Semantic Approximation for Reducing Code Bloat in Genetic Programming

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Suppelment 2: Post-hoc analysis of Friedman's test.

Table 1: Post-hoc analysis of Friedman's test using symmetry test conducted on training errors. If the result of the method in the first column is better than that of the method in the second column, p-value of this post-hoc test is printed in bold face. Significant results marked in italic face ($\alpha = 0.05$).

Probl	ems	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18
Fried	man	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
RDO	GP	.119	.000	.015	.007	.196	.596	.028	1	.991	.000	.217	.000	.004	.000	.000	.020	.017	.000
PP	GP	.000	.000	.000	.094	.014	.000	.000	.000	.000	.535	.000	.066	.000	.001	.002	.000	.000	.000
TS-S	GP	.020	1	.000	.767	1	.012	.000	.911	1	1	.001	1	.000	1	.768	.026	.000	1
SA10	GP	1	.162	.938	.416	.984	1	1	1	.967	.000	.879	.017	.958	.995	.504	1	1	.997
SA20	GP	.039	.997	.074	.998	.118	.075	.027	.000	.001	.416	.000	.995	.045	.179	1	.000	.000	.004
SAD	GP	.000	.000	.566	.001			.000	.000	.000		.000	1	.040	.000	.685	.000	.000	.000
DA10	GP	1	.179	.998	.003		.993	.991	1		.000	1	.000	.023	.260	.000	.859		.084
DA20	GP	.030	.991	.949	-		.179	.000	.259	.793	.000	.145	.000	1	.991	.013	.878	.685	1
DAD	GP	.000	.003	.991	.997	.000	.005	.000	.000	.003	.000	.000	.009	1	1	.307	.004	.132	.387
PP	RDO	.000	.000	.000	.000			.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
TS-S	RDO	.000	.000	.000	.000		.000	.066	.566	1	.000	.000	.000	.000	.000	.000	.000	.000	.000
SA10	RDO	.026	.260	.000	.895	.878	.656	.089	.998	1	.017	.001	.000	.000	.012	.000	.015	.106	.004
SA20	RDO	.000	.000	.000	.000	.000	.000	1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SAD	RDO	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
DA10	RDO	.387	.238	.179	1	.839	.991	.373	1	1	.859	.656	.816	1	.596	.565	.685	.566	.741
DA20	RDO	.000	.000	.000	.995		.000	.986	.059		.015	.000	.045	.035	.017	.026	.000	.000	.000
DAD	RDO	.000	.000	.000	.000	.000	.000	.001	.000	.000	.000	.000	.000	.008	.000	.000	.000	.000	.000
TS-S	PP	.000	.000	1	.973		.026	.982				.333			.011	.415	.028	.741	
SA10	PP	.000	.000	.001	.000	.000	.000	.000	.000		.000	.000		.000	.000	.000	.000	.000	
SA20	PP	.000	.000		.534	1	.003	.001	1	.084		1		.197		.013	.976		.180
SAD	PP	.949	1	.015	.967	.535	.938	1	.967		.000	1	.059	.217	1	.504	1		.626
DA10	PP	.000	.000	.000	.000		.000	.000			.000			.000	.000	.000	.000		.000
DA20	PP	.000	.000		.000		.001		.006				.000		.000	.000	.000		.000
DAD	PP	.284	.859		.566		.058	1	1							.000	.124	.002	.001
SA10	TS-S	.095	.444		.003	1	.009	.000	.967			.145			.839	.004	.035	.000	.878
SA20	TS-S	1	.925	.657	.997	.020	1	.070	.000	.000	.627		.984		.596	.949	.475	1	.039
SAD	TS-S	.017	.000	.105	.308	.000		.827	.000	.000	.535	.106	1	.011	.002	1	.013	.995	.003
DA10	TS-S	.002	.475	.000	.000	1									.045	.000	.000		.011
DA20	TS-S	1	.878	.011		.131	.997		.988				.000		.793	.000	.714	.052	1
DAD	TS-S	.359	.000	.004	.998	.000	1		.000		.000	1	.005		1	.001	1	.445	.816
SA20	SA10	.162	.011	.817	.058	.003	.058	.083	.000		.011	.000		.656	.011	.238	.000	.000	.000
SAD	SA10	.000	.000	1	.000	.000	.000	.000	.000	.000		.000		.626	.000	.002	.000	.000	.000
	SA10		1		.816	1	.997	1	.999	1						.146			
	SA10																.911		
DAD	SA10	.000	.000	1	.051	.000	.003	.000	.000	.000	.993	.106	1	.911	.949	1	.006	.023	.045
	SA20										1	1	.997	1		.911		1	.999
	SA20																		
DA20		1	1		.009		1									.002			
DAD	SA20	.238	.074	.596	1	.360	.998	.001	1	1	.198	.475	.162	.026	.387	.118	.816	.132	.859
DA10	SAD	.000	.000	.105	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
DA20	SAD	.011	.003	.999	.000	.023	.105	.011	.000	.026	.020	.000	.000	.005	.000	.000	.000	.002	.001
DAD	SAD	.979	.991	.991	.034	1	.768	1	.896	.979	.260	.145	.011	.023	.000	.001	.070	.052	.387
DA20	DA10	.004	.008	.475	.984	.039	.009	.023	.066	.035	.627	.020	.878	.132	.896	.949	.058	.030	.020
	DA10																		
	DA20																		
	0	0.					• / • / /		<u>z</u> .	5	.,,,	.010	.,,,,,		., _5	•		.,,,	

