GENETIC OPERATORS

In this exercise we study three genetic operators: **Selection, Crossover and Mutation:**

1. Read de basics of each operator
2. Classify each method into one of the 3 operators

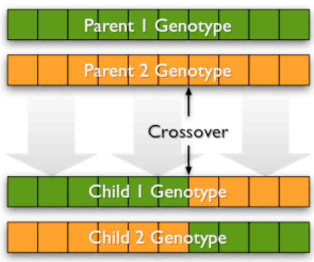
SELECTION OPERATOR

Decide which individuals will breed a new generation.

- The key idea is to give preference to better individuals, allowing them to pass on their genes to the next generation.
- The goodness of each individual depends on its fitness.
- Some individuals will be selected more than once, while others will die without leaving any descent.

CROSSOVER OPERATOR

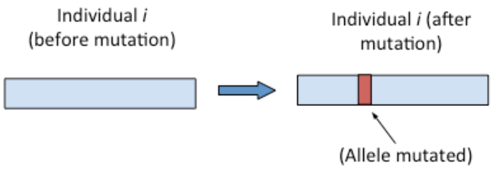
- Two individuals are chosen from the population using the selection operator.
- The two new offspring created from this mating are put into the next generation of the population.
- By recombining portions of good individuals, this process is likely to create even better individuals.



MUTATION OPERATOR

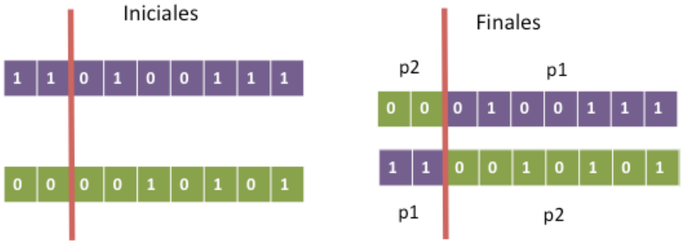
- Alter each gene independently with a probability p_m
- p_m is called the mutation rate

  Typically between 1/pop_size and 1/ chromosome_length



METHOD 1: Choose a random point on the two parents

- Split parents at this point
- Create children by exchanging tails
- P_c typically in range (0.6, 0.9)



METHOD 2: Insertion

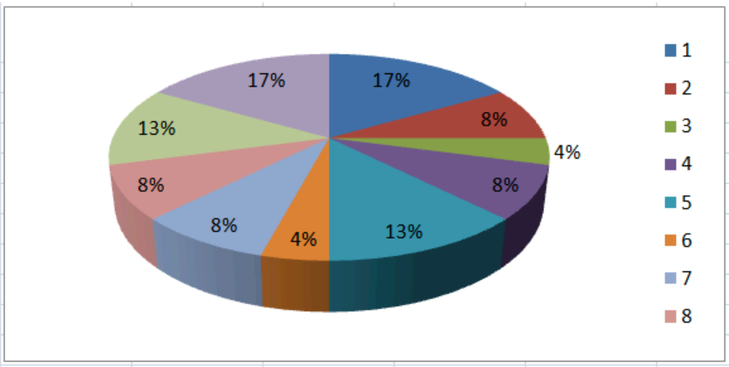
- Pick two allele values at random
- Place the first to follow the second, shifting the rest along to accommodate
- Note that this preserves most of the order and the adjacency information

v = (1 9 **8** 7 6 5 **4** 3 2) v' = (1 9 7 6 5 **8** 4 3 2)

METHOD 3 – Roulette Wheel

- Assign to each individual a part of the roulette wheel, based on the evaluation function
- Spin the wheel n times to select n individuals

Función de Evaluación	Prob	Acumulada
4	0,17	0,17
2	0,08	0,25
1	0,04	0,29
2	0,08	0,38
3	0,13	0,50
1	0,04	0,54
2	0,08	0,63
2	0,08	0,71
3	0,13	0,83
4	0,17	1,00



METHOD 4: Inversion

Invert the order of a sub-chain

v = (1 9 8 | **7 6 5 4** | 3 2) v' = (1 9 8 | **4 5 6 7** | 3 2)

