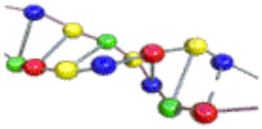
Introduction to
Genetic Algorithms



XI. Crossover and Mutation

Introduction

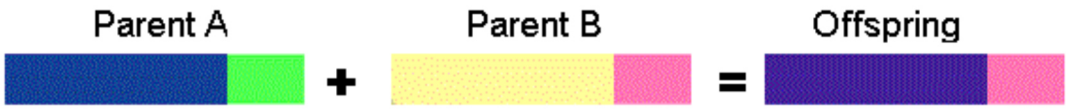
Crossover and mutation are two basic operators of GA. Performance of GA very depends on them. Type and implementation of operators depends on encoding and also on a problem.

There are many ways how to do crossover and mutation. In this chapter are only some examples and suggestions how to do it for several encoding.

Binary Encoding

Crossover

> **Single point crossover** - one crossover point is selected, binary string from beginning of chromosome to the crossover point is copied from one parent, the rest is copied from the second parent

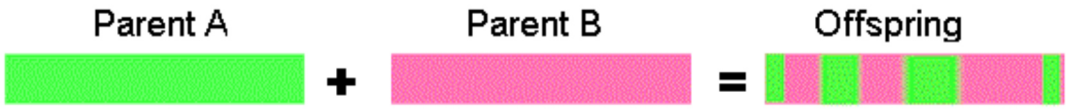


11001011+11011**111** = **11001111**

Two point crossover - two crossover point are selected, binary string from beginning of chromosome to the first crossover point is copied from one parent, the part from the first to the second crossover point is copied from the second parent and the rest is copied from the first parent

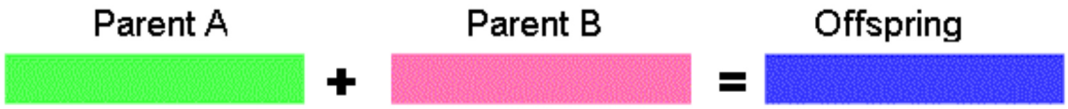
11001011 + 11**011**111 = **11011111**

Uniform crossover - bits are randomly copied from the first or from the second parent



1**10**01011 + 1**11**0111**01** = 11011111

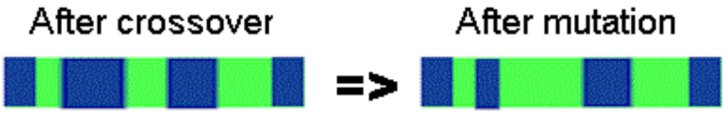
Arithmetic crossover - some arithmetic operation is performed to make a new offspring



11001011 + 11011111 = 11001001 (AND)

Mutation

Bit inversion - selected bits are inverted



1**1**001001 => 1**0**001001

Permutation Encoding

Crossover

Single point crossover - one crossover point is selected, till this point the permutation is copied

from the first parent, then the second parent is scanned and if the number is not yet in the offspring it is added
Note: there are more ways how to produce the rest after crossover point

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

Mutation

Order changing - two numbers are selected and exchanged

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

Value Encoding

Crossover

All crossovers from **binary encoding** can be used

Mutation

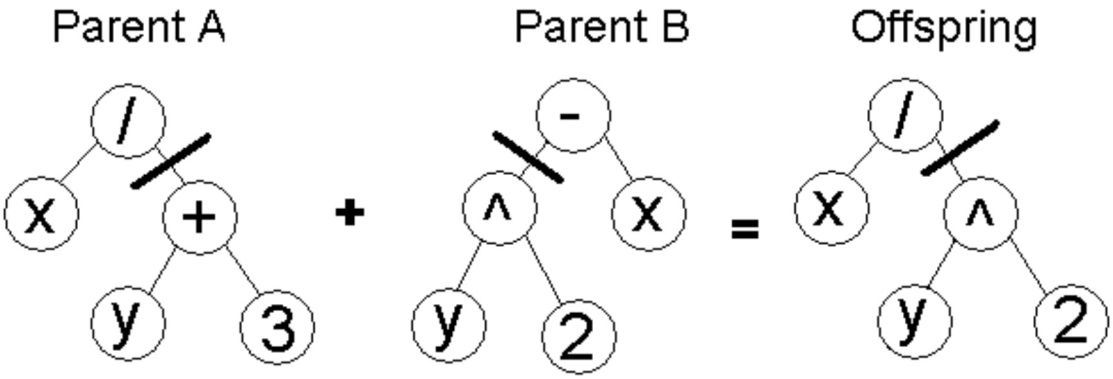
Adding a small number (for real value encoding) - to selected values is added (or subtracted) a small number

(1.29 5.68 **2.86** **4.11** 5.55) => (1.29 5.68 **2.73** **4.22** 5.55)

Tree Encoding

Crossover

Tree crossover - in both parent one crossover point is selected, parents are divided in that point and exchange part below crossover point to produce new offspring



Mutation

Changing operator, number - selected nodes are changed