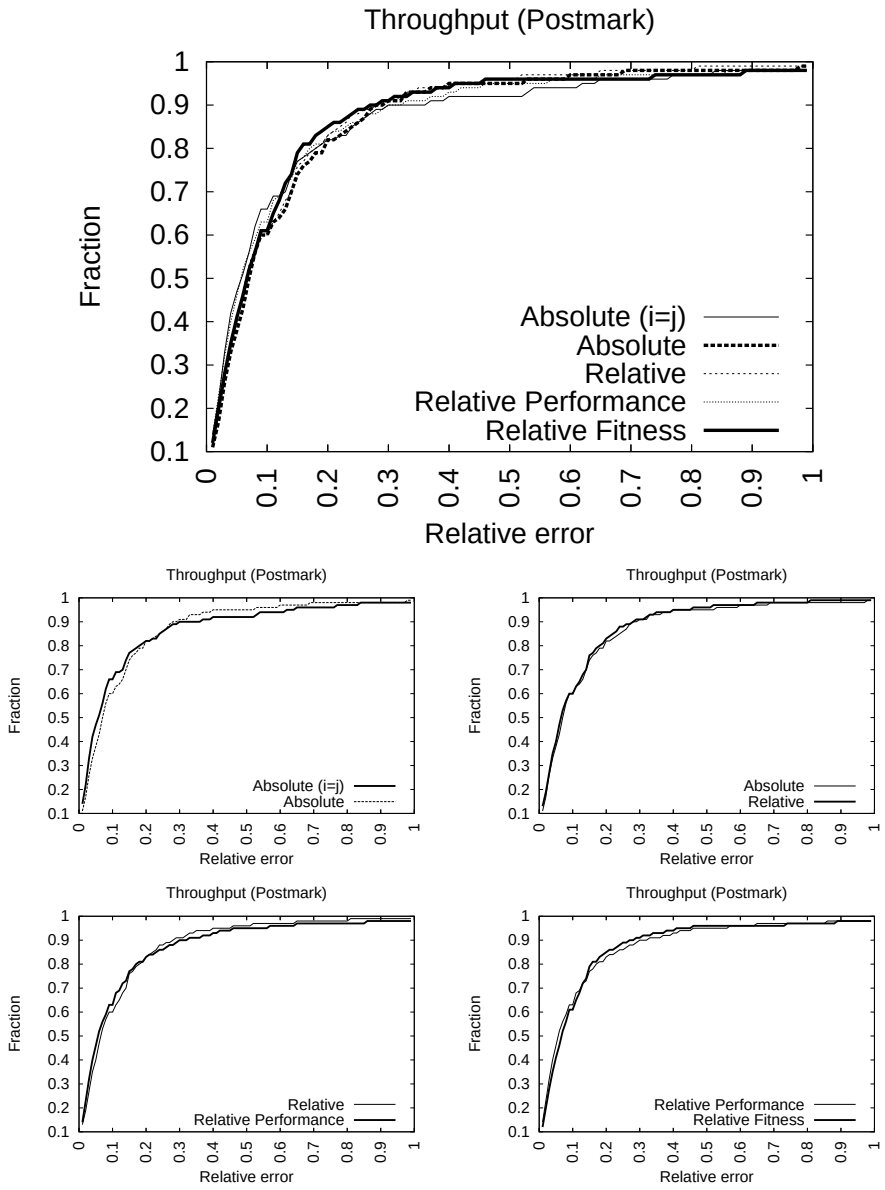

Figure V.3: The cumulative distribution of relative error over all pairwise predictions.

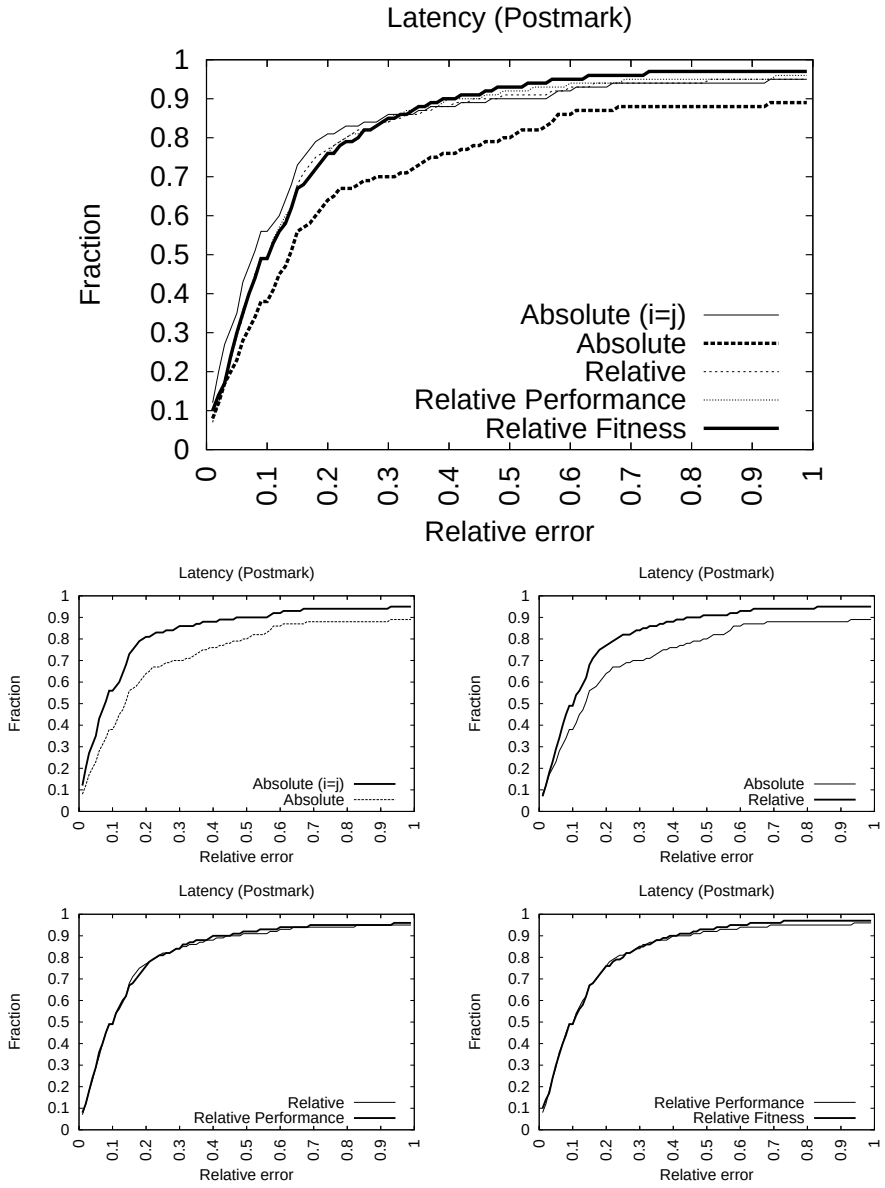

Figure V.4: The cumulative distribution of relative error over all pairwise predictions.

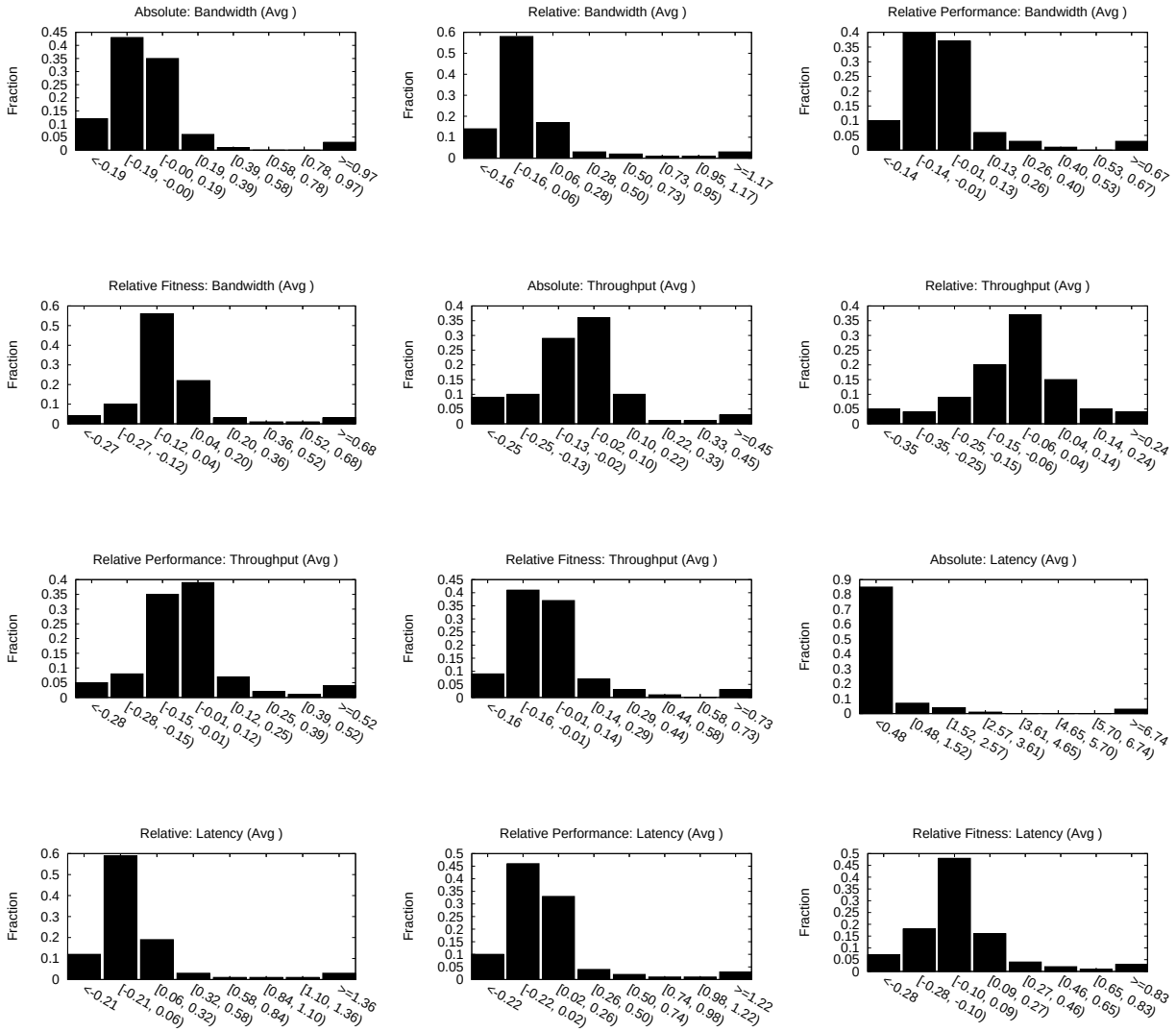

Figure V.5: The probability distribution of relative error over all pairwise predictions.

