Appendix for Optimised fitness functions for automated runtime improvement of software

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Appendix A

A visual representation of the variants examined and their fitness values in 2 different scenarios. One with the `perf_task_clock` measure and a retry setting of 1 and the other with the `weights` measure and a retry of 2. We can observe how different measures and retry setting affect the exploration of the search space.

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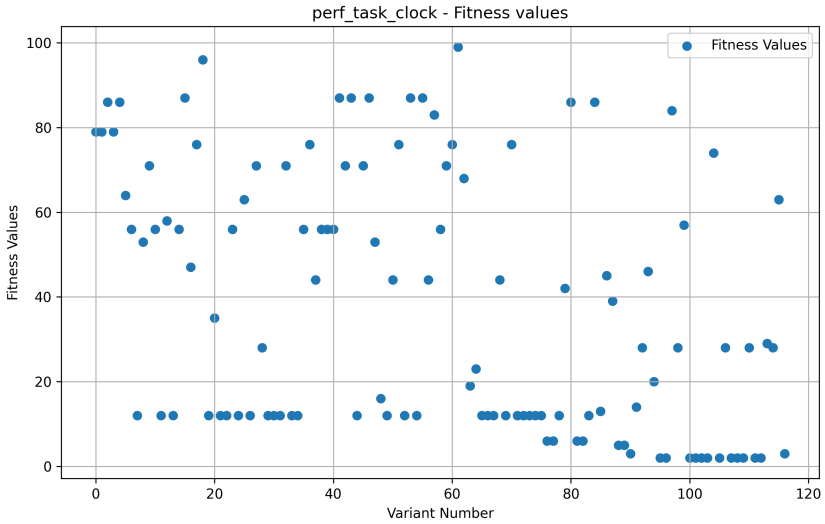
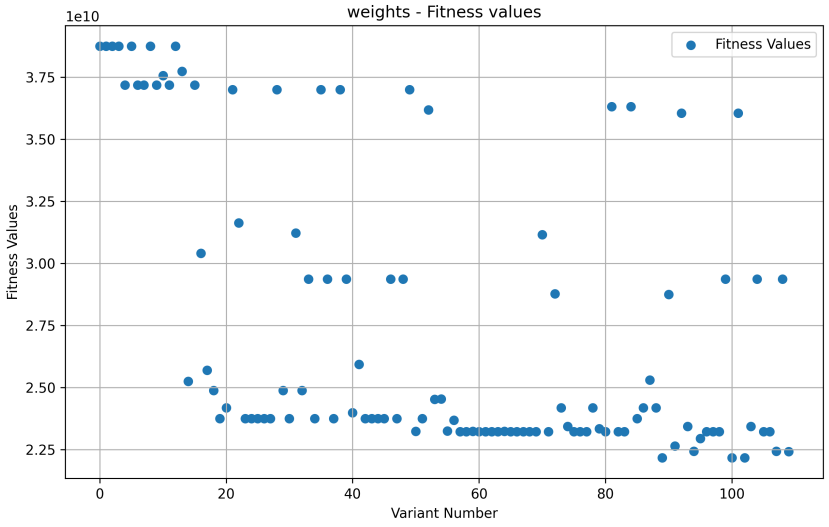
Fig. 1. Comparative analysis of the search space for the LPG benchmark under different measures and retries.



(a) Search space exploration with perf_task_clock and retry=1



(b) Search space exploration with ‘weights‘ measure and retry=2

Appendix B

In this section we present the results of running the same exact experiments as seen in Section ??, with the only difference being that MAGPIE was invoked with the Genetic Programming approach as the search strategy.

Table 1. RQ2: Mean Median Execution Times, Median Ranks, and Number of Variants for Each Measure

Measure	Mean MET(s)	Median Rank	NoV
Original	9.65	13	-
Energy	6.21	11	257
perf_L1_dcache_loads	5.99	7	397
perf_branch_misses	5.75	5	431
perf_branches	6.22	7	393
perf_cache_misses	7.02	8	419
perf_cache_references	4.64	5	451
perf_cpu_clock	8.85	14	376
perf_cycles	6.15	4	426
perf_faults	7.28	12	381
perf_instructions	6.48	7	384
perf_task_clock	9.87	14	387
perf_time	5.66	7	409
Time	5.17	4	414
Weights	6.96	12	275

