SOLVING AN EXAM SCHEDULING PROBLEM USING A GENETIC ALGORITHM

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The Exam Scheduling Problem

- Solve exam scheduling problem using a genetic algorithm, hillclimbing, random search, and a variant of simulated annealing (mutate search)
- Compare how each algorithm performs in small/medium/large data sets.
- Development tools: java and mathematica

Fitness function

- We need a fitness function to determine how good a schedule is.
- the fitness of a schedule means how much each student or room likes their given timetable.
- For both a student and a room, the fitness function is $$q(TT) = \frac{1}{1 + penalty_{TT}}$$
- Runtime: a single evaluation of the fitness function took 0.2 seconds for a large data set.

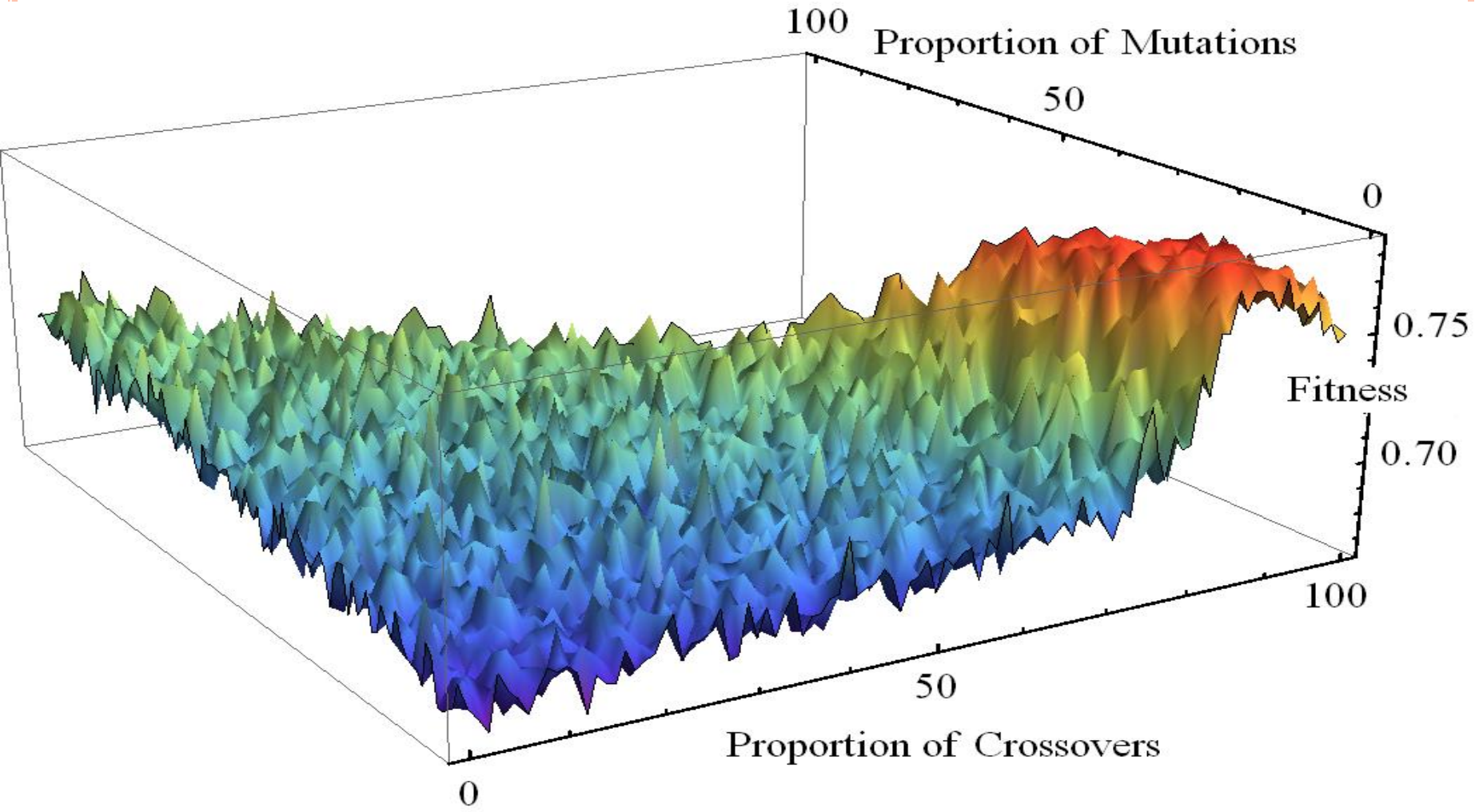
Genetic Algorithm

- It maintains a population of schedules and constructs subsequent generations
- To generate a new schedule: random, copying, mutation, crossover
- Mutation/crossover: schedules are selected with a probability proportional to their fitness.
- free parameters: size of the population, number of generations, proportions of copy, random, mutation, and crossover