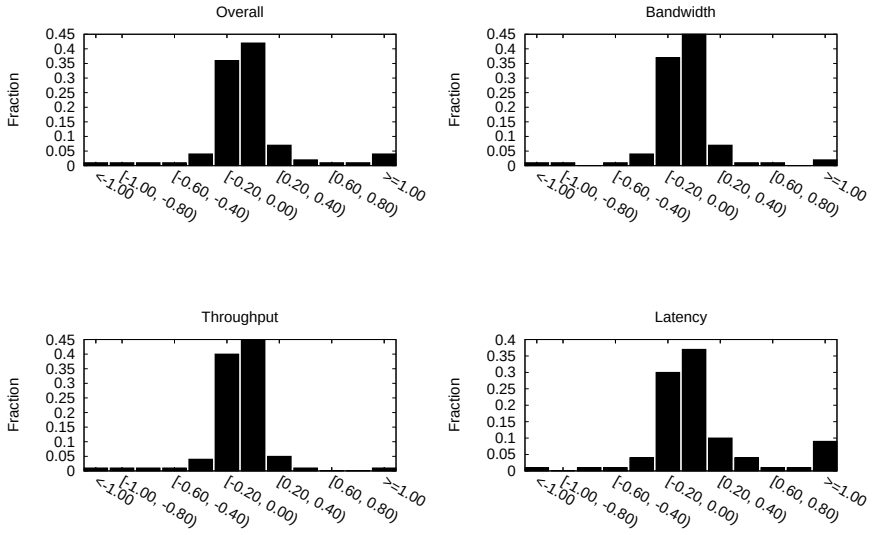

Figure V.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	11 / 3 / 34	19 / 16 / 13	15 / 16 / 17	22 / 21 / 5	24 / 19 / 5
A → C	10 / 7 / 31	12 / 22 / 14	21 / 19 / 8	20 / 24 / 4	13 / 27 / 8
A → D	8 / 4 / 36	19 / 12 / 17	10 / 25 / 13	30 / 13 / 5	28 / 16 / 4
B → A	7 / 5 / 36	17 / 10 / 21	19 / 25 / 4	14 / 26 / 8	15 / 29 / 4
B → C	9 / 6 / 33	16 / 21 / 11	11 / 21 / 16	25 / 20 / 3	15 / 28 / 5
B → D	9 / 2 / 37	12 / 19 / 17	20 / 16 / 12	18 / 21 / 9	14 / 25 / 9
C → A	14 / 8 / 26	17 / 19 / 12	17 / 26 / 5	15 / 29 / 4	14 / 30 / 4
C → B	10 / 6 / 32	24 / 8 / 16	15 / 26 / 7	15 / 24 / 9	20 / 21 / 7
C → D	12 / 6 / 30	18 / 11 / 19	12 / 18 / 18	16 / 24 / 8	18 / 24 / 6
D → A	5 / 9 / 34	20 / 17 / 11	16 / 19 / 13	20 / 23 / 5	20 / 25 / 3
D → B	7 / 4 / 37	23 / 13 / 12	11 / 21 / 16	27 / 15 / 6	23 / 21 / 4
D → C	10 / 7 / 31	14 / 25 / 9	18 / 18 / 12	21 / 23 / 4	17 / 23 / 8
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	9 / 7 / 32	11 / 24 / 13	18 / 22 / 8	19 / 18 / 11	16 / 27 / 5
A → C	14 / 6 / 28	21 / 19 / 8	26 / 18 / 4	17 / 27 / 4	22 / 22 / 4
A → D	14 / 4 / 30	19 / 22 / 7	15 / 25 / 8	18 / 22 / 8	15 / 30 / 3
B → A	9 / 2 / 37	18 / 20 / 10	12 / 20 / 16	33 / 11 / 4	31 / 13 / 4
B → C	16 / 5 / 27	26 / 11 / 11	17 / 27 / 4	23 / 19 / 6	21 / 23 / 4
B → D	11 / 5 / 32	15 / 18 / 15	23 / 24 / 1	19 / 23 / 6	14 / 26 / 8
C → A	11 / 3 / 34	8 / 25 / 15	12 / 8 / 28	29 / 15 / 4	23 / 20 / 5
C → B	20 / 10 / 18	19 / 25 / 4	19 / 29 / 0	18 / 23 / 7	18 / 28 / 2
C → D	13 / 7 / 28	17 / 23 / 8	19 / 19 / 10	17 / 27 / 4	21 / 23 / 4
D → A	11 / 4 / 33	8 / 11 / 29	8 / 9 / 31	23 / 17 / 8	21 / 22 / 5
D → B	3 / 5 / 40	17 / 18 / 13	15 / 24 / 9	28 / 15 / 5	21 / 22 / 5
D → C	17 / 5 / 26	15 / 19 / 14	22 / 23 / 3	26 / 19 / 3	26 / 19 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	28 / 3 / 17	12 / 36 / 0	23 / 24 / 1	23 / 19 / 6	7 / 37 / 4
A → C	28 / 6 / 14	8 / 32 / 8	28 / 16 / 4	14 / 34 / 0	7 / 38 / 3
A → D	15 / 5 / 28	20 / 26 / 2	26 / 15 / 7	19 / 25 / 4	15 / 30 / 3
B → A	15 / 6 / 27	20 / 20 / 8	17 / 23 / 8	30 / 15 / 3	25 / 20 / 3
B → C	17 / 10 / 21	21 / 25 / 2	24 / 23 / 1	23 / 23 / 2	19 / 26 / 3
B → D	13 / 8 / 27	17 / 14 / 17	13 / 26 / 9	25 / 21 / 2	17 / 28 / 3
C → A	21 / 1 / 26	13 / 27 / 8	19 / 14 / 15	20 / 23 / 5	17 / 28 / 3
C → B	15 / 8 / 25	15 / 20 / 13	20 / 19 / 9	25 / 23 / 0	22 / 22 / 4
C → D	13 / 7 / 28	16 / 19 / 13	23 / 14 / 11	17 / 25 / 6	16 / 28 / 4
D → A	16 / 4 / 28	16 / 13 / 19	15 / 23 / 10	26 / 19 / 3	21 / 24 / 3
D → B	14 / 7 / 27	14 / 18 / 16	17 / 26 / 5	20 / 20 / 8	14 / 31 / 3
D → C	17 / 9 / 22	15 / 21 / 12	12 / 14 / 22	19 / 25 / 4	15 / 26 / 7
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table V.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.07	0.07	0.06	0.08
Absolute	0.09	0.08	0.08	0.13
Relative	0.08	0.09	0.07	0.10
Relative Performance	0.07	0.07	0.06	0.10
Relative Fitness	0.08	0.06	0.07	0.10

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.07	0.11	0.12	0.10
Array B	0.07	0.07	0.10	0.08
Array C	0.11	0.09	0.08	0.08
Array D	0.08	0.08	0.09	0.06
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.07	0.07	0.09	0.09
Array B	0.08	0.07	0.12	0.07
Array C	0.09	0.11	0.08	0.07
Array D	0.09	0.07	0.08	0.06
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.01	0.08	0.09	0.07
Array B	0.06	0.01	0.08	0.07
Array C	0.08	0.08	0.01	0.09
Array D	0.07	0.06	0.08	0.01
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.08	0.07	0.08
Array B	0.08	0.0	0.09	0.07
Array C	0.07	0.08	0.0	0.07
Array D	0.07	0.08	0.09	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.10	0.05	0.09	0.06	0.04	0.06	0.10	0.13	0.07	0.44	0.52	0.13
Array B	0.10	0.05	0.09	0.06	0.05	0.08	0.10	0.08	0.10	0.09	0.12	0.12
Array C	0.13	0.05	0.08	0.07	0.06	0.09	0.07	0.07	0.15	0.11	0.08	0.10
Array D	0.10	0.05	0.08	0.06	0.06	0.07	0.10	0.06	0.12	0.09	0.10	0.08
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.10	0.07	0.05	0.10	0.04	0.06	0.10	0.10	0.07	0.11	0.12	0.09
Array B	0.12	0.05	0.07	0.05	0.04	0.08	0.15	0.06	0.09	0.09	0.11	0.10
Array C	0.11	0.11	0.08	0.10	0.05	0.12	0.07	0.07	0.11	0.09	0.08	0.07
Array D	0.13	0.07	0.05	0.06	0.04	0.06	0.09	0.06	0.12	0.09	0.09	0.08
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.01	0.06	0.05	0.06	0.00	0.06	0.10	0.06	0.01	0.10	0.15	0.09
Array B	0.07	0.01	0.06	0.07	0.04	0.01	0.09	0.06	0.07	0.01	0.10	0.07
Array C	0.08	0.07	0.01	0.07	0.04	0.08	0.01	0.07	0.13	0.09	0.01	0.10
Array D	0.08	0.06	0.05	0.01	0.04	0.05	0.09	0.01	0.09	0.06	0.10	0.01
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.06	0.05	0.08	0.0	0.05	0.09	0.05	0.0	0.13	0.08	0.09
Array B	0.06	0.0	0.07	0.05	0.07	0.0	0.07	0.07	0.13	0.0	0.13	0.07
Array C	0.04	0.05	0.0	0.06	0.07	0.07	0.0	0.07	0.09	0.10	0.0	0.09
Array D	0.06	0.07	0.06	0.0	0.05	0.09	0.10	0.0	0.13	0.07	0.10	0.0

Table V.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.20	0.15	0.16	0.29
Absolute	0.33	0.17	0.15	0.66
Relative	0.21	0.23	0.13	0.26
Relative Performance	0.18	0.15	0.16	0.24
Relative Fitness	0.17	0.14	0.14	0.22