MET: Median Execution Time
NoV: Number of Variants examined

Table 2. RQ3: Statistical Analysis of Retry Rankings Across All Benchmarks

Retries	Median Rank	Mean Rank	STD	IQR
1	2.36	2.47	0.27	0.39
2	2.93	2.95	0.40	0.50
3	3.00	3.07	0.46	0.71
4	3.29	3.18	0.41	0.39
5	3.36	3.33	0.41	0.32

Table 3. Recommended Retry Numbers for Each Measure

Measure	Mean RN	Median RN	IQR	STD
Energy	3.0	3.0	1.0	1.10
perf_L1_dcache_loads	2.64	2.0	2.5	1.57
perf_branch_misses	2.64	2.0	2.0	1.50
perf_branches	2.18	2.0	1.5	1.54
perf_cache_misses	3.0	3.0	4.0	1.79
perf_cache_references	2.18	2.0	1.5	1.33
perf_cpu_clock	3.45	3.0	2.5	1.44
perf_cycles	2.45	3.0	2.0	1.37
perf_faults	2.09	2.0	1.5	1.22
perf_instructions	2.55	2.0	3.0	1.51
perf_task_clock	3.64	4.0	1.5	1.29
perf_time	2.82	3.0	2.5	1.54
Time	2.73	2.0	3.5	1.74
Weights	2.27	2.0	2.0	1.35

RN: Retry Number

Table 4. Percentage Decrease in Variants Explored by Number of Retries

Retries	Mean Decr.%	Median Decr. %	STD	IQR
1	0.0	0.0	0.0	0.0
2	31.87	34.84	24.64	38.11
3	52.86	60.07	22.30	25.65
4	64.73	69.93	19.58	21.00
5	72.40	75.58	15.14	15.63

Table 5. Median and Mean MAD for Each Measure

Measure	Med. MAD	Mean MAD	STD	IQR
Energy	0.085	0.097	0.230	0.234
perf_L1_dcache_loads	0.140	0.129	0.224	0.229
perf_branch_misses	0.126	0.121	0.190	0.176
perf_branches	0.183	0.162	0.246	0.245
perf_cache_misses	0.087	0.077	0.159	0.152
perf_cache_refs	0.186	0.175	0.251	0.280
perf_cpu_clock	0.461	0.533	0.150	0.123
perf_cycles	0.170	0.145	0.210	0.191
perf_faults	0.022	0.025	0.036	0.040
perf_instructions	0.142	0.139	0.260	0.257
perf_task_clock	0.428	0.498	0.165	0.131
perf_time	0.122	0.150	0.248	0.224
Time	0.210	0.169	0.252	0.257
Weights	0.153	0.159	0.340	0.350

Table 6. Median and Mean MAD for Each Retry Number

Retries	Med. MAD	Mean MAD	STD	IQR
1	0.261	0.311	0.206	0.249
2	0.197	0.242	0.189	0.192
3	0.176	0.223	0.194	0.207
4	0.146	0.188	0.168	0.207
5	0.141	0.193	0.169	0.242

Table 7. Analysis of Retry Parameters on Search Efficiency

Retries	TD	ADPS	POD
1	8.0	0.0500	0.0123
2	7.0	0.0563	0.0178
3	6.0	0.0521	0.0251
4	6.0	0.0497	0.0303
5	5.5	0.0642	0.0365

TD: Total decreases
ADPS: Average Decrease Percentage per Step
POD: Proportion of Decreases

Table 8. Performance of Each Measure in the Search Process

Measure	TD	ADPS	POD
Energy	6.0	0.0291	0.0383
perf_L1_dcache_loads	8.0	0.0343	0.0253
perf_branch_misses	8.0	0.0486	0.0215
perf_branches	8.0	0.0429	0.0254
perf_cache_misses	6.0	0.0324	0.0232
perf_cache_references	7.0	0.0571	0.0209
perf_cpu_clock	4.0	0.2337	0.0149
perf_cycles	8.0	0.0497	0.0231
perf_faults	7.0	0.0129	0.0255
perf_instructions	7.0	0.0384	0.0296
perf_task_clock	5.0	0.1791	0.0153
perf_time	7.0	0.0439	0.0254
Time	7.0	0.0564	0.0229
Weights	5.0	0.0792	0.0329

TD: Total decreases
ADPS: Average Decrease Percentage per Step
POD: Proportion of Decreases