

# Guidelines for Coverage-Based Comparisons of Non-Adequate Test Suites

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Subject	NBNC	Size of test pool	Total mutants	Killed mutants
<b>language: Java</b>				
JFreeChart	72490	2217	45409	14932
JodaTime	27472	3828	24956	16478
AvlTree	344	11041	335	51
BinomialHeap	264	8423	205	37
BinTree	100	13825	55	16
FibHeap	264	12842	186	38
FibonacciHeap	397	4478	295	74
HeapArray	98	4064	122	61
IntAVLTreeMap	213	17072	199	38
IntRedBlackTree	296	20419	279	210
LinkedList	245	1307	167	5
NodeCachLList	234	1776	159	16
SinglyLList	98	1762	57	10
TreeMap	449	14076	463	106
TreeSet	323	17400	360	82
<b>language: C</b>				
Space	6,200	1,350	1,142	753
SQLite	81,934	117,240	52,367	19,294
YAFFS2	11,760	5,000	10,674	4,186
Printtokens	479	4,130	536	442
Printtokens2	401	4,115	343	343
Replace	512	5,542	613	530
Schedule	292	2,650	140	125
Schedule2	297	2,710	300	251
SglibRbtree	1,564	5,000	443	193
Tcas	135	1,608	311	311
Totinfo	340	917	511	511

Table 1: Subject programs used in the evaluation (basic statistics)

Subject	SC stmts	BC branches		DBB states	Intra-method paths states		predicates		PCT points			states	
		static	exe		IMP	AIMP	MS	BB,ST	MS	BB	ST	BB	ST
<b>language: Java</b>													
JFreeChart	23132	17866	12083	3409	11182	7281	-	13536	-	32907	42372	34899	45406
JodaTime	9480	7357	6364	3498	5141	4826	-	2913	-	9476	10570	16673	18723
AvlTree	47	104	20	18	110	30	4	87	104	189	167	153	156
BinomialHeap	130	60	60	35	442	79	9	49	60	109	150	335	419
BinTree	51	32	32	25	2388	51	7	26	32	51	54	224	228
FibHeap	113	60	44	19	43795	60	14	67	56	98	160	132	228
FibonacciHeap	120	66	45	18	5658	46	14	58	62	100	156	139	252
HeapArray	59	32	30	17	1319	37	3	19	32	50	60	205	235
IntAVLTreeMap	100	56	47	41	99	45	4	52	56	100	112	242	277
IntRedBlackTree	171	90	83	60	275	106	6	76	90	149	177	479	534
LinkedList	34	36	8	8	531	26	4	40	36	78	107	34	53
NodeCachLList	59	34	14	12	550	32	4	34	34	68	103	82	129
SinglyLList	43	26	20	12	478	20	3	22	26	39	55	67	95
TreeMap	207	147	101	72	317	119	6	102	119	239	280	749	837
TreeSet	175	93	83	67	313	106	6	69	94	150	183	462	521
<b>language: C</b>													
Space	3,366	1,190	1,014	584	5,384	654	-	1,552	-	884	3,927	5,708	25,100
SQLite	23,565	17,304	15,676	-	749,052	16,514	-	21,285	-	13,786	37,313	529,272	1,432,590
YAFFS2	3,236	4,274	1,852	229	180,770	1,361	-	4,149	-	3,520	8,273	27,501	755,42
Printtokens	185	66	63	50	1,568	115	-	70	-	73	265	292	1,050
Printtokens2	200	162	159	64	2,346	131	-	108	-	133	282	908	2,339
Replace	234	180	169	93	3,803	164	-	190	-	177	345	1,041	1,968
Schedule	150	58	55	39	1,838	75	-	52	-	64	176	545	1,554
Schedule2	128	88	83	33	2,455	82	-	54	-	75	190	705	1,751
SglibRbtree	502	378	238	114	2,175	106	-	426	-	350	720	3,794	9,841
Tcas	64	66	61	14	50	50	-	45	-	72	133	1,311	2,603
Totinfo	117	88	79	34	1,039	80	-	55	-	76	238	977	3,109

Table 2: Subject programs used in the evaluation (coverage statistics)

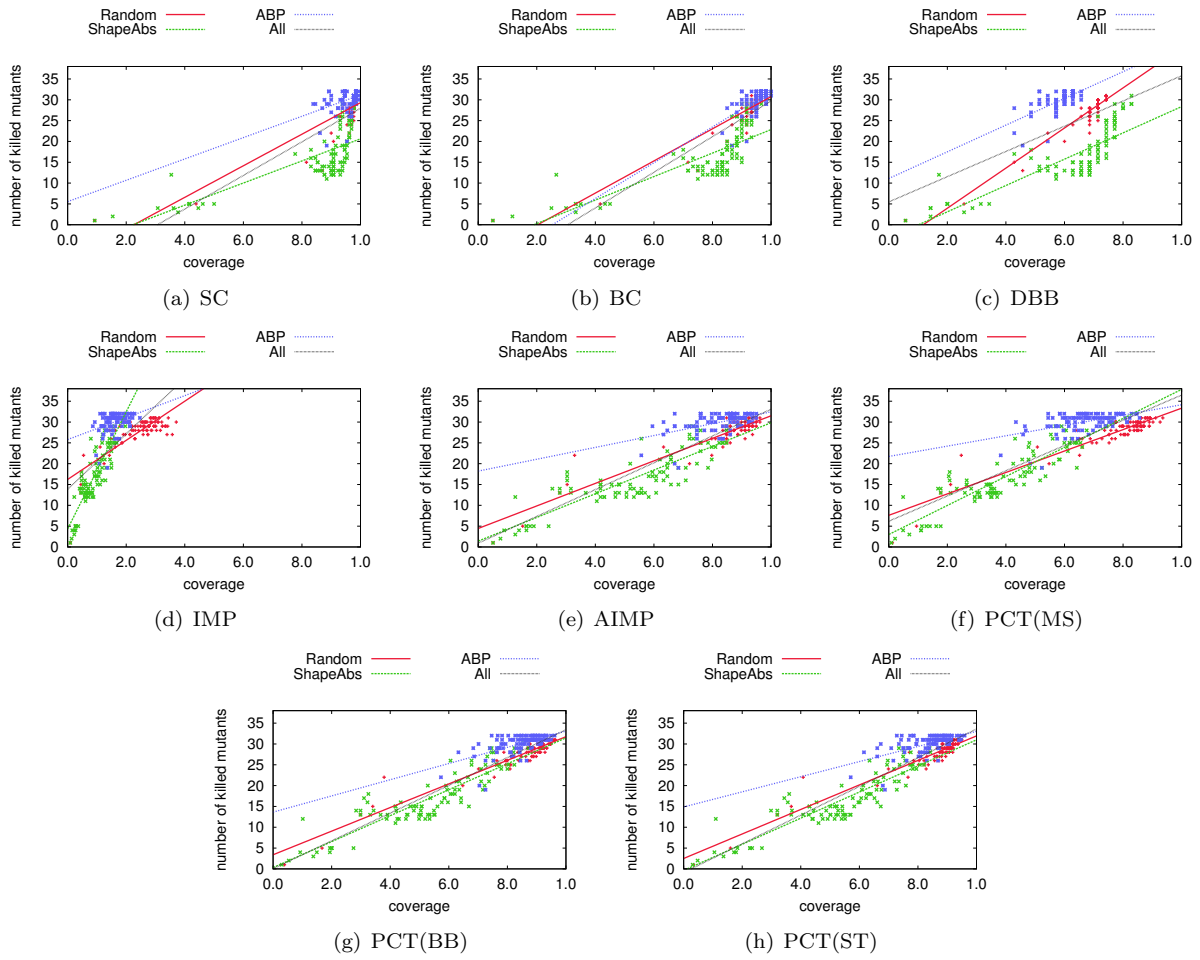


Figure 1: Correlation between various coverage criteria and killed mutants for BinomialHeap

Subject	Size	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java									
JFreeChart	0.958	0.962	0.966	0.961	0.845	0.964	-	0.951	0.936
JodaTime	0.937	0.966	0.972	0.958	0.965	0.964	-	0.959	0.961
AvlTree	0.012	0.773	0.774	0.665	0.783	0.785	0.756	0.789	0.816
BinomialHeap	-0.152	0.617	0.775	0.069	0.487	0.585	0.527	0.637	0.631
BinTree	0.389	0.132	0.220	0.340	0.341	0.351	0.491	0.417	0.510
FibHeap	0.058	0.759	0.807	0.692	0.278	0.395	0.509	0.634	0.515
FibonacciHeap	0.202	0.494	0.512	0.259	0.539	0.527	0.497	0.480	0.478
HeapArray	-0.017	0.803	0.801	-0.377	0.761	0.726	0.638	0.771	0.703
IntAVLTreeMap	0.239	0.777	0.770	0.612	0.788	0.815	0.786	0.728	0.762
IntRedBlackTree	0.111	0.710	0.741	-0.020	0.712	0.751	0.697	0.748	0.737
LinkedList	-0.048	0.756	0.746	0.603	0.713	0.716	0.746	0.705	0.701
NodeCachLList	-0.142	0.737	0.724	0.020	0.527	0.670	0.693	0.531	0.495
SinglyLList	0.243	0.577	0.586	0.174	0.451	0.495	0.492	0.571	0.634
TreeMap	0.242	0.747	0.772	0.578	0.690	0.748	0.721	0.743	0.755
TreeSet	0.063	0.755	0.784	0.346	0.696	0.770	0.737	0.752	0.772
language: C									
Space	0.876	0.926	0.929	0.881	0.913	0.929	-	0.917	0.911
SQLite	0.585	0.908	0.904	-	0.837	0.909	-	0.906	0.904
YAFFS2	0.347	0.688	0.702	0.347	0.501	0.690	-	0.667	0.680
Printtokens	0.552	0.894	0.781	0.548	0.901	0.916	-	0.794	0.855
Printtokens2	0.561	0.851	0.845	0.564	0.826	0.831	-	0.839	0.844
Replace	0.541	0.717	0.699	0.533	0.691	0.697	-	0.677	0.681
Schedule	0.437	0.773	0.776	0.408	0.747	0.766	-	0.716	0.711
Schedule2	0.339	0.766	0.767	0.338	0.683	0.749	-	0.691	0.751
SglibRbtree	0.693	0.763	0.793	0.691	0.680	0.698	-	0.765	0.762
Tcas	0.639	0.732	0.773	0.710	0.739	0.739	-	0.766	0.749
Totinfo	0.380	0.673	0.758	0.389	0.743	0.748	-	0.671	0.711
Standard deviation	ignored	0.166	0.147	0.318	0.172	0.158	0.116	0.134	0.133
Geometric mean	ignored	0.707	0.735	-	0.660	0.709	0.627	0.711	0.717
Arithmetic mean	ignored	0.741	0.757	0.452	0.686	0.728	0.638	0.724	0.729
#The best results	ignored	5	13	0	1	5	0	0	3
#The worst results	ignored	1	0	21	4	0	0	0	0

Table 3: Kendall  $\tau_b$  values when test-suites are selected with Coverage-varied Selection

Subject	Size	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java									
JFreeChart	0.703	0.777	0.818	0.813	0.768	0.792	-	0.818	0.776
JodaTime	0.748	0.808	0.835	0.842	0.836	0.840	-	0.826	0.815
AvlTree	0.560	0.301	0.301	0.301	0.556	0.492	0.494	0.520	0.530
BinomialHeap	0.428	0.624	0.629	0.629	0.367	0.521	0.409	0.467	0.450
BinTree	0.594	0.271	0.510	0.271	0.587	0.696	0.564	0.658	0.656
FibHeap	0.495	0.566	0.637	0.584	0.475	0.641	0.676	0.622	0.617
FibonacciHeap	0.479	0.409	0.419	0.411	0.492	0.487	0.440	0.389	0.395
HeapArray	0.507	0.728	0.723	0.728	0.519	0.742	0.646	0.592	0.583
IntAVLTreeMap	0.584	0.684	0.682	0.706	0.633	0.677	0.665	0.621	0.617
IntRedBlackTree	0.489	0.671	0.726	0.717	0.757	0.803	0.755	0.778	0.758
LinkedList	0.130	0.353	0.849	0.353	0.132	0.154	0.849	0.157	0.155
NodeCachLList	0.358	0.404	0.355	0.403	0.343	0.393	0.404	0.377	0.380
SinglyLList	0.466	0.494	0.494	0.494	0.419	0.824	0.385	0.667	0.699
TreeMap	0.492	0.680	0.700	0.696	0.759	0.777	0.746	0.741	0.738
TreeSet	0.511	0.703	0.739	0.733	0.736	0.774	0.732	0.764	0.754
language: C									
Space	0.793	0.853	0.858	0.836	0.815	0.881	-	0.769	0.759
SQLite	0.585	0.908	0.904	-	0.837	0.909	-	0.906	0.904
YAFFS2	0.583	0.614	0.640	0.591	0.466	0.655	-	0.640	0.632
Printtokens	0.642	0.815	0.627	0.670	0.730	0.829	-	0.617	0.688
Printtokens2	0.533	0.717	0.695	0.587	0.548	0.605	-	0.655	0.679
Replace	0.541	0.483	0.504	0.520	0.566	0.539	-	0.485	0.493
Schedule	0.551	0.776	0.720	0.630	0.546	0.653	-	0.731	0.745
Schedule2	0.562	0.474	0.493	0.512	0.588	0.532	-	0.529	0.548
SglibRbtree	0.567	0.646	0.627	0.602	0.581	0.583	-	0.628	0.647
Tcas	0.677	0.589	0.720	0.689	0.703	0.703	-	0.747	0.729
Totinfo	0.448	0.576	0.554	0.455	0.492	0.517	-	0.478	0.478
Standard deviation	ignored	0.173	0.156	0.161	0.170	0.172	0.157	0.166	0.163
Geometric mean	ignored	0.585	0.624	0.567	0.555	0.624	0.577	0.593	0.595
Arithmetic mean	ignored	0.612	0.645	0.591	0.587	0.655	0.597	0.622	0.624
#The best results	ignored	4	3	3	4	10	3	2	1
#The worst results	ignored	9	1	3	11	0	1	2	2

