CENTRAL WASHINGTON UNIVERSITY OF THE COMPUTER SCIENCE DEPARTMENT

Project 4

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1 INTRODUCTION

For this lab we again took our 15 optimization functions and ran them through 3 new methods of determining the global minimum. The functions being: The Self Organizing Migrating Algorithm (SOMA) which uses an evolutional approach , The Firefly Algorithm (FA) which uses an evolutional swarm approach similar to Particle Swarm, and the Harmony Search Algorithm (HS) which uses another evolutional style approach.

2 METHODS

For each of the 3 search methods and all 15 of the search functions we ran tests for a set amount of iterations using the python scripts we wrote for the previous lab. These results were then written out to a file from which we calculated the min, max, range, etc.

We also slightly modified the way FA calculated the step when changin it's direction. Instead of using a random distribution when calculating the FA random step we used a suggested regular distribution that we found when researching the problem online.

3 ANALYSIS

This lab produced both surprising and disappointing results when evaluating the search functions. The most surprising results are that of SOMA, where it regularly equaled or beat the most accurate search function so far which has been Differential Evolution (DE). Of the 15 functions tested, SOMA had better results than DE for 6 of the functions. The rest of the 9 functions tested were very close to the results found by the DE search function.

The disappointing results produced by this lab lay in the other two functions tested. HS and FA produced very similar results overall, most possibly because they are not all that much better than particle swarm of which they are in the same class. Between the two search functions, there was very seldom a difference of more than 20 to 30 percent in their fitnesses. We think it's best to compare these two functions to their cousin Particle Swarm (PSO) as it is the closest related method.

In relation to PSO the functions did very similarly for the later functions (>4). The lower functions (<4) all produced results which were much more inaccurate than traditional particle swarm. In regards to the later functions, HS was only able to beat a PSO search method under function 6 with 11.28 determined as the minimum, with PSO returning 12.15. FA wasn't able to beat PSO in function 6 but it did come close with 13.32. Another notable point to look at is function 15 where HS was able to find the minimum at -18.70, but FA was unable to capture the minimum with 16.40.

4 Conclusion

The conclusion for this lab is a pessimistic one, SOMA was a great success and a valuable addition to our growing library of search functions. But are overshadowed by the poor performance not only in the accuracy of answers, but also the run times of FA and HS. PSO was able to outperform HS and FA in almost every aspect, and that is even telling as PSO performs poorly when compared to other search functions we have used for some specific functions. Walking away from this lab, I believe that we will add SOMA to our list of highly accurate and performance search methods, while leaving FA and HS for problem sets which they are most suited to.

Although we scrutinized our code to an appropriate degree we can't rule out the poor performance of the FA and HS algorithms being caused by incorrect implementations. We're reasonably sure that this is not the case though as the comparable performance to PSO was expected. Additionally SOMA was not entirely without faults either. Function 10 for example shows an almost 250 percent increase in the minimum value over it's DE an PSO counterparts. This is worrisome as all of the other results produced by SOMA were within 20 to 30 percent of PSO and DE.

5 Results

Figure 5.1: Computation comparison of SOMA, HS and FA

Problem	SOMA					HS					FA				
	Avg	Median	Range	SD	T(s)	Avg	Median	Range	SD	T(s)	Avg	Median	Range	SD	T(s)
f_1	-7299.02	-7386.83	1503.58	452.97	0.08	-1736.64	-1762.09	901.78	340.48	4.73	-2078.10	-2121.93	1297.24	956.34	2.00
f_2	73.06	33.94	332.07	100.36	0.05	38678.19	39044.00	14740.90	5545.68	3.63	39611.35	41038.00	15876.60	8095.76	0.87
f_3	149.76	119.57	338.84	99.33	0.10	15223266000.00	15499350000.00	9746940000.00	3077498860.01	3.87	13940456000.00	13970750000.00	11865890000.00	3765178464.71	1.06
f_4	-7758.64	-7737.15	362.37	131.58	0.20	132487.90	138380.00	75080.00	22337.69	4.71	135166.40	136884.00	22462.00	30028.16	2.09
f_5	45.26	35.50	124.00	36.68	0.07	249.51	249.76	66.18	22.99	4.75	219.01	229.32	130.89	46.52	2.18
f_6	13.70	13.84	2.91	0.99	0.00	11.28	11.24	0.82	0.24	5.90	13.32	13.25	1.35	3.11	2.89
f_7	36.00	34.30	24.57	8.03	0.04	34.10	34.92	5.20	1.82	6.54	45.15	44.93	8.66	9.88	4.59
f_8	14.49	15.01	72.42	28.43	0.10	279.82	282.06	57.12	17.79	5.95	273.29	278.48	37.49	62.42	3.66
f_9	141.72	212.47	376.52	154.36	0.09	305.15	306.60	19.46	6.85	7.10	342.88	354.12	71.60	74.94	4.89
f_{10}	-13566.43	-14173.65	3948.20	1297.42	0.55	-3194.74	-2846.66	2290.95	832.19	6.07	-3332.62	-3378.12	2053.65	1555.81	3.43
f_{11}	-8428.54	-8806.80	3527.50	1076.29	0.58	-2037.88	-1976.69	1404.16	421.07	8.39	-2009.29	-1998.01	1467.36	1004.39	6.10
f_{12}	8.91	8.88	0.87	0.27	0.01	7.78	7.74	0.59	0.19	5.76	8.71	8.77	0.44	2.14	3.10
f_{13}	-2.36	-2.38	2.90	0.81	0.01	-5.46	-5.55	1.53	0.48	7.33	-2.53	-2.52	2.33	1.43	4.73
f_{14}	-7.39	-7.74	8.78	3.13	0.01	-12.86	-12.81	2.15	0.67	5.41	-7.47	-7.21	6.35	4.04	3.20
f_{15}	-17.46	-18.45	6.22	2.14	0.03	-18.70	-18.70	0.00	0.00	11.09	-16.40	-17.37	6.14	6.23	9.65

