

Advanced Algorithms

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Lab 10 – Exercises on evolutionary algorithms

Exercise 1

- Discuss whether there is the survival of the fittest in generational GAs

Exercise 1

Solution

In generational GAs the entire population is replaced by the offspring at each generation. Therefore, the fittest individual at generation t survives at generation $t+1$ if:

- It is included in the selected parents
- It is not "destroyed" by crossover or mutation

Assuming fitness proportionate selection, the number of copies in the parent pool of the fittest individual is as high as the fittest is outstanding in the population (its fitness is much higher than all other fitnesses). At least one of these copies should not be "destroyed" by crossover or mutation. This depends on the probabilities of crossover and mutation.

Exercise 2

Consider the simple genetic algorithm applied on a population of 8 integer numbers. Suppose that at time t of the evolution the population has the following composition:

- $x=1$: 2 copies
- $x=2$: 3 copies
- $x=3$: 3 copies

Assuming that the fitness function is $f(x)=x^2$, calculate the probability of selecting the individuals $x=1$, $x=2$, and $x=3$ using roulette wheel selection.

Exercise 2

Solution

- The probability of selecting an individual is proportional to its fitness. In general, the probability of selecting an individual a from a population P of size N is
 - $p(a) = f(a) * nc(a) / \sum_{i=1}^K nc(i) * f(i)$
 where $f(x)$ is the fitness of x , $nc(x)$ is the number of copies of x in P , K is the number of distinct individuals, and $\sum_{i=1}^K nc(i) = N$
- In this particular case we have $N=8$, $K=3$, and the fitnesses and the number of copies of each individual are
 - $f(1) = 1^2 = 1$ $nc(1) = 2$
 - $f(2) = 2^2 = 4$ $nc(2) = 3$
 - $f(3) = 3^2 = 9$ $nc(3) = 3$
- Therefore, the probability of selecting the 3 individuals are
 - $p(1) = 1^2 * 2 / (2*1^2+3*2^2+3*3^2) = 2 / 41$
 - $p(2) = 2^2 * 3 / (2*1^2+3*2^2+3*3^2) = 12 / 41$
 - $p(3) = 3^2 * 3 / (2*1^2+3*2^2+3*3^2) = 27 / 41$

Exercise 3

Calculate the probability that a binary chromosome of length L will not be changed by applying the usual bit-flip mutation with probability $p_m = 1/L$

Exercise 3

Solution

- The chromosome does not change if none of its bits is changed
- The probability that no bits are changed is

$$p_{nc} = (1 - p_m)^L$$

Assignment 09



Exercise 1

Implement in Octave (or Java, but attempt with Octave first! ☺) an Evolutionary Algorithm that solves the 8-queens problem presented in Lecture 10

Exercise 2 (optional but useful for the final exam)

Consider a generational GA that has a population size of 100 individuals and uses roulette-wheel selection. Suppose that after running for t generations, the mean population fitness is 76.0 and that in the population there is only one copy of the best member, which has fitness 157.0. Also suppose that parents parent selection is performed on the population

- What is the expected number of copies of the best individual in the set of selected parents?
- What is the probability that there will be no copies of the best individual in the selected parents?