Table 4: Kendall  $\tau_b$  values when test-suites are selected with Size-varied Selection

Subject	Size	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java									
JFreeChart	0.997	0.997	0.997	0.997	0.945	0.997	-	0.995	0.994
JodaTime	0.992	0.997	0.998	0.997	0.997	0.997	-	0.996	0.997
AvlTree	0.002	0.880	0.885	0.784	0.901	0.901	0.892	0.918	0.935
BinomialHeap	-0.210	0.724	0.889	0.067	0.654	0.743	0.690	0.796	0.786
BinTree	0.481	0.161	0.241	0.410	0.436	0.448	0.620	0.531	0.642
FibHeap	0.065	0.895	0.921	0.837	0.354	0.544	0.679	0.802	0.688
FibonacciHeap	0.246	0.641	0.661	0.353	0.706	0.689	0.666	0.639	0.634
HeapArray	-0.026	0.913	0.911	-0.484	0.917	0.878	0.801	0.920	0.868
IntAVLTreeMap	0.302	0.908	0.900	0.773	0.921	0.931	0.922	0.885	0.907
IntRedBlackTree	0.090	0.887	0.905	-0.146	0.896	0.917	0.886	0.917	0.911
LinkedList	-0.051	0.833	0.826	0.673	0.817	0.819	0.826	0.807	0.806
NodeCachLList	-0.170	0.848	0.841	-0.003	0.692	0.813	0.820	0.694	0.636
SinglyLList	0.295	0.673	0.678	0.208	0.579	0.603	0.617	0.691	0.769
TreeMap	0.275	0.902	0.913	0.751	0.877	0.912	0.896	0.909	0.914
TreeSet	0.045	0.916	0.930	0.475	0.876	0.923	0.908	0.916	0.929
language: C									
Space	0.876	0.987	0.988	0.962	0.985	0.990	-	0.989	0.911
SQLite	0.585	0.984	0.983	-	0.942	0.984	-	0.985	0.904
YAFFS2	0.347	0.862	0.874	0.424	0.672	0.862	-	0.843	0.680
Printtokens	0.552	0.981	0.921	0.664	0.983	0.986	-	0.939	0.855
Printtokens2	0.561	0.962	0.960	0.707	0.950	0.952	-	0.959	0.844
Replace	0.541	0.890	0.876	0.683	0.869	0.878	-	0.862	0.681
Schedule	0.437	0.902	0.908	0.505	0.895	0.905	-	0.874	0.711
Schedule2	0.339	0.908	0.904	0.416	0.842	0.896	-	0.858	0.751
SglibRbtree	0.693	0.917	0.934	0.829	0.853	0.865	-	0.919	0.762
Tcas	0.639	0.884	0.923	0.855	0.892	0.892	-	0.920	0.749
Totinfo	0.380	0.823	0.883	0.481	0.874	0.870	-	0.834	0.711
Standard deviation	ignored	0.168	0.151	0.373	0.166	0.141	0.116	0.115	0.114
Geometric mean	ignored	0.824	0.849	-	0.799	0.840	0.778	0.853	0.799
Arithmetic mean	ignored	0.857	0.871	0.529	0.820	0.854	0.786	0.861	0.807
#The best results	ignored	6	10	1	1	5	0	3	4
#The worst results	ignored	1	0	17	2	0	0	1	5

Table 5: Spearman  $\rho$  values when test-suites are selected with Coverage-varied Selection

Subject	Size	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java									
JFreeChart	0.881	0.931	0.955	0.954	0.918	0.942	-	0.953	0.931
JodaTime	0.911	0.947	0.961	0.963	0.961	0.963	-	0.957	0.951
AvlTree	0.718	0.350	0.350	0.350	0.709	0.592	0.633	0.636	0.622
BinomialHeap	0.530	0.659	0.662	0.661	0.457	0.588	0.502	0.559	0.543
BinTree	0.741	0.309	0.579	0.309	0.741	0.817	0.709	0.798	0.802
FibHeap	0.653	0.677	0.754	0.687	0.637	0.768	0.824	0.763	0.759
FibonacciHeap	0.646	0.507	0.512	0.503	0.660	0.607	0.580	0.524	0.534
HeapArray	0.646	0.791	0.787	0.791	0.649	0.832	0.743	0.717	0.712
IntAVLTreeMap	0.707	0.751	0.750	0.768	0.742	0.753	0.788	0.740	0.737
IntRedBlackTree	0.655	0.823	0.861	0.850	0.917	0.942	0.914	0.930	0.917
LinkedList	0.158	0.355	0.851	0.355	0.162	0.169	0.851	0.173	0.172
NodeCachLList	0.434	0.410	0.358	0.409	0.416	0.432	0.442	0.421	0.428
SinglyLList	0.570	0.514	0.514	0.514	0.515	0.868	0.442	0.741	0.780
TreeMap	0.660	0.832	0.841	0.836	0.918	0.924	0.906	0.905	0.903
TreeSet	0.678	0.843	0.863	0.857	0.900	0.921	0.894	0.918	0.911
language: C									
Space	0.793	0.968	0.970	0.962	0.950	0.979	-	0.922	0.917
SQLite	0.585	0.984	0.983	-	0.942	0.984	-	0.985	0.984
YAFFS2	0.583	0.796	0.822	0.777	0.648	0.837	-	0.823	0.816
Printtokens	0.642	0.923	0.770	0.831	0.883	0.940	-	0.768	0.845
Printtokens2	0.533	0.825	0.799	0.740	0.696	0.726	-	0.775	0.788
Replace	0.541	0.645	0.670	0.696	0.747	0.711	-	0.658	0.669
Schedule	0.551	0.877	0.845	0.792	0.728	0.795	-	0.885	0.897
Schedule2	0.562	0.559	0.656	0.668	0.761	0.704	-	0.713	0.732
SglibRbtree	0.567	0.800	0.778	0.761	0.745	0.729	-	0.786	0.805
Tcas	0.677	0.718	0.642	0.824	0.775	0.775	-	0.746	0.746
Totinfo	0.448	0.617	0.607	0.539	0.595	0.603	-	0.582	0.584
Standard deviation	ignored	0.203	0.174	0.195	0.189	0.188	0.174	0.186	0.185
Geometric mean	ignored	0.675	0.713	0.664	0.687	0.731	0.688	0.712	0.716
Arithmetic mean	ignored	0.708	0.736	0.696	0.722	0.765	0.710	0.745	0.749
#The best results	ignored	2	3	2	4	10	4	1	2
#The worst results	ignored	8	3	4	9	1	1	1	2

Table 6: Spearman  $\rho$  values when test-suites are selected with Size-varied Selection

Subject	Size	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java									
JFreeChart	0.898	0.992	0.995	0.987	0.836	0.998	-	0.989	0.989
JodaTime	0.857	0.990	0.994	0.987	0.999	0.998	-	0.997	0.998
AvlTree	0.005	0.801	0.790	0.726	0.778	0.753	0.867	0.916	0.927
BinomialHeap	0.000	0.520	0.690	0.250	0.520	0.824	0.771	0.875	0.863
BinTree	0.098	0.248	0.271	0.449	0.198	0.310	0.454	0.393	0.485
FibHeap	0.018	0.825	0.884	0.809	0.124	0.277	0.599	0.713	0.536
FibonacciHeap	0.213	0.473	0.497	0.157	0.441	0.517	0.472	0.493	0.478
HeapArray	0.028	0.743	0.870	0.086	0.506	0.679	0.581	0.846	0.679
IntAVLTreeMap	0.039	0.888	0.860	0.666	0.800	0.896	0.767	0.785	0.827
IntRedBlackTree	0.056	0.637	0.659	0.010	0.807	0.834	0.769	0.833	0.813
LinkedList	0.004	0.583	0.757	0.381	0.423	0.818	0.757	0.658	0.546
NodeCachLList	0.003	0.492	0.730	0.064	0.566	0.694	0.702	0.550	0.440
SinglyLList	0.140	0.325	0.359	0.081	0.176	0.304	0.302	0.399	0.468
TreeMap	0.108	0.799	0.829	0.605	0.781	0.889	0.875	0.897	0.903
TreeSet	0.053	0.762	0.776	0.232	0.777	0.874	0.824	0.827	0.875
language: C									
Space	0.645	0.947	0.989	0.905	0.839	0.993	-	0.985	0.972
SQLite	0.002	0.937	0.950	-	0.051	0.981	-	0.965	0.960
YAFFS2	0.161	0.785	0.804	0.143	0.137	0.802	-	0.770	0.779
Printtokens	0.296	0.947	0.834	0.570	0.745	0.976	-	0.799	0.899
Printtokens2	0.374	0.850	0.854	0.399	0.724	0.827	-	0.856	0.856
Replace	0.325	0.757	0.771	0.418	0.537	0.751	-	0.746	0.749
Schedule	0.146	0.701	0.813	0.205	0.558	0.837	-	0.826	0.821
Schedule2	0.062	0.745	0.705	0.094	0.574	0.732	-	0.735	0.760
SglibRbtree	0.379	0.852	0.877	0.559	0.660	0.773	-	0.842	0.835
Tcas	0.564	0.464	0.819	0.755	0.790	0.790	-	0.828	0.791
Totinfo	0.155	0.560	0.667	0.171	0.610	0.695	-	0.664	0.637
Standard deviation	ignored	0.204	0.176	0.311	0.259	0.206	0.177	0.167	0.176
Geometric mean	ignored	0.681	0.744	0.287	0.480	0.725	0.646	0.755	0.743
Arithmetic mean	ignored	0.716	0.771	0.428	0.575	0.762	0.672	0.776	0.765
#The best results	ignored	0	6	0	1	10	0	3	7
#The worst results	ignored	1	0	19	6	0	0	0	0

Table 7:  $R^2$  values for each subject program and criteria when test-suites are selected with Coverage-varied Selection

Subject	Size	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java									
JFreeChart	0.774	0.875	0.916	0.913	0.417	0.892	-	0.900	0.863
JodaTime	0.810	0.914	0.935	0.926	0.934	0.937	-	0.929	0.918
AvlTree	0.434	0.390	0.418	0.423	0.575	0.622	0.674	0.627	0.605
BinomialHeap	0.198	0.617	0.766	0.803	0.369	0.866	0.782	0.881	0.878
BinTree	0.529	0.172	0.276	0.185	0.600	0.667	0.665	0.606	0.700
FibHeap	0.424	0.735	0.805	0.763	0.414	0.652	0.703	0.796	0.752
FibonacciHeap	0.406	0.222	0.300	0.326	0.377	0.415	0.439	0.396	0.398
HeapArray	0.316	0.834	0.897	0.818	0.577	0.862	0.828	0.911	0.846
IntAVLTreeMap	0.285	0.891	0.872	0.888	0.793	0.884	0.766	0.863	0.865
IntRedBlackTree	0.438	0.486	0.462	0.467	0.817	0.815	0.744	0.793	0.782
LinkedList	0.022	0.751	0.904	0.631	0.042	0.463	0.904	0.362	0.373
NodeCachLList	0.087	0.725	0.707	0.580	0.122	0.691	0.618	0.357	0.343
SinglyLList	0.312	0.446	0.456	0.450	0.484	0.567	0.492	0.607	0.741
TreeMap	0.481	0.686	0.695	0.721	0.851	0.895	0.872	0.875	0.873
TreeSet	0.497	0.683	0.662	0.668	0.827	0.869	0.824	0.818	0.847
language: C									
Space	0.807	0.932	0.963	0.899	0.900	0.974	-	0.899	0.896
SQLite	0.002	0.937	0.950	-	0.051	0.981	-	0.965	0.960
YAFFS2	0.564	0.762	0.798	0.680	0.397	0.826	-	0.793	0.775
Printtokens	0.524	0.952	0.764	0.808	0.700	0.969	-	0.740	0.882
Printtokens2	0.393	0.658	0.653	0.579	0.455	0.642	-	0.651	0.639
Replace	0.454	0.622	0.652	0.564	0.560	0.669	-	0.635	0.642
Schedule	0.324	0.680	0.816	0.455	0.494	0.825	-	0.845	0.849
Schedule2	0.242	0.716	0.434	0.371	0.503	0.545	-	0.540	0.739
SglibRbtree	0.493	0.837	0.834	0.712	0.648	0.765	-	0.823	0.827
Tcas	0.609	0.433	0.768	0.752	0.770	0.770	-	0.803	0.772
Totinfo	0.294	0.599	0.681	0.510	0.420	0.691	-	0.694	0.674
Standard deviation	ignored	0.212	0.202	0.201	0.245	0.158	0.139	0.176	0.166
Geometric mean	ignored	0.630	0.672	0.598	0.448	0.742	0.702	0.710	0.725
Arithmetic mean	ignored	0.675	0.707	0.636	0.542	0.760	0.716	0.735	0.748
#The best results	ignored	4	3	0	1	8	3	4	4
#The worst results	ignored	7	2	2	13	0	1	0	1

