Introduction to Genetic Algorithms – Part II

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Initial Pool

↓

Fitness Value

↓

Formation Mating Pool

↓

Crossover / Mutation

↓

Stopping Condition

No

Yes

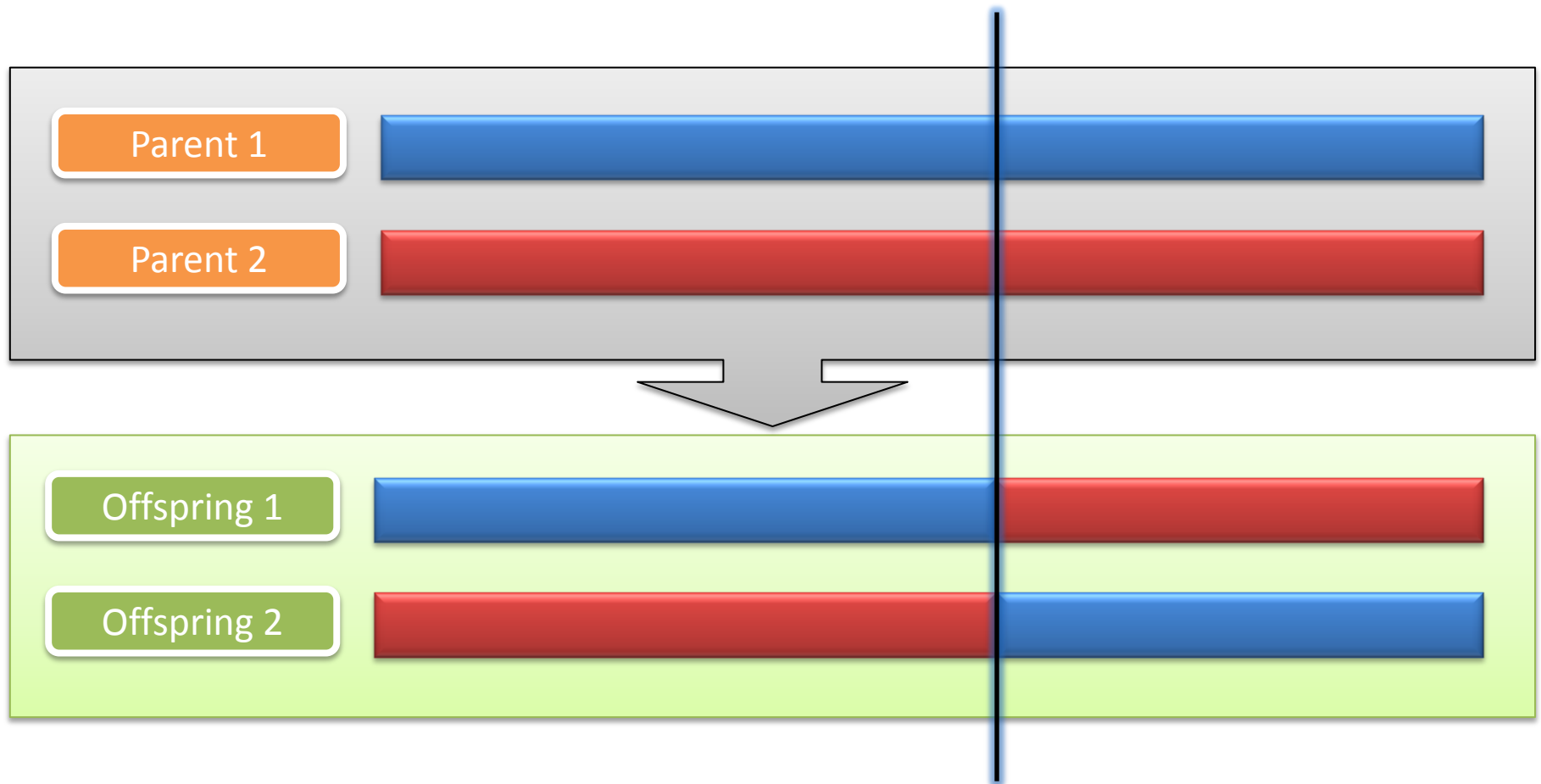↓

Stop
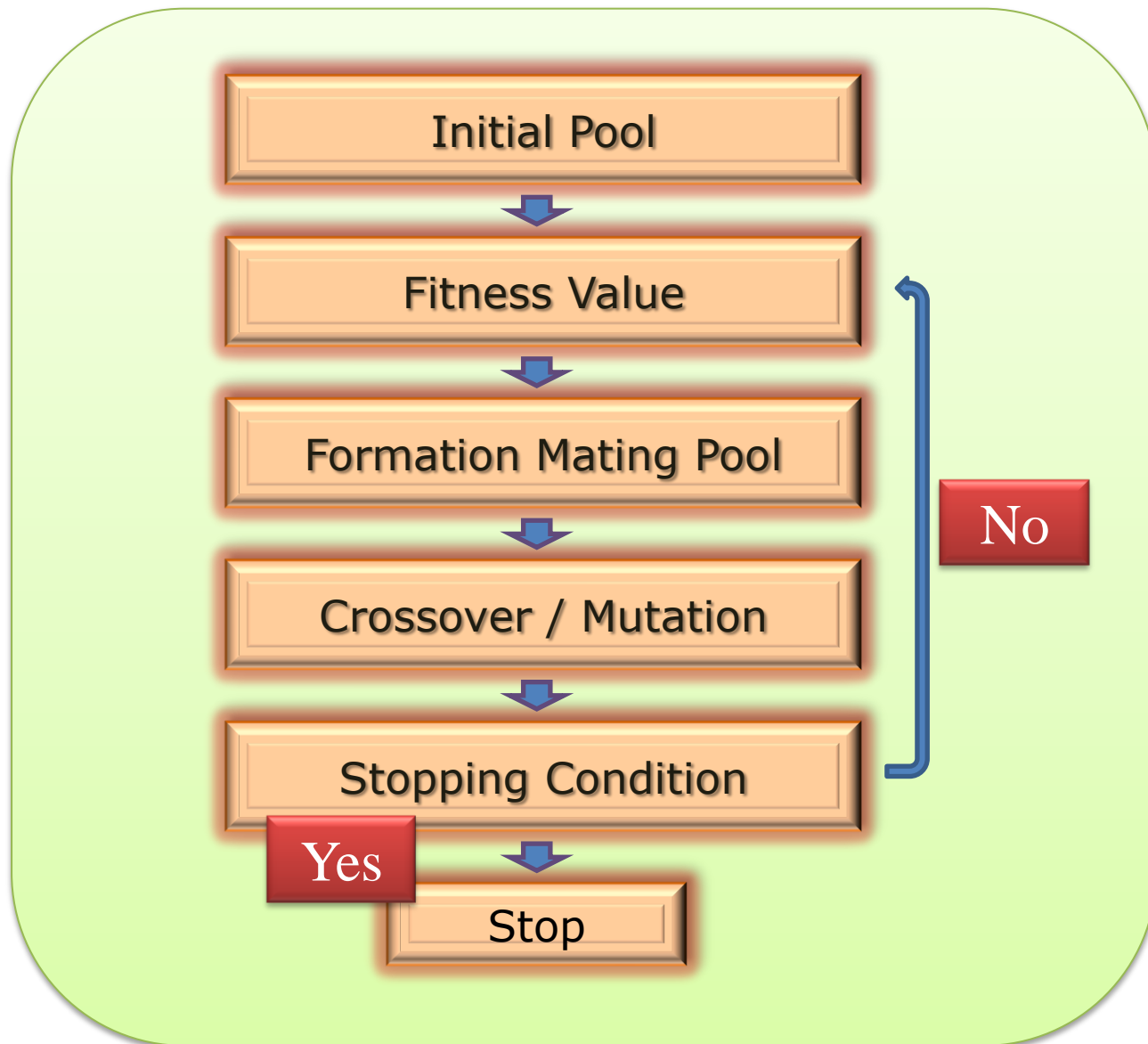
Idea of Crossover

-        Swap gene(s)/segment(s) between chromosomes (i.e. 2 or 3 …).
-        Swap Structure
-        Swapping can be random.

