Order Crossover (*OX*): proposed by Davis[99]

A kind of variation of PMX with a different repairing procedure

Procedure: OX

1. Select a substring from a parent at random.
2. Produce a proto-child by copying the substring into the corresponding position of it.
3. Delete the cities which are already in the substring from the 2nd parent. The resulted sequence of citires contains the cities that the proto-child needs.
4. Place the cities into the unfixed positions of the proto-child from left to right according to the order of the sequence to produce an offspring.

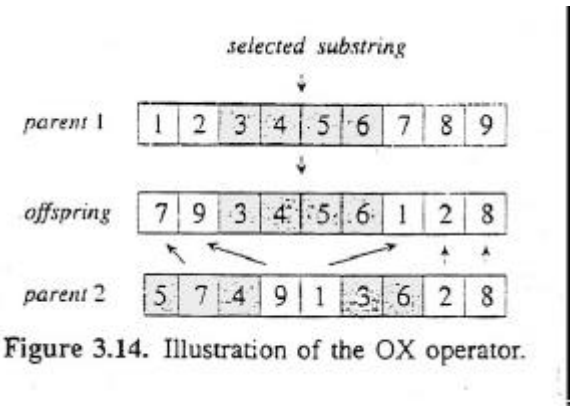

Figure 3.14. Illustration of the OX operator.

Position-Based Crossover :

Procedure: Position-Based Crossover

1. Select a set of position from one parent at random.
2. Produce a proto-child by copying the cities on these positions into the corresponding position of the proto-child.
3. Delete the cities which are already selected from the second parent. The resulting sequence of cities contains the cities the proto-child needs.
4. Place the cities into the unfixed position of the proto-child from left to right according to the order of the sequence to produce one offspring.

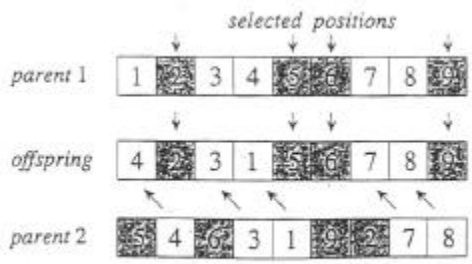

Figure 3.15. Illustration of the position-based crossover operator.

Order-Based Crossover :

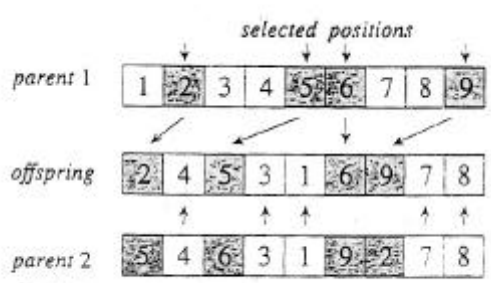

Figure 3.16. Illustration of the order-based crossover operator.

3

CX Crossover :

Procedure: CX.

1. Find the cycle which is defined the corresponding positions of cities between parents.
2. Copy the cities in the cycle to a child with the corresponding positions of one parent.
3. Determine the remaining cities from the child by deleting those cities which are already in the cycle from the other parent.
4. Fulfill the child with the remaining cities.

4

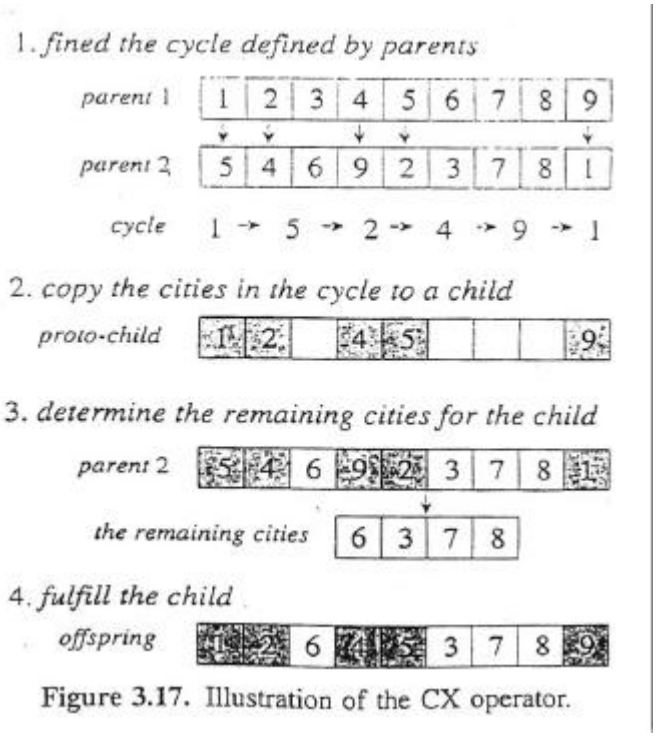

Figure 3.17. Illustration of the CX operator.

5

Subtour Exchange Crossover :

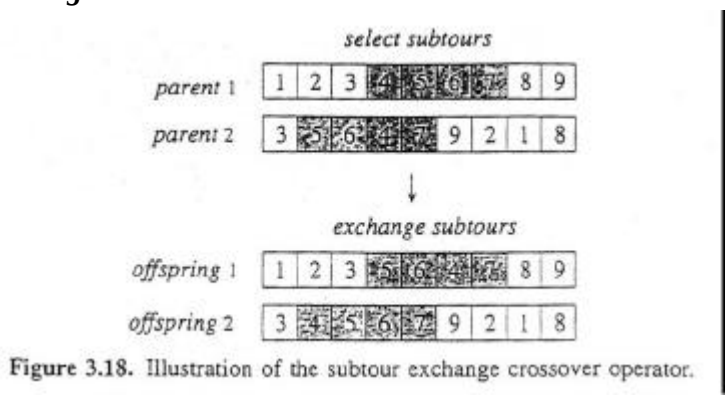

Figure 3.18. Illustration of the subtour exchange crossover operator.