Table 8:  $R^2$  values for each subject program and criteria when test-suites are selected with Size-varied Selection

Subject	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java								
JFreeChart	0.998	0.998	0.997	0.914	0.998	-	0.991	0.990
JodaTime	0.998	0.998	0.996	0.999	0.999	-	0.997	0.998
AvlTree	0.804	0.799	0.748	0.792	0.771	0.867	0.916	0.930
BinomialHeap	0.528	0.695	0.294	0.523	0.826	0.771	0.875	0.864
BinTree	0.332	0.352	0.472	0.299	0.368	0.484	0.431	0.505
FibHeap	0.825	0.885	0.816	0.147	0.291	0.607	0.717	0.543
FibonacciHeap	0.624	0.640	0.289	0.442	0.642	0.605	0.620	0.604
HeapArray	0.748	0.872	0.124	0.689	0.679	0.582	0.846	0.679
IntAVLTreeMap	0.889	0.860	0.673	0.800	0.896	0.782	0.786	0.827
IntRedBlackTree	0.640	0.663	0.097	0.827	0.836	0.777	0.836	0.816
LinkedList	0.583	0.758	0.383	0.600	0.820	0.758	0.658	0.546
NodeCachLList	0.497	0.731	0.064	0.590	0.696	0.704	0.558	0.450
SinglyLList	0.529	0.556	0.151	0.430	0.505	0.486	0.556	0.603
TreeMap	0.801	0.830	0.610	0.781	0.899	0.883	0.900	0.908
TreeSet	0.762	0.777	0.240	0.786	0.874	0.825	0.828	0.876
language: C								
Space	0.971	0.991	0.935	0.954	0.993	-	0.986	0.977
SQLite	0.938	0.950	-	0.053	0.981	-	0.965	0.960
YAFFS2	0.812	0.820	0.167	0.215	0.803	-	0.785	0.799
Printtokens	0.956	0.849	0.578	0.896	0.981	-	0.832	0.916
Printtokens2	0.851	0.856	0.399	0.724	0.834	-	0.858	0.857
Replace	0.776	0.773	0.424	0.684	0.761	-	0.748	0.751
Schedule	0.753	0.831	0.209	0.827	0.837	-	0.829	0.830
Schedule2	0.755	0.708	0.094	0.662	0.743	-	0.738	0.760
SglibRbtree	0.852	0.877	0.570	0.724	0.774	-	0.842	0.838
Tcas	0.703	0.830	0.760	0.793	0.793	-	0.831	0.803
Totinfo	0.577	0.668	0.171	0.644	0.700	-	0.664	0.639
Standard deviation	0.171	0.144	0.301	0.249	0.179	0.136	0.144	0.160
Geometric mean	0.728	0.776	0.343	0.562	0.754	0.689	0.778	0.762
Arithmetic mean	0.750	0.791	0.450	0.646	0.781	0.702	0.792	0.780
#The best results	2	6	0	1	11	0	4	6
#The worst results	1	0	21	4	0	0	0	0

Table 9:  $R^2$  values for each subject program and criteria when test-suites are selected with Coverage-varied Selection (mutants~coverage+size)

Subject	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java								
JFreeChart	0.924	0.938	0.926	0.804	0.921	-	0.925	0.916
JodaTime	0.927	0.939	0.928	0.936	0.939	-	0.940	0.936
AvlTree	0.682	0.693	0.695	0.577	0.716	0.695	0.740	0.739
BinomialHeap	0.665	0.784	0.811	0.369	0.866	0.801	0.882	0.881
BinTree	0.604	0.633	0.607	0.604	0.725	0.702	0.707	0.734
FibHeap	0.789	0.816	0.786	0.426	0.682	0.726	0.804	0.768
FibonacciHeap	0.478	0.491	0.488	0.453	0.520	0.512	0.502	0.505
HeapArray	0.867	0.915	0.843	0.579	0.867	0.828	0.914	0.850
IntAVLTreeMap	0.902	0.873	0.893	0.812	0.884	0.801	0.864	0.868
IntRedBlackTree	0.586	0.578	0.581	0.825	0.815	0.744	0.793	0.782
LinkedList	0.758	0.904	0.649	0.067	0.562	0.904	0.427	0.442
NodeCachLList	0.727	0.708	0.585	0.129	0.724	0.660	0.357	0.343
SinglyLList	0.557	0.561	0.568	0.494	0.615	0.541	0.638	0.749
TreeMap	0.756	0.760	0.772	0.853	0.897	0.872	0.875	0.873
TreeSet	0.761	0.752	0.753	0.828	0.870	0.827	0.829	0.851
language: C								
Space	0.966	0.972	0.907	0.902	0.974	-	0.932	0.943
SQLite	0.943	0.950	-	0.053	0.981	-	0.965	0.960
YAFFS2	0.830	0.837	0.681	0.569	0.826	-	0.840	0.833
Printtokens	0.846	0.806	0.811	0.701	0.974	-	0.802	0.907
Printtokens2	0.670	0.669	0.586	0.462	0.645	-	0.663	0.660
Replace	0.665	0.666	0.564	0.576	0.669	-	0.646	0.653
Schedule	0.795	0.827	0.457	0.688	0.832	-	0.845	0.860
Schedule2	0.411	0.442	0.372	0.555	0.545	-	0.540	0.743
SglibRbtree	0.831	0.838	0.719	0.681	0.767	-	0.824	0.827
Tcas	0.807	0.810	0.790	0.770	0.770	-	0.815	0.799
Totinfo	0.686	0.697	0.517	0.525	0.706	-	0.695	0.684
Standard deviation	0.144	0.144	0.156	0.241	0.137	0.119	0.162	0.154
Geometric mean	0.733	0.749	0.674	0.495	0.768	0.730	0.740	0.754
Arithmetic mean	0.747	0.764	0.692	0.586	0.780	0.739	0.760	0.773
#The best results	3	5	0	1	8	1	5	4
#The worst results	3	2	4	17	1	1	0	0

Table 10:  $R^2$  values for each subject program and criteria when test-suites are selected with Size-varied Selection (mutants~coverage+size)

Subject	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java								
JFreeChart	0.995	0.997	0.994	0.924	0.998	-	0.994	0.993
JodaTime	0.997	0.998	0.996	0.999	0.999	-	0.997	0.998
AvlTree	0.805	0.805	0.760	0.799	0.782	0.867	0.916	0.929
BinomialHeap	0.544	0.706	0.337	0.521	0.829	0.771	0.876	0.866
BinTree	0.405	0.421	0.499	0.358	0.431	0.527	0.480	0.539
FibHeap	0.825	0.884	0.835	0.151	0.299	0.620	0.720	0.548
FibonacciHeap	0.607	0.625	0.249	0.458	0.640	0.611	0.615	0.599
HeapArray	0.743	0.870	0.135	0.572	0.683	0.583	0.850	0.683
IntAVLTreeMap	0.889	0.860	0.710	0.801	0.896	0.782	0.787	0.828
IntRedBlackTree	0.657	0.677	0.156	0.833	0.866	0.824	0.873	0.863
LinkedList	0.583	0.758	0.398	0.507	0.819	0.758	0.658	0.546
NodeCachLList	0.525	0.738	0.069	0.595	0.704	0.712	0.570	0.473
SinglyLList	0.587	0.615	0.157	0.509	0.563	0.541	0.612	0.652
TreeMap	0.800	0.830	0.639	0.781	0.895	0.883	0.899	0.907
TreeSet	0.764	0.777	0.340	0.781	0.875	0.828	0.829	0.880
language: C								
Space	0.987	0.992	0.979	0.977	0.993	-	0.992	0.992
SQLite	0.945	0.953	-	0.490	0.982	-	0.966	0.963
YAFFS2	0.821	0.824	0.244	0.276	0.802	-	0.790	0.805
Printtokens	0.957	0.863	0.603	0.746	0.980	-	0.862	0.923
Printtokens2	0.851	0.856	0.475	0.726	0.832	-	0.858	0.857
Replace	0.771	0.772	0.498	0.547	0.766	-	0.747	0.750
Schedule	0.778	0.842	0.278	0.656	0.837	-	0.831	0.832
Schedule2	0.758	0.708	0.113	0.667	0.747	-	0.740	0.761
SglibRbtree	0.853	0.878	0.679	0.670	0.773	-	0.842	0.836
Tcas	0.719	0.819	0.759	0.794	0.794	-	0.828	0.792
Totinfo	0.577	0.667	0.189	0.625	0.702	-	0.665	0.638
Standard deviation	0.160	0.132	0.296	0.207	0.169	0.125	0.136	0.156
Geometric mean	0.742	0.785	0.383	0.603	0.765	0.705	0.788	0.770
Arithmetic mean	0.759	0.797	0.484	0.645	0.788	0.716	0.800	0.787
#The best results	0	7	0	1	9	0	4	6
#The worst results	1	0	19	6	0	0	0	0

Table 11:  $R^2$  values for each subject program and criteria when test-suites are selected with Coverage-varied Selection (mutants~coverage+log(size))

Subject	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)
language: Java								
JFreeChart	0.911	0.932	0.921	0.758	0.914	-	0.922	0.906
JodaTime	0.920	0.935	0.927	0.934	0.937	-	0.937	0.932
AvlTree	0.728	0.729	0.730	0.615	0.732	0.697	0.743	0.744
BinomialHeap	0.711	0.802	0.822	0.438	0.866	0.794	0.882	0.881
BinTree	0.715	0.723	0.714	0.703	0.743	0.729	0.734	0.748
FibHeap	0.782	0.813	0.784	0.555	0.674	0.756	0.801	0.761
FibonacciHeap	0.476	0.480	0.480	0.497	0.496	0.496	0.489	0.487
HeapArray	0.873	0.917	0.851	0.610	0.865	0.828	0.913	0.849
IntAVLTreeMap	0.906	0.875	0.897	0.802	0.885	0.785	0.863	0.866
IntRedBlackTree	0.556	0.546	0.550	0.846	0.829	0.761	0.808	0.797
LinkedList	0.762	0.905	0.667	0.103	0.578	0.905	0.405	0.428
NodeCachLList	0.736	0.708	0.581	0.269	0.710	0.640	0.383	0.372
SinglyLList	0.594	0.596	0.599	0.540	0.629	0.567	0.648	0.750
TreeMap	0.738	0.740	0.752	0.852	0.897	0.876	0.875	0.873
TreeSet	0.747	0.736	0.740	0.827	0.869	0.824	0.820	0.847
language: C								
Space	0.956	0.970	0.939	0.939	0.975	-	0.960	0.962
SQLite	0.945	0.953	-	0.490	0.982	-	0.966	0.963
YAFFS2	0.829	0.841	0.720	0.719	0.826	-	0.834	0.831
Printtokens	0.965	0.872	0.820	0.813	0.970	-	0.873	0.927
Printtokens2	0.675	0.666	0.586	0.568	0.646	-	0.662	0.659
Replace	0.678	0.673	0.617	0.619	0.673	-	0.660	0.664
Schedule	0.832	0.849	0.556	0.558	0.827	-	0.851	0.869
Schedule2	0.815	0.514	0.443	0.504	0.567	-	0.563	0.739
SglibRbtree	0.844	0.843	0.728	0.721	0.775	-	0.834	0.833
Tcas	0.749	0.789	0.795	0.773	0.773	-	0.804	0.784
Totinfo	0.656	0.699	0.518	0.494	0.698	-	0.696	0.688
Standard deviation	0.126	0.138	0.145	0.198	0.135	0.118	0.163	0.154
Geometric mean	0.762	0.760	0.695	0.592	0.770	0.733	0.746	0.757
Arithmetic mean	0.773	0.773	0.709	0.636	0.782	0.743	0.766	0.775
#The best results	6	6	0	2	6	1	3	4
#The worst results	4	2	4	16	0	1	0	0

Table 12:  $R^2$  values for each subject program and criteria when test-suites are selected with Size-varied Selection (mutants~coverage+log(size))