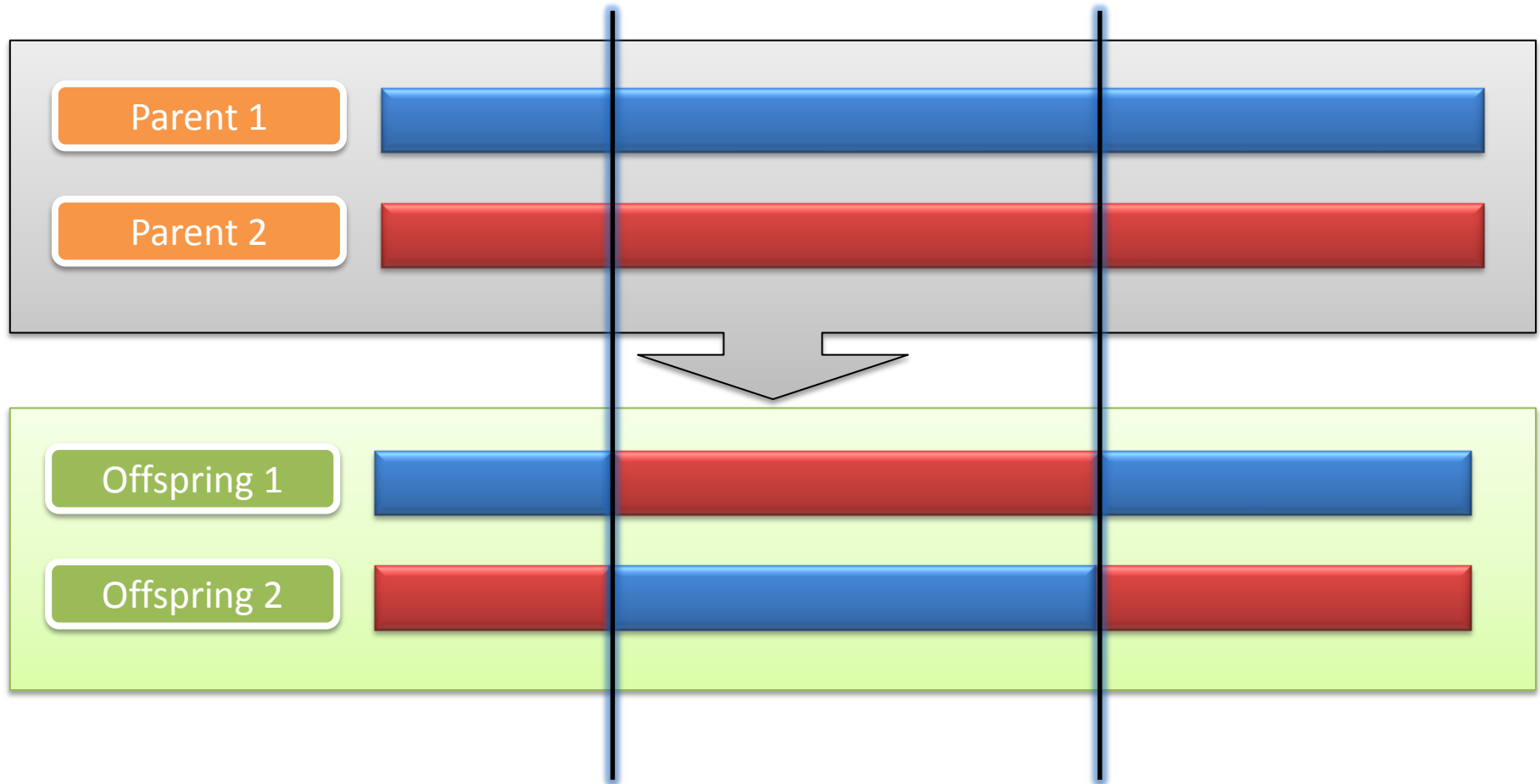# Crossover Methods

-        One Point
-        Two Points
-        Cut and Slice