Table 2: Post-hoc analysis of Friedman's test using symmetry test conducted on testing errors. If the result of the method in the first column is better than that of the method in the second column, p-value of this post-hoc test is printed in bold face. Significant results marked in italic face ($\alpha = 0.05$).

Probl	ems	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18
Fried	man	.000	.000	.415	.000	.000	.000	.000	.023	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
RDO	GP	.012	.000		.000	.034	1	.805	1	.958	.058	.131	.000	.656	.000	.979	.307	1	.118
PP	GP	1	.997		.878	1	1	.000	1	.817	.596	.009	.180	.685	.741	.958	.154	.001	.058
TS-S	GP	.046	.106		1	1	.938	.805	.839	.998	1	.044	1	.132	1	.938	.995	.046	.793
SA10	GP	.030	.000		.008	.967	.535	.925	1	1	.001	1	.026	.000	.839	.009	.949	.002	.020
SA20	GP	.001			1	.007	.030	.035	.993	.009	.001	.005	.949	.000	1	.030	.000	.000	.973
SAD	GP	.504			.260		.001		.991			.118	1	.000	.197	.596	.000	.000	1
DA10	GP	.000	.000		.000	.332	.973		1	.993	.000	1	.000	.000	.003	.000	.386	.006	.000
DA20	GP	.656			.002	.000	.002	.118	.839	.993	.000		.000	.000	.009		.000		.035
DAD	GP	.967	.002		1	.034	.001	.000	.741	.445	.000	.013	.000	.000	.333	.000	.000	.045	.535
PP	RDO	.004	.000		.000	.058	.995	.001	1	1	.000	.000	.000	1	.000	.307	.000	.000	.000
TS-S	RDO	.000	.000		.000	.009	.995	1	.535	.505	.019	.000	.000	.997	.000	1	.026	.009	.000
SA10	RDO	.000	.008		.999	.566	.816	1	1	1	.984	.095	.000	.000	.074	.259	.007	.000	1
SA20	RDO	.000	.009		.004	1	.105	.849	1	.333	.988	.000	.000	.000	.000	.475	.000	.000	.816
SAD	RDO	.000	.000		.000	.997	.004	.001	1	.307	1	.000	.000	.000	.000	.998	.000	.000	.093
DA10	RDO	.000	.023		1	.997	.999	1	1	.415	.793	.030		.008	.999	.000	.000	.000	.878
DA20	RDO	.000	.163		1	.656	.011	.976		1		.000		.000		.000	.000	.000	1
DAD	RDO	.360	.000		.002	1	.006	.000	.949	.995	.938	.000	.017	.000	.415	.000	.000	.006	.999
TS-S	PP	.283	.596		.967	1	.686	.001	.816	.260	.816	1	.596	.995	.714	.196	.728	.958	.925
SA10	PP	.075	.001		.000	.988	.217	.000	1	.993	.000	.015	.000	.000	.022	.000	.919	1	.000
SA20	PP	.003	.001		.504	.013	.005	.217	.995	.596	.000	1	.002	.000	.911	.000	.320	.535	.001