Coverage:Coverage'	Coverage-varied Selection				Size-varied Selection			
	Java		C		Java		C	
	$\tau_b$	$R^2$	$\tau_b$	$R^2$	$\tau_b$	$R^2$	$\tau_b$	$R^2$
BC:IMP	11:4	12:3	10:1	11:0	9:6	10:5	8:3	9:2
BC:PCT(BB)	12:3	7:8	9:2	6:5	9:6	6:9	6:5	6:5
BC:PCT(ST)	12:3	7:8	9:2	6:5	8:7	7:8	5:6	6:5
BC:SC	11:4	13:2	4:7	11:0	10:5	11:4	5:6	9:2
BC:AIMP	10:5	5:10	8:3	5:6	5:10	5:10	5:6	2:9
IMP:PCT(BB)	4:11	3:12	4:7	0:11	6:9	3:12	5:6	1:10
IMP:PCT(ST)	6:9	2:13	5:6	0:11	6:9	2:13	5:6	1:10
IMP:SC	8:7	11:4	3:8	0:11	11:4	12:3	3:8	2:9
IMP:AIMP	3:12	2:13	1:10	1:10	2:13	1:14	3:8	1:10
PCT(BB):PCT(ST)	8:7	7:8	5:6	6:5	10:5	9:6	5:6	6:5
PCT(BB):SC	4:11	12:3	2:9	6:5	10:5	12:3	4:7	6:5
PCT(BB):AIMP	6:9	7:8	3:8	4:7	3:12	6:9	4:7	5:6
PCT(ST):SC	7:8	9:6	3:8	5:6	9:6	11:4	6:5	7:4
PCT(ST):AIMP	7:8	7:8	4:7	4:7	2:13	4:11	5:6	4:7
SC:AIMP	7:8	4:11	7:4	4:7	4:11	3:12	5:6	2:9

Table 13: Comparison of coverages based on  $\tau_b$  and  $R^2$  values for different test suite composition

		Discordant Pairs								
		SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)	Mutants
		language: Java								
Concordant Pairs	SC		1.97	20.59	9.44	5.97	8.55	7.08	7.70	9.94
	BC	85.61		21.46	9.19	5.26	7.61	5.86	7.40	8.91
	DBB	64.10	63.24		28.31	24.79	28.46	25.63	25.25	23.12
	IMP	79.30	80.21	58.14		6.13	8.18	8.41	9.29	14.27
	AIMP	82.06	83.47	60.95	88.19		5.28	5.83	6.29	11.85
	PCT(MS)	78.76	80.61	56.29	85.82	87.15		6.76	7.30	14.10
	PCT(BB)	82.29	84.22	61.52	87.23	88.42	88.07		3.61	11.79
	PCT(ST)	81.76	82.73	62.00	86.49	88.08	87.65	93.27		11.86
	Mutants	73.94	75.39	58.58	74.36	75.73	72.75	77.30	77.32	
			language: C							
Concordant Pairs	SC		9.32	5.31	13.23	10.98	-	11.45	10.46	9.17
	BC	84.92		6.87	7.62	4.45	-	3.91	3.72	14.06
	DBB	55.58	54.53		6.62	6.44	-	7.37	7.29	7.56
	IMP	80.94	87.41	54.91		4.93	-	9.02	8.76	15.92
	AIMP	83.52	90.87	55.15	90.75		-	6.36	5.98	14.45
	PCT(MS)	-	-	-	-	-		-	-	-
	PCT(BB)	84.53	93.09	54.93	87.70	90.68	-		3.14	15.52
	PCT(ST)	85.72	93.45	55.08	88.14	91.26	-	96.03		15.19
	Mutants	86.23	82.06	54.31	80.10	81.89	-	82.59	83.15	

Table 14: Percentage of discordant/concordant pairs (averaged over all subject programs); Java, Coverage-varied Selection

		Discordant Pairs								
		SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)	Mutants
		language: Java								
Concordant Pairs	SC		0.94	0.99	7.92	3.65	4.95	4.64	4.59	6.01
	BC	55.17		0.66	7.27	2.78	4.55	3.70	4.09	5.22
	DBB	56.03	55.01		7.05	2.86	4.03	3.84	4.00	5.02
	IMP	50.16	51.23	49.76		9.81	12.52	13.55	14.06	12.17
	AIMP	52.42	53.81	52.09	73.47		7.69	5.94	6.11	7.70
	PCT(MS)	44.94	46.70	44.41	72.27	64.81		9.95	10.31	11.14
	PCT(BB)	53.35	54.73	52.91	77.26	74.23	70.45		2.57	10.07
	PCT(ST)	53.51	54.42	52.83	76.30	73.86	69.37	87.16		10.12
	Mutants	45.90	47.75	45.70	62.06	60.50	57.15	61.94	61.23	
			language: C							
Concordant Pairs	SC		10.64	9.14	15.52	13.47	-	13.16	12.30	10.07
	BC	68.98		13.60	13.33	7.36	-	3.90	4.72	15.95
	DBB	73.24	73.66		13.18	13.38	-	16.67	16.22	13.79
	IMP	68.12	76.63	80.85		10.11	-	15.72	16.07	17.30
	AIMP	68.24	80.80	78.15	85.22		-	10.09	10.35	16.05
	PCT(MS)	-	-	-	-	-		-	-	-
	PCT(BB)	70.54	86.57	77.39	82.01	85.03	-		4.28	18.09
	PCT(ST)	71.73	86.00	78.31	82.14	85.21	-	94.28		18.12
	Mutants	69.99	69.55	73.27	72.86	71.95	-	72.33	72.69	

Table 15: Percentage of discordant/concordant pairs (averaged over all subject programs); Java, Size-varied Selection

Subject	Overhead/Slowdown					
	SC	BC	IMP	MS	PCT BB	ST
language: Java						
JFreeChart	4.21	3.71	3.84	-	4.30	4.79
JodaTime	55.38	63.50	92.31	-	67.50	61.88
AvlTree	3.73	2.07	39.87	4.14	22.59	21.92
BinomialHeap	2.48	2.14	13.01	4.96	11.58	12.27
BinTree	2.13	1.63	4.91	2.22	3.65	3.74
FibHeap	2.38	1.86	7.65	3.13	5.63	7.54
FibonacciHeap	2.05	1.31	5.95	3.00	4.17	5.48
HeapArray	1.79	2.00	6.41	2.34	6.62	6.70
IntAVLTreeMap	2.29	1.59	15.75	2.48	7.56	7.70
IntRedBlackTree	2.13	1.41	10.88	2.65	5.10	6.19
LinkedList	1.63	0.94	4.28	1.64	3.15	3.57
NodeCachLLList	1.56	1.09	6.01	1.74	5.07	5.68
SinglyLLList	1.97	1.86	5.85	3.22	4.80	5.14
TreeMap	2.25	1.62	15.33	3.45	11.41	10.19
TreeSet	2.02	1.66	14.11	4.59	10.98	9.24
language: C						
Space	0.87	0.87	1.33	-	0.86	1.02
SQLite	1.40	1.40	31.83	-	15.87	58.43
YAFFS2	1.96	1.96	108.25	-	9.82	28.58
Printtokens	1.88	1.88	1.85	-	1.75	1.81
Printtokens2	2.29	2.29	2.85	-	2.35	2.86
Replace	2.30	2.30	2.68	-	2.17	2.59
Schedule	1.33	1.33	1.63	-	1.42	1.57
Schedule2	1.82	1.82	2.62	-	1.85	1.99
SglibRbtree	0.99	0.99	4.71	-	1.98	2.69
Tcas	1.99	1.99	2.01	-	2.27	2.65
Totinfo	1.66	1.66	2.13	-	1.77	1.90
Geometric mean	2.20	1.90	6.96	2.88	4.75	5.66

Table 16: Overhead measured as ratio of execution time of all tests on instrumented to original code

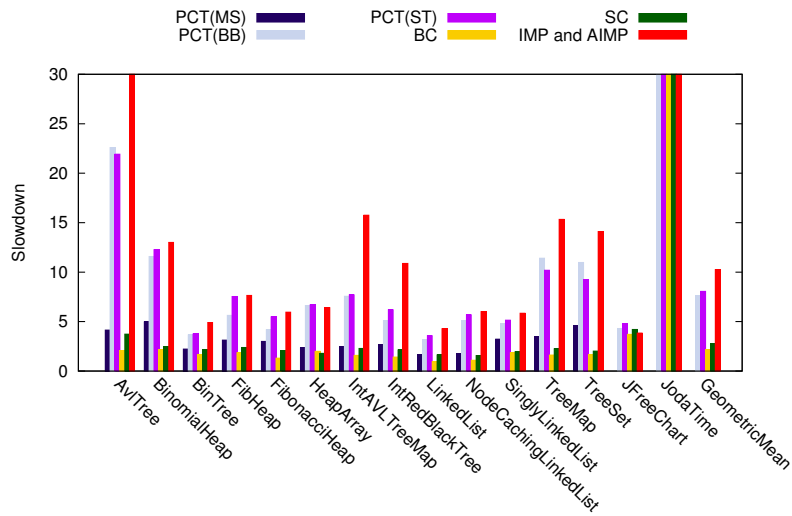


Figure 2: Runtime overhead for Java programs

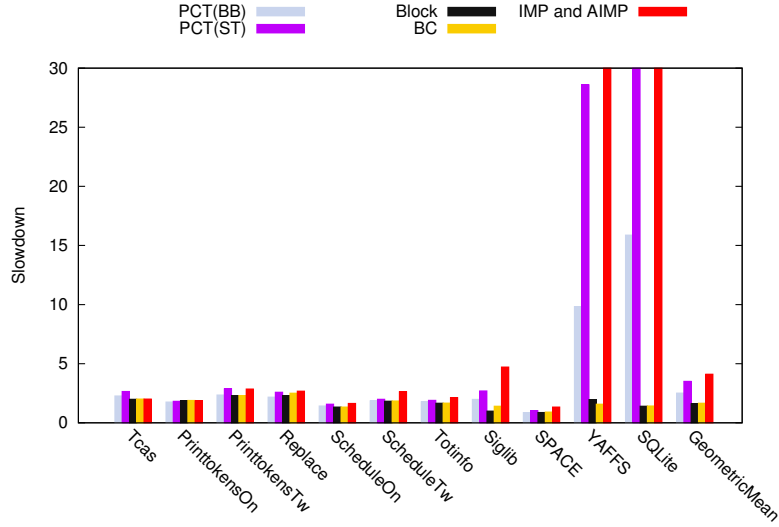


Figure 3: Runtime overhead for C programs

Subject	Tests killing mutants [%]				Tests executing branch [%]			
	Min	Max	Mean	SD	Min	Max	Mean	SD
language: Java								
JFreeChart	0.05	26.79	0.34	1.00	0.05	29.72	0.44	1.41
JodaTime	0.03	75.10	0.61	2.65	0.03	82.42	1.35	5.29
AvlTree	0.01	100.00	41.94	38.69	45.39	100.00	77.05	17.12
BinomialHeap	0.07	98.72	41.86	28.09	2.48	98.72	67.52	24.19
BinTree	1.40	99.23	33.31	32.53	9.77	99.23	74.16	19.13
FibHeap	0.02	100.00	38.45	42.80	2.16	100.00	64.05	39.45
FibonacciHeap	0.02	99.98	32.91	37.54	4.89	99.98	69.60	27.84
HeapArray	1.33	100.00	49.87	37.24	1.48	100.00	59.33	33.26
IntAVLTreeMap	0.04	100.00	61.74	31.46	5.73	100.00	58.89	30.25
IntRedBlackTree	0.00	99.51	17.97	29.87	4.77	99.51	51.75	27.80
LinkedList	69.01	100.00	91.80	13.15	63.43	92.35	76.63	10.49
NodeCachLLList	22.52	100.00	69.31	25.38	3.21	94.37	63.14	25.26
SinglyLLList	7.15	94.32	41.90	29.95	24.80	94.32	47.70	22.85
TreeMap	0.04	99.29	20.11	26.44	2.29	99.29	40.67	26.34
TreeSet	0.03	99.42	26.96	29.95	3.33	99.42	49.57	27.15
language: C								
Space	0.07	100.00	17.22	27.41	0.07	100.00	24.67	33.16
SQLite	0.17	100.00	26.85	38.77	0.21	100.00	26.73	37.33
YAFFS2	0.02	100.00	32.83	42.23	0.02	100.00	77.61	33.90
Printtokens	0.17	100.00	38.86	34.60	0.29	99.27	57.95	39.36
Printtokens2	0.73	99.27	39.17	36.89	0.73	98.54	52.55	36.29
Replace	0.02	89.32	24.09	24.57	0.40	99.60	39.02	31.53
Schedule	0.04	100.00	45.61	29.06	0.45	98.87	64.28	30.86
Schedule2	0.04	85.28	60.40	28.82	0.33	98.86	69.92	36.61
SglibRbtree	0.70	100.00	81.24	32.05	0.02	100.00	62.60	37.91
Tcas	0.06	100.00	19.35	32.37	1.87	98.13	24.54	20.49
Totinfo	9.16	100.00	44.04	30.50	8.29	99.89	61.26	29.63

Table 17: Statistics about percentage of tests that kill a mutant and execute a branch

Subject	NBNC	Size of test pool	Superheroes										
			100%	>90%	>80%	>70%	>60%	>50%	>40%	>30%	>20%	>10%	>0%
AvlTree	344	467	0	0	0	0	3	76	145	249	359	459	467
BinomialHeap	264	493	0	0	110	379	414	440	452	472	472	473	485
BinTree	100	365	0	0	0	0	0	109	243	319	352	357	365
FibHeap	264	276	0	1	3	126	263	273	274	275	275	276	276
FibonacciHeap	397	279	0	0	0	0	0	61	275	275	275	275	278
HeapArray	98	351	0	0	0	0	185	338	351	351	351	351	351
IntAVLTreeMap	213	500	0	137	343	449	484	495	495	499	500	500	500
IntRedBlackTree	296	500	0	0	0	28	244	411	471	492	498	500	500
LinkedList	245	100	0	0	86	86	100	100	100	100	100	100	100
NodeCachLList	234	140	0	0	60	66	66	125	140	140	140	140	140
SinglyLList	98	211	0	0	5	9	74	113	184	186	211	211	211
TreeMap	449	500	0	0	1	150	327	393	450	486	497	499	500
TreeSet	323	500	0	4	268	388	433	472	488	496	499	499	500