Other search algorithms

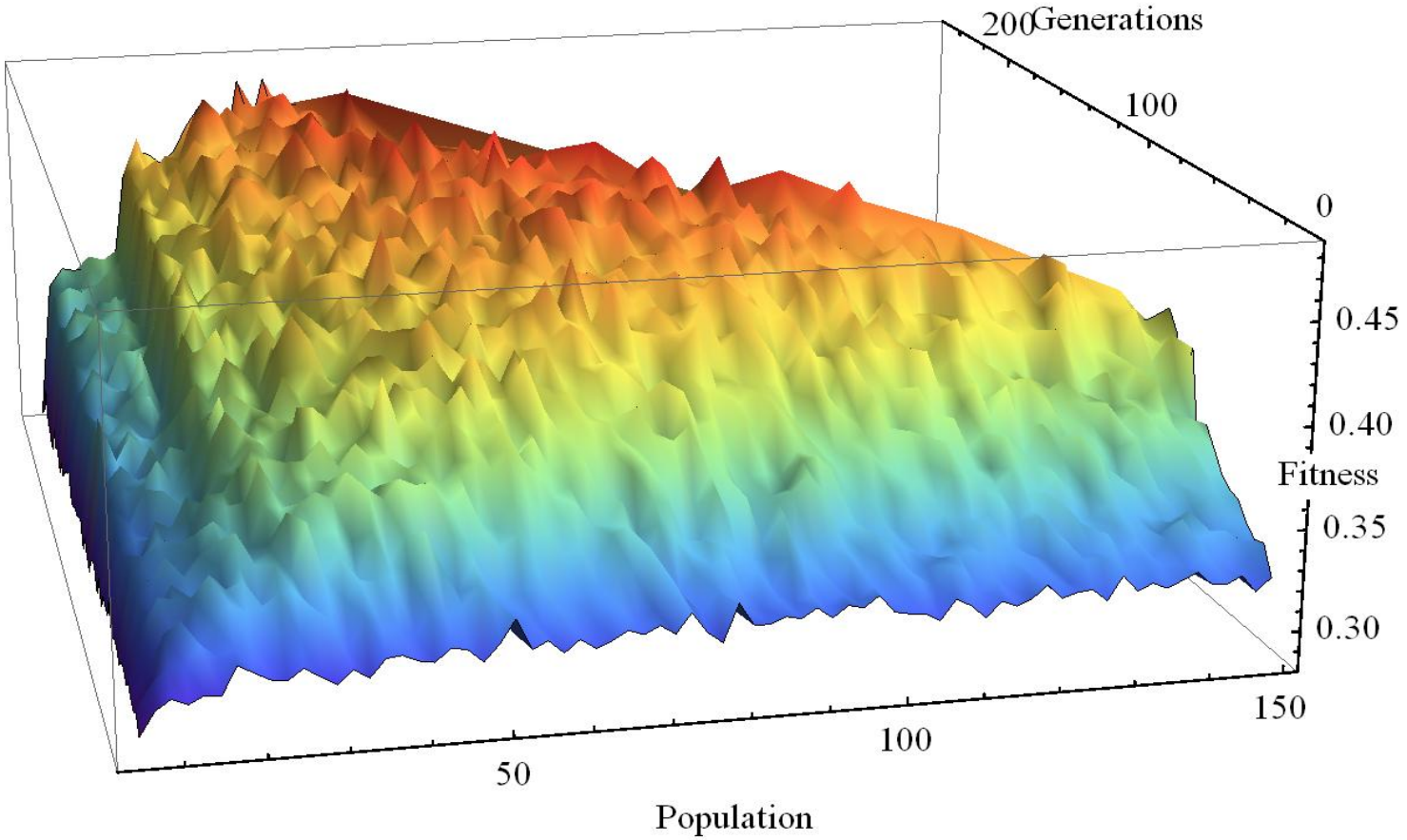
- Random Search: randomly generate some schedules, return the one with highest fitness.
- Mutate-search: Make 1% changes to the current best one and check the fitness. If the new one is better, replace the old one.
- Hill Climbing: examines every schedule in the neighborhood of a given schedule, then continues from the best one, until it reaches the maximum number of evaluation allowed.

