Report

Problem 1: Graph 2 Coloring

(a)

I've implemented Metropolis SA algorithm in 2-coloring. The graph is specially generated as a uni-connected graph(A-B-C-D...) for scale-up convenience. Initial temperature t_0 is selected as 10, end by $t_{final} = 0.1$, deducts 0.05 at every step.

Graph_size	Error_mean	Error_std
5	0.05	0.217944947
10	0.4	0.583095189
15	0.95	0.804673847
20	1.75	0.993730346
25	2.45	1.59608897
30	2.85	1.194780315
35	3.85	1.796524422
40	4.8	1.805547009
50	7.05	2.132486811

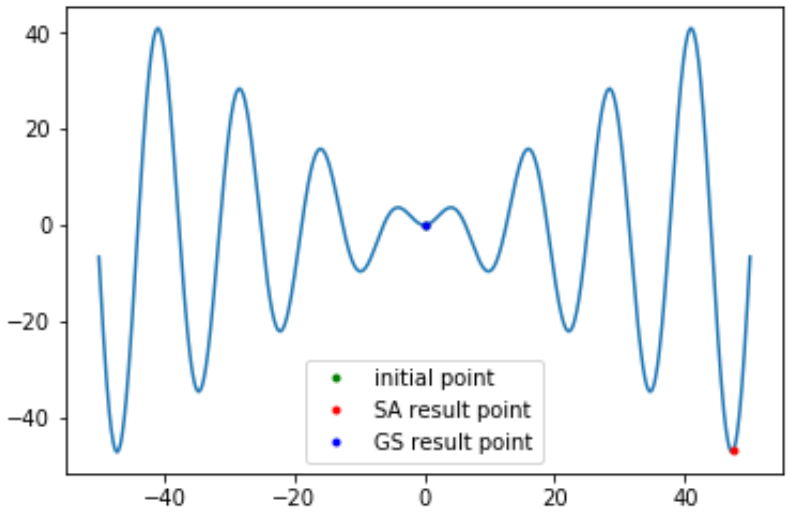
(b)

After generalized to multi-way choices, I tested 3-coloring with graph_size=50, this one-time error is 0.0, which is way lower than the 2-coloring error, the coloring ability has been greatly improved.

Problem 2: Function Optimization

Then I've integrated the graph coloring and function optimization into 1 simulated_annealing function(dicern tasks by whether providing graph input). With default value set to $t_0 = 10$, $t_{final} = 0.1$, N_T=5, N_c=2, T_step=0.05, x update initial step=0.9, $x_{initial} = 0.0$.

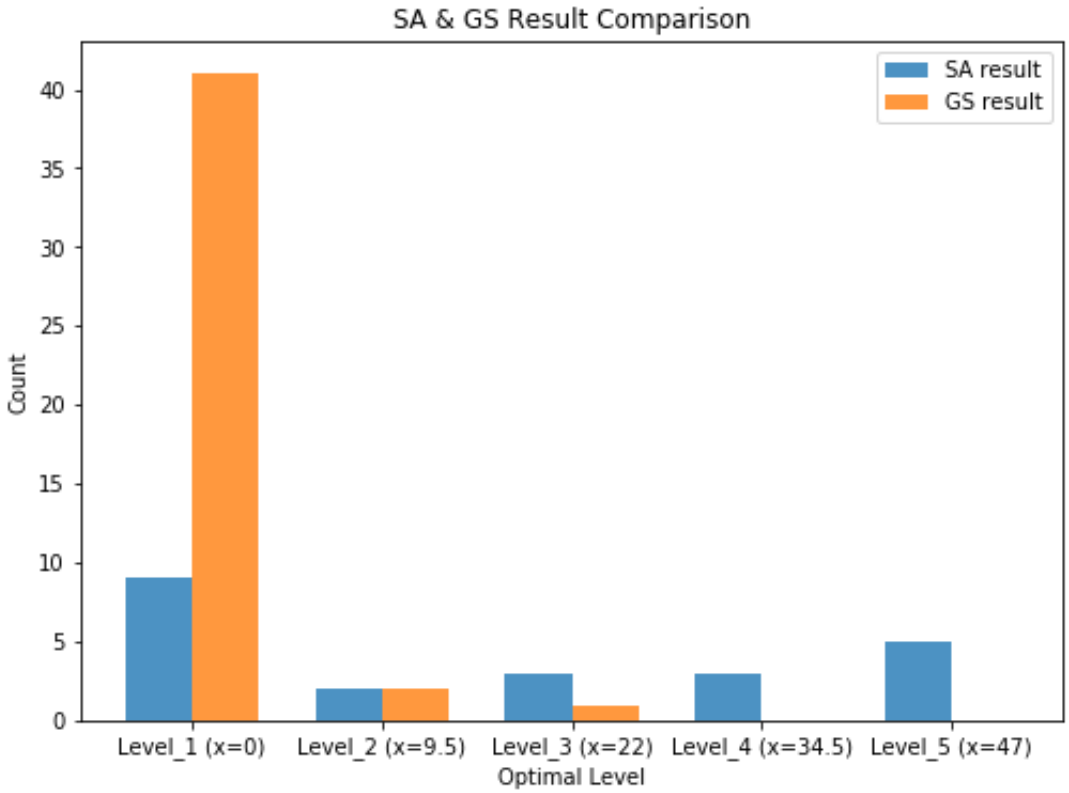
For test function, I chose $xsin(x/2)$ in range of [-50, 50] where contains 9 local optima and 2 of them are the best result.



To feel this directly from aboving plot, it's obvious that SA can reach a more global optimum than coordinate descent.

More quatitatively, I evaluate the results by following aspects:

1. Counting: Number points that belong to different optimal levels, if x is in [optimum_x +- gap]
2. Average Weighted Error: Assign different weights to different optimal range, sum up and average to get a error measure.



SA average error to the nearest optimum point: 3.1393

GS average error to the nearest optimum point: 0.0459

For GS, results are more concentrated around the worst optimal point x=0, but errors to this point is relatively small. SA can get to higher level optima easily, but the precision is relatively low.