Homework #1

Due date & time: March 28, 2019, 10:00AM

Do the following problems and exercises.

1. The eight queens problem.
   (a) How big is the phenotype space for the eight queens problem?
   (b) Give a genotype to encode the 8x8 chessboard configuration.
   (c) How big is the genotype space you give in 1b?
   (d) Briefly describe why the proposed genotype is able to cover the phenotype space.
2. Given a function $f(x) : [0, 1] \to \mathbb{R}$. We want to find an optimal x value with a required precision of 0.001 of the solution. That is, we want to be sure that the distance between the found optimum and the real optimum is at most 0.001. How many bits are needed at least to achieve this precision for a bit-string genetic algorithm?
3. Implement a genetic algorithm to solve the 50-bit OneMax problem

$$f(x) = \sum_{i=1}^{50} x_i, \quad x_i \in \{0, 1\}, i = 1, \ldots, 50,$$

   with the following parameters:

   - Binary representation;
   - Random initialization;
   - Parent selection: Roulette wheel selection with replacement;
   - Recombination: One-point crossover with probability $p_c = 1.0$;
   - No mutation operator;
   - Replacement: Generational model (no elitism);
   - Population size: 200;
   - Termination criterion: 100 generations.

   For every generation (including generation 0), record the best fitness value in the population. Do ten independent runs and average the best fitness values of the ten runs for each generation. Plot a graph with time (in generation) as the x-axis and the average of the best fitness values for each generation as the y-axis.

4. Repeat the problem above with a modification to the fitness function as

$$f(x) = 1000 + \sum_{i=1}^{50} x_i, \quad x_i \in \{0, 1\}, i = 1, \ldots, 50.$$

   Then subtract 1000 from all fitness values collected along the process for statistics and the graph.

5. Compare the results you got for problems 3 and 4. Discuss the difference in the two plots.

6. Repeat problem 3 with using tournament selection with replacement instead of roulette wheel selection. Tournament size = 2.

7. Repeat problem 4 with using tournament selection with replacement instead of roulette wheel selection. Tournament size = 2.

8. Compare the results and plots you got for problems 6 and 7.

9. Compare the results and plots you got for problems 3, 4, 6, and 7.