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.12	0.63	0.53	0.94
Array B	0.16	0.25	0.24	0.22
Array C	0.16	0.23	0.21	0.24
Array D	0.14	0.22	0.23	0.20
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.12	0.31	0.17	0.18
Array B	0.19	0.25	0.20	0.16
Array C	0.15	0.24	0.21	0.22
Array D	0.21	0.29	0.17	0.20
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.01	0.15	0.18	0.20
Array B	0.14	0.03	0.25	0.12
Array C	0.18	0.21	0.01	0.23
Array D	0.15	0.19	0.19	0.02
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.19	0.11	0.25
Array B	0.19	0.0	0.20	0.11
Array C	0.13	0.23	0.0	0.14
Array D	0.16	0.15	0.13	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.16	0.21	0.23	0.14	0.07	0.13	0.24	0.18	0.12	1.55	1.12	2.51
Array B	0.18	0.10	0.21	0.15	0.08	0.18	0.21	0.15	0.21	0.48	0.31	0.35
Array C	0.17	0.10	0.18	0.18	0.09	0.15	0.22	0.12	0.21	0.44	0.24	0.41
Array D	0.13	0.10	0.19	0.14	0.07	0.17	0.26	0.17	0.21	0.39	0.25	0.31
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.16	0.35	0.16	0.21	0.07	0.09	0.16	0.16	0.12	0.47	0.19	0.18
Array B	0.29	0.10	0.13	0.13	0.08	0.18	0.19	0.11	0.19	0.48	0.27	0.24
Array C	0.20	0.26	0.18	0.25	0.09	0.14	0.22	0.13	0.17	0.33	0.24	0.28
Array D	0.25	0.45	0.14	0.14	0.11	0.10	0.18	0.17	0.25	0.32	0.19	0.31
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.01	0.10	0.10	0.11	0.01	0.12	0.15	0.14	0.02	0.23	0.29	0.36
Array B	0.16	0.01	0.25	0.10	0.14	0.07	0.32	0.13	0.12	0.01	0.17	0.15
Array C	0.20	0.17	0.01	0.09	0.16	0.13	0.01	0.13	0.17	0.33	0.03	0.47
Array D	0.18	0.09	0.27	0.01	0.13	0.14	0.18	0.02	0.14	0.33	0.13	0.02
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.17	0.09	0.24	0.0	0.18	0.11	0.18	0.0	0.24	0.14	0.33
Array B	0.21	0.0	0.16	0.10	0.17	0.0	0.21	0.10	0.19	0.0	0.22	0.14
Array C	0.09	0.13	0.0	0.12	0.15	0.12	0.0	0.09	0.15	0.43	0.0	0.23
Array D	0.16	0.13	0.11	0.0	0.14	0.13	0.15	0.0	0.17	0.20	0.15	0.0

Table V.4: Mean relative error

Appendix W

WorkloadMix model testing on Cello samples

Application	Samples	Iters	First sample	Last sample
(srt)	78	3	39	77
Total used	39			

Table W.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

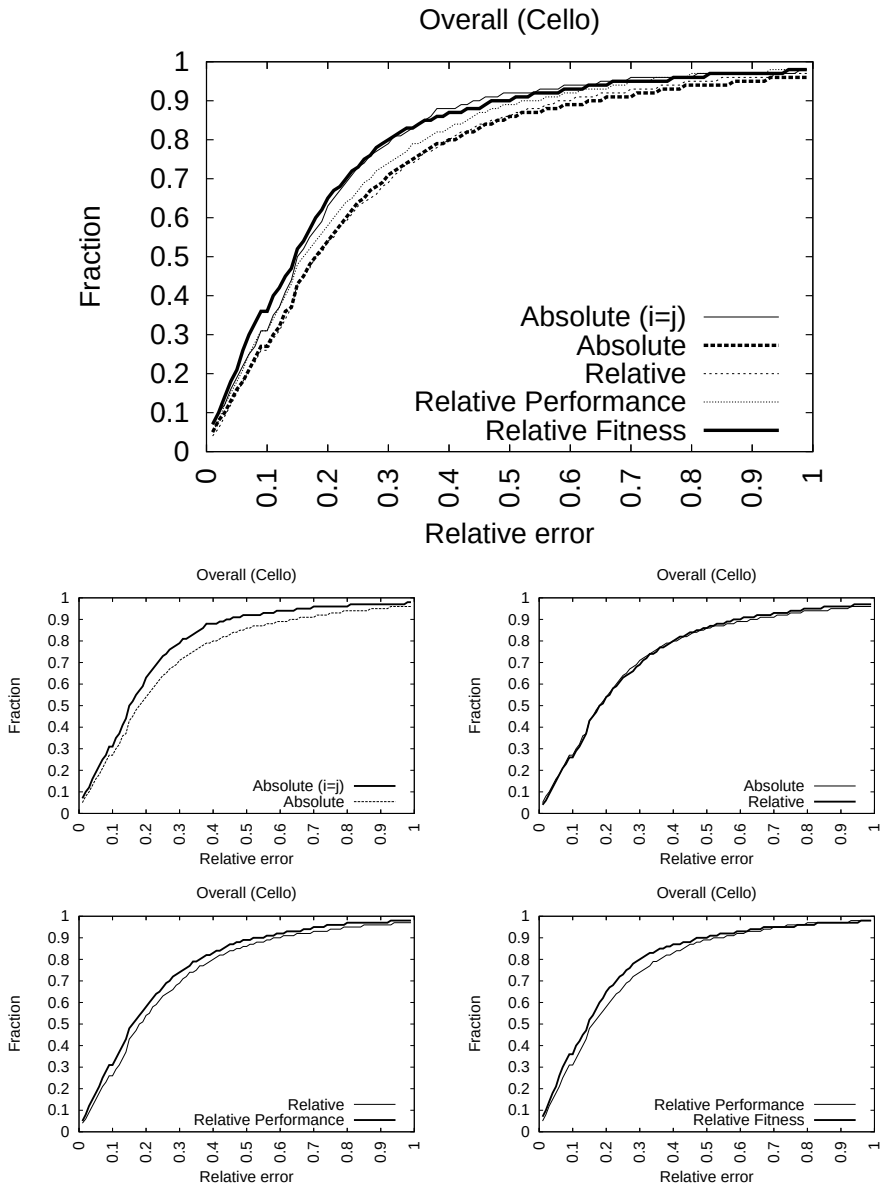

Figure W.1: The cumulative distribution of relative error over all pairwise predictions.

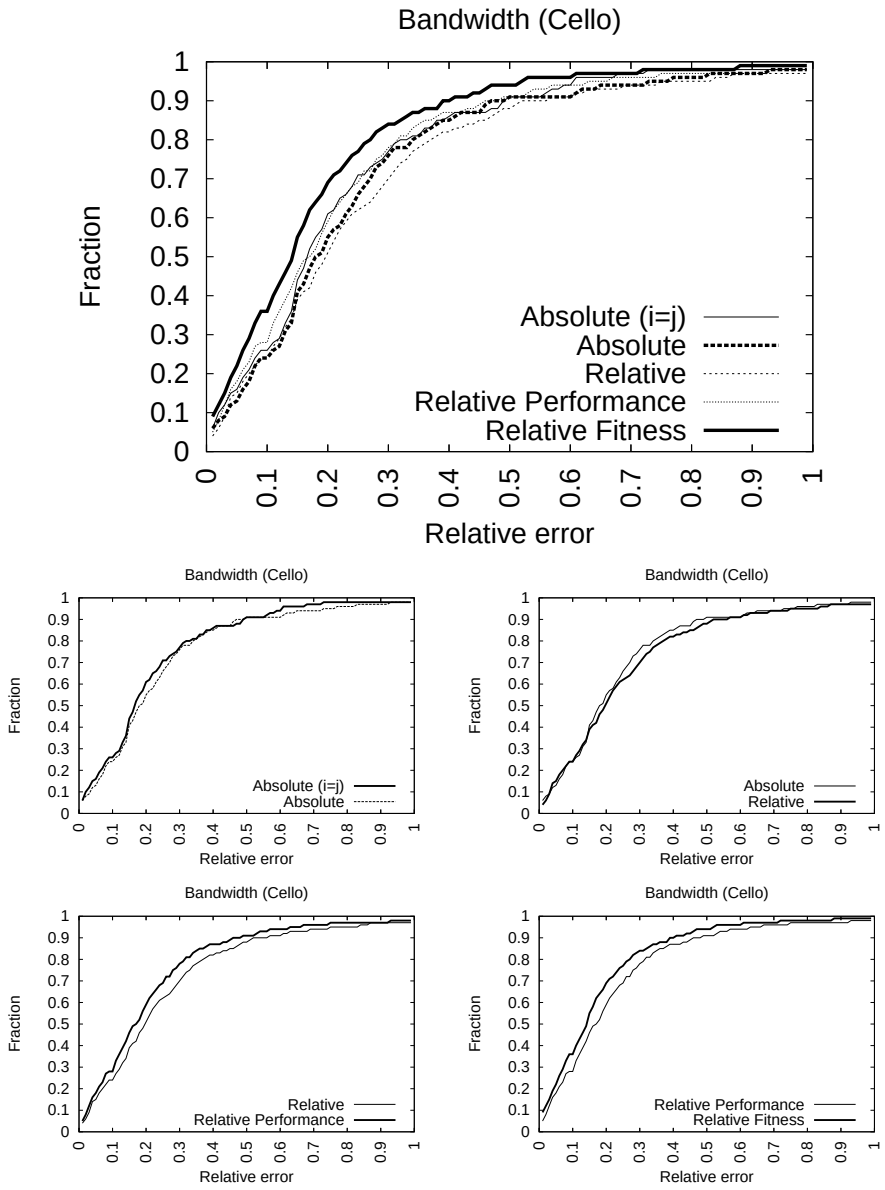

Figure W.2: The cumulative distribution of relative error over all pairwise predictions.