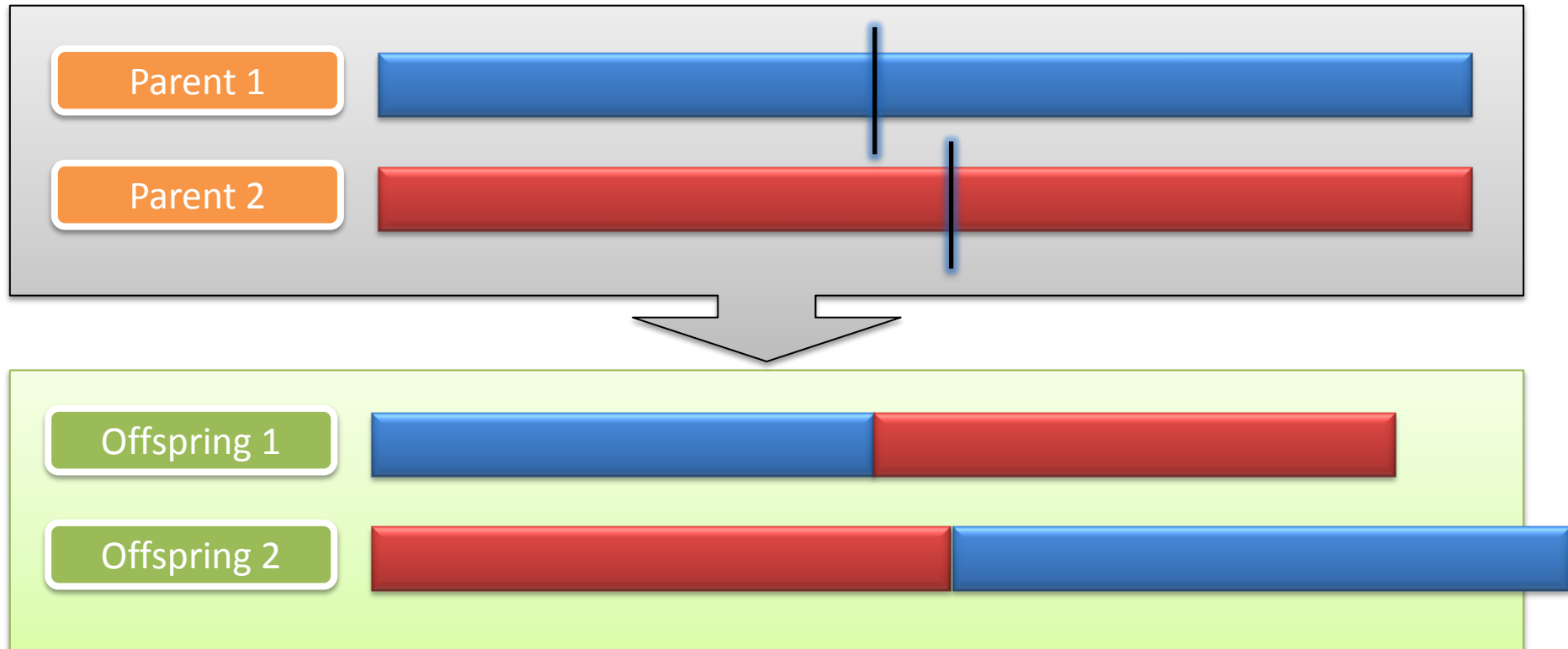-   Uniform
-        Adaptive
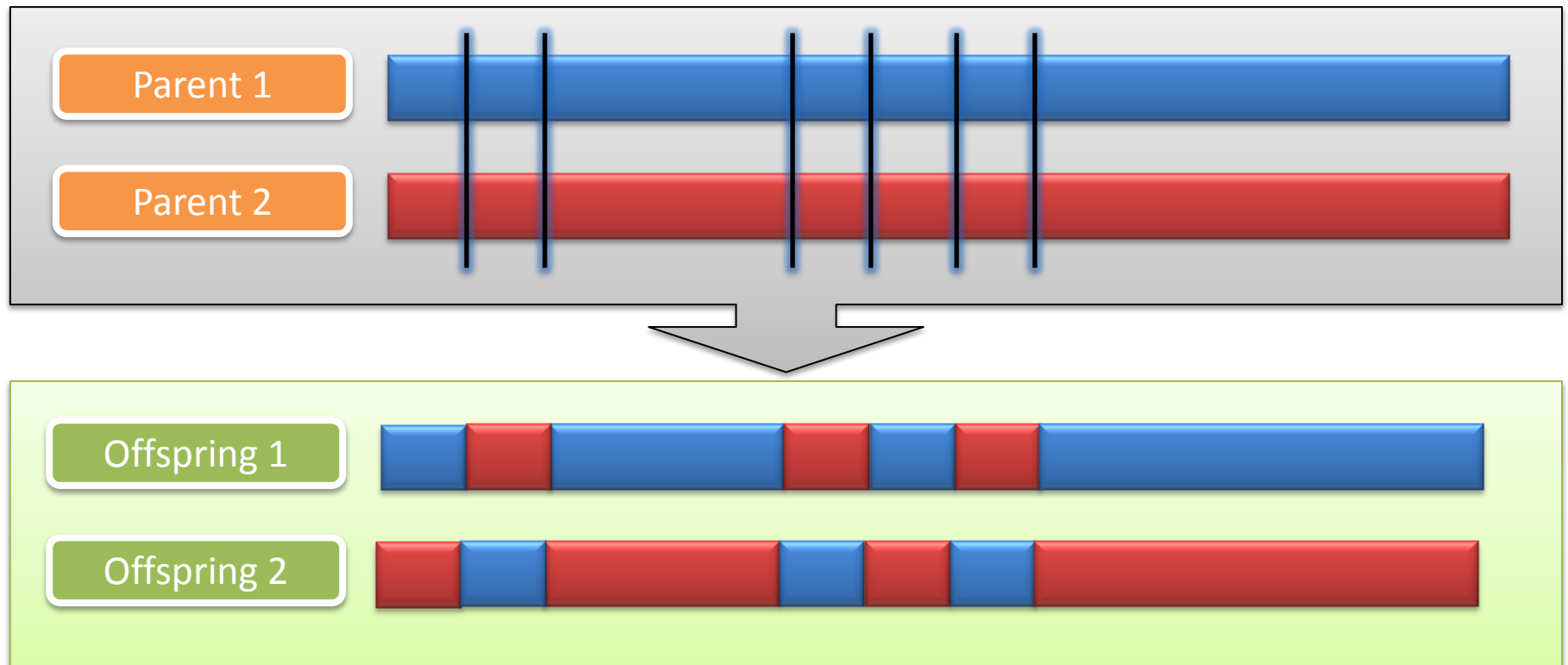
One Point Crossover