Figure 4: Random Test Cases: Number of test cases that kill more than X% mutants

Subject	NBNC	Size of test pool	Superheroes										
			100%	>90%	>80%	>70%	>60%	>50%	>40%	>30%	>20%	>10%	>0%
AvlTree	344	2734	0	0	0	0	0	0	14	408	1631	2534	2734
BinomialHeap	264	6172	0	0	0	0	0	88	1481	3935	4183	5492	6072
BinTree	100	4941	0	0	0	0	0	0	35	2389	3662	4554	4941
FibHeap	264	3769	0	0	0	0	822	1835	1840	3226	3375	3475	3769
FibonacciHeap	397	3879	0	0	0	0	0	102	1351	1938	3485	3485	3879
HeapArray	98	3090	0	0	0	0	0	778	2182	2182	3090	3090	3090
IntAVLTreeMap	213	7574	0	0	38	350	1618	3252	3578	5445	7174	7374	7574
IntRedBlackTree	296	11744	0	0	0	0	0	0	96	1930	8892	11744	11744
LinkedList	245	300	0	0	196	196	300	300	300	300	300	300	300
NodeCachLList	234	800	0	0	0	0	0	596	700	700	700	800	800
SinglyLList	98	1100	0	0	0	0	0	100	533	700	1000	1100	1100
TreeMap	449	10450	0	0	0	0	0	11	141	1069	3243	7736	10450
TreeSet	323	10883	0	0	0	1	10	88	919	2040	5601	8135	10883

Figure 5: ShapeAbs Test Cases: Number of test cases that kill more than X% mutants

Subject	NBNC	Size of test pool	Superheroes										
			100%	>90%	>80%	>70%	>60%	>50%	>40%	>30%	>20%	>10%	>0%
AvlTree	344	7840	0	0	0	0	103	4026	7627	7829	7840	7840	7840
BinomialHeap	264	1758	0	2	1149	1681	1731	1755	1756	1758	1758	1758	1758
BinTree	100	8519	0	0	0	0	0	341	2188	8466	8515	8519	8519
FibHeap	264	8797	0	0	0	0	0	0	70	8797	8797	8797	8797
FibonacciHeap	397	320	0	0	1	9	34	117	190	310	320	320	320
HeapArray	98	623	0	135	595	623	623	623	623	623	623	623	623
IntAVLTreeMap	213	8998	0	21	2554	8084	8977	8995	8996	8998	8998	8998	8998
IntRedBlackTree	296	8175	0	0	0	0	0	0	3	234	5894	8174	8175
LinkedList	245	907	902	902	902	902	907	907	907	907	907	907	907
NodeCachLList	234	836	0	731	836	836	836	836	836	836	836	836	836
SinglyLList	98	451	15	34	42	260	442	451	451	451	451	451	451
TreeMap	449	3126	0	0	0	0	0	11	181	1088	3032	3126	3126
TreeSet	323	6017	0	0	0	1	18	385	1461	4823	6005	6016	6017

Figure 6: ABP Test Cases: Number of test cases that kill more than X% mutants

Subject	Superheroes											
	100%	>90%	>80%	>70%	>60%	>50%	>40%	>30%	>20%	>10%	>0%	
AvlTree	0	0	0	0	106	4102	7786	8486	9830	10833	11041	
BinomialHeap	0	2	1259	2060	2145	2283	3689	6165	6413	7723	8315	
BinTree	0	0	0	0	0	450	2466	11174	12529	13430	13825	
FibHeap	0	1	3	126	1085	2108	2184	12298	12447	12548	12842	
FibonacciHeap	0	0	1	9	34	280	1816	2523	4080	4080	4477	
HeapArray	0	135	595	623	808	1739	3156	3156	4064	4064	4064	
IntAVLTreeMap	0	158	2935	8883	11079	12742	13069	14942	16672	16872	17072	
IntRedBlackTree	0	0	0	28	244	411	474	822	8322	17566	20419	
LinkedList	902	902	1184	1184	1307	1307	1307	1307	1307	1307	1307	
NodeCachLList	0	731	896	902	902	1557	1676	1676	1676	1776	1776	
SinglyLList	15	34	47	269	516	664	1168	1337	1662	1762	1762	
TreeMap	0	0	1	150	327	415	772	2643	6772	11361	14076	
TreeSet	0	4	268	390	461	945	2868	7359	12105	14650	17400	
JFreeChart	0	0	0	0	0	0	0	0	0	0	2160	
JodaTime	0	0	0	0	0	0	0	0	0	0	3800	
Space	0	0	0	0	0	0	0	0	0	961	4,130	
SQLite	0	0	0	0	0	0	0	0	0	3	592	
YAFFS2	0	0	0	0	0	0	0	0	0	4,871	5,000	
Printtokens	0	0	0	16	92	282	706	2,367	3,810	4,035	4,130	
Printtokens2	30	30	35	88	242	619	1,753	3,144	4,028	4,085	4,115	
Replace	0	0	0	2	119	314	785	1,228	2,504	4,314	5,542	
Schedule	0	0	0	93	708	1,132	1,422	1,703	2,019	2,429	2,650	
Schedule2	0	0	0	402	1,299	1,851	2,192	2,290	2,303	2,310	2,710	
SglibRbtree	0	0	0	0	0	0	0	4,620	5,000	5,000	5,000	
Totinfo	80	84	84	86	157	254	630	678	721	856	917	
Tcas	0	0	1	1	1	1	1	1	264	470	1,608	

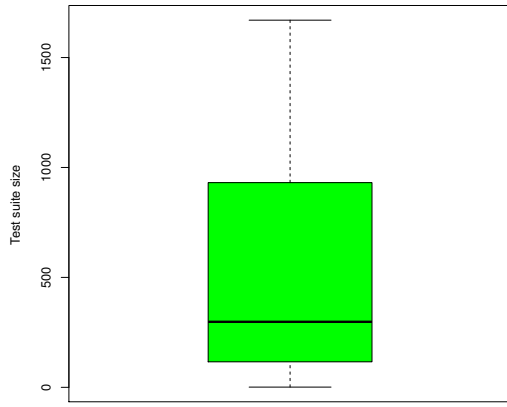
Figure 7: All Test Cases: Number of test cases that kill more than X% of mutants

Subject	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)	Mutants
language: Java									
JFreeChart	0.00	0.06	0.08	0.02	0.06	-	0.00	0.00	0.02
JodaTime	0.02	0.04	0.10	0.04	0.06	-	0.06	0.00	0.04
AvlTree	7.96	9.53	18.12	5.79	6.18	1.74	1.11	1.34	4.93
BinomialHeap	10.80	10.36	10.66	0.84	3.25	0.48	0.86	0.67	7.84
BinTree	18.19	10.18	24.03	1.38	3.05	0.96	0.67	0.74	21.00
FibHeap	11.25	11.69	15.09	1.75	2.89	5.04	2.96	1.82	11.26
FibonacciHeap	9.08	9.16	12.78	1.96	4.19	1.35	1.59	0.91	5.32
HeapArray	24.14	14.79	17.85	1.18	5.28	3.27	0.93	1.00	5.03
IntAVLTreeMap	4.50	5.28	5.24	2.33	5.16	0.74	0.88	0.74	6.84
IntRedBlackTree	2.34	4.63	4.09	0.93	1.61	0.43	0.33	0.34	0.96
LinkedList	25.46	24.18	29.64	15.79	14.72	24.18	15.95	14.91	44.83
NodeCachLList	17.93	16.83	20.48	4.56	9.14	12.15	5.67	7.09	21.09
SinglyLList	16.71	16.85	17.65	3.26	7.23	3.71	5.31	4.87	16.46
TreeMap	2.21	4.71	4.24	0.79	1.57	0.43	0.26	0.21	1.75
TreeSet	1.99	3.96	4.97	0.87	1.83	0.60	0.45	0.32	1.89
language: C									
Space	0.09	0.19	13.52	0.31	0.34	-	0.07	0.03	0.27
SQLite	4.10	2.53	4.10	3.38	3.39	-	2.31	2.51	2.19
YAFFS2	0.25	0.32	83.58	0.21	0.54	-	0.05	0.02	0.23
Printtokens	1.41	4.03	45.47	2.01	2.14	-	1.23	0.36	0.45
Printtokens2	1.38	1.34	34.71	1.79	1.35	-	0.29	0.16	0.57
Replace	1.03	1.05	22.67	1.43	0.99	-	0.18	0.18	1.53
Schedule	11.20	6.04	47.48	2.89	3.69	-	0.52	0.22	1.23
Schedule2	4.88	6.31	64.39	3.05	3.88	-	1.03	0.27	1.12
SglibRbtree	0.50	1.14	26.63	1.15	2.73	-	0.06	0.02	2.71
Tcas	10.63	2.53	18.10	5.91	5.91	-	0.86	0.81	1.51
Totinfo	4.97	4.90	52.52	10.42	3.73	-	1.12	0.62	3.09
Arithmetic mean	7.42	6.64	23.01	2.85	3.65	4.24	1.72	1.54	6.31

Table 18: Percentage of tied pairs achieved by test suites created using Coverage-varied Selection

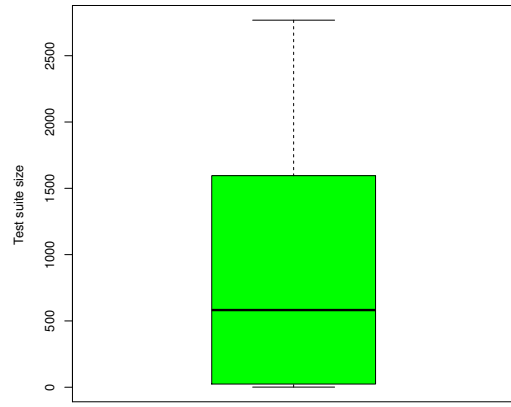
Subject	SC	BC	DBB	IMP	AIMP	PCT(MS)	PCT(BB)	PCT(ST)	Mutants
language: Java									
JFreeChart	0.04	0.05	0.12	0.09	0.08	-	0.08	0.07	0.04
JodaTime	0.04	0.07	0.12	0.12	0.11	-	0.06	0.06	0.03
AvlTree	91.39	91.42	91.42	3.04	26.30	6.08	20.02	38.77	10.20
BinomialHeap	38.67	38.61	38.96	0.59	19.66	2.30	5.63	3.79	36.71
BinTree	92.60	67.52	92.61	0.43	10.59	2.68	4.25	2.18	15.89
FibHeap	21.60	16.63	25.18	0.51	13.69	1.90	6.49	6.24	9.19
FibonacciHeap	39.37	40.83	41.74	0.51	25.18	9.17	6.92	5.76	2.97
HeapArray	43.99	44.26	44.06	0.45	13.22	14.44	2.82	2.22	20.87
IntAVLTreeMap	34.41	34.51	36.31	6.42	21.23	1.57	3.23	2.51	34.68
IntRedBlackTree	18.31	20.58	21.82	1.03	2.56	0.76	0.54	0.50	0.81
LinkedList	86.00	97.58	86.01	0.54	26.21	97.58	28.82	27.36	98.25
NodeCachLList	45.96	47.72	45.98	0.60	24.77	26.66	21.02	19.01	85.07
SinglyLList	86.30	86.30	86.31	0.94	51.34	17.76	21.96	20.98	55.79
TreeMap	9.31	12.49	12.98	0.71	1.95	0.75	0.26	0.22	2.33
TreeSet	14.65	18.06	18.56	0.89	2.80	1.19	0.97	0.77	3.50
language: C									
Space	0.12	0.32	0.56	0.21	0.49	-	0.05	0.01	0.37
SQLite	4.10	2.53	4.10	3.38	3.39	-	2.31	2.51	2.19
YAFFS2	0.98	0.81	1.13	0.01	0.52	-	0.08	0.04	0.23
Printtokens	10.16	9.94	4.77	0.55	3.56	-	2.80	0.80	2.13
Printtokens2	9.94	9.04	3.24	0.53	4.51	-	1.47	0.85	4.68
Replace	4.35	3.15	2.06	0.48	1.77	-	0.41	0.24	2.70
Schedule	30.96	16.56	4.39	1.30	8.48	-	1.98	0.82	5.45
Schedule2	43.20	7.80	7.36	3.06	5.73	-	0.89	0.60	4.61
SglibRbtree	1.19	2.90	2.16	0.49	6.95	-	0.28	0.10	9.66
Tcas	24.81	9.19	19.16	3.91	3.91	-	0.28	0.17	0.94
Totinfo	42.99	37.72	7.32	0.93	5.26	-	1.56	0.62	63.61
Arithmetic mean	30.59	27.56	26.86	1.22	10.93	14.06	5.20	5.28	18.19