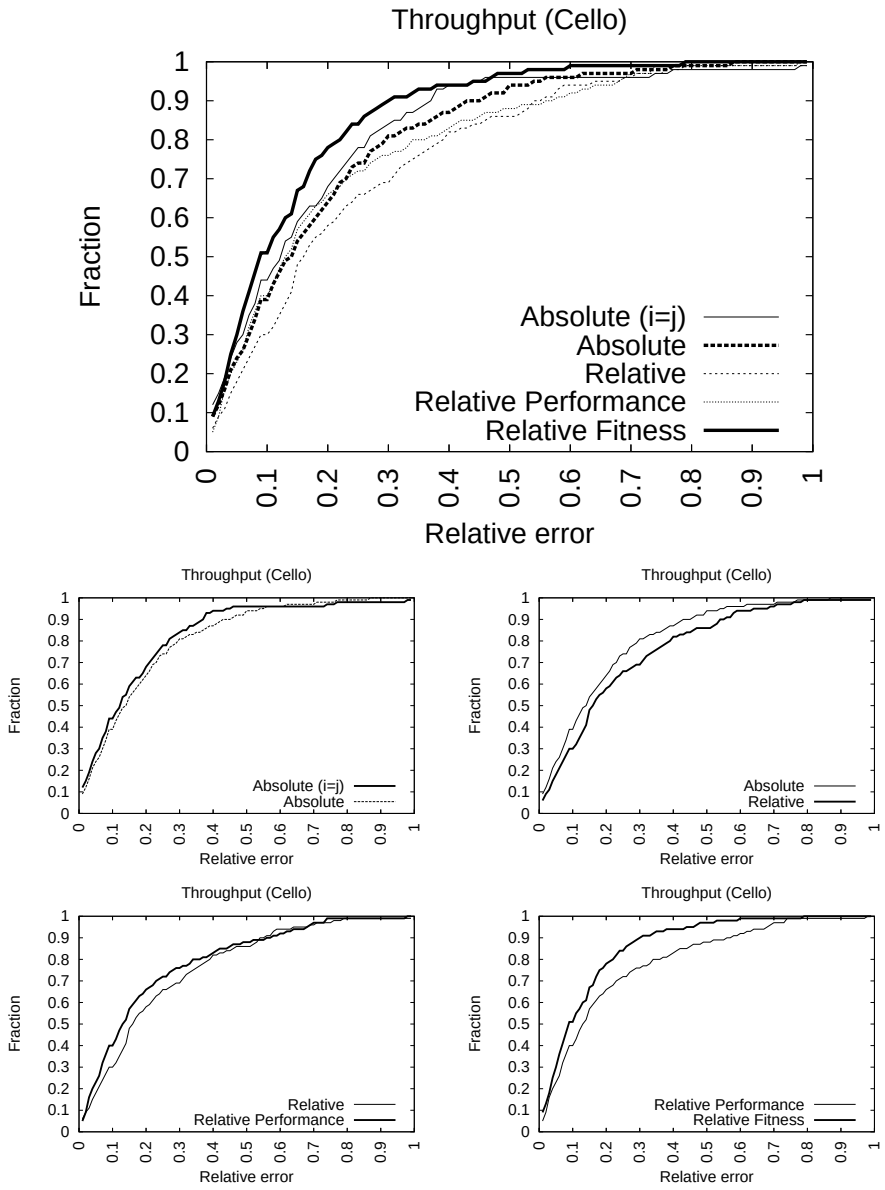

Figure W.3: The cumulative distribution of relative error over all pairwise predictions.

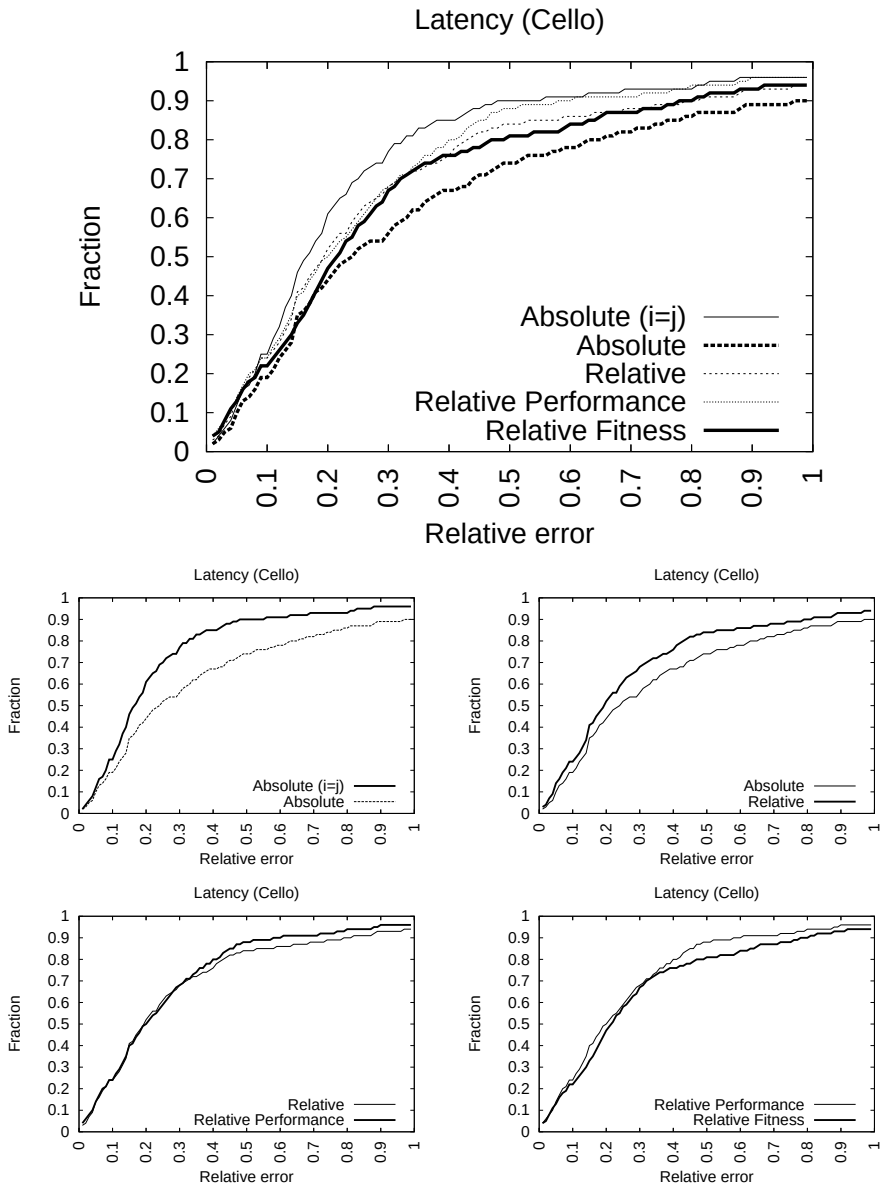

Figure W.4: The cumulative distribution of relative error over all pairwise predictions.

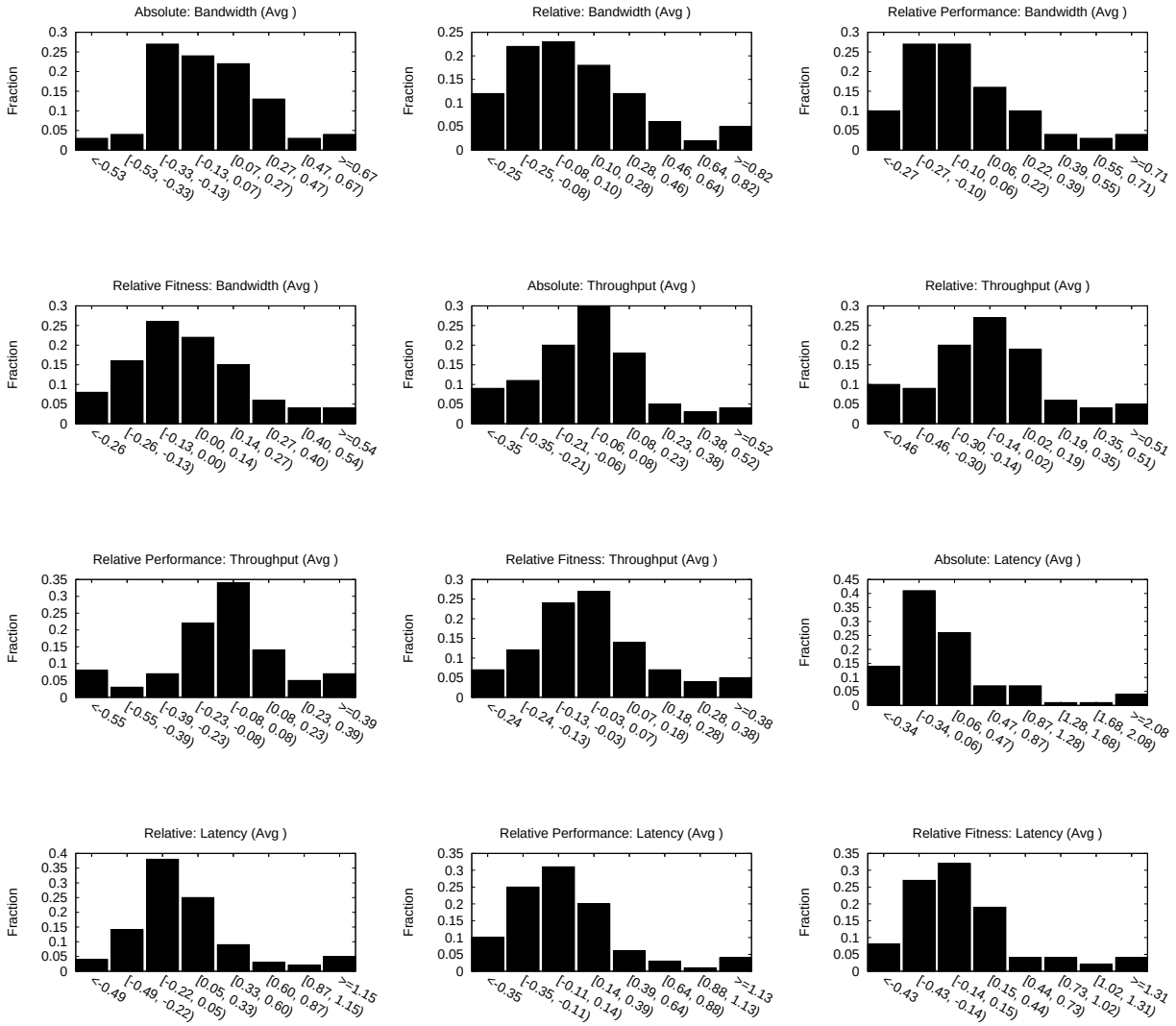

Figure W.5: The probability distribution of relative error over all pairwise predictions.

