Evolutionary Computation Homework 1

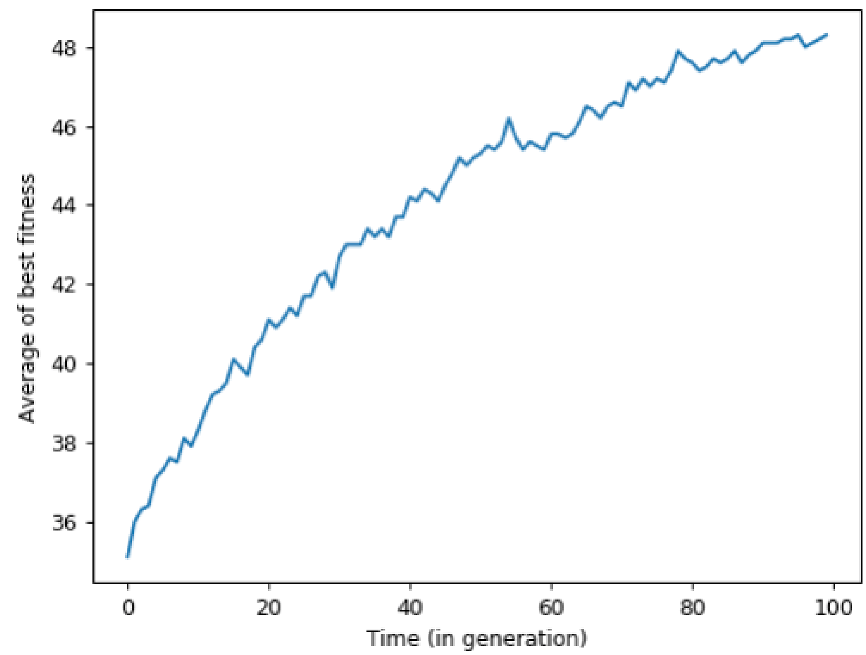
學號: 0416106 **姓名**: 彭敬樺

1. The eight queens problem
   a. The phenotype space contains all the possible configurations.
   In the most general version of the 8-queen problem, a configuration is valid if each queen is put on a different square, with no other restrictions. Therefore, the size of the phenotype space is
   $$size(PS) = \binom{8^2}{8}$$
   that is, the number of combinations of 8 squares taken from the 64 squares in the chessboard. In general, if the number of queens is *n* and the chess board has the *n**n* squares the size of the phenotype space is
   $$size(PS) = \binom{n^2}{n}$$
   To improve it further, there are some additional constraints on the configurations:
   - There is exactly one queen per row
   - There is exactly one queen per column

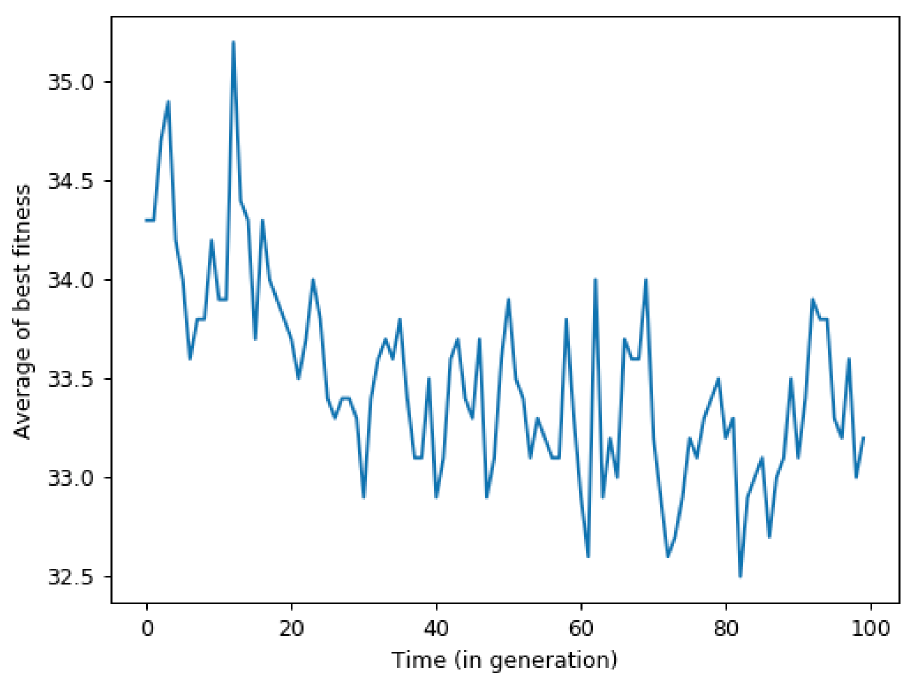
   So *size(PS)* is much smaller, and in case of 8 queens is
   $$size(PS) = 8!$$
   b. A genotype, or chromosome, is a permutation of the numbers 1, . . . , 8, and a given g = <i1, . . . , i8> denotes the (unique) board configuration, where the n-th column contains exactly one queen placed on the in-th row.
   c. The genotype space size is
   $$size(GS) = 8!$$
   d. We use elements of P represented as matrices directly as genotype, meaning that we design variation operators acting such matrices. For instance, the permutation g = <1, . . . , 8> represents a board where the queens are placed along the main diagonal.