Table 19: Percentage of tied pairs achieved by test suites created using Size-varied Selection



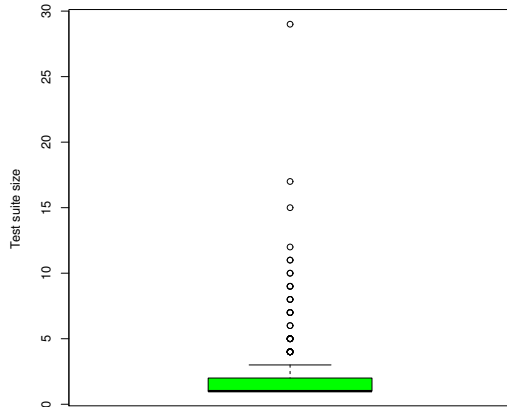
JFreeChart

(a)



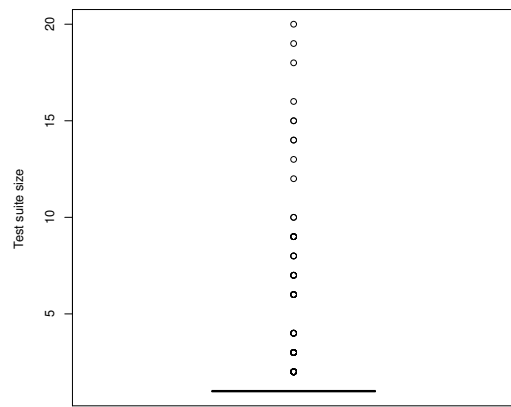
JodaTime

(b)



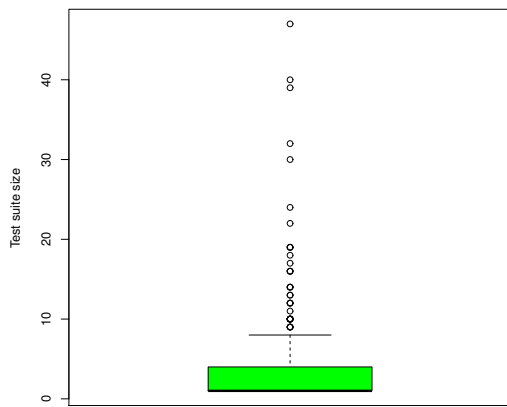
example.taco.avltree.AviTree

(c)



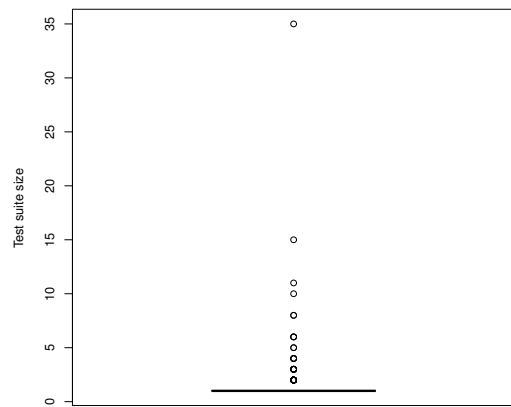
example.issta2006.binomialheap.BinomialHeap

(d)



example.issta2006.bintree.BinTree

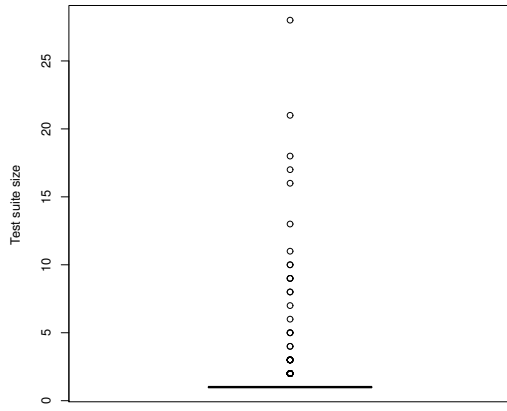
(e)



example.issta2006.fibheap.FibHeap

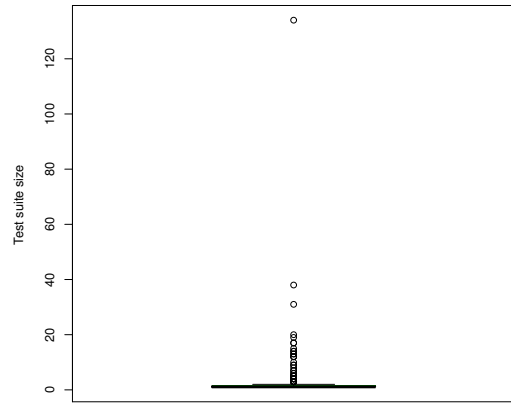
(f)

Figure 8: Distribution of sizes for test suites created by Coverage-varied Selection



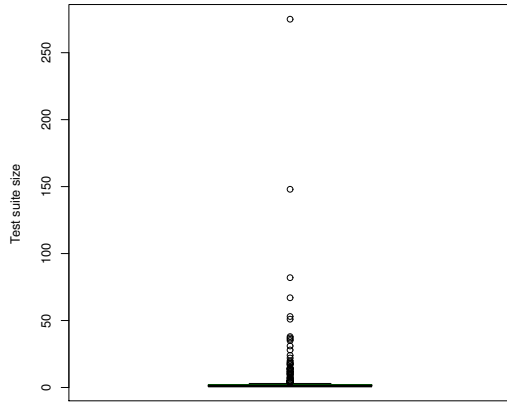
example.fibonacciheap.FibonacciHeap

(a)



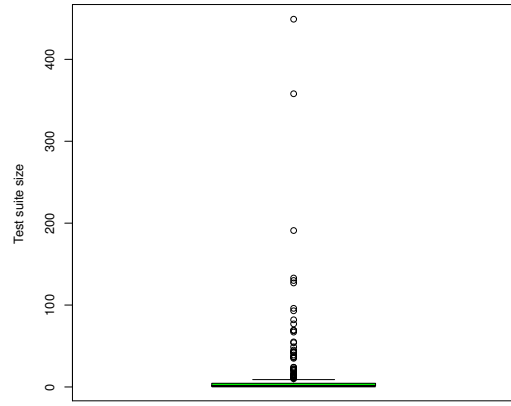
example.heaparray.HeapArray

(b)



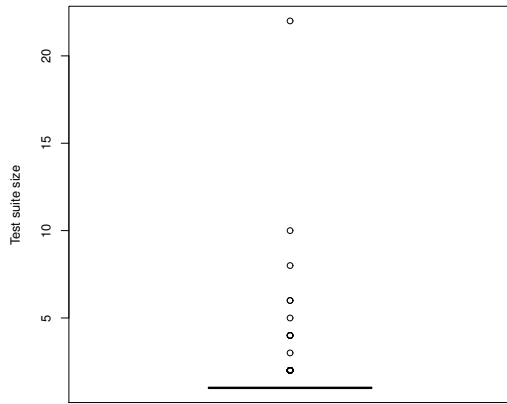
example.avl.IntAVLTreeMap

(c)



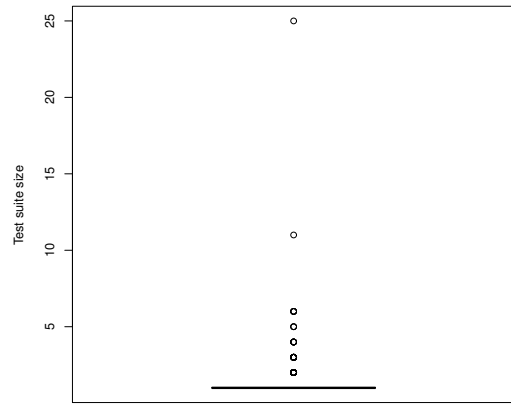
example.intredblacktree.IntRedBlackTree

(d)



example.taco.linkedlist.LinkedList

(e)

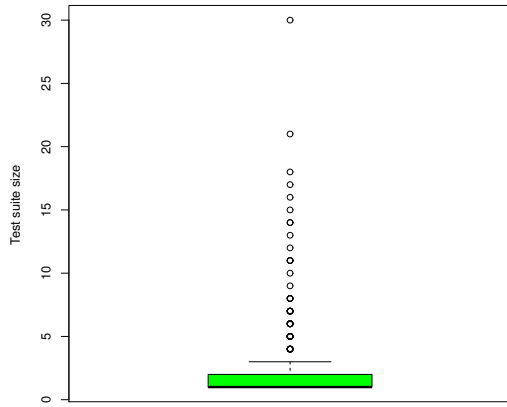


example.taco.cachelist.NodeCachingLinkedList

(f)

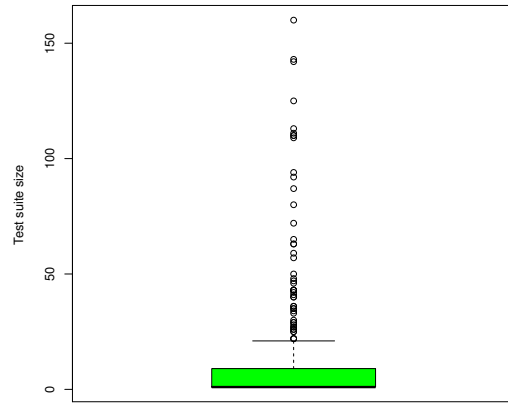
Figure 9: Distribution of sizes for test suites created by Coverage-varied Selection





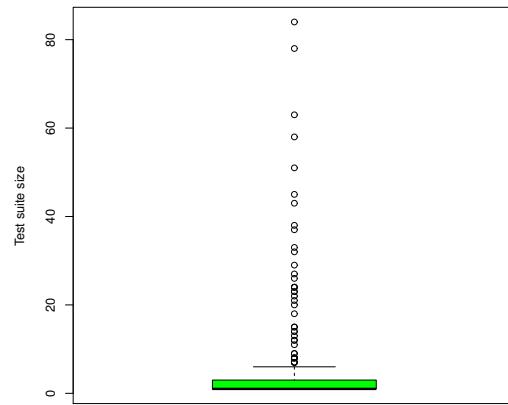
example.taco.singlylist.SinglyLinkedList

(a)



example.issta2006.treemap.TreeMap

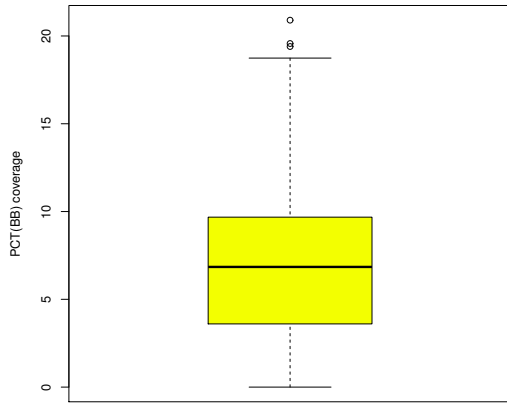
(b)



example.taco.treeset.TreeSet

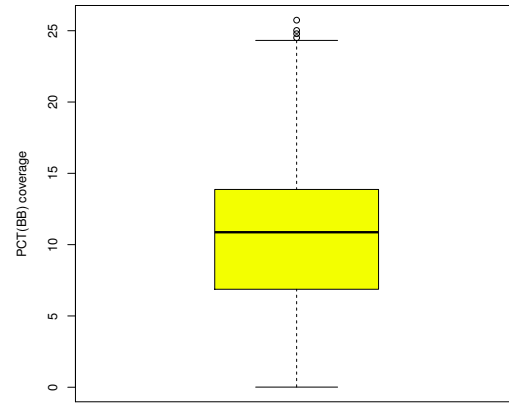
(c)

Figure 10: Distribution of sizes for test suites created by Coverage-varied Selection



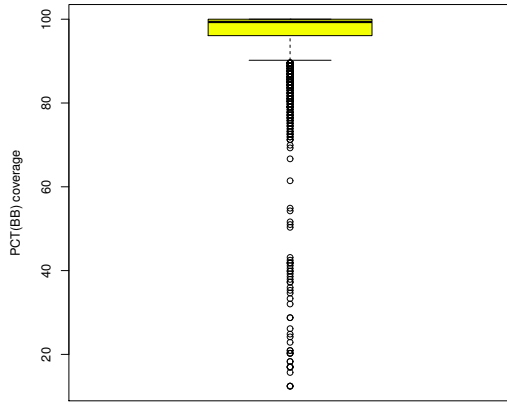
JFreeChart

(a)



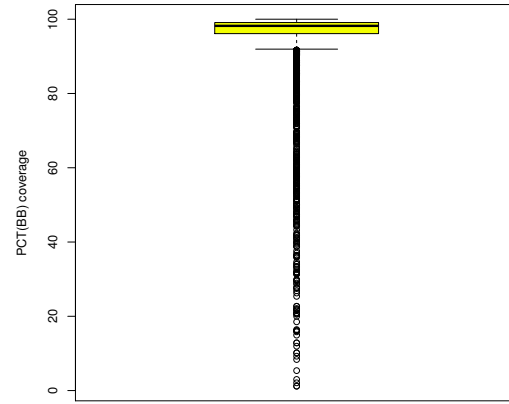
JodaTime

(b)