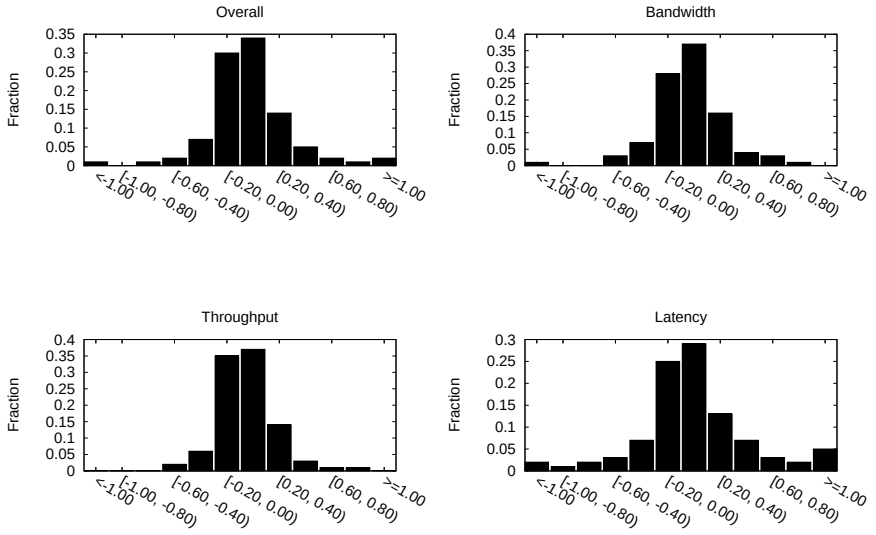

Figure W.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	7 / 9 / 21	13 / 17 / 7	15 / 17 / 5	15 / 22 / 0	15 / 19 / 3
A → C	2 / 5 / 30	21 / 15 / 1	19 / 17 / 1	9 / 27 / 1	12 / 23 / 2
A → D	11 / 9 / 17	18 / 16 / 3	15 / 20 / 2	18 / 17 / 2	12 / 25 / 0
B → A	6 / 2 / 29	12 / 17 / 8	20 / 11 / 6	17 / 17 / 3	16 / 18 / 3
B → C	4 / 3 / 30	15 / 13 / 9	8 / 22 / 7	18 / 14 / 5	12 / 22 / 3
B → D	19 / 8 / 10	18 / 19 / 0	16 / 21 / 0	17 / 17 / 3	12 / 23 / 2
C → A	2 / 1 / 34	15 / 12 / 10	21 / 16 / 0	10 / 25 / 2	14 / 20 / 3
C → B	5 / 7 / 25	22 / 15 / 0	13 / 21 / 3	12 / 23 / 2	10 / 27 / 0
C → D	13 / 9 / 15	12 / 20 / 5	12 / 23 / 2	21 / 15 / 1	13 / 21 / 3
D → A	3 / 2 / 32	16 / 17 / 4	15 / 20 / 2	13 / 21 / 3	16 / 20 / 1
D → B	8 / 10 / 19	23 / 13 / 1	13 / 21 / 3	17 / 19 / 1	14 / 22 / 1
D → C	3 / 4 / 30	19 / 18 / 0	8 / 22 / 7	20 / 16 / 1	16 / 18 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	18 / 7 / 12	20 / 13 / 4	10 / 26 / 1	19 / 15 / 3	11 / 22 / 4
A → C	6 / 8 / 23	8 / 11 / 18	37 / 0 / 0	0 / 37 / 0	16 / 21 / 0
A → D	3 / 9 / 25	23 / 13 / 1	13 / 19 / 5	13 / 20 / 4	15 / 20 / 2
B → A	12 / 6 / 19	14 / 18 / 5	22 / 13 / 2	17 / 17 / 3	18 / 16 / 3
B → C	10 / 2 / 25	34 / 3 / 0	1 / 36 / 0	18 / 17 / 2	15 / 20 / 2
B → D	7 / 9 / 21	19 / 18 / 0	21 / 16 / 0	15 / 21 / 1	16 / 17 / 4
C → A	10 / 7 / 20	22 / 15 / 0	10 / 20 / 7	13 / 20 / 4	12 / 24 / 1
C → B	7 / 6 / 24	21 / 14 / 2	11 / 16 / 10	15 / 18 / 4	15 / 19 / 3
C → D	9 / 9 / 19	22 / 15 / 0	15 / 21 / 1	8 / 26 / 3	13 / 19 / 5
D → A	8 / 3 / 26	14 / 18 / 5	14 / 19 / 4	13 / 20 / 4	12 / 22 / 3
D → B	17 / 7 / 13	17 / 13 / 7	10 / 15 / 12	19 / 15 / 3	16 / 20 / 1
D → C	8 / 9 / 20	16 / 14 / 7	19 / 15 / 3	18 / 15 / 4	19 / 15 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	19 / 7 / 11	8 / 23 / 6	15 / 22 / 0	21 / 15 / 1	11 / 25 / 1
A → C	14 / 8 / 15	13 / 18 / 6	16 / 19 / 2	14 / 23 / 0	16 / 21 / 0
A → D	3 / 4 / 30	14 / 18 / 5	18 / 12 / 7	18 / 17 / 2	10 / 24 / 3
B → A	10 / 4 / 23	18 / 11 / 8	12 / 19 / 6	24 / 13 / 0	24 / 12 / 1
B → C	15 / 5 / 17	21 / 15 / 1	17 / 20 / 0	20 / 17 / 0	21 / 14 / 2
B → D	20 / 4 / 13	12 / 18 / 7	11 / 19 / 7	17 / 17 / 3	9 / 28 / 0
C → A	10 / 3 / 24	7 / 7 / 23	11 / 9 / 17	18 / 19 / 0	20 / 16 / 1
C → B	11 / 4 / 22	12 / 21 / 4	16 / 21 / 0	20 / 12 / 5	15 / 22 / 0
C → D	19 / 3 / 15	9 / 22 / 6	27 / 6 / 4	15 / 21 / 1	11 / 25 / 1
D → A	7 / 2 / 28	15 / 17 / 5	19 / 11 / 7	14 / 19 / 4	14 / 21 / 2
D → B	19 / 7 / 11	9 / 26 / 2	19 / 14 / 4	21 / 14 / 2	14 / 23 / 0
D → C	19 / 7 / 11	10 / 20 / 7	22 / 15 / 0	19 / 18 / 0	12 / 24 / 1
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table W.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.16	0.17	0.12	0.17
Absolute	0.18	0.18	0.13	0.24
Relative	0.19	0.20	0.16	0.20
Relative Performance	0.17	0.17	0.13	0.20
Relative Fitness	0.15	0.14	0.09	0.22

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.12	0.24	0.16	0.18
Array B	0.15	0.16	0.20	0.24
Array C	0.13	0.19	0.16	0.21
Array D	0.14	0.24	0.17	0.18
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.12	0.24	0.16	0.17
Array B	0.15	0.16	0.32	0.22
Array C	0.14	0.23	0.16	0.19
Array D	0.14	0.22	0.15	0.18
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.01	0.19	0.36	0.13
Array B	0.13	0.02	0.15	0.18
Array C	0.13	0.16	0.01	0.20
Array D	0.12	0.19	0.15	0.02
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.15	0.12	0.14
Array B	0.15	0.0	0.18	0.16
Array C	0.09	0.14	0.0	0.15
Array D	0.10	0.20	0.17	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.12	0.22	0.15	0.18	0.10	0.13	0.10	0.18	0.13	0.59	0.21	0.18
Array B	0.17	0.20	0.17	0.24	0.12	0.07	0.16	0.19	0.14	0.28	0.23	0.37
Array C	0.14	0.19	0.17	0.18	0.10	0.09	0.10	0.14	0.14	0.35	0.16	0.31
Array D	0.14	0.24	0.16	0.16	0.12	0.13	0.10	0.19	0.14	0.57	0.23	0.17
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.12	0.30	0.18	0.15	0.10	0.15	0.11	0.20	0.13	0.26	0.17	0.13
Array B	0.11	0.20	0.20	0.24	0.13	0.07	0.45	0.15	0.17	0.28	0.29	0.20
Array C	0.12	0.26	0.17	0.16	0.16	0.13	0.10	0.21	0.14	0.25	0.16	0.20
Array D	0.14	0.30	0.18	0.16	0.15	0.12	0.12	0.19	0.12	0.24	0.17	0.17
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.02	0.25	0.25	0.13	0.01	0.08	0.67	0.11	0.01	0.32	0.21	0.13
Array B	0.17	0.03	0.13	0.19	0.11	0.01	0.11	0.18	0.13	0.02	0.23	0.15
Array C	0.16	0.15	0.02	0.12	0.11	0.08	0.02	0.17	0.13	0.19	0.01	0.24
Array D	0.10	0.22	0.12	0.01	0.09	0.09	0.10	0.02	0.15	0.27	0.22	0.02
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.16	0.12	0.14	0.0	0.06	0.07	0.12	0.0	0.32	0.18	0.14
Array B	0.15	0.0	0.13	0.15	0.11	0.0	0.10	0.14	0.21	0.0	0.25	0.17
Array C	0.10	0.10	0.0	0.14	0.06	0.09	0.0	0.09	0.17	0.26	0.0	0.20
Array D	0.07	0.19	0.14	0.0	0.08	0.10	0.15	0.0	0.15	0.30	0.26	0.0

Table W.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.22	0.22	0.17	0.25
Absolute	0.33	0.25	0.19	0.54
Relative	0.30	0.29	0.24	0.39
Relative Performance	0.26	0.23	0.21	0.34
Relative Fitness	0.25	0.20	0.14	0.42

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.16	0.46	0.29	0.22
Array B	0.21	0.28	0.33	0.32
Array C	0.20	0.38	0.20	0.28
Array D	0.24	0.60	0.37	0.23
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.16	0.45	0.29	0.23
Array B	0.21	0.28	0.47	0.28
Array C	0.21	0.35	0.20	0.29
Array D	0.19	0.33	0.34	0.23
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.02	0.26	0.45	0.19
Array B	0.22	0.02	0.31	0.23
Array C	0.18	0.24	0.02	0.26
Array D	0.18	0.29	0.31	0.03
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.25	0.25	0.19
Array B	0.20	0.0	0.42	0.34
Array C	0.16	0.24	0.0	0.21
Array D	0.15	0.30	0.32	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.18	0.32	0.18	0.23	0.14	0.19	0.15	0.20	0.15	0.87	0.53	0.22
Array B	0.22	0.30	0.22	0.33	0.22	0.12	0.21	0.23	0.20	0.42	0.56	0.40
Array C	0.18	0.29	0.21	0.26	0.21	0.14	0.16	0.21	0.20	0.71	0.22	0.39
Array D	0.18	0.33	0.19	0.21	0.17	0.18	0.16	0.28	0.36	1.28	0.76	0.19
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.18	0.53	0.20	0.22	0.14	0.33	0.16	0.30	0.15	0.50	0.52	0.18
Array B	0.18	0.30	0.26	0.26	0.17	0.12	0.46	0.23	0.28	0.42	0.70	0.36
Array C	0.21	0.44	0.21	0.22	0.18	0.18	0.16	0.29	0.24	0.42	0.22	0.35
Array D	0.21	0.49	0.21	0.21	0.16	0.23	0.17	0.28	0.21	0.27	0.63	0.19
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.03	0.32	0.27	0.17	0.03	0.11	0.66	0.24	0.01	0.35	0.42	0.17
Array B	0.25	0.04	0.17	0.23	0.16	0.01	0.15	0.23	0.25	0.02	0.61	0.22
Array C	0.21	0.30	0.02	0.16	0.13	0.14	0.03	0.25	0.20	0.28	0.01	0.36
Array D	0.16	0.35	0.16	0.03	0.12	0.16	0.15	0.03	0.26	0.36	0.62	0.02
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.23	0.14	0.27	0.0	0.11	0.10	0.16	0.0	0.42	0.52	0.16
Array B	0.16	0.0	0.31	0.22	0.13	0.0	0.19	0.21	0.32	0.0	0.75	0.58
Array C	0.16	0.21	0.0	0.18	0.09	0.12	0.0	0.16	0.23	0.38	0.0	0.29
Array D	0.13	0.23	0.18	0.0	0.11	0.18	0.15	0.0	0.21	0.48	0.64	0.0

Table W.4: Mean relative error

Appendix X

WorkloadMix model testing on TPC-C samples

Application	Samples	Iters	First sample	Last sample
TPC-C (tpcc)	50	3	25	49
Total used	25			

Table X.1: Multiple testing samples are collected. Each sample is run for multiple iterations in order to calculate the variance across runs.