Generation Parameters for GA



Crossover is outperforming!

Size Parameters for GA



the population per generation and the number of generation seem to both influence as much the fitness.

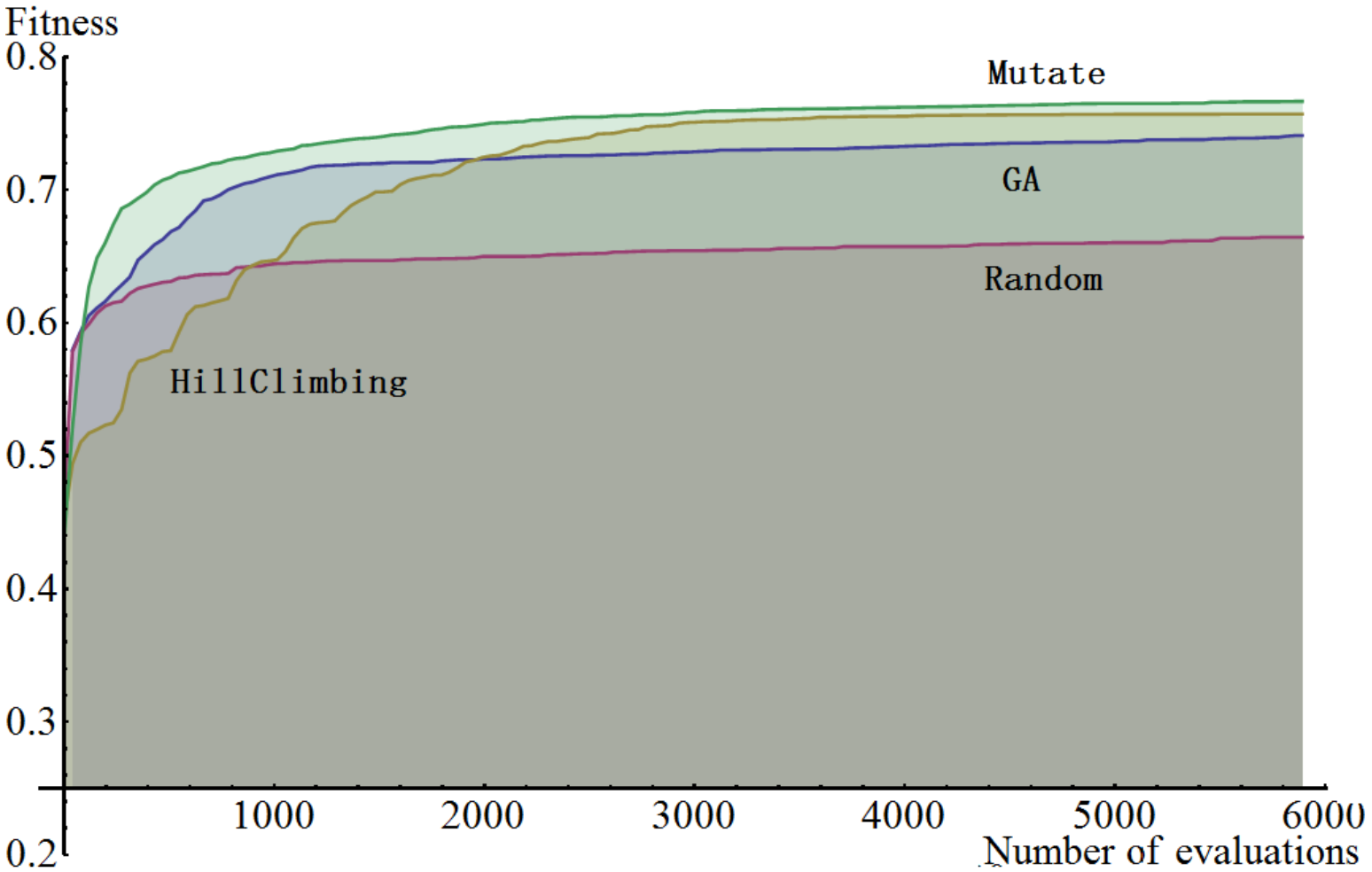
How to test the algorithms?

