University of Babylon
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Advanced Intelligent Applications

crossover and their types

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Crossover:

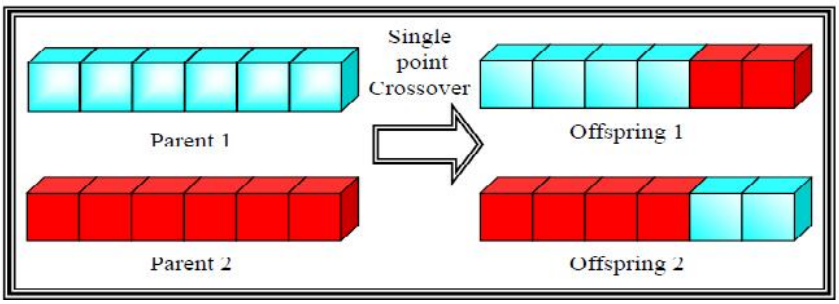
Crossover is considered the most important genetic operator to improve the quality of solutions. The idea is to recombine useful features of parent chromosomes in a way that allows the new offspring to benefit from favourable bit segments of both parents. Crossover explores the most promising regions of search space in a more purposeful and efficient way than a purely random global search. The interaction of crossover and selection merely generates new variants in those regions which already demonstrated to contain well adapted solutions, i.e., it performs an appropriate exploitation of search space.

Instead of every parent chromosome, only a fraction of P' selected at random according to the crossover probability Pc is subject to recombination. Typical values for the crossover rate are Pc ∈ [0.6,0.95].

Without crossover, the average fitness of the population,f,,, will climb until it equals the fitness of the fittest member,f,,. After this point it can only improve via mutation.

1- 1X-Crossover:

In the traditional one-point crossover, both parent chromosomes A and B are aligned with each other and cut at a common randomly chosen crossover position as shown in Fig.. The parents swap the segments located to the right of the crossover point resulting in two new offspring A' and B'.



One-point crossover operator has the drawback of a positional bias, in that genes located at both ends of the chromosomes are disrupted more

requently than those in the centre. Two-point avoids this positional asymmetry in cutting the chromosome at two locations rather than one and swapping the middle segments in the offspring.

The new population now consists of ***N*** individuals (the same number as the original population) created by selection and crossover. Mutation then operates on the whole population except the elite member (if elitism is being applied). Once this is done, the old population is replaced by the new one and the generational counter, ***g,*** incremented by one.

Algorithm 1X

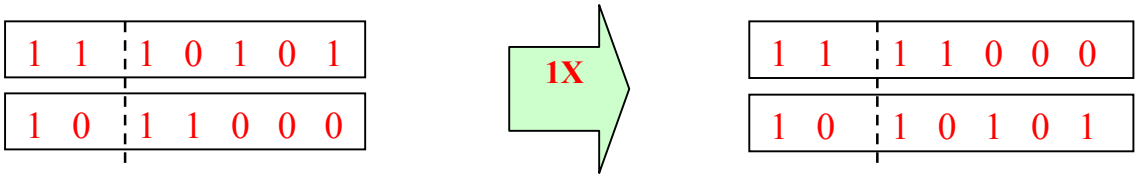
```
input : parent1,parent2,chromosome_length,pc
output : child1,child2

begin
   if flip(pc) then
     begin
        choose cross site randomly;
                copy the first part of parent1 to child1 and the second to
    child2;
        copy the first part of parent2 to child2 and the second to
        child1;
     end;
end;
```

Note:

منطقة القطع هي عبارة عن موقع(index) عشوائي لجينة معيّنة حيث أنَّ

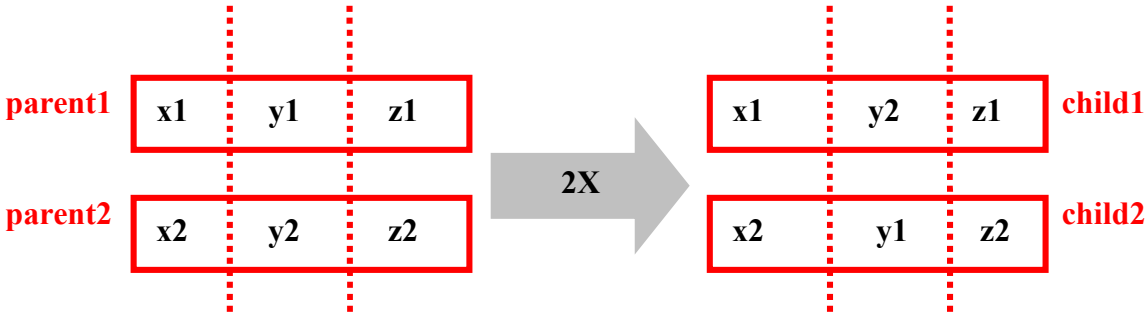
. 1≤ cross site ≤ chromosome length

مثال تطبيقي :



2- 2X-crossover:

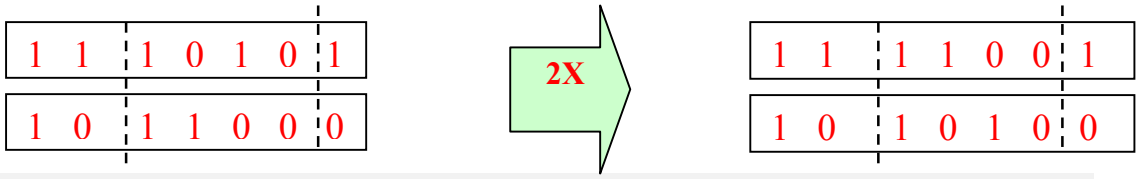
A generalisation to two-point-crossover allows n crossover locations in which the offspring inherits subsequent segments from both parents in alternating order.



Algorithm 2X

```
input :parent1,parent2,chromosom1_length,pc
output: child1,child2

begin
if flip(pc)
   begin
      repeat
         choose cross site1 randomly;
          choose cross site2 randomly;
          until cross site1 ≠ cross site2;

       copy the first part of parent1 to child1;
       copy the first part of parent2 to child2;

       copy the middle part of parent1 to child2;
       copy the middle part of parent2 to child1;

       copy the last part of the parent1 to child1;
       copy the last part of the parent2 to child2;
    end;
end;
```

Example :



3- Uniform Crossover :

Uniform crossover takes n-point-crossover to the extreme by reducing the swapped segments to single bits which are independently drawn from either one of the parents.

```
Algorithm UX
input :parent1,parent2,chromosom1_length,pc
output: child1,child2

begin
if flip(pc)
   begin
      for i ← 1 to chromosome_length do
          begin
            if flip(0.5) then
               begin
                  child1(i) ← parent1(i);
                  child2(i) ← parent2(i);
               end;
             else
               begin
                  child1(i) ← parent2(i);
                  child2(i) ← parent1(i);
               end;
             end;
          end;
   end;
end;
```

Exercise1: Execute the types of crossover on chromosomes encoding with integer, real and hybrid.

Exercise2 : What are children and your fitness, (when pc=1 and pc=0), crossite=3 for the following parents: fitness=(∑parent(i))/3

Parent 1	2	0	14	6	8

Parent 2	3	5	1	11	10