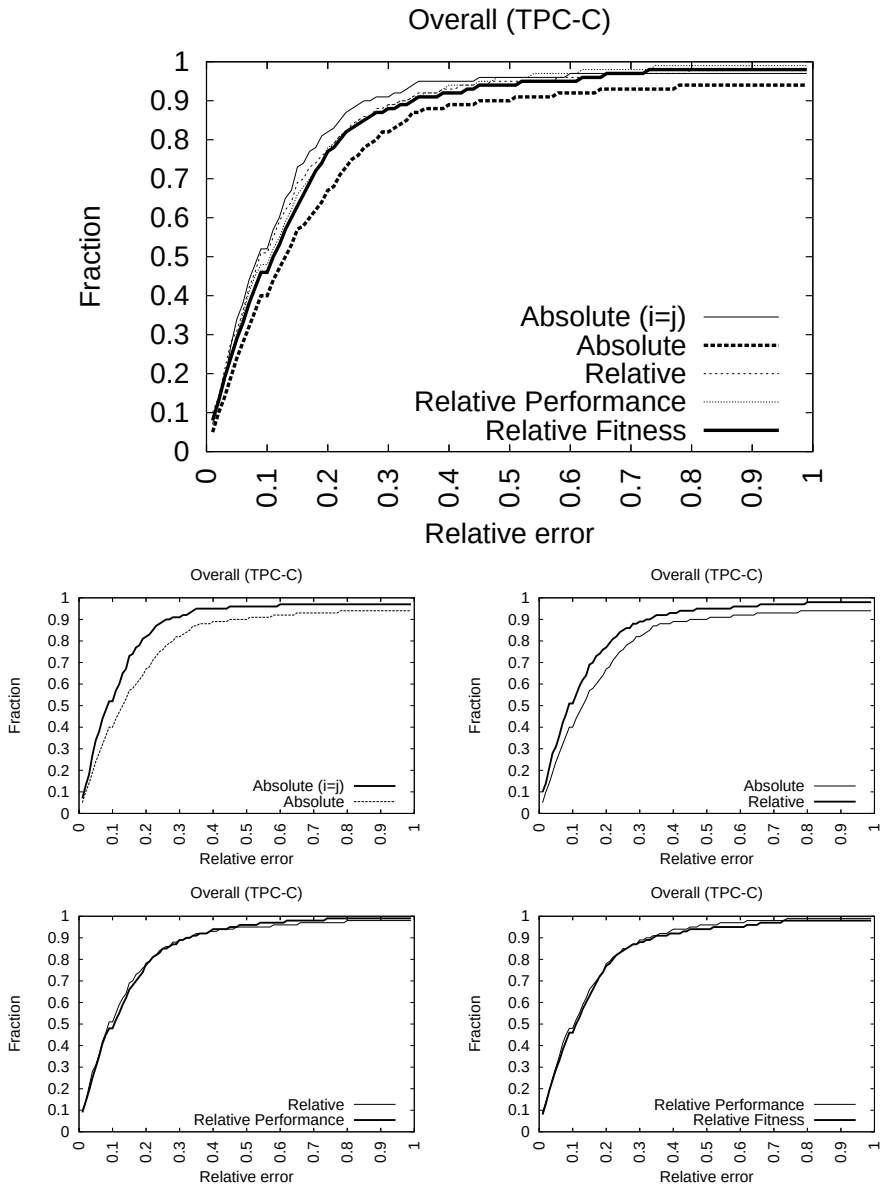

Figure X.1: The cumulative distribution of relative error over all pairwise predictions.

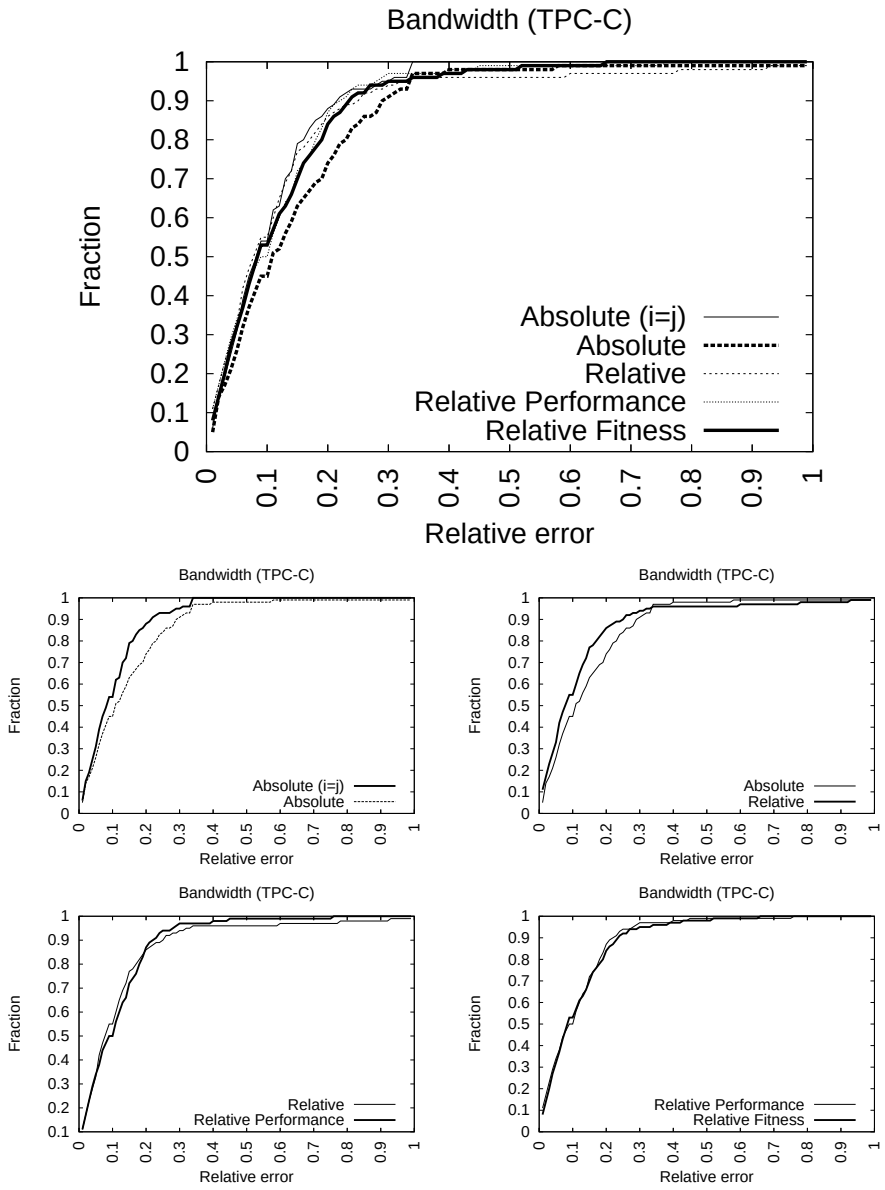

Figure X.2: The cumulative distribution of relative error over all pairwise predictions.

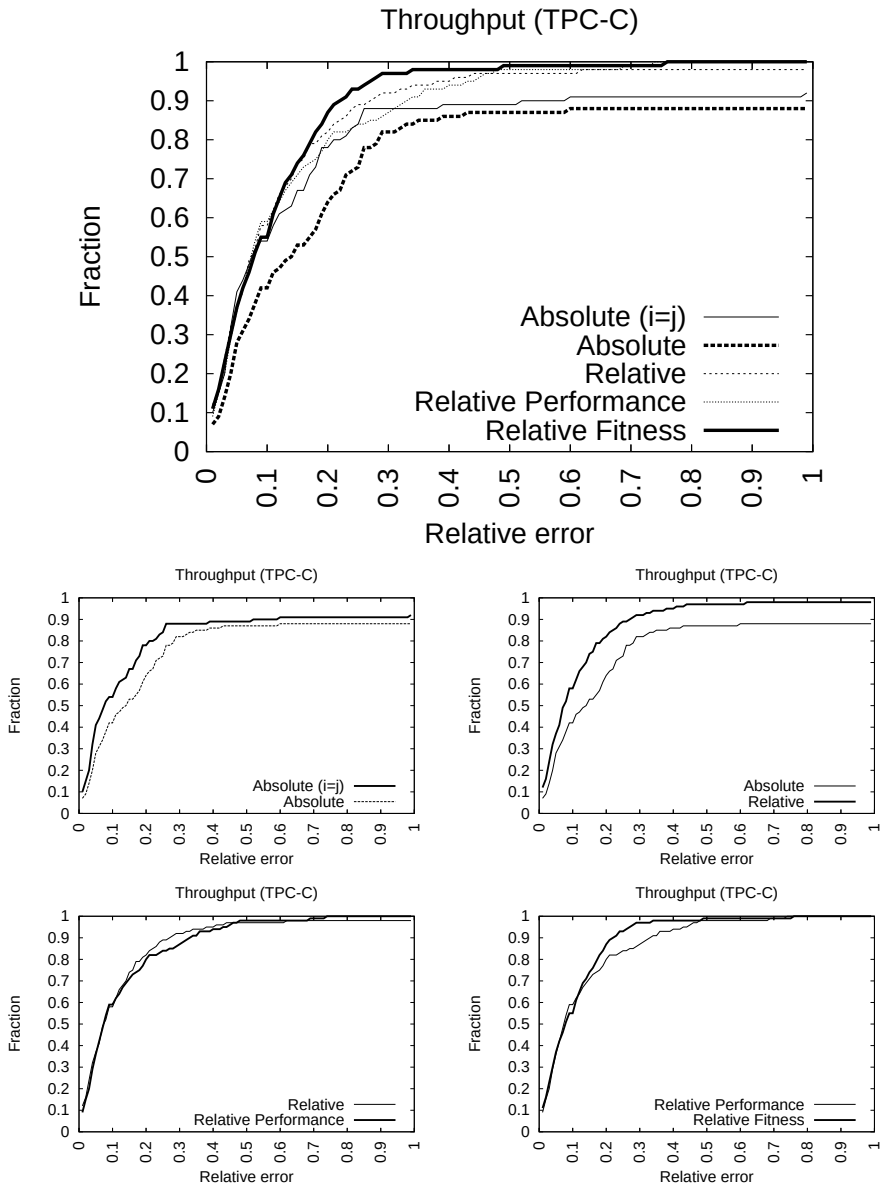

Figure X.3: The cumulative distribution of relative error over all pairwise predictions.