[1] ThinkPad, 3.4GHz Intel Core i7 (3rd gen), 16 GB RAM

6 Previous Results

Figure 6.1: Computation comparison of DE, GA and PSO

Problem	DE					GA					PSO				
	Avg	Median	Range	SD	T(s)	Avg	Median	Range	SD	T(s)	Avg	Median	Range	SD	T(s)
f_1	-6112.33	-6084.59	114.26	47.83	1.14	-3276.12	-3292.95	943.02	245.68	2.69	-2871.98	-2904.39	1194.77	322.06	0.12
f_2	129.53	25.00	900.00	251.52	0.53	23185.53	22853.00	10310.00	3148.43	0.72	0.17	0.15	0.25	0.08	0.09
f_3	26105.67	10019.00	168100.00	43662.88	0.78	5291234666.67	5017400000.00	5739020000.00	1539343402.74	0.68	421.98	200.19	1657.68	497.31	0.10
f_4	-7600.00	-7960.00	2560.00	728.99	1.00	79752.00	81520.00	23240.00	8507.40	2.12	-5206.62	-5324.98	3479.78	1178.83	0.13
f_5	0.00	0.00	0.00	0.00	1.08	145.86	150.55	51.89	17.68	2.31	9.17	8.93	5.88	1.95	0.13
f_6	12.38	12.71	2.19	0.60	1.46	12.04	11.97	0.67	0.22	2.52	12.15	12.18	1.25	0.33	0.14
f_7	19.06	19.01	0.62	0.16	1.67	36.69	36.60	5.76	1.54	4.20	20.55	20.45	2.63	0.68	0.18
f_8	58.74	58.73	4.74	1.54	1.60	212.86	213.95	41.20	11.06	3.41	-9.92	-11.64	35.51	9.72	0.10
f_9	-83.30	-80.69	21.87	6.99	2.09	276.38	276.83	14.65	4.35	4.10	251.53	288.37	173.05	64.83	0.14
f_{10}	-4959.12	-4579.12	2896.23	966.10	3.02	-4778.37	-4822.17	978.82	327.79	4.72	-4107.05	-3830.50	2663.98	711.61	0.13
f_{11}	-8478.48	-8821.20	5161.40	1330.20	3.56	-3188.30	-3181.83	1334.30	339.30	8.34	-2899.33	-2888.72	901.67	227.81	0.21
f_{12}	0.00	0.00	0.00	0.00	1.48	8.00	8.01	0.69	0.17	2.70	7.02	7.08	1.30	0.37	0.15
f_{13}	-4.28	-4.22	2.71	0.83	3.06	-4.27	-4.22	2.30	0.57	5.54	-10.39	-9.86	4.92	1.50	0.14
f_{14}	-18.99	-19.00	0.04	0.01	1.47	-10.88	-10.53	3.70	1.00	3.65	-16.07	-16.15	5.22	1.59	0.14
f_{15}	-21.91	-23.03	8.39	2.95	6.05	-14.64	-14.64	0.00	0.00	12.55	-18.70	-18.70	0.00	0.00	0.27

[1] ThinkPad, 3.4GHz Intel Core i7 (3rd gen), 16 GB RAM