SAD	PP	.714	.074		.993	.444	.000	1	.993	.565	.000	.998	.026	.000	.998	.034	.162	.118	.074
DA10	PP	.001	.000		.000	.444	.793	.006	1	.197	.000	.051	.000	.007	.000	.000	1	1	.000
DA20	PP	.839	.000		.000	.000	.000	.075	.859	1	.000	1	.000	.000	.000	.000	.780	1	.000
DAD	PP	.878	.045		.626	.058	.000	1	.768	1	.000	1	.000	.000	.001	.000	.037	.979	.000
SA10	TS-S	1	.416		.002	.839	.999	1	.656	.878	.000	.106	.002	.001	.859	.387	1	.991	.000
SA20	TS-S	.878	.387		.997	.001	.626	.849	.217	.000	.000	.998	.596	.009	1	.626	.001	.026	.106
SAD	TS-S	1	.991		.445	.146	.094	.001	.198	.000	.003	1	.938	.005	.179	1	.000	.001	.839
DA10	TS-S	.741	.237		.000	.146	1	1	.793	1	.000	.259	.000	.132	.004	.001	.938	.999	.000
DA20	TS-S	.998	.040		.001	.000	.179	.976	.039	.714	.000	.995	.000	.000	.011	.000	.015	.973	.000
DAD	TS-S	.003	.973		.999	.009	.118	.000	.023	.065	.000	1	.000	.000	.359	.000	.000	1	.006
SA20	SA10	.993	1		.058	.259	.967	.686	1	.084	1	.008	.565	1	.626	1	.005	.360	.416
SAD	SA10	.973	.967		.000	.979	.445	.000	.999	.074	1	.162	.180	1	.001	.816	.001	.058	.015
DA10	SA10	.967	1		.991	.979	.997	1	1	.817	1	1	.058	.938	.387	.596	.993	1	.995
DA20	SA10	.925	.993		1	.003	.626	.911	.949	1	.416	.005	.444	.839	.565	.118	.051	1	1
DAD	SA10	.000	.988		.034	.566	.504	.000	.896	.878	1	.020	.988	1	.999	.105	.000	.997	.938
SAD	SA20	.474	.958		.058	.938	.993	.146	1	1	1	.993	1	1	.387	.949	1	.999	.958
DA10		1	1		.002	.938	.504	.973	.997	.000	1		.000	.998			.117	.198	.045
DA20		.333	.995			.911		1	1	.179	.387	1			.002		1	.476	.535
	SA20				1	1		.106	.998		1	1					.998		
DA10		.307			.000	1					.973	.359	.000					.023	
DA20		1	.445		.000		1	.045	1				.000					.095	
DAD		.026	1		.094		1	1					.007				1	.002	
DA20			1		1								.997		1		.474	1	.984
	DA10							.002					.565					1	.387
DAD	DA20	.051	.565		.011	.656	I	.030		.967	.596	1	.979	.993	.958	1	.878	.988	.973

Table 3: Post-hoc analysis of Friedman's test using symmetry test conducted on solution size. If the result of the method in the first column is better than that of the method in the second column, p-value of this post-hoc test is printed in bold face. Significant results marked in italic face ($\alpha = 0.05$).