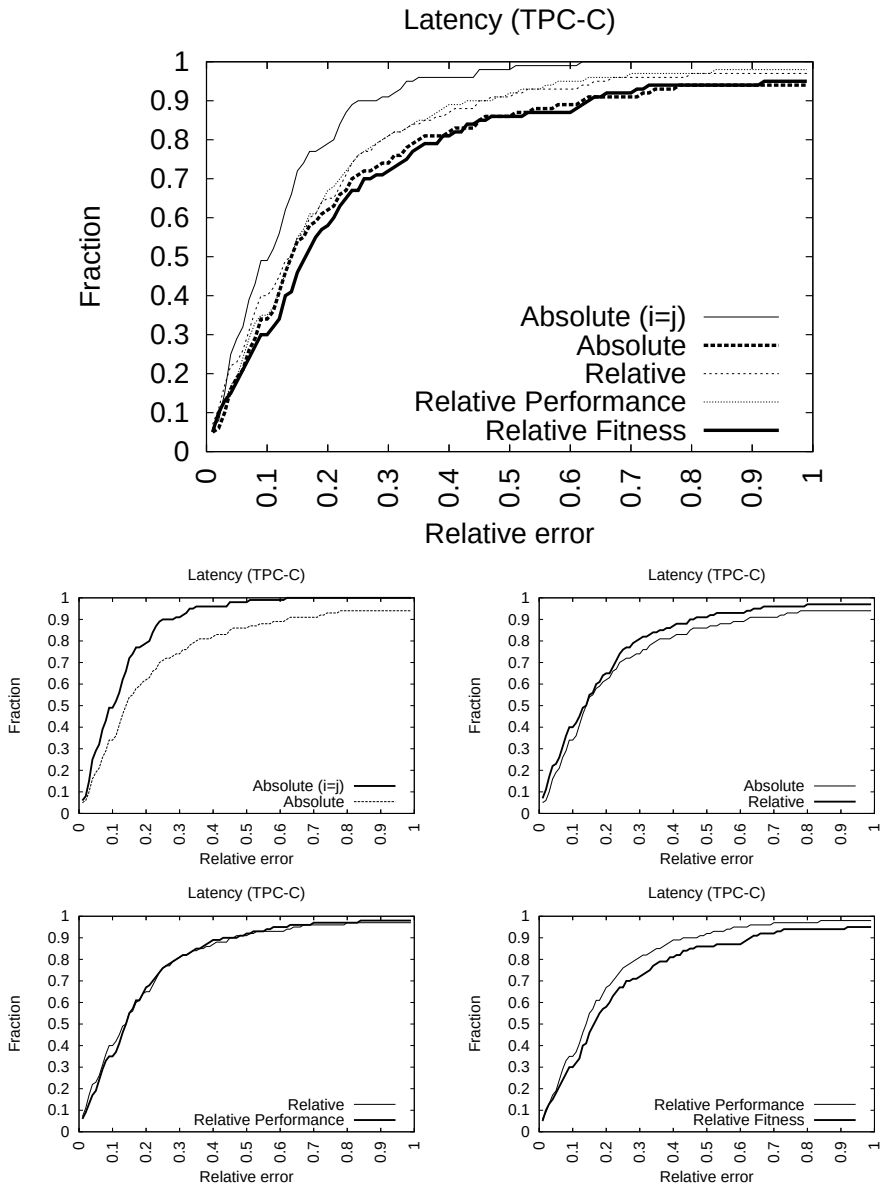

Figure X.4: The cumulative distribution of relative error over all pairwise predictions.

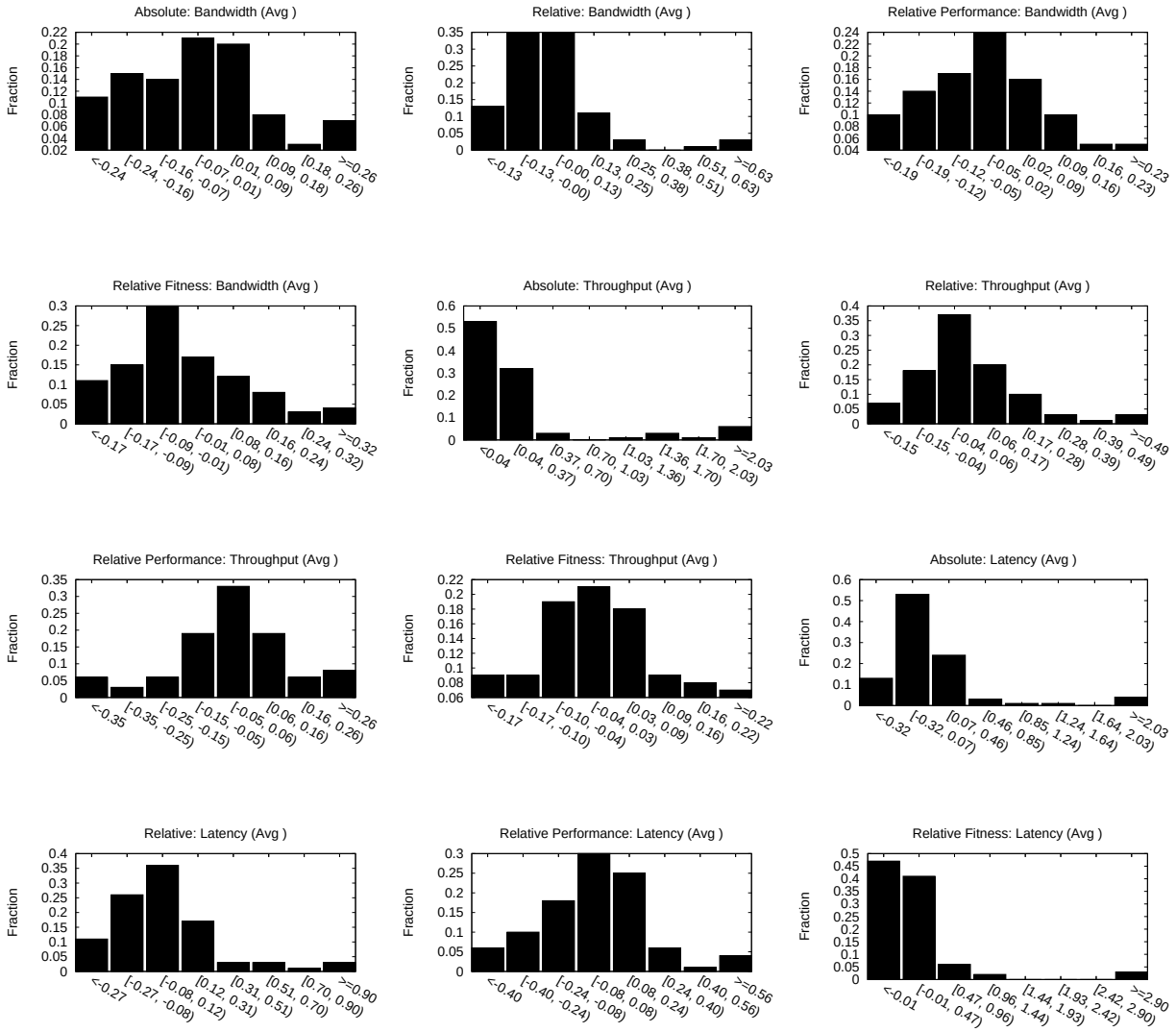

Figure X.5: The probability distribution of relative error over all pairwise predictions.

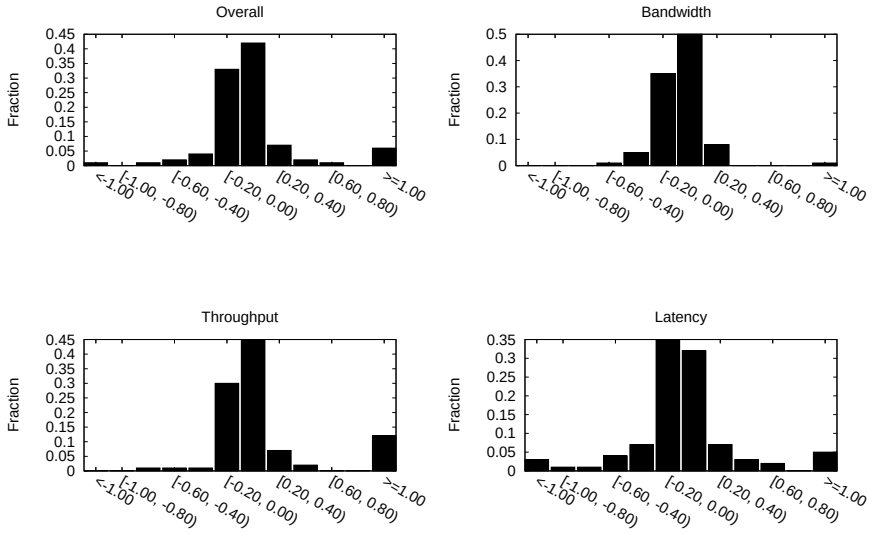

Figure X.6: Probability distributions of the *difference* in the absolute value of the relative error ($|\frac{predicted\ value - measured\ value}{measured\ value}|$) between the absolute and relative fitness models, over all predictions. The x axis represent the amount by which relative error is reduced. Negative values indicate an increase in error.

