Project-1
(CS471-Optimization)

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Introduction

This research is about Analyzing eighteen standard benchmark functions of different properties. I created Java code to solve problems and get results. Input numbers are generated by MersenTwister. For the input vector,used 30 vectors with 10,20,30 dimension.

	Name	$f(x^*)$	Dimensions	Range
f_1	Schwefel	0	10,20,30	$[-512, 512]^n$
f_2	De Jong 1	0	10,20,30	$[-100, 100]^n$
f_3	Rosenbrock's Saddle	0	10,20,30	$[-100, 100]^n$
f_4	Rastrigin	0	10,20,30	$[-30, 30]^n$
f_5	Griewangk	0	10,20,30	$[-500, 500]^n$
f_6	Sine Envelope Sine Wave	$-1.4915(n-1)$	10,20,30	$[-30, 30]^n$
f_7	Stretch V Sine Wave	0	10,20,30	$[-30, 30]^n$
f_8	Ackley One	$-7.54276 - 2.91867(n-3)$	10,20,30	$[-32, 32]^n$
f_9	Ackley Two	0	10,20,30	$[-32, 32]^n$
f_{10}	Egg Holder	–	10,20,30	$[-500, 500]^n$
f_{11}	Rana	–	10,20,30	$[-500, 500]^n$
f_{12}	Pathological	–	10,20,30	$[-100, 100]^n$
f_{13}	Michalewicz	$0.966n$	10,20,30	$[0, \pi]^n$
f_{14}	Masters' Cosine Wave	$1-n$	10,20,30	$[-30, 30]^n$
f_{15}	Quartic	0	10,20,30	$[-100, 100]^n$
f_{16}	Levy	0	10,20,30	$[-10, 100]^n$
f_{17}	Step	0	10,20,30	$[-100, 100]^n$
f_{18}	Alpine	0	10,20,30	$[-100, 100]^n$

Table1. Experiments

According to the Table1, second colum shows ideal global minimum value of each functions. This research will shows and compare all the functions with average, standard devation, range, median and time(millisecond).

	A	B	C	D	E	F
1	f(x)	average	SD(Standard Devation	Range	Median	Time(ms)
2	Schwefel	**5669.15041**	-1.17E+07	1855.6152458197298~ 5431.574999993358	3239.33	109499
3	De Jong 1	841717.569	-1.51E+11	44536.195864613524~ 969101.9011525272	524920	13593
4	Rosenbrock's Saddle	4.68E+11	-4.84E+22	3.2241986848882282E10~ 5.2735462774451385E	2.80E+11	20767
5	Rastrigin	9.15E+13	-3.35E+27	5.490999661401993E13~ 5.4910004934798836E1	5.49E+13	55882
6	Griewangk	9.15E+11	-3.35E+23	5.4910004993523755E11~ 5.49100056500096E11	5.49E+11	58525
7	Sine Envelope Sine Wave	9.15E+11	-3.35E+23	5.491000493355499E11~ 5.491000493429925E11	5.49E+11	59280
8	Stretch V Sine Wave	9.15E+11	-3.35E+23	5.49100049356851E11~ 5.4910004983748035E11	5.49E+11	120448
9	Ackley One	9.15E+11	-3.35E+23	5.491000507325961E11~ 5.49100056038494E11	5.49E+11	122714
10	Ackley Two	9.15E+11	-3.35E+23	5.4910005622231195E11~ 5.491000614653481E1	5.49E+11	159339
11	Egg Holder	9.15E+11	-3.35E+23	5.4910005429071045E11~ 5.4910006140685474E	5.49E+11	98926
12	Rana	9.15E+11	-3.35E+23	5.4910005041952716E11~ 5.491000561989499E1	5.49E+11	195209
13	Pathological	8.79E+11	-3.09E+23	5.273546277490087E11~ 5.27354627867986E11	5.27E+11	80802
14	Michalewicz	9.15E+11	-3.35E+23	5.491000498085162E11~ 5.4910004983574023E1	5.49E+11	146501
15	Master's Cosine Wave	9.15E+11	-3.35E+23	5.4910004934083356E11~ 5.491000493515495E1	5.49E+11	163115
16	Quartic	8.98E+11	-3.22E+23	1855.6152458197298~ 5.490989681780155E11	5.38E+11	36625
17	Levy	9.15E+11	-3.35E+23	1855.6152458197298~ 5.4910044293929095E11	5.49E+11	102702
18	Step	9.15E+11	-3.35E+23	1855.6152458197298~ 5.490999553245725E11	5.49E+11	**12838**
19	Alpine	9.15E+11	-3.35E+23	1855.6152458197298~ 5.490999625832434E11	5.49E+11	54749

Table2. 30 vectors with 10 dimensions

According to Table2, Schwefel has the lowest average value and standard deviation which means values are cohesived. Schwefel, Quartic, Levy, Step and Alpine have the smallest minimum value(around 1855). However the smallest value has big difference between global minimum. Step functions has the fastest execution time. In this case, Schwefel functions gives the best valuse however takes long time. Step function can be executed fast but low possibility to get value which is the most similar to ideal global minimum.