METHOD 5: Tournament

- Pick k members at random, then select the best of these

- Repeat to select more individuals

METHOD 6: Bit Flip (Binary)
We select one or more random bits and flip them (from 0 to 1 or viceversa)

METHOD 7: PMX

1. Two points are selected at random (or determined before execution)

   p_1 = (1 2 3 | 4 5 6 7 | 8 9) p_2 = (4 5 2 | 1 8 7 6 | 9 3)

2. The central part of one parent is mapped to the central area of the other parent:

   s_1 = (x x x | 1 8 7 6 | x x)
   s_2 = (x x x | 4 5 6 7 | x x)

   taking into account the interchanges: 1/4, 8/5, 7/6, y 6/7

2. Then, the values that are not in conflict (already inserted) are added to each offspring:
   For example value 1 in p1 already exists in s1, then we look for the next value
   p_1 = (1 2 3 | 4 5 6 7 | 8 9) s1 = (x 2 3 | 1 8 7 6 | x 9)
   p_2 = (4 5 2 | 1 8 7 6 | 9 3) s2 = (x x 2 | 4 5 6 7 | 9 3)

3. Finally, the values in conflict must be replaced by the interchanges: 1/4, 8/5, 7/6, y 6/7
   For example value 1 in p1 already exists in s1, the interchange was 1/4 , thus, value 4 is added instead
   s1 = (4 2 3 | 1 8 7 6 | 5 9)
   s2 = (1 8 2 | 4 5 6 7 | 9 3)

METHOD 8: OX
From a substring of p1, and preserving the relative order of the p2:

1. Two points are selected at random (or determined before execution)
   p_1 = (1 2 3 | 4 5 6 7 | 8 9) p_2 = (4 5 2 | 1 8 7 6 | 9 3)
2. The central part is copied into the offspring:
   s1 = (x x x | 4 5 6 7 | x x) s2 = (x x x | 1 8 7 6 | x x)
3. Starting from the second point, copy the values of the other parent in the same order, omitting those repeated values.
   s1 = (x x x | 4 5 6 7 | 9 3) s2 = (x x x | 1 8 7 6 | 9 2)
4. When the end of the string is reached, start from the first position on the left:
   s1 = (2 1 8 | 4 5 6 7 | 9 3) s2 = (3 4 5 | 1 8 7 6 | 9 2)

METHOD 9: Swap
We select two positions on the chromosome at random, and interchange the values. (This is common in permutation-based encodings).

EXERCISES

Use the following random numbers:

8 2 1 3 6 2 3 8 4 5 7 6 1 3 8 4 7 3 6 4 4 2 6 5 3 1 5 1 5 6 1 5 8 1 8 7 7 4 6 2 4 2 7 2	0.5129 0.3693 0.4460 0.3933 0.1194 0.9404 0.3204 0.4032 0.4605 0.0336 0.5083 0.8044 0.6344 0.4156 0.6579 0.8024 0.3504 0.1922 0.5281 0.0111 0.8624 0.2720 0.0018 0.8621 0.0950 0.4714 0.5729 0.2331 0.1582 0.9280 0.6290 0.1438

1. Given the following individuals belonging to the 4-Queens problem, where the fith column corresponds to the evaluation function, apply all the selection operators studied above:

2	1	3	4	**4**
1	3	2	4	**4**
3	4	1	2	**2**
3	2	4	1	**5**
4	2	3	1	**4**
2	3	4	1	**2**
4	3	1	2	**4**
1	4	2	3	**5**

2. Apply the crossover methods according to the representation of the individuals. Crossover points are 3 and 7:

A)

6	3	**7**	**8**	**5**	**1**	**2**	4	9	10
2	10	**8**	**9**	**1**	**5**	**7**	6	3	4

B) 0 0 **1 1 1 0 0** 0 1 1
1 1 **1 1 0 1 0** 1 0 1

3. Apply mutation operators when possible, according to the representation. PMut=0.2

A) 0 0 0 1 1 1 0 0 0 1 1

B) 6 10 7 8 5 1 2 4 9 3