Bandwidth					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	1 / 3 / 19	14 / 8 / 1	0 / 0 / 23	6 / 13 / 4	9 / 10 / 4
A → C	5 / 2 / 16	12 / 10 / 1	9 / 13 / 1	13 / 9 / 1	12 / 9 / 2
A → D	15 / 1 / 7	4 / 17 / 2	0 / 0 / 23	11 / 11 / 1	5 / 17 / 1
B → A	2 / 1 / 20	3 / 14 / 6	12 / 5 / 6	7 / 15 / 1	5 / 16 / 2
B → C	11 / 4 / 8	6 / 14 / 3	12 / 11 / 0	11 / 9 / 3	5 / 18 / 0
B → D	17 / 1 / 5	5 / 18 / 0	0 / 1 / 22	12 / 9 / 2	6 / 17 / 0
C → A	0 / 2 / 21	6 / 15 / 2	14 / 9 / 0	10 / 11 / 2	11 / 11 / 1
C → B	1 / 3 / 19	3 / 5 / 15	0 / 1 / 22	17 / 3 / 3	13 / 7 / 3
C → D	4 / 0 / 19	3 / 6 / 14	9 / 14 / 0	14 / 8 / 1	9 / 11 / 3
D → A	2 / 1 / 20	2 / 9 / 12	0 / 0 / 23	11 / 12 / 0	10 / 12 / 1
D → B	3 / 1 / 19	2 / 5 / 16	14 / 8 / 1	10 / 11 / 2	10 / 10 / 3
D → C	1 / 0 / 22	13 / 7 / 3	9 / 9 / 5	9 / 12 / 2	11 / 9 / 3
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Throughput					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	4 / 6 / 13	2 / 7 / 14	10 / 11 / 2	13 / 8 / 2	10 / 10 / 3
A → C	5 / 1 / 17	10 / 10 / 3	21 / 2 / 0	1 / 22 / 0	9 / 12 / 2
A → D	11 / 5 / 7	5 / 14 / 4	0 / 3 / 20	16 / 7 / 0	5 / 16 / 2
B → A	12 / 3 / 8	5 / 14 / 4	8 / 15 / 0	7 / 13 / 3	0 / 22 / 1
B → C	11 / 1 / 11	8 / 14 / 1	14 / 8 / 1	6 / 16 / 1	3 / 18 / 2
B → D	10 / 4 / 9	1 / 20 / 2	4 / 4 / 15	14 / 8 / 1	4 / 19 / 0
C → A	14 / 5 / 4	7 / 12 / 4	5 / 18 / 0	10 / 9 / 4	4 / 18 / 1
C → B	7 / 8 / 8	18 / 5 / 0	13 / 10 / 0	12 / 9 / 2	9 / 11 / 3
C → D	6 / 2 / 15	4 / 16 / 3	6 / 11 / 6	12 / 9 / 2	7 / 14 / 2
D → A	13 / 5 / 5	7 / 16 / 0	11 / 11 / 1	11 / 12 / 0	4 / 18 / 1
D → B	12 / 8 / 3	14 / 7 / 2	14 / 5 / 4	6 / 16 / 1	10 / 8 / 5
D → C	3 / 3 / 17	12 / 10 / 1	10 / 13 / 0	14 / 8 / 1	14 / 9 / 0
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%
Latency					
Pair	**AM(i=j) vs. AM**	**AM vs. RM**	**RM vs. RM'**	**RM' vs. RF**	**AM vs. RF**
A → B	17 / 0 / 6	15 / 8 / 0	9 / 13 / 1	8 / 14 / 1	6 / 17 / 0
A → C	1 / 0 / 22	1 / 0 / 22	1 / 1 / 21	11 / 11 / 1	12 / 11 / 0
A → D	0 / 0 / 23	13 / 10 / 0	12 / 10 / 1	12 / 9 / 2	15 / 6 / 2
B → A	3 / 0 / 20	0 / 3 / 20	6 / 16 / 1	19 / 4 / 0	14 / 8 / 1
B → C	6 / 0 / 17	15 / 8 / 0	16 / 7 / 0	13 / 10 / 0	15 / 5 / 3
B → D	2 / 1 / 20	12 / 10 / 1	13 / 10 / 0	19 / 1 / 3	16 / 4 / 3
C → A	1 / 0 / 22	0 / 1 / 22	9 / 13 / 1	11 / 8 / 4	12 / 9 / 2
C → B	21 / 0 / 2	5 / 13 / 5	3 / 4 / 16	18 / 5 / 0	7 / 16 / 0
C → D	1 / 0 / 22	12 / 11 / 0	11 / 12 / 0	11 / 10 / 2	14 / 9 / 0
D → A	1 / 0 / 22	0 / 0 / 23	12 / 9 / 2	15 / 8 / 0	13 / 9 / 1
D → B	21 / 1 / 1	7 / 15 / 1	13 / 10 / 0	11 / 11 / 1	5 / 18 / 0
D → C	4 / 1 / 18	2 / 4 / 17	15 / 8 / 0	9 / 11 / 3	10 / 13 / 0
Totals	nan% nan% nan%	100% 0% 0%	100% 0% 0%	100% 0% 0%	100% 0% 0%

Table X.2: Models are compared across all pairwise predictions. For each prediction, a score of 1 is assigned to the model with the lowest accuracy. If the accuracy of two models is within 0.01, a score of 1 goes to the tie category (3rd number shown). Hypotheses are tested in turn. Specifically, idealized absolute models ($i = j$) are compared against in-practice absolute models ($i \neq j$), relative models are compared to absolute models (AM vs. RM), relative models that use performance are compared to those that do not (RM vs. RM'), and relative fitness models are compared to relative models that use performance (RM' vs. RF). In addition, relative fitness models are compared directly to absolute models (AM vs. RF).

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.09	0.09	0.08	0.10
Absolute	0.12	0.10	0.13	0.13
Relative	0.09	0.08	0.08	0.14
Relative Performance	0.10	0.09	0.08	0.14
Relative Fitness	0.10	0.09	0.08	0.17

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.11	0.07	0.10	0.16
Array B	0.17	0.06	0.17	0.19
Array C	0.13	0.08	0.09	0.10
Array D	0.13	0.10	0.10	0.08
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.11	0.09	0.11	0.08
Array B	0.09	0.06	0.10	0.07
Array C	0.10	0.08	0.09	0.08
Array D	0.10	0.07	0.11	0.08
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.01	0.09	0.20	0.07
Array B	0.08	0.01	0.16	0.08
Array C	0.10	0.06	0.02	0.08
Array D	0.08	0.11	0.12	0.01
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.07	0.12	0.12
Array B	0.07	0.0	0.11	0.11
Array C	0.09	0.12	0.0	0.10
Array D	0.14	0.10	0.12	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.10	0.06	0.09	0.21	0.11	0.05	0.09	0.19	0.09	0.23	0.15	0.07
Array B	0.13	0.06	0.12	0.22	0.23	0.05	0.22	0.23	0.12	0.06	0.15	0.08
Array C	0.09	0.06	0.09	0.10	0.20	0.05	0.06	0.11	0.11	0.26	0.12	0.07
Array D	0.10	0.06	0.09	0.06	0.20	0.05	0.06	0.11	0.11	0.31	0.17	0.07
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.10	0.10	0.12	0.07	0.11	0.04	0.07	0.08	0.09	0.26	0.17	0.08
Array B	0.09	0.06	0.09	0.07	0.07	0.05	0.07	0.05	0.09	0.06	0.24	0.08
Array C	0.07	0.05	0.09	0.07	0.11	0.08	0.06	0.07	0.09	0.23	0.12	0.09
Array D	0.10	0.06	0.09	0.06	0.08	0.08	0.07	0.11	0.11	0.17	0.17	0.07
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.03	0.10	0.07	0.07	0.00	0.04	0.40	0.06	0.02	0.14	0.17	0.08
Array B	0.08	0.03	0.12	0.07	0.05	0.01	0.07	0.06	0.10	0.01	0.38	0.11
Array C	0.14	0.04	0.02	0.07	0.08	0.06	0.01	0.06	0.10	0.18	0.05	0.10
Array D	0.10	0.10	0.12	0.02	0.07	0.09	0.06	0.01	0.09	0.15	0.15	0.03
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.07	0.12	0.08	0.0	0.05	0.07	0.10	0.0	0.08	0.12	0.13
Array B	0.07	0.0	0.07	0.06	0.04	0.0	0.06	0.10	0.24	0.0	0.29	0.18
Array C	0.09	0.09	0.0	0.10	0.07	0.07	0.0	0.09	0.08	0.23	0.0	0.09
Array D	0.12	0.07	0.11	0.0	0.12	0.07	0.11	0.0	0.17	0.14	0.12	0.0

Table X.3: Median relative error

Model	Overall	Bandwidth	Throughput	Latency
Absolute ($i = j$)	0.17	0.11	0.26	0.13
Absolute	0.32	0.16	0.37	0.42
Relative	0.18	0.13	0.15	0.26
Relative Performance	0.16	0.11	0.13	0.23
Relative Fitness	0.23	0.12	0.11	0.46

Pairwise				
Absolute	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.21	0.15	0.24	0.31
Array B	0.37	0.10	0.76	0.28
Array C	0.33	0.20	0.14	0.25
Array D	0.22	0.27	0.42	0.21
Relative	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.21	0.20	0.19	0.14
Array B	0.23	0.10	0.19	0.15
Array C	0.15	0.17	0.14	0.15
Array D	0.15	0.28	0.14	0.21
Relative Performance	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.03	0.17	0.26	0.17
Array B	0.10	0.02	0.21	0.12
Array C	0.13	0.13	0.03	0.12
Array D	0.18	0.20	0.13	0.03
Relative Fitness	**Array A**	**Array B**	**Array C**	**Array D**
Array A	0.0	0.11	0.29	0.15
Array B	0.18	0.0	0.79	0.29
Array C	0.14	0.22	0.0	0.13
Array D	0.16	0.17	0.13	0.0

	Bandwidth				**Throughput**				**Latency**			
Absolute	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.13	0.07	0.14	0.21	0.34	0.08	0.42	0.61	0.15	0.29	0.17	0.10
Array B	0.27	0.08	0.23	0.22	0.49	0.13	0.66	0.47	0.36	0.10	1.40	0.13
Array C	0.11	0.07	0.11	0.14	0.68	0.07	0.15	0.42	0.21	0.46	0.16	0.19
Array D	0.13	0.24	0.12	0.10	0.31	0.08	0.15	0.42	0.21	0.48	0.98	0.10
	Bandwidth				**Throughput**				**Latency**			
Relative	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.13	0.10	0.24	0.12	0.34	0.05	0.11	0.19	0.15	0.44	0.23	0.11
Array B	0.13	0.08	0.12	0.17	0.42	0.13	0.12	0.12	0.15	0.10	0.32	0.14
Array C	0.09	0.11	0.11	0.12	0.22	0.12	0.15	0.12	0.15	0.29	0.16	0.21
Array D	0.12	0.07	0.13	0.10	0.11	0.11	0.13	0.42	0.21	0.67	0.18	0.10
	Bandwidth				**Throughput**				**Latency**			
Relative Performance	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.04	0.10	0.12	0.12	0.00	0.06	0.39	0.11	0.03	0.36	0.27	0.27
Array B	0.11	0.04	0.13	0.12	0.07	0.01	0.12	0.12	0.13	0.01	0.38	0.13
Array C	0.14	0.06	0.03	0.11	0.10	0.10	0.01	0.11	0.14	0.23	0.05	0.12
Array D	0.13	0.10	0.13	0.04	0.14	0.17	0.09	0.01	0.27	0.32	0.18	0.04
	Bandwidth				**Throughput**				**Latency**			
Relative Fitness	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Array A	0.0	0.08	0.21	0.14	0.0	0.07	0.10	0.16	0.0	0.18	0.54	0.17
Array B	0.08	0.0	0.11	0.12	0.06	0.0	0.09	0.14	0.41	0.0	2.18	0.60
Array C	0.12	0.13	0.0	0.11	0.15	0.11	0.0	0.11	0.15	0.41	0.0	0.16
Array D	0.12	0.10	0.12	0.0	0.12	0.10	0.12	0.0	0.24	0.31	0.16	0.0

Table X.4: Mean relative error