Tecnológico de Monterrey

Computational intelligence

Homework 4

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September 20, 2019

Problems

1. Tournament selection

	Population	f
A	010111000	-1
B	011101001	4
C	111000110	-2
D	100001000	1
E	010101000	0

   - How many copies of each chromosome are present in the mating pool?
     - A: 0
     - B: 3
     - C: 0
     - D: 2
     - E: 0
   - What is the average fitness of the chromosomes in the mating pool?

     2.8
   - If the tournament size is reduced to one, what is the probability that the chromosome 100001000 appears in the mating pool?

     100%
   - If the tournament size is increased to five, and both crossover and mutation rate are set to zero, what is the probability that the chromosome 010111000 survives to the next population?

     0%

2. Whole arithmetic crossover

$$x = \{0.18, 0.75, 0.92, 0.26, 0.44\}$$
$$y = \{0.36, 0.77, 0.62, 0.13, 0.51\}$$

$$c^1_{.5} = \{0.27, .76, .77, .195, .475\} \qquad c^2_{.5} = \{0.27, .76, .77, .195, .475\}$$
$$c^1_{.1} = \{0.342, 0.768, 0.65, 0.143, 0.503\} \qquad c^2_{.1} = \{0.198, 0.752, 0.89, 0.247, 0.447\}$$

3. Exponential ranking selection Sum: 5.4375

	Population	f	r	f'
A	6661166703	5	3.5	2.296875
B	3306772232	5	3.5	2.296875
C	0489794549	4	1.5	0.421875
D	2660088784	4	1.5	0.421875
E	3578647359	3	0	0

- A: $\frac{2.29}{5.4375} = 0.4224$
- B: $\frac{2.29}{5.4375} = 0.4224$
- C: $\frac{0.42}{5.4375} = 0.0775$
- D: $\frac{0.42}{5.4375} = 0.0775$
- E: 0

4. Schemata

- Given two schemata, 1*001*1* and 00*11*11, which schema corresponds to more solutions?

  1*001*1* → 8
  - 11001111
  - 11001110
  - 11001011
  - 11001010
  - 10001111
  - 10001110
  - 10001011
  - 10001010

  00*11*11 → 4
  - 00111111
  - 00111011
  - 00011111
  - 00011011

- What is the order of the schemata 01101001, ****1**0 and 1*0*0010?
  - 01101001 → 8 → 2
  - ****1**0 → 2 → 0
  - 1*0*0010 → 6 → 1
- What is the defining length of the schemata 00**1010, **0**111 and *0***1*0?
  - 00**1010 → 7
  - **0**111 → 5
  - *0***1*0 → 6

- Given a population of five chromosomes: 100, 001, 111, 010, and 000, how many different schemata exist in such a population? As part of your answer, calculate the lower and upper bounds of schemata in the population.
  Upper bound = $5 * 2^3 = 40$
  Lower bound = $2^3 = 8$

  - 000
  - 00*
  - 0*0
  - *00
  - 0**
  - **0
  - *0*
  - ***
  - 010
  - 01*
  - *10
  - *1*
  - 111
  - 11*
  - 1*1
  - *11
  - 1**
  - **1
  - 001
  - 0*1
  - *01
  - 100
  - 10*
  - 1*0

5. Practical case

   The representation chosen for this exervise would be one in which each action is represented by a number associated with it. For example 1 = Go Up, 2 = Go Right, 3 = Go Down and 4 = Go Left. As the memory of the robot can only store 100 actions, the chromosome would have a length of 100. A crossover operator would be as simple as an index in which each parent splits and each part goes to each children. A mutation operand would simply change a selected entity to a random option different that the one it already has.

   The optimal path in the figure shown, which consists in actions "move up", "move to the right", "move to the right", "move to the right", "move up", "move up", "move to the left", "move to the left", "move to the left", "move up", and "move up" would then be represented as $[1, 2, 2, 2, 1, 1, 3, 3, 3, 1, 1...1]$

6. Analysis

   - What would you think of using elitism in a steady-state genetic algorithm? Do you think it is a good idea? What would be the benefits?

     Elitism may be beneficial when you reach a steady-state, because you can replace more of your population and maybe found a better solution and breaking with the steady-state. Although if the population is already too uniform, it probably won't have a significant impact in creating different items in the new population.

   - Imagine that someone proposes a mutation operator for binary strings that is inspired on a uniform crossover. This mutation operator uses a binary template and only the elements located at positions of the template that contain a 1 will be flipped. What could you say about this mutation operator?

     It may be useful, but as only that positions change it may lead to a somewhat static set of chromosomes which the would need to be mutated more to create more variety in the new populations.

   - Imagine that linear ranking selection (using C = 2) is executed on a population of n chromosomes. What would be the effect on the selection probabilities if the fitness of every chromosome in the population is multiplied by a constant k?

     The rank would remain the same as the constant is applied to all, in any case, if the constant is less than 1, the points would be drawn closer together, whereas if the constant is bigger than one, the ranks would be spread farther away.

   - Given a binary-string chromosome of 100 genes and a mutation rate $pm = 0.01$ (that is evaluated independently for each gene in the chromosome), what is the probability that a given chromosome remains unaltered during the mutation phase? What would be the probability that a given chromosome remains unaltered during the mutation phase if $pm = 0.05$? What value should we use for pm if we would like that around half of the genes in the chromosomes are flipped as a result of mutation?

     If the pm is equal to 0.01, that means that the possibility of remain the same, would be calculated by the expression $1 - pm$, which would then be equivalent to 0.99 in this case. On the other hand, if pm is equal to 0.05, the probability of remaining the same would then be 0.95. In order to have half the chromosomes flipped, you would then have to have a pm of 0.5.

- Given two real-valued chromosomes of length five, $\vec{x} = x_1, x_2, x_3, x_4, x_5$ and $\vec{y} = y_1, y_2, y_3, y_4, y_5$, what would be the result of combining $\vec{x}$ and $\vec{y}$ through a whole arithmetic crossover with $\alpha = 1.0$? How would the offspring change if $\alpha = 0$?

  The result of combining $\vec{x}$ and $\vec{y}$ with and α of 1 would be just the same as $\vec{x}$ and $\vec{y}$ because the values in $\vec{y}$ would be mutliplied by 0 in the first instance and the values of $\vec{x}$ in the second. If α is set to 0,the same would pass, only the positions would be changed.