- We would like to compare data sets which their courses are with and without correlation.
- We want to see how these algorithms perform with small/medium/large data sets.
- Thus we have 2 sets of 3 differently sized scheduling problem instances to test our algorithms.
- The large data has the same size as actual U of T data

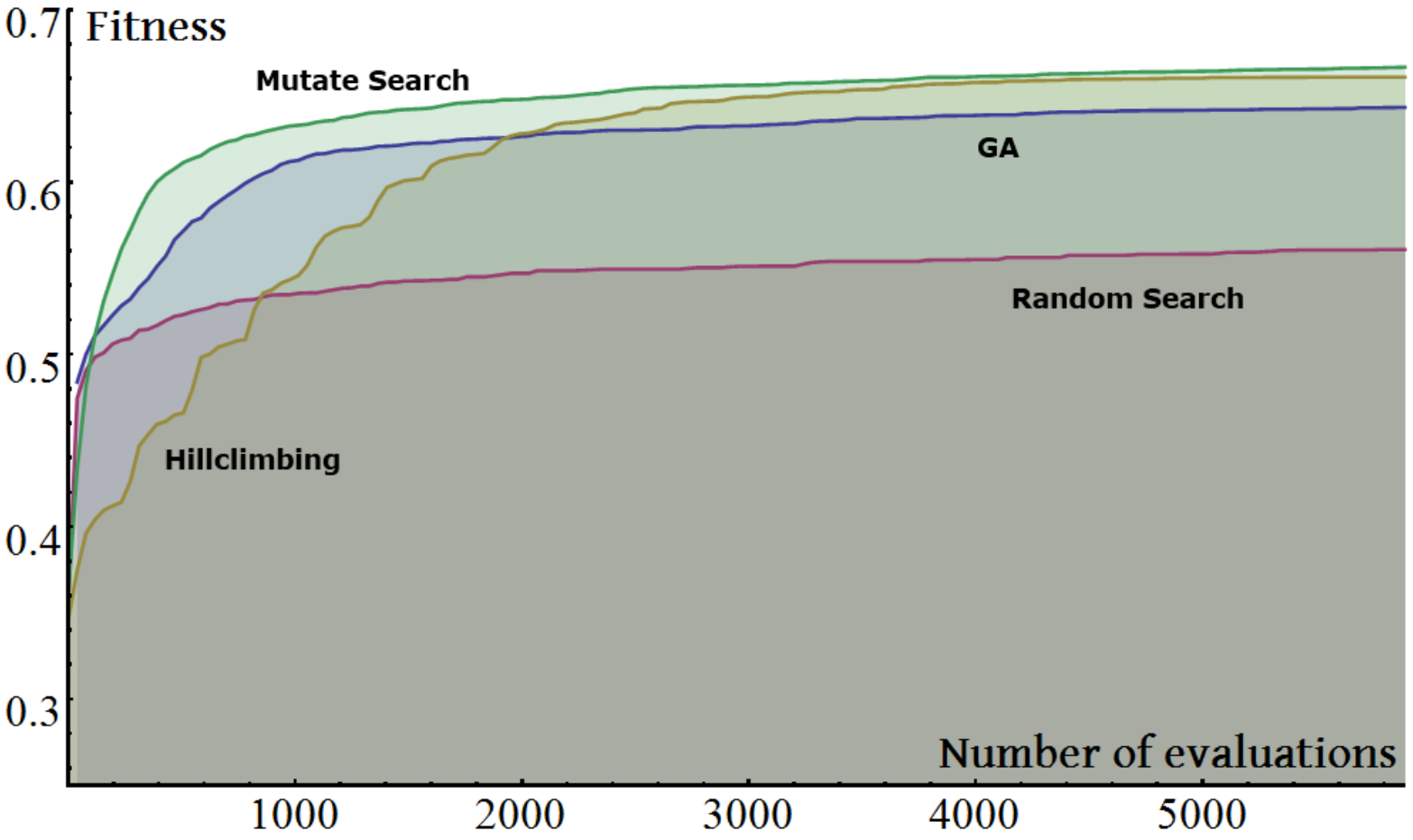
Testing data