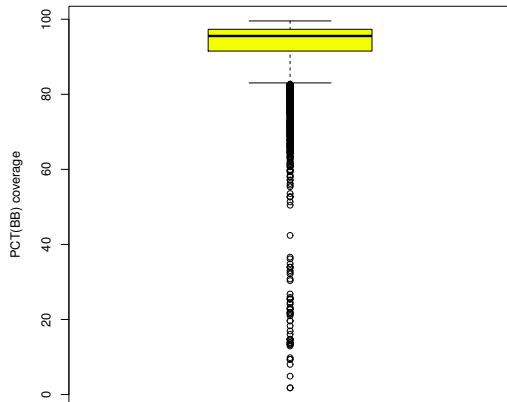
example.taco.avltree.AviTree

(c)



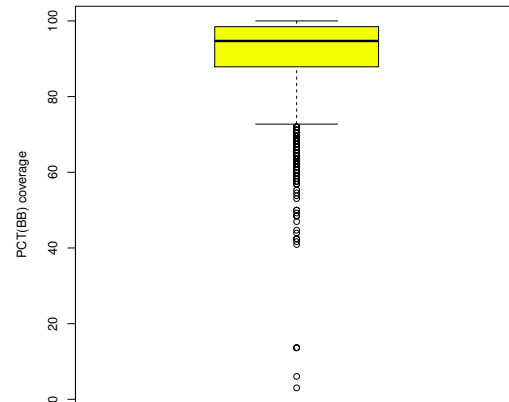
example.issta2006.binomialheap.BinomialHeap

(d)



example.issta2006.bintree.BinTree

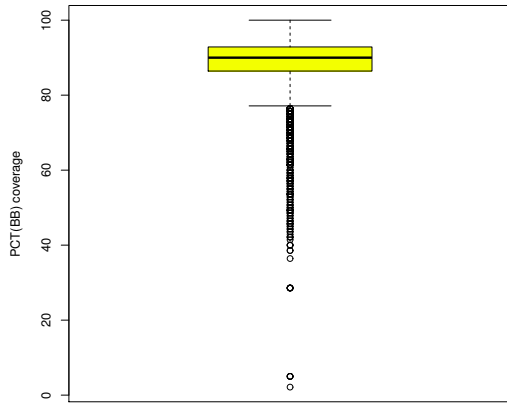
(e)



example.issta2006.fibheap.FibHeap

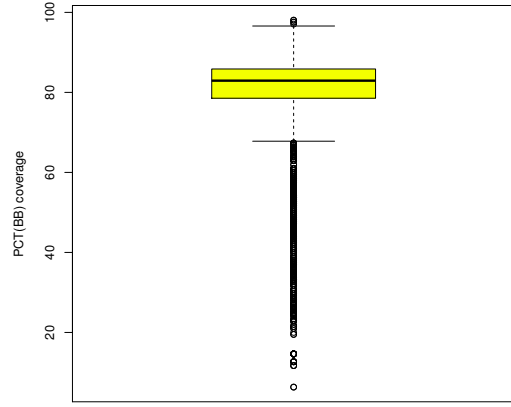
(f)

Figure 11: Distribution of coverage for test suites created by Size-varied Selection



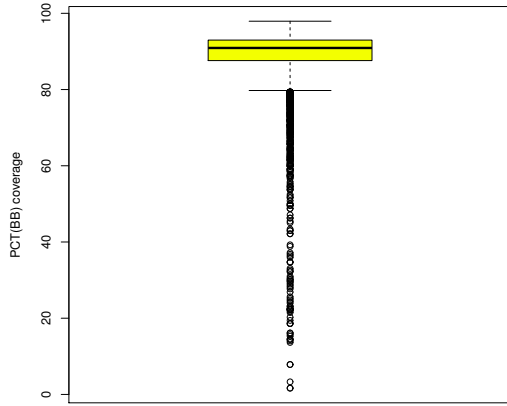
example.fibonacciheap.FibonacciHeap

(a)



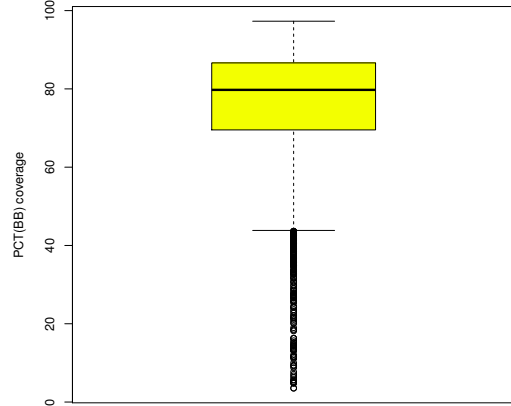
example.heaparray.HeapArray

(b)



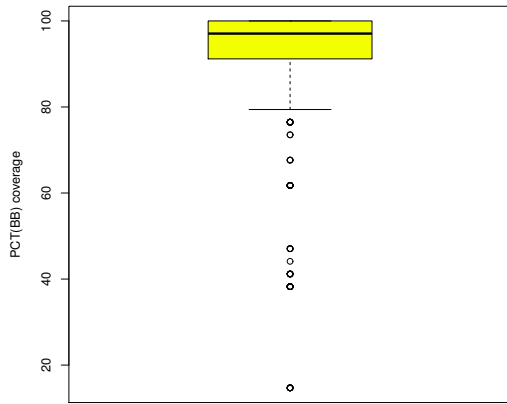
example.avl.IntAVLTreeMap

(c)



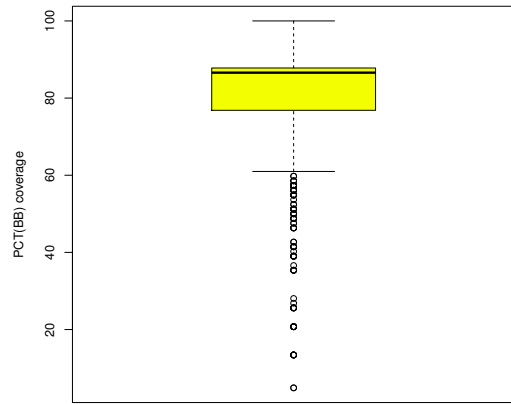
example.intredblacktree.IntRedBlackTree

(d)



example.taco.linkedlist.LinkedList

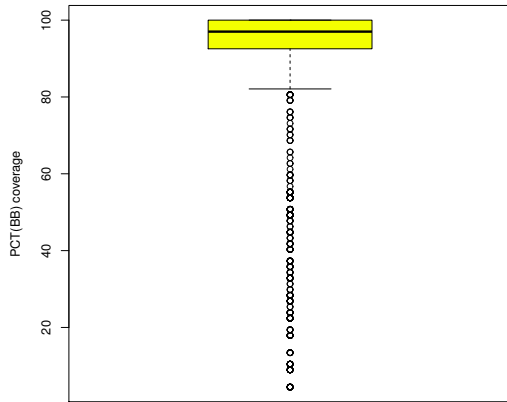
(e)



example.taco.cachelist.NodeCachingLinkedList

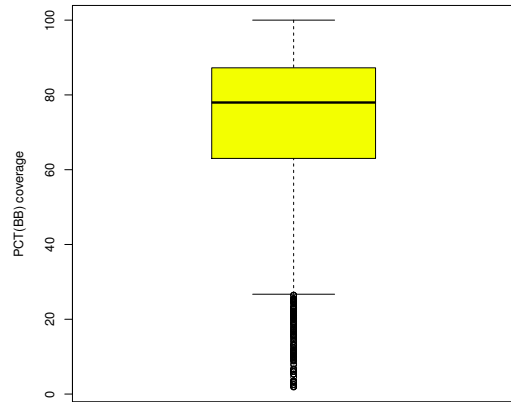
(f)

Figure 12: Distribution of coverage for test suites created by Size-varied Selection



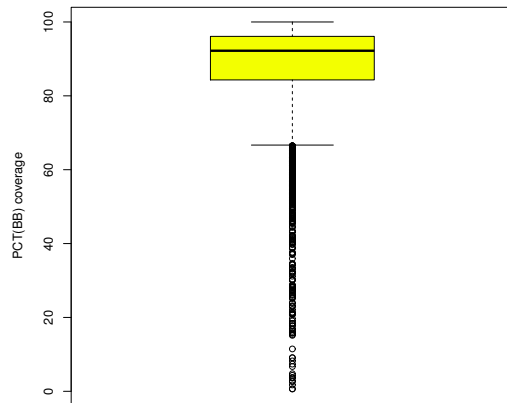
example.taco.singlylist.SinglyLinkedList

(a)



example.issta2006.treemap.TreeMap

(b)



example.taco.treeset.TreeSet

(c)

Figure 13: Distribution of coverage for test suites created by Size-varied Selection

95-100																				
90-95																				
85-90																				
80-85																				
75-80																				
70-75																				
65-70																				
60-65																				
55-60			0.09																	
50-55					0.04															
45-50			0.04																	
40-45		0.02	0.01		0.01	0.01	0.02	0.01												
35-40		0.06	0.18		0.42		0.08	0.03	0.01	0.01	0.01									
30-35	0.06	0.07	0.45		1.08		0.52		0.03	0.01	0.02	0.01								
25-30	0.18	0.19	0.05	0.02	0.02	0.01	0.04				0.02	0.07								
20-25	0.44	0.46	0.15	0.04	0.13	0.02	0.13	0.01	0.01		0.01	0.06								
15-20	1.39	2.74	1.75	0.72	0.34	0.16	0.06	0.02	0.04	0.01	0.01	0.01								
10-15	2.98	3.76	1.81	0.62	0.22	0.12	0.02	0.02	0.05	0.03	0.04									
5-10	7.78	3.68	2.11	1.01	0.22	0.27	0.19	0.09	0.06	0.04	0.09	0.01	0.01							
0-5	35.76	12.93	6.15	2.81	1.76	0.67	0.97	0.52	0.39	0.11	0.08	0.01	0.01							
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	

Figure 14: Percentage of discordant pairs in various groups for SC Coverage-varied Selection (Coverage diff is y axis and mutant diff is x axis)

95-100																				
90-95				0.01																
85-90																				
80-85																				
75-80																				
70-75																				
65-70																				
60-65																				
55-60			0.01																	
50-55					0.01															
45-50																				
40-45																				
35-40			0.03	0.01	0.02															
30-35			0.02		0.09		0.01													
25-30	0.01			0.02																
20-25	0.05	0.01		0.03	0.01															
15-20	0.15	0.04		0.02	0.01	0.01														
10-15	0.56	0.11	0.02	0.13	0.03	0.03	0.02	0.01												
5-10	6.22	1.67	0.66	0.68	0.25	0.24	0.15	0.09	0.04	0.02	0.01									
0-5	63.71	12.72	4.58	3.92	1.81	1.17	0.35	0.10	0.05	0.01										
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	

Figure 15: Percentage of discordant pairs in various groups for SC Size-varied Selection (Coverage diff is y axis and mutant diff is x axis)

95-100																				
90-95																				
85-90																				
80-85			0.01	0.01																
75-80	0.01	0.01	0.01	0.01	0.02															
70-75	0.01	0.01	0.01	0.01																
65-70	0.05	0.03	0.09	0.03	0.02	0.01	0.01													
60-65	0.06	0.04	0.03	0.04	0.09	0.01	0.02	0.01			0.01									
55-60	0.06	0.03	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01								
50-55	0.07	0.02	0.06	0.02	0.21	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.01							
45-50	0.08	0.06	0.15	0.03	0.27	0.03	0.07	0.02	0.02	0.01	0.01	0.01	0.02							
40-45	0.11	0.10	0.36	0.04	0.79	0.03	0.15	0.03	0.03	0.02	0.02	0.02	0.04							
35-40	0.10	0.09	0.10	0.04	0.16	0.04	0.34	0.02	0.04	0.01	0.01	0.01	0.02							
30-35	0.36	0.27	0.09	0.05	0.06	0.04	0.06	0.03	0.02	0.02	0.02	0.04	0.01							
25-30	0.82	0.93	0.32	0.18	0.46	0.15	0.17	0.04	0.05	0.03	0.06	0.06	0.01							
20-25	0.97	1.36	0.58	0.24	0.17	0.15	0.16	0.11	0.07	0.06	0.09	0.11	0.01	0.01	0.01	0.01	0.02	0.01		
15-20	1.79	2.69	2.04	0.87	0.25	0.25	0.13	0.13	0.12	0.09	0.09	0.12	0.01	0.01	0.01	0.02	0.02	0.01		
10-15	3.43	2.51	1.60	0.82	0.73	0.34	0.36	0.18	0.22	0.12	0.11	0.16	0.03	0.01	0.02	0.02	0.02	0.02		
5-10	8.21	4.80	2.26	1.17	0.67	0.38	0.55	0.28	0.34	0.16	0.21	0.21	0.08	0.03	0.04	0.02	0.03	0.02		
0-5	28.19	8.98	4.09	2.28	1.14	0.65	0.41	0.36	0.28	0.19	0.23	0.35	0.12	0.06	0.10	0.05	0.04	0.04		
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	

Figure 16: Percentage of discordant pairs in various groups for BC Coverage-varied Selection (Coverage diff is y axis and mutant diff is x axis)