Two Points Crossover

Cut and Slice Crossover

Uniform Crossover
- Rather than segment, now gene
- Exchange with a Probability

Invalid after Chromosome: Allocation Example

1	0	0	1	1	0	0

0	0	0	1	1	1	1

1	0	0	1	1	1	1

Invalid
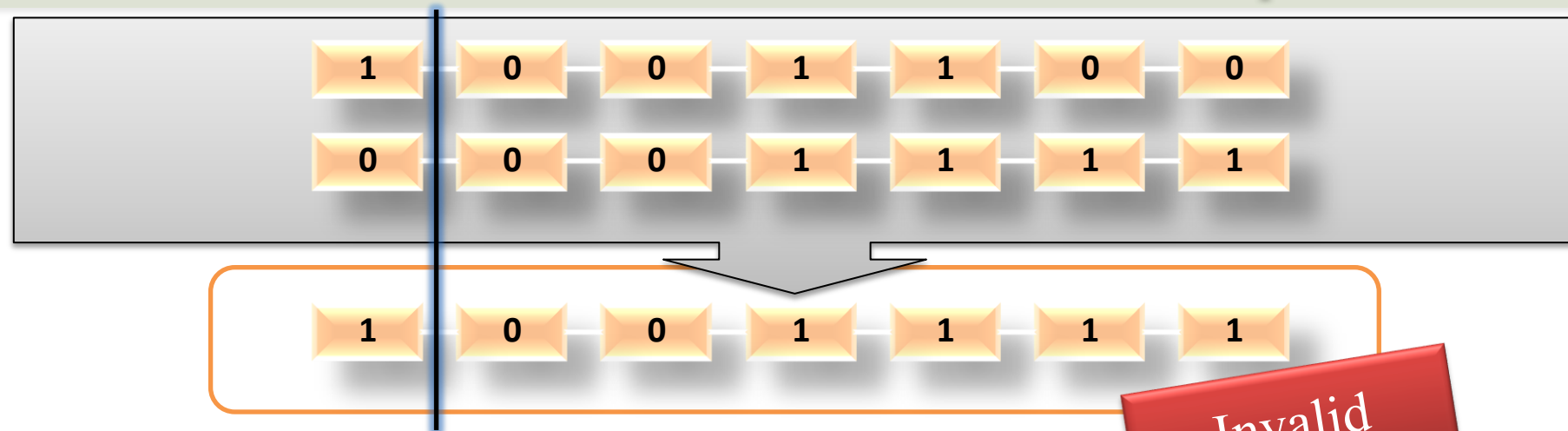
Cargo	Volume (m³)	Weight (lb)
1	3	400
2	4	500
3	6	200
4	5	600
5	2	250
6	1	300
7	2	350

Cargo	Volume	Weight
1	3	400
4	5	600
5	2	250
6	1	300
7	2	350
Total	**13**	**1900**

Constraints	12	2100

What to do?

- Fix it
- No allow, discard chromosome
- Assign a penalty

Others??