	Small	Medium	Large	Small w/ Correlations	Medium w/ Correlations	Large w/ Correlations
Days	7	10	7	7	10	7
Time slots	5	8	8	5	8	8
Courses	20	200	603	20	200	600
Rooms	4	10	43	4	10	43
Students	50	300	21945	50	300	21945
Courses taking	1-5	1-6	1-5	2-6	2-6	2-6
Number of Majors	N/A	N/A	N/A	4	10	20
Search space size	10^{182}	10^{1840}	10^{6695}	10^{182}	10^{1840}	10^{6689}

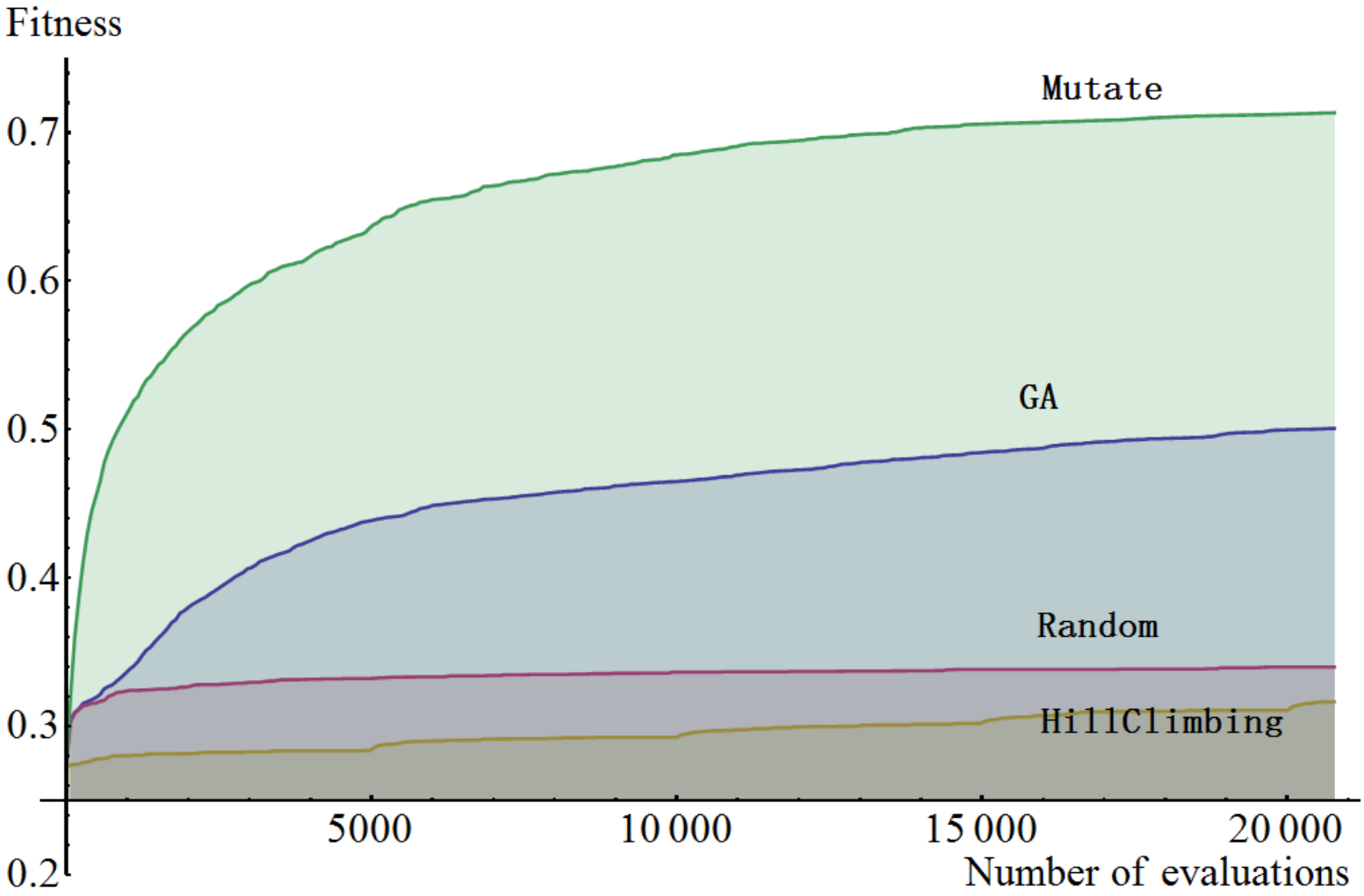
Small data set (uncorrelated)