Probl	ome	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	E15	F16	F17	F18
Fried	man	.000	.000	.000	.000	.000	.000	.000	.000		.000		.000	.000		.000	.000	.000	.000
RDO	GP	.895	.488		.009		.057					1	.999	.571	.666	1	1	1	1
PP	GP	.000	.000		.000								.000	.000			.000	.000	.000
TS-S	GP	.117	.625		.026						1	.068	1		.789		.000	.001	
SA10	GP		.004		.017														.004
SA20	GP	.000	.000		.000														.000
SAD	GP	.000	.000		.000												.000		.000
DA10	GP	.000	.000		.001			-		.008				.418					
DA20	GP	.000	.000	.000			.000										.000	.000	.000
DAD	GP	.000	.000	.000	.000												.000	.000	.000
PP	RDO	.001	.000	.000	.017	.000	.000	.026	.000				.000	.018	.000		.000	.000	.000
TS-S	RDO	.938	1	.000	1	1	1	1	1		.989	.303	1	.000	1	.003			.996
SA10	RDO	.196	.779	.331	1	.812	1	.293	.949	1		.038	.002	.001			.110	.115	
SA20	RDO	.000	.000	.000	.003	.000	.000		.000				.000	.000			.000	.000	.000
SAD	RDO	.000	.000	.000	.000		.000				.000		.000		.000		.000	.000	.000
DA10	RDO	.055	.372	.886	1		.999	.282	.610	1		.410	.057	1	.992	.437	.316	.212	.060
DA20	RDO	.000	.000	.000			.000		.000		.000		.000		.000		.000	.000	.000
DAD	RDO	.000	.000	.000	.000	.000	.000	.032	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
TS-S	PP	.130	.000	.918	.005	.000	.000	.044	.000	.000	.000	.000	.000	.064	.000	.003	.000	.007	.000
SA10	PP	.878	.153	.196	.009	.038	.002	.000	.000	.066	.895	.000	.047	.998	.000	.001	.000	.000	.097
SA20	PP	.169	.827	1	1	.989	1	.953	1	.877	.019	1	.993	.002	1	.999	.998	.893	.545
SAD	PP	.002	.017	.998	.662	.042	.457	1	1	.088	.012	.986	.803	.007		.679	1	.559	.073
DA10	PP	.989	.488	.015	.094	.149	.003	.000	.000	.073	.235	.000	.002	.036	.000	.000	.000	.000	.014
DA20	PP	.048	.887	1		.574	1	1	1	1	.984	.439	1		.738	.649	.185	.884	1
DAD	PP	.000	.013	.988	.172	.277	.894	1	1	.027	.487	.993	.918	.335	.999	1	.638	1	.991
SA10	TS-S	.958	.655	.002	1	.722	.998	.206	.684	.123	.000	.998	.019	.418	.637	1	.937	.989	.135
SA20	TS-S	.000	.000	.979	.001	.000	.000	.669	.000	.000	.000	.000	.000	.995	.000	.000	.003	.000	.000
SAD	TS-S	.000	.000	1	.000	.000	.000			.000	.000	.000	.000	1	.000	.000	.000	.000	.000
DA10	TS-S	.753	.258	.000	.997			.196		.110		1		.000		.775	.711	.953	.469
DA20	TS-S	.000	.000	.815			.000			.000		.013	.000		.000		.501		.000
DAD	TS-S	.000	.000	1	.000	.000	.000	.054	.000	.000	.000	.000	.000	1	.000	.001	.116	.006	.000
SA20	SA10	.001	.001	.098	.001	.001	.001	.000	.000	.000	.000	.000	.001	.043	.000	.000	.000	.000	.000
SAD	SA10	.000	.000	.017	.000	.000	.000	.000	.000	.000	.000	.000	.000	.103	.000	.000	.000	.000	.000
DA10	SA10	1	1	.997	.999	1	1	1	1	1	.988	.993	.995	.002	.999	.884	1	1	1
DA20	SA10	.000	.001	.318	.000	.000	.000	.000	.000	.007	.215	.151	.186	1	.040	.422	.016	.036	.222
DAD	SA10	.000	.000	.008	.000	.000	.000	.000	.000	.000	.010	.003	.000	.867	.001	.000	.001	.000	.003
SAD	SA20	.938	.699	1	.915	.482	.472	.886	1	.917	1	.958	.999	1	.953	.981	.931	1	.994
DA10	SA20	.007	.006	.006	.022	.005	.003	.000	.003	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
DA20	SA20	1	1	1	.972	.993	1	.993	1	.997	.356	.576	.894	.087	.885	.182	.711	.076	.315
DAD	SA20	.779	.640	.999	.434	.917	.903	.966	.998	.725	.953	.999	1	.824	1	1	.984	.909	.989
DA10	SAD	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
DA20	SAD		.610		1		.639	1	1								.041		
DAD	SAD	1	1	1		.999		1	1	1		.545	1				.268		
	DA10																		
	DA10																		
DAD	DA20	.962	.549	.953	.990	1	.966	1	4	.177	.989	.966	.638	.949	.992	.452	.999	.866	.936

Table 4: Post-hoc analysis of Friedman's test using symmetry test conducted on running time. If the result of the method in the first column is better than that of the method in the second column, p-value of this post-hoc test is printed in bold face. Significant results marked in italic face ($\alpha = 0.05$).