2. We need 10 bits.
$$Precision(L) = \frac{1-0}{2^L} \le 0.001$$
$$10^3 \le 2^L$$
$$L \ge 10$$

3. Resulting Graph of 50-bit OneMax Problem with Roulette Wheel and sum as fitness



4. Resulting Graph of 50-bit OneMax Problem with Roulette Wheel and sum+1000 as fitness



5. In the problem 3, the selection is happening normally, which is the higher fitness level has significantly higher chance to be chosen as candidate, however, in problem 4, due to the increase of 1000 in the value of the sum, the best and worst fitness value diverse in only small ratio of number, which made their probability to be chosen to be nearly equal.

Therefore, the search space diversity does not change very much, which results in bad results.

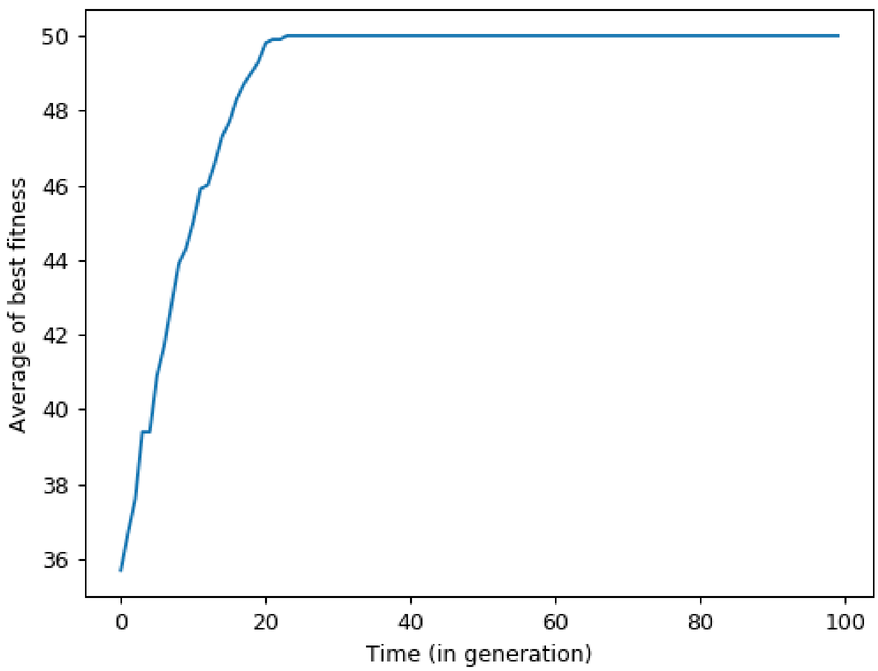
$$y_i = f(x_i) = x_i, then \frac{y_i}{\sum_{y=1}^{50} y_i} \rightarrow have\ large\ effect\ with\ different\ y_i$$

$$Meanwhile,$$

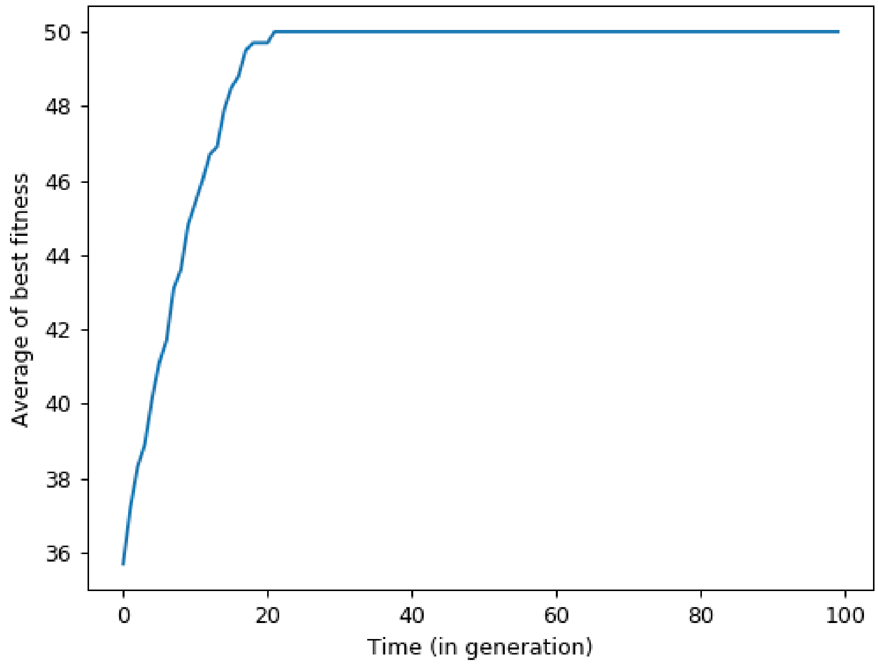
$$y_i = f(x_i) = x_i + 1000, then \frac{y_i}{\sum_{y=1}^{50} y_i} \rightarrow small\ effect\ with\ different\ y_i$$

$$mostly\ \approx 0.02$$

6. Resulting Graph of 50-bit OneMax Problem with Tournament Selection and sum as fitness



7. Resulting Graph of 50-bit OneMax Problem with Tournament Selection and sum+1000 as fitness



8. The resulting graph for problem 6 and 7 does not differ much. The reason behind this is due to the working method of tournament selection which respect rank of the fitness value. In the ranking system, the added value does not change the rank of each individual, therefore, the result does not change at all.
9. Roulette Wheel use random probability of being chosen with probability of being chosen depended on its individual fitness value. In the situation where, the value difference is small and the number of population is high, this random selection method will result in nearly uniform probability of each individual being chosen, which does not help the model to converges quickly.
   However, Tournament Selection does not suffer from this method due to its nature to prefer higher ranked fitness individual to be prioritized as mate. It can be seen that the Tournament Selection method converges significantly faster than using Roulette Wheel.