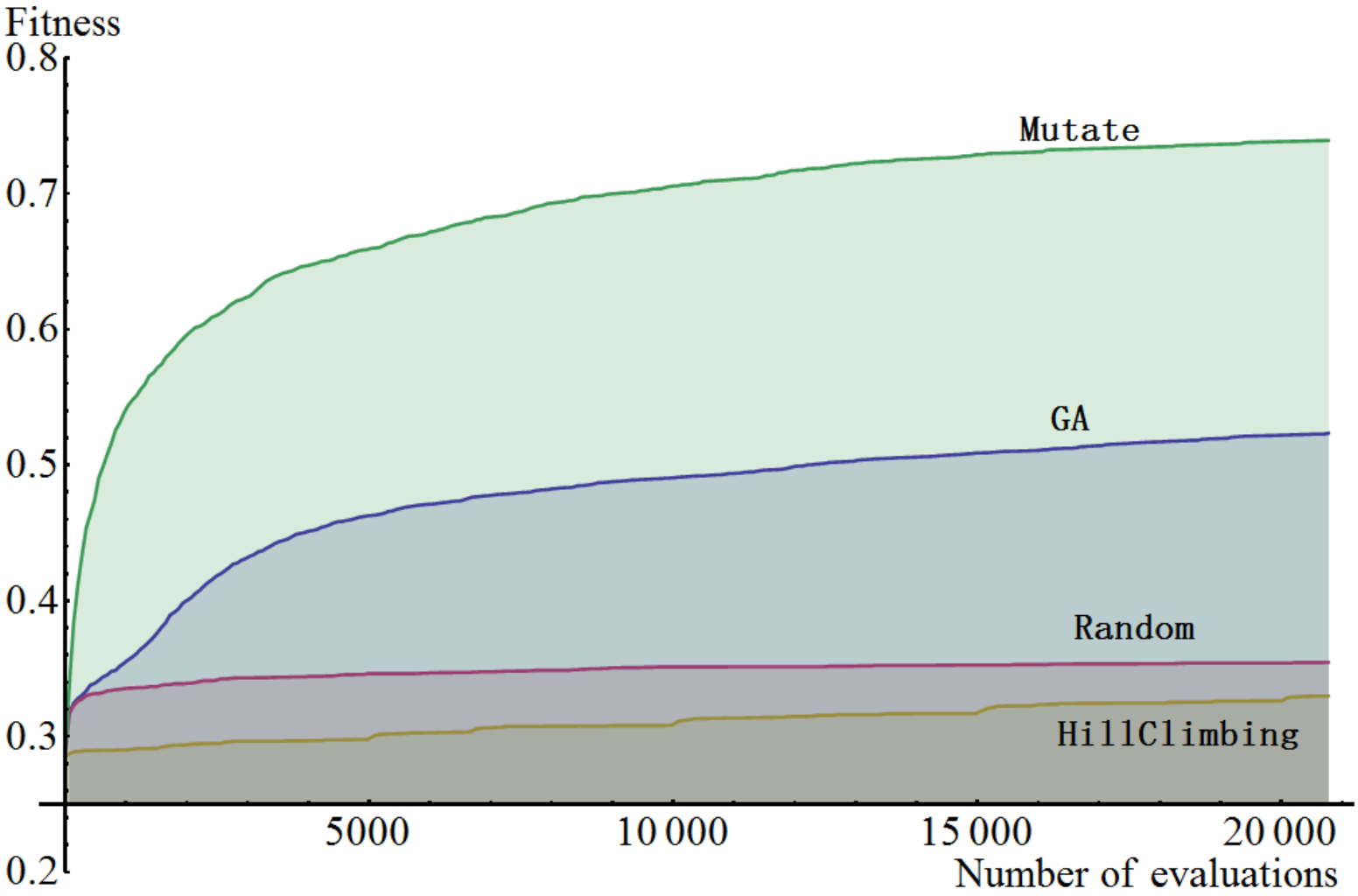
Small data set (correlated)