Heuristic Crossover :

Procedure: Heuristic Crossover.

1. For a pair of parents, pick a random city for the start.
2. Choose the shortest edge (that is represented in the parents) leading from the current city which does not lead to a cycle. If two edges lead to a cycle, choose a random city that continues the tour.
3. If the tour is completed, stop; otherwise go to step 2.

6

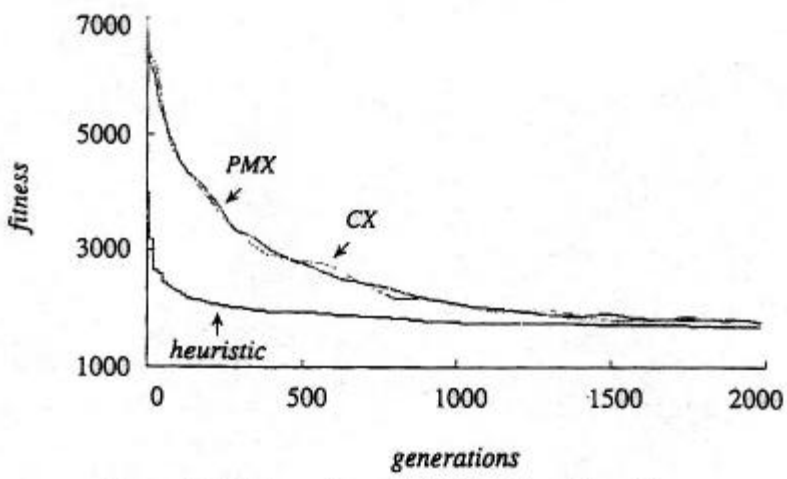

Figure 3.19. Comparison of PMX, CX, and heuristic.

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Mutation Operators:

Inversion Mutation :

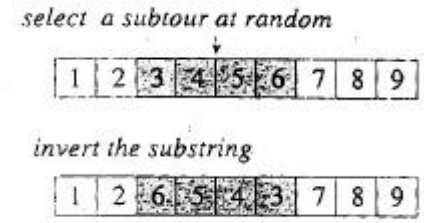

Figure 3.20. Illustration of inversion mutation.

Insertion Mutation :

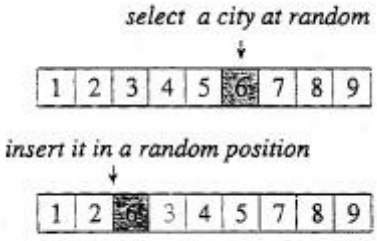

Figure 3.21. Illustration of insertion mutation.

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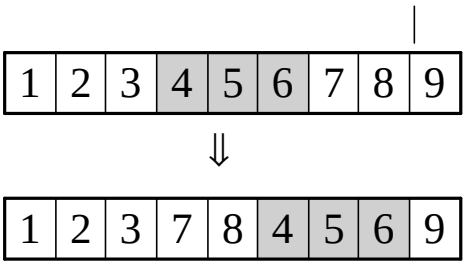
Displacement Mutation :



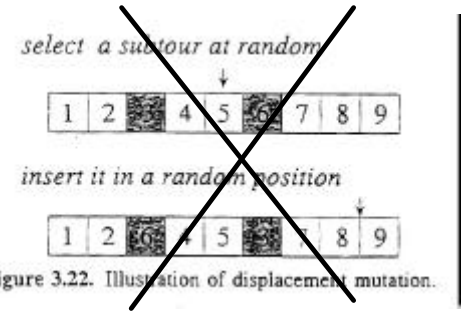


Figure 3.22. Illustration of displacement mutation.

Exchange Mutation :

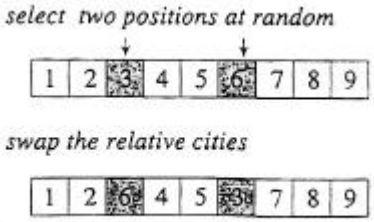


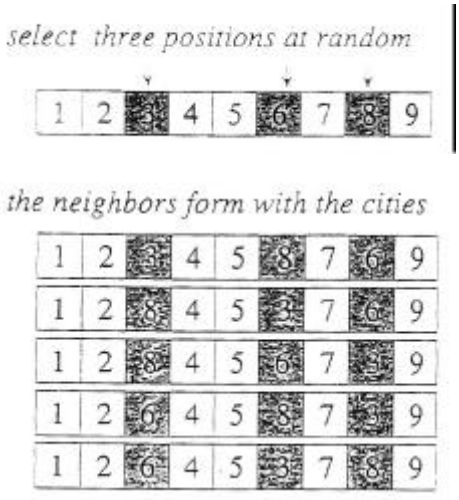
Figure 3.23. Illustration of reciprocal exchange mutation.

9

Heuristic Mutation :

Procedure: Heuristic Mutation.

1. Pick up λ genes at random.
2. Generate neighbors according to all possible permutations of the selected gens.
3. Evaluate all neighbors and select the best one as offspring.



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