MUTATIONS

Contents

1.1.   Displacement Mutation

Parameters
none

Displacement mutation operates on a sequence of elements, chosen randomly within a chromosome. On implementation, the selected swath is shifted to the left or right edge of the chromosome. Direction in which the sequence is shifted is determined in a random way.

Example

Chromosome:

A	C	D	E	F	B

Mutated chromosome:

At first, a random number of elements to shift is obtained, in this case: **3** (marked on green above). On implementation, three first elements are shifted to the right or three last characters are shifted to the left. At random, the first alternative was enforced, finally producing the mutated individual:

E	F	B	A	C	D

1.2.   Flip Bit Mutation

Parameters
none

Flip bit mutation is a mutation operator taking a random element in a binary representation of a floating point chromosome. The selected gene is then inverted, i.e. 1 replaced with 0, or 0 replaced with 1. The flip bit mutation returns exception if used in ordered chromosome-based problems.

Example

Chromosome:

1	0	1	1	0	1

Mutated chromosome:

At random, the element at the second index was chosen to be inverted (marked on green). Since its original value is 0, the operator replaces it with 1:

1	1	1	1	0	1

1.3.   Insertion Mutation

Parameters
none

Insertion mutation is a particular variant of the displacement mutation operator (see: chapter 1.1). In this case, only one element is chosen randomly within the whole chromosome. On implementation, the selected gene is shifted to the left or to the right edge of the chromosome. Direction in which the element is shifted is determined in a random way.

Example

Chromosome:

A	C	D	E	F	B

Mutated chromosome:

At random, the element at the second index was chosen within the chromosome to be shifted (marked on green above). On implementation, the element will be moved to the left or to the right edge of the chromosome. At random, the first alternative was enforced, finally producing the mutated individual:

A	D	E	F	B	C

1.4.   Partial Shuffle Mutation

Parameters
none

Partial shuffle mutation (**PSM**) operator obtains a random swath within a chromosome. The idea of the operator is to shuffle elements included in the swath. Several shuffles may be used if previous one did not cause any change in the sequence.

Example

Chromosome:

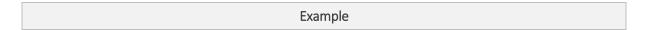| A	C	D	E	F	B

Mutated chromosome:

It is assumed that second, third and fourth elements are chosen to form a swath (marked on green above). The implemented randomizer is responsible for shuffling the elements within the swath. Finally, a new sequence is produced:

A	C	E	D	F	B

1.5.   Reverse Sequence Mutation

Parameters
none

Reverse sequence mutation (**RSM**) is an operator considering a randomly chosen swath within a chromosome. The selected sequence is then reversed.
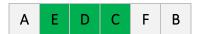
Example

Chromosome:

A	C	D	E	F	B

Mutated chromosome:

At random, second, thing and fourth elements were chosen and will be modified by the operator. The initial order of the elements is: **C**, **D** and **E** (marked on green above). After reversion, the new order is: **E**, **D** and **C**, respectively:

A	E	D	C	F	B

Genetic Algorithms for Dynamo

1.6.   Twors Mutation

Parameters
none

Twors mutation operator obtains a random pair of elements within a chromosome. The elements are then shuffled, trading their locations.

Example

Chromosome:

A	C	D	E	F	B

Mutated chromosome:

First and third elements were randomly chosen to be shuffled (marked on green above). First element is then moved to the third index and third element is moved to the first index, forming a new order in the chromosome structure:

D	C	A	E	F	B

1.7.　　　Uniform Mutation

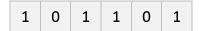| Parameters |
|:---:|
| *none* |

The uniform mutation iterates through the whole length of a chromosome. At each element, a random number is obtained, deciding if the element should be replaced with a new one or skipped. Decision is made basing on mutation probability specified by a user.

The operator cannot be used on chromosomes in ordered chromosome-based problems as it may cause repetition of genes.
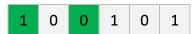
Example

Chromosome:

1	0	1	1	0	1

Mutated chromosome:

The algorithm iterates through the chromosome. At random, two elements – at first and third index were chosen for mutation (marked on green below). The new values of the elements are uniformly drawn – note that the element chosen for mutation may change its initial value or not, if drawn so:

1	0	0	1	0	1

References

Larrañaga, P., Kuijpers, C. M. H., Murga, R. H., Inza, I., Dizdarevic, S.: *Genetic Algorithms for the Travelling Salesman Problem: A Review of Representations and Operators*. Artificial Intelligence Review, vol. 13, issue 2, April 1999, pp. 129 – 170.