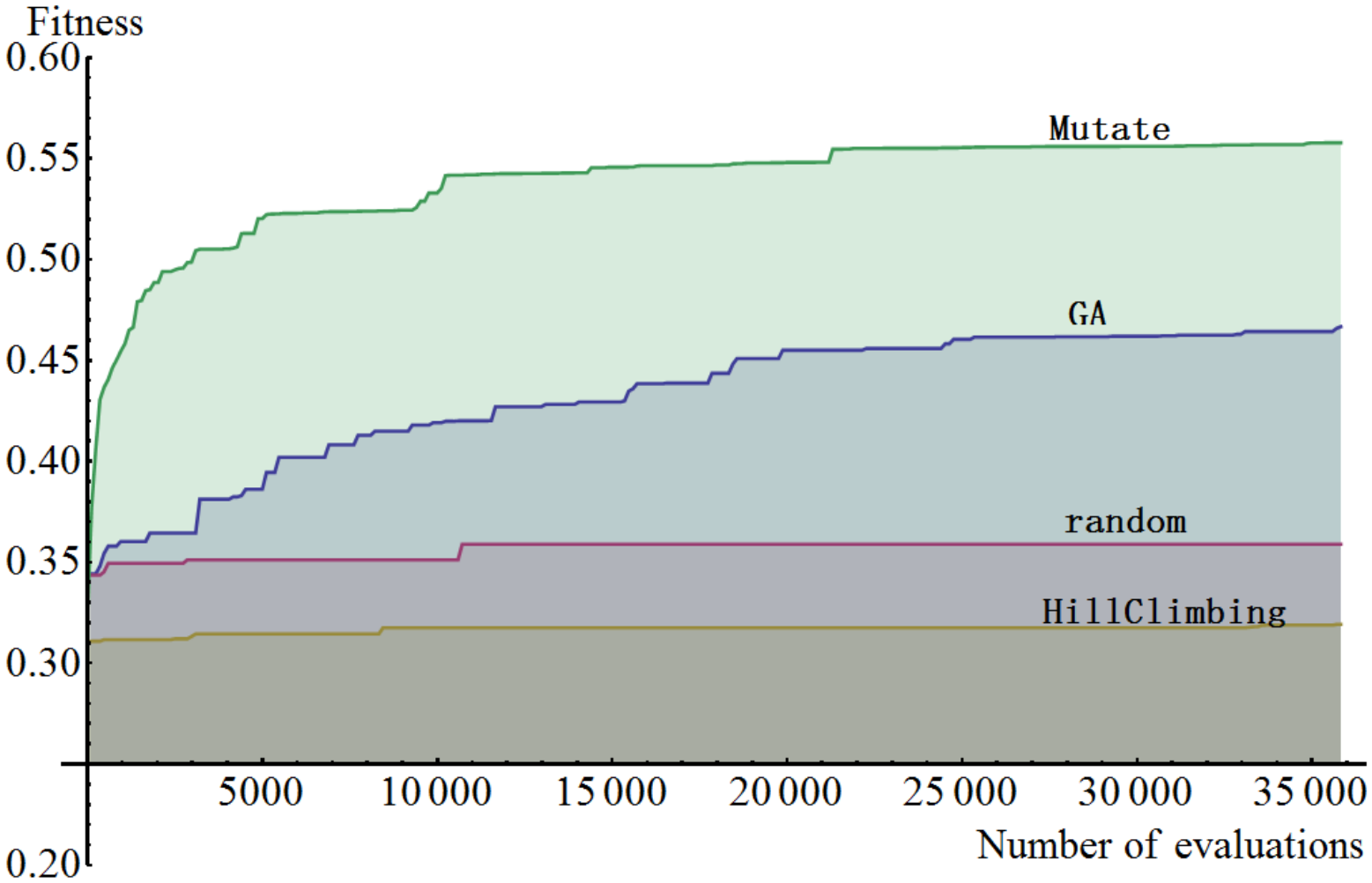
Medium data set (uncorrelated)