	A	B	C	D	E	F
1	f(x)	average	SD(Standard Devation	Range	Median	Time(ms)
2	Schwefel	**17379.9366**	-1.19E+08	8284.89596184143~ 12295.535893000206	10633.1945	191056
3	De Jong 1	1756564.69	-6.40E+11	79922.29377211872~ 2046652.856600366	1078878.57	31717
4	Rosenbrock's Saddle	1.01E+12	-2.15E+23	5.369409069779517E10~ 1.1553433572322861E12	6.26E+11	57015
5	Rastrigin	4.20E+14	-7.04E+28	2.517166087395106E14~ 2.5171664626284603E14	2.52E+14	87976
6	Griewangk	2.10E+12	-1.76E+24	1.2585832327967634E12~ 1.258583243986587E12	1.26E+12	143481
7	Sine Envelope Sine Wave	2.10E+12	-1.76E+24	1.2585832312960613E12~ 1.2585832313051577E12	1.26E+12	90619
8	Stretch V Sine Wave	2.10E+12	-1.76E+24	1.258583231331375E12~ 1.2585832323460706E12	1.26E+12	203139
9	Ackley One	2.10E+12	-1.76E+24	1.258583233890053E12~ 1.2585832450643076E12	1.26E+12	**286207**
10	Ackley Two	2.10E+12	-1.76E+24	1.2585832454501182E12~ 1.25858325651171E12	1.26E+12	351906
11	Egg Holder	2.10E+12	-1.76E+24	1.2585832370350522E12~ 1.2585832429244966E12	1.26E+12	257510
12	Rana	2.10E+12	-1.76E+24	1.2585832286109675E12~ 1.2585832371520234E12	1.26E+12	473864
13	Pathological	1.93E+12	-1.48E+24	1.1553433572417485E12~ 1.1553433574971692E12	1.16E+12	141592
14	Michalewicz	2.10E+12	-1.76E+24	1.2585832322796226E12~ 1.2585832323343786E12	1.26E+12	209179
15	Master's Cosine Wave	2.10E+12	-1.76E+24	1.2585832312977727E12~ 1.2585832313188313E12	1.26E+12	176708
16	Quartic	2.02E+12	-1.63E+24	8284.89596184143~ 1.258580937110703E12	1.21E+12	62301
17	Levy	2.10E+12	-1.76E+24	8284.89596184143~ 1.258584115799671 6E12	1.26E+12	237120
18	Step	2.10E+12	-1.76E+24	8284.89596184143~ 1.2585830175965303E12	1.26E+12	**19257**
19	Alpine	2.10E+12	-1.76E+24	8284.89596184143~ 1.258583037472294E12	1.26E+12	84956

Table3. 30 vectors with 20 dimensions

Table 3 has same conclusion as Table2. In this case, Also Schwefel gives stable values and Step functions has the fastest execution time.

	A	B	C	D	E	F
1	f(x)	average	SD(Standard Devation	Range	Median	Time(ms)
2	Schwefel	**21460.9329**	-1.78E+08	9258.55570451984~ 16423.69121322677	12843.3488	297156
3	De Jong 1	2432792.38	-1.27E+12	99224.43754205278~ 2813781.1099327477	1549648.85	**51351**
4	Rosenbrock's Saddle	1.34E+12	-3.78E+23	5.474099803449849E10~ 1.553633126004013E12	8.77E+11	120448
5	Rastrigin	8.89E+14	-3.16E+29	5.333606836440054E14~ 5.333607629892445E14	5.33E+14	242785
6	Griewangk	2.96E+12	-3.51E+24	1.7778692121420928E12~ 1.7778692296170222E	1.78E+12	261663
7	Sine Envelope Sine Wave	2.96E+12	-3.51E+24	1.7778692099542979E12~ 1.7778692099681313E	1.78E+12	254489
8	Stretch V Sine Wave	2.96E+12	-3.51E+24	1.7778692100215364E12~ 1.7778692115702822E	1.78E+12	511245
9	Ackley One	2.96E+12	-3.51E+24	1.7778692421329346E12~ 1.777869259099631E1	1.78E+12	560707
10	Ackley Two	2.96E+12	-3.51E+24	1.7778692596946821E12~ 1.7778692766793362E	1.78E+12	684554
11	Egg Holder	2.96E+12	-3.51E+24	1.7778692286735693E12~ 1.7778692388424912E	1.78E+12	515398
12	Rana	2.96E+12	-3.51E+24	1.777869237434817E12~ 1.7778692419626748E1	1.78E+12	929982
13	Pathological	2.59E+12	-2.68E+24	1.5536331260177627E12~ 1.5536331264128577E	1.55E+12	414206
14	Michalewicz	2.96E+12	-3.51E+24	1.7778692114705593E12~ 1.7778692115658794E	1.78E+12	490855
15	Master's Cosine Wave	2.96E+12	-3.51E+24	1.7778692099439446E12~ 1.777869209968058E1	1.78E+12	507091
16	Quartic	2.78E+12	-3.09E+24	9258.55570451984~ 1.7778660456968445E12	1.68E+12	146879
17	Levy	2.96E+12	-3.51E+24	9258.55570451984~ 1.777870561558652E12	1.78E+12	504826
18	Step	2.96E+12	-3.51E+24	9258.55570451984~ 1.7778689065368123E12	1.78E+12	68342
19	Alpine	2.96E+12	-3.51E+24	9258.55570451984~ 1.7778689352876763E12	1.78E+12	238253

Table4. 30 vectors with 30 dimensions

Table 4 has different conclusion. In this case, Schwefel function has comprehensive result compare to other functions. For 30 dimensions input,

De Jong 1 function has the fastest execution time.

In conclusion

According to Three result tables, Schwefel gives the most comprehensive values. However, it take the longest time to execute. For the 3 cases there was no function which is the most accurate and the fastest. It is hard to get the exact result because all the input vector is created by random which means we need high fortune to get ideal value.However, all the function result has there bounds of the results. We can find that if we run the program many times. It has low possibility to get exact ideal value for the functions as i said input vector is created by random. For the next research i will figure out how to make minimum value closer to ideal global minimum.