Probl	ems	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18
Fried	man	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
RDO	GP	.911	.896	.002	.925	.878	.938	.896	.839	.713	.627	.896	.714	.896	.938	.445	.685	.656	.767
PP	GP	.988	.595	.997	.084	.051	.000	.026	.006	.118	.131	.002	.030	.003	.006	.685	.714	.474	.026
TS-S	GP	.030	.360	.000	.474	.999	.896	.035	1	1	1	.000	1	.000	.896	.000	.000	.000	1
SA10	GP	.000	.000	.000	.005	.000	.030	.020	.002	.002	.000	.000	.000	.000	.000	.000	.001	.001	.000
SA20	GP	.000	.000	.006	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
SAD	GP	.000	.000	.333	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
DA10	GP	.000	.000	.741	.023	.009			.093							1	1	1	.162
DA20	GP	.000	.000	.000	.000	.000		.000							.000	.000	.000	.000	.000
DAD	GP	.000	.000	.967	.000	.000	.000	.000	.000	.000	.000	.030	.000	.359	.000	.359	.000	.000	.000
PP	RDO	.259	.017	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.002	.008	.002	.000
TS-S	RDO	.000	.005	.000	.012		.118				.685			.000	.118		.000	.000	.387
SA10	RDO	.000	.000	.000	.000	.000						.000		.000			.000	.000	.000
SA20	RDO	.000	.000	.000	.000	.000						.000			.000	.000	.000	.000	.000
SAD	RDO	.000	.000	.839	.000		.000			.000					.000	.000	.000	.000	.000
DA10	RDO	.000	.000	.000	.000		.000			.000		.030				.105	.238		.000
DA20	RDO	.000	.000	.000	.000		.000		.000		.000				.000	.000	.000	.000	.000
DAD	RDO	.000	.000	.000	.000	.000				.000				.005			.000		.000
TS-S	PP	.415	1	.000	.998	.333	.074	1	.051	.283		.993		.002	.388	.000	.026	.074	.131
SA10	PP	.012	.180	.002	.998	.926	.974	1	1	.973		.714	.626		1	.023	.360	.565	.032
SA20	PP	.000	.000		.000		.013								.000	.000	.000	.000	.000
SAD	PP	.000	.008	.034	.000	.000			.002	.000	.000	.878	.000	1	.002	.012	.146	.170	.058
DA10	PP	.000	.008	.997	.000	1	.974	.958	.998	1	1	.414	1	.504	1 .000	.974	.979	.817 .000	1 .000
DA20 DAD	PP PP		.000	.000	.011	.000 .105	.006		.002			.000	.360	.105 .838	.445	.000	.000	.010	.958
SA10	TS-S TS-S	.949 .001	.360	.998 .597		.006		1 .000	.017	.010	.000		.000	1 1	.094	.505	.991 . 009	.993 . 015	.000
SA20 SAD	TS-S	.001	.000	.000	.000	.000		.000	.000		.000	.001	.000	.019	.000	1 .627	1	1	.000 .000
DA10	TS-S	.520	.026	.002	.967	.105		.973		.118		.039	.283	.000	.535	.000	.000	.000	.473
DA10	TS-S	.000	.000	1	.000				.000				.000		.000	.999	.006	.015	.000
DAD	TS-S		.008	.000		.000					.000		.000	.000		.000	.984	1	.002
SA20	SA10		.045	.974	.000				.000				.020	1	.000	.237	.000	.000	.196
SAZO	SA10			.000		.030			.009			.023	.020	.004	.019	1	.000	1	1
	SA10			.045	1	.997	1									_	.017	_	.003
	SA10																		
	SA10												1				.504		
	SA20	1			.685		1		.896	1							.001		
	SA20																		
	SA20				1	.991	1		.926			1		.970			1	1	.963
	SA20						1	1									.238		
DA10		.878	1		.001														
DA10			.003			1	1	.475	1	1	1	.034	1				.003		
	SAD		1		.993														
-																			
	DA10	.001	.003	.013					.000					.000					
	DA10																.000		
DAD	DA20	.003	.009	.001	.445	.415	.999	.998	.926	.997	.911	.000	.859	.000	.198	.001	.180	.100	.022