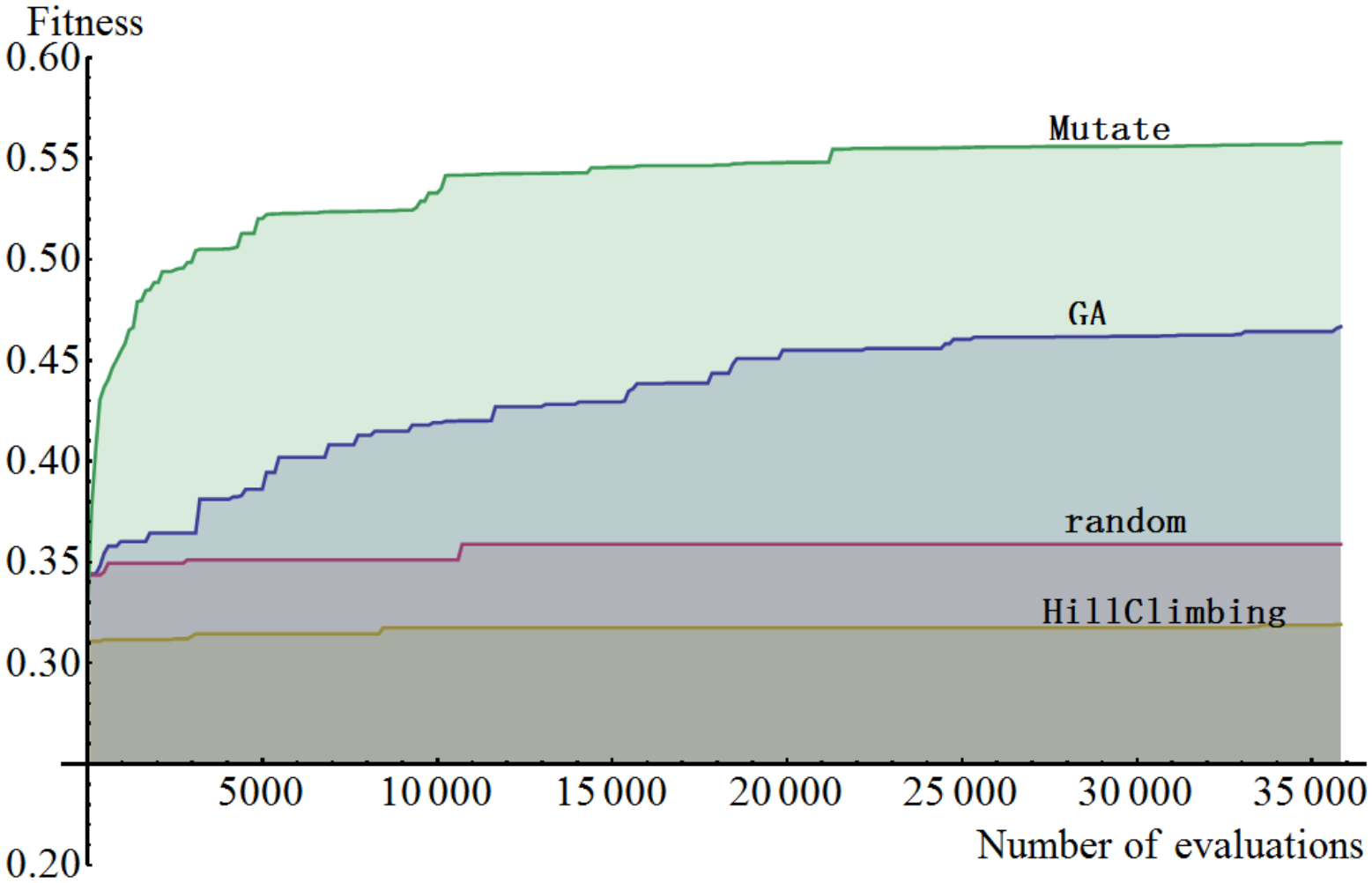
Medium data set (correlated)



Large data set (uncorrelated)



Large data set (correlated)



Conclusions

- Hillclimbing is not so valuable for this problem, if the data gets big, it will get stuck at a low local maxima.
- GA solves the problem pretty decently, but simulated annealing (mutate search) performs better.
- Searches perform better on data without course correlations than on those with correlations.