95-100																				
90-95																				
85-90																				
80-85																				
75-80																				
70-75																				
65-70																				
60-65																				
55-60																				
50-55																				
45-50																				
40-45																				
35-40			0.02		0.06		0.02		0.01											
30-35	0.02	0.01	0.16		0.36		0.21		0.01											
25-30	0.06	0.03	0.20		0.50		0.18													
20-25	0.19	0.12	0.16	0.01	0.10		0.06													
15-20	0.47	0.42	0.14	0.03	0.02	0.01														
10-15	1.34	1.05	0.42	0.10	0.05	0.01	0.01													
5-10	2.83	1.98	1.12	0.37	0.21	0.05	0.18	0.01	0.10											
0-5	35.56	19.37	10.12	5.24	4.67	3.28	2.79	1.31	1.42	0.59	0.71	0.76	0.21	0.09	0.15	0.11	0.12	0.10	0.01	0.01
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100

Figure 20: Percentage of discordant pairs in various groups for IMP Coverage-varied Selection (Coverage diff is y axis and mutant diff is x axis)

95-100																				
90-95																				
85-90																				
80-85																				
75-80																				
70-75																				
65-70																				
60-65																				
55-60																				
50-55																				
45-50																				
40-45			0.01		0.01															
35-40	0.01		0.01		0.02															
30-35	0.09	0.01	0.01		0.02															
25-30	0.15	0.06	0.01		0.01		0.01													
20-25	0.26	0.07	0.02			0.01	0.01													
15-20	0.65	0.17	0.04		0.01	0.01	0.03	0.01												
10-15	2.07	0.57	0.18	0.02	0.02	0.01	0.14	0.01												
5-10	6.57	1.71	0.57	0.26	0.10	0.04	0.38	0.02	0.01											
0-5	56.46	15.08	5.37	4.40	1.88	1.15	1.03	0.08	0.05	0.03	0.02									
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100

Figure 21: Percentage of discordant pairs in various groups for IMP Size-varied Selection (Coverage diff is y axis and mutant diff is x axis)

95-100																				
90-95																				
85-90																				
80-85																				
75-80			0.05																	
70-75			0.02		0.01															
65-70			0.03		0.03															
60-65	0.01		0.01		0.14		0.01													
55-60	0.02	0.01	0.07	0.01	0.14		0.02													
50-55	0.06	0.04	0.07	0.02	0.27	0.01	0.09	0.01		0.01		0.01								
45-50	0.13	0.12	0.12	0.05	0.34	0.03	0.08	0.01	0.01	0.01		0.01								
40-45	0.25	0.18	0.13	0.06	0.30	0.06	0.17	0.02	0.01	0.01	0.01	0.01	0.02							
35-40	0.34	0.41	0.30	0.13	0.17	0.09	0.15	0.03	0.02	0.02	0.02	0.02	0.02							
30-35	0.52	0.47	0.49	0.24	0.25	0.13	0.22	0.04	0.04	0.02	0.05	0.04								
25-30	0.87	0.82	0.64	0.33	0.45	0.36	0.21	0.07	0.13	0.06	0.06	0.10	0.01		0.01	0.01	0.02	0.01		
20-25	1.47	1.25	0.74	0.46	0.61	0.39	0.42	0.09	0.15	0.05	0.07	0.06	0.01		0.01	0.01	0.01	0.01	0.02	
15-20	2.02	2.08	1.18	0.67	0.66	0.39	0.49	0.11	0.22	0.08	0.10	0.13	0.02	0.01	0.02	0.02	0.02	0.02	0.01	
10-15	4.28	3.00	1.56	0.94	0.74	0.47	0.50	0.18	0.31	0.11	0.12	0.17	0.04	0.01	0.02	0.01	0.02	0.02	0.02	
5-10	8.09	5.65	2.58	1.41	1.19	0.61	0.56	0.30	0.33	0.13	0.18	0.18	0.07	0.03	0.04	0.02	0.02	0.02	0.02	
0-5	22.96	7.85	3.42	1.87	1.35	0.65	0.51	0.37	0.24	0.17	0.19	0.30	0.11	0.04	0.06	0.06	0.04	0.03	0.03	0.01
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100

Figure 22: Percentage of discordant pairs in various groups for PMIT Coverage-varied Selection (Coverage diff is y axis and mutant diff is x axis)

95-100																					
90-95																					
85-90																					
80-85																					
75-80																					
70-75																					
65-70			0.01		0.01																
60-65			0.01		0.01																
55-60	0.01																				
50-55	0.01			0.01																	
45-50	0.02	0.01																			
40-45	0.04	0.01		0.01																	
35-40	0.06	0.02	0.02	0.03	0.02	0.01															
30-35	0.12	0.03	0.02	0.03	0.03	0.02	0.01														
25-30	0.25	0.07	0.02	0.05	0.03	0.03	0.01														
20-25	0.49	0.13	0.04	0.07	0.04	0.05	0.02	0.01													
15-20	1.09	0.26	0.07	0.17	0.07	0.07	0.03	0.01	0.01												
10-15	3.84	0.78	0.21	0.31	0.13	0.13	0.07	0.02	0.01	0.01											
5-10	13.73	3.07	0.81	0.83	0.34	0.26	0.14	0.03	0.02	0.02	0.01										
0-5	51.35	11.75	3.19	2.98	1.16	0.68	0.16	0.05	0.03	0.02	0.01										
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	

Figure 23: Percentage of discordant pairs in various groups for PMIT Size-varied Selection (Coverage diff is y axis and mutant diff is x axis)

95-100																					
90-95																					
85-90																					
80-85																					
75-80					0.04																
70-75																					
65-70			0.08		0.01																
60-65			0.05		0.07																
55-60		0.02	0.05		0.15		0.02														
50-55		0.04	0.16		0.53		0.08														
45-50	0.03	0.08	0.04		0.26		0.14														
40-45	0.11	0.14	0.09		0.33		0.17														
35-40	0.22	0.41	0.07		0.48		0.15														
30-35	0.37	0.89	0.33	0.01	0.26		0.13		0.01												
25-30	0.92	1.63	0.74	0.07	0.69		0.32		0.02												
20-25	2.10	2.29	0.88	0.16	0.17	0.01	0.27		0.04												
15-20	3.53	3.48	1.40	0.38	0.62	0.14	0.26		0.17												
10-15	4.96	5.06	2.48	1.46	1.35	0.39	0.72	0.02	0.24												
5-10	7.87	7.76	3.71	1.67	1.77	1.13	0.63	0.16	0.25		0.02										
0-5	11.19	9.29	5.02	2.12	2.00	0.90	0.98	0.22	0.29		0.01										
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	

Figure 24: Percentage of discordant pairs in various groups for PCTMS Coverage-varied Selection (Coverage diff is y axis and mutant diff is x axis)

95-100																					
90-95																					
85-90																					
80-85			0.01																		
75-80			0.01		0.01																
70-75			0.02		0.01																
65-70			0.01		0.02																
60-65			0.01		0.02																
55-60			0.01		0.03																
50-55					0.03																
45-50			0.02		0.03		0.01														
40-45			0.01		0.01																
35-40	0.01	0.01	0.01		0.01		0.01														
30-35	0.04	0.02	0.01		0.01		0.01														
25-30	0.16	0.08	0.02		0.01		0.02														
20-25	0.44	0.29	0.07	0.01	0.01		0.04														
15-20	1.28	0.92	0.29	0.09	0.04	0.01	0.07														
10-15	3.29	2.38	0.90	0.29	0.16	0.05	0.21														
5-10	9.68	6.33	2.55	0.95	0.56	0.23	0.58	0.01													
0-5	33.47	17.66	7.58	2.86	2.06	1.13	2.71	0.04	0.02												
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	

Figure 25: Percentage of discordant pairs in various groups for PCTMS Size-varied Selection (Coverage diff is y axis and mutant diff is x axis)



95-100																				
90-95																				
85-90																				
80-85																				
75-80																				
70-75	0.01		0.01	0.01																
65-70	0.01		0.01																	
60-65	0.01	0.01	0.07	0.01	0.02															
55-60	0.04	0.03	0.04	0.02	0.03	0.01	0.01	0.01		0.01	0.01									
50-55	0.06	0.07	0.03	0.03	0.02	0.02	0.01	0.01	0.01		0.01	0.01								
45-50	0.07	0.11	0.12	0.05	0.18	0.02	0.02	0.02	0.01	0.01	0.01	0.01								
40-45	0.09	0.19	0.13	0.04	0.30	0.04	0.12	0.02	0.01	0.01	0.01	0.01								
35-40	0.08	0.27	0.24	0.05	0.18	0.03	0.09	0.02	0.02	0.01	0.01	0.01								
30-35	0.26	0.44	0.28	0.11	0.33	0.07	0.10	0.03	0.04	0.02	0.04	0.04				0.01		0.01		
25-30	0.50	0.77	0.37	0.15	0.43	0.11	0.21	0.06	0.05	0.04	0.06	0.05	0.01	0.01		0.01	0.01	0.02	0.01	
20-25	1.24	1.06	0.54	0.22	0.55	0.16	0.21	0.11	0.11	0.07	0.08	0.13	0.01		0.01	0.01	0.01	0.01	0.01	
15-20	2.38	1.86	0.88	0.40	0.37	0.19	0.20	0.13	0.10	0.08	0.09	0.09	0.03	0.01	0.02	0.02	0.02	0.02	0.01	
10-15	4.27	3.16	1.63	0.66	0.61	0.23	0.37	0.19	0.21	0.09	0.13	0.15	0.03	0.01	0.01	0.02	0.02	0.01	0.01	
5-10	8.97	5.27	2.61	1.38	0.95	0.39	0.42	0.24	0.39	0.10	0.16	0.16	0.06	0.03	0.04	0.01	0.02	0.02	0.02	
0-5	25.39	10.25	4.65	2.30	1.33	0.83	0.73	0.45	0.50	0.20	0.24	0.31	0.12	0.05	0.08	0.05	0.05	0.04	0.04	0.04
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100

Figure 26: Percentage of discordant pairs in various groups for PCTBB Coverage-varied Selection (Coverage diff is y axis and mutant diff is x axis)

95-100																				
90-95																				
85-90																				
80-85																				
75-80																				
70-75																				
65-70																				
60-65																				
55-60			0.01																	
50-55	0.01		0.01																	
45-50	0.01				0.01															
40-45	0.02		0.01		0.01															
35-40	0.03	0.01	0.01		0.02															
30-35	0.05	0.02	0.01	0.02	0.02															
25-30	0.10	0.03	0.01	0.03	0.02	0.01														
20-25	0.22	0.07	0.02	0.03	0.01	0.02	0.01													
15-20	0.57	0.17	0.05	0.05	0.02	0.03	0.02													
10-15	2.40	0.58	0.20	0.23	0.09	0.07	0.03	0.01	0.01											
5-10	11.44	2.83	0.95	0.77	0.46	0.30	0.10	0.03	0.02	0.01	0.01									
0-5	52.93	13.78	4.06	3.53	1.57	1.11	0.41	0.11	0.06	0.03	0.01									
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100

Figure 27: Percentage of discordant pairs in various groups for PCTBB Size-varied Selection (Coverage diff is y axis and mutant diff is x axis)

95-100																				
90-95																				
85-90																				
80-85			0.01																	
75-80	0.01	0.01	0.01	0.01																
70-75	0.01		0.01	0.01																
65-70	0.02	0.01	0.01	0.01	0.01	0.01				0.01			0.01							
60-65	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01		0.01			0.01							
55-60	0.07	0.04	0.04	0.05	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01						
50-55	0.08	0.05	0.12	0.03	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01								
45-50	0.06	0.07	0.04	0.03	0.03	0.03	0.01	0.02	0.01	0.01	0.01	0.01								
40-45	0.14	0.16	0.06	0.03	0.02	0.04	0.03	0.02	0.02	0.02	0.01	0.04								
35-40	0.14	0.27	0.13	0.04	0.06	0.03	0.02	0.02	0.02	0.01	0.02	0.02								
30-35	0.30	0.48	0.47	0.07	0.54	0.04	0.07	0.03	0.03	0.02	0.02	0.03	0.01							
25-30	0.61	0.57	0.25	0.14	0.56	0.11	0.18	0.02	0.04	0.02	0.03	0.03								
20-25	1.20	1.34	0.66	0.25	0.77	0.18	0.24	0.06	0.11	0.05	0.08	0.07	0.01		0.01	0.01	0.02	0.01		
15-20	2.29	1.73	0.88	0.58	0.68	0.24	0.26	0.18	0.18	0.08	0.09	0.11	0.02		0.01	0.01	0.02	0.02	0.01	
10-15	3.93	3.32	1.63	0.85	0.72	0.44	0.28	0.26	0.29	0.10	0.13	0.12	0.04	0.02	0.02	0.02	0.02	0.02	0.02	
5-10	8.72	4.76	2.36	1.38	1.15	0.62	0.30	0.29	0.32	0.12	0.18	0.20	0.06	0.03	0.04	0.01	0.03	0.02	0.02	
0-5	25.64	9.45	4.34	2.30	1.80	0.90	0.69	0.40	0.48	0.21	0.27	0.32	0.09	0.05	0.08	0.06	0.06	0.04	0.04	0.04
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100

Figure 28: Percentage of discordant pairs in various groups for PCTST Coverage-varied Selection (Coverage diff is y axis and mutant diff is x axis)

