INTRODUCTION TO ARTIFICIAL INTELLIGENCE – LECTURE 4 – GENETIC ALGORITHMS

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I. Given the following chromosome in the binary encoding, representing an example solution for the knapsack problem:

1	0	1	1	0	0

present a chromosome obtained after a flip bit mutation

0	1	0	0	1	1

II. Given the following chromosome representing a permutation of cities, being an example solution for the travelling salesman problem, and two genes (in gray) selected for the purpose of performing a mutation,

3	6	5	1	2	4

present the chromosomes obtained after:

a) swap mutation:

3	1	5	6	2	4

b) insert mutation:

3	1	6	5	2	4

III. Given the two below presented chromosomes in the binary encoding:

1	0	1	1	0	0

0	1	1	0	0	1

present a pair of chromosomes obtained after applying 2-point crossover with crossover points after the second and fifth genes:

1	0	1	1	0	1

0	1	1	0	0	0

IV. Given the two below presented chromosomes, representing the permutations:

3	6	5	1	2	4

2	3	1	5	6	4

present pairs of chromosomes obtained after applying the following operators:

a) order 1 crossover with the arbitrary parts copied from the 1st and 2nd parent to, respectively, 1st and 2nd child being distinguished with gray color (*hint*: for the 1*st* parent, fill the free slots after the cut point (i.e., after the fourth gene) with 2, 3, and 4, using the order in which they appear in the 2*nd* parent after the cut point, i.e., 4, 2, and 3):

3	6	5	1	4	2

2	3	1	5	4	6

b) cycle crossover (*hint*: three cycles can be found, involving 3, 2, and 1 node):

3	6	1	5	2	4

2	3	5	1	6	4

V. Given the three below presented binary-encoded chromosomes (A, B, C) for the knapsack problem and the respective vectors of weights ***w*** and values ***v***:

A	**1**	**0**	**1**	**1**	**0**	**0**
B	**0**	**1**	**1**	**0**	**0**	**1**
C	**0**	**0**	**1**	**0**	**0**	**1**

w_i	**2**	**1**	**3**	**1**	**2**	**4**
v_i	10	2	20	10	15	30

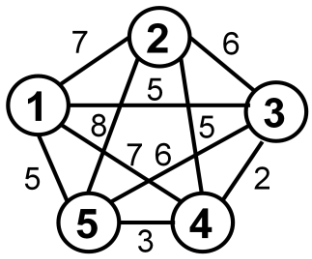
a) Compute the fitness of each chromosome (solution) given by: the sum of values of items contained in the knapsack in case they do not exceed the maximal allowed capacity of 7, or 0 otherwise (i.e., if the chromose represents an infeasible solution).

Answer: A - 40, B - 0 , C - 50

b) Which solution is the best out of these three? ***Answer***: C

VI. Given the three below presented permutation-encoded chromosomes for the TSP and the respective distances between all pairs of cities:

A	**5**	**3**	**4**	**2**	**1**
B	**5**	**4**	**3**	**2**	**1**
C	**5**	**1**	**3**	**2**	**4**



a) Compute the fitness of each chromosome (solution) given by the sum of distances between all pairs of adjacent cities (remember about the need of returning to the starting point).

Answer: A - 25 , B - 23 , C - 24

b) Which solution is the best out of these three? ***Answer***: B

VII. Given the following table of fitness values for seven solutions ***a*** - ***g*** (fitness F_i to be maximized)

sol	***a***	***b***	***c***	***d***	***e***	***f***	***g***
F_i	**3**	**1**	**3**	**2**	**0.5**	**1.5**	**1**

Indicate the three parents selected for the recombination operator with the tournament selection of size 4, when the following subsets of solutions participate in each tournament:

i) {*a, d, f, g*} - ***Winner***: a

ii) {*b, c, e, f*} - ***Winner***: c

iii) {*b, d, e, g*} - ***Winner***: d