Skills:

Avoid dramatic change of chromosome
Exchange probability: 0.1 ~ 0.2

Avoid: Random search

Effect of Rates
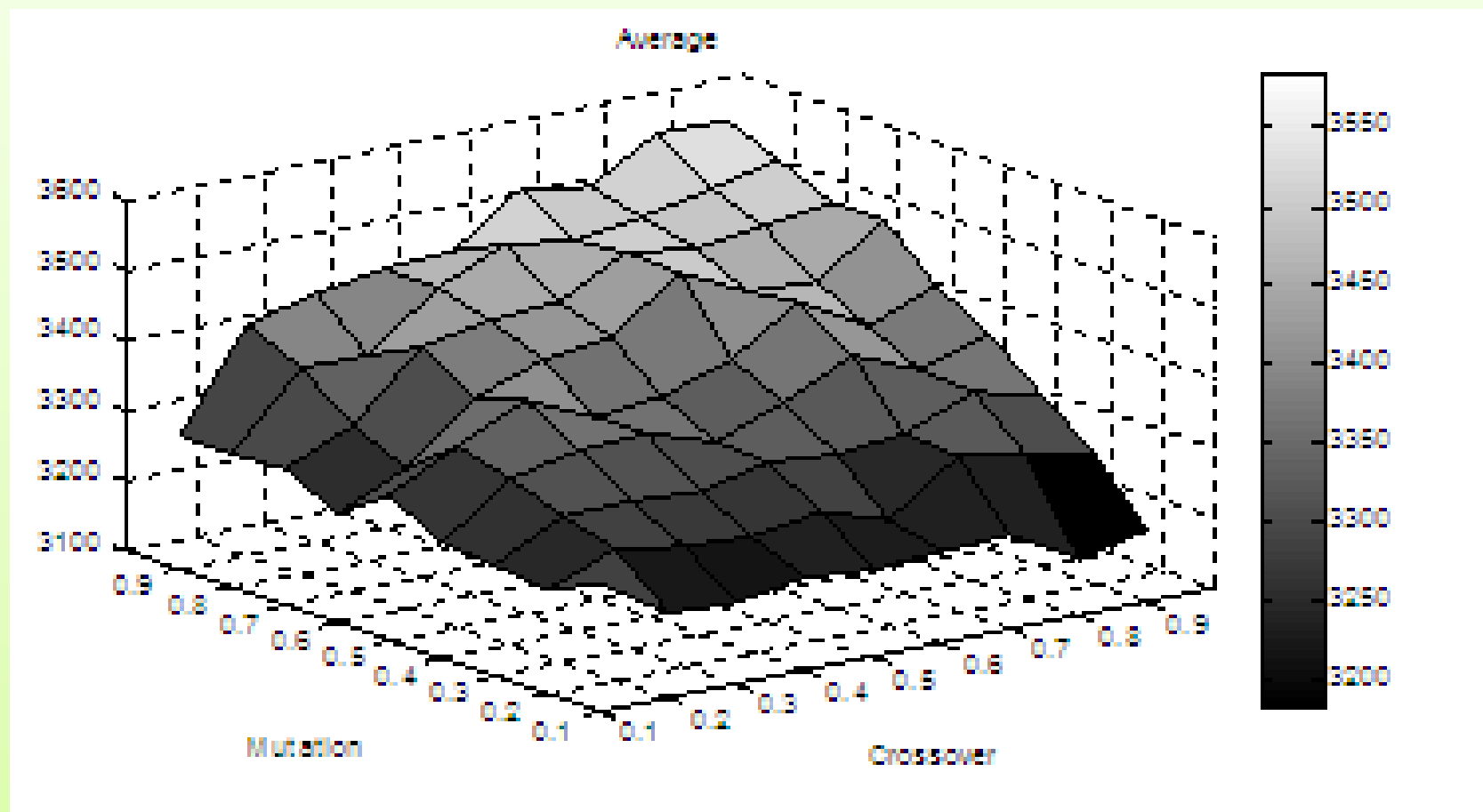
Adaptive Crossover
-	Depending on

1)	Performance after crossover	(Fitness Value)

2)	No. of Evoluions

Idea of Mutation

- Maintain diversity of solution pool
- Avoid local minima
- Prevent chromosome too similar to each other
- By change the gene(s) value

Remark

- Change all genes (new chromosome)
- Mutation probability should be low

Singe Point Mutation

Regenerate chromosome
- The weakness one(s)
- Randomly select

1	
2	
3	
4	
5	
6	

Idea of Stopping Condition
- Checking when to stop

Methods
- Number of Evolutions
- Steady solution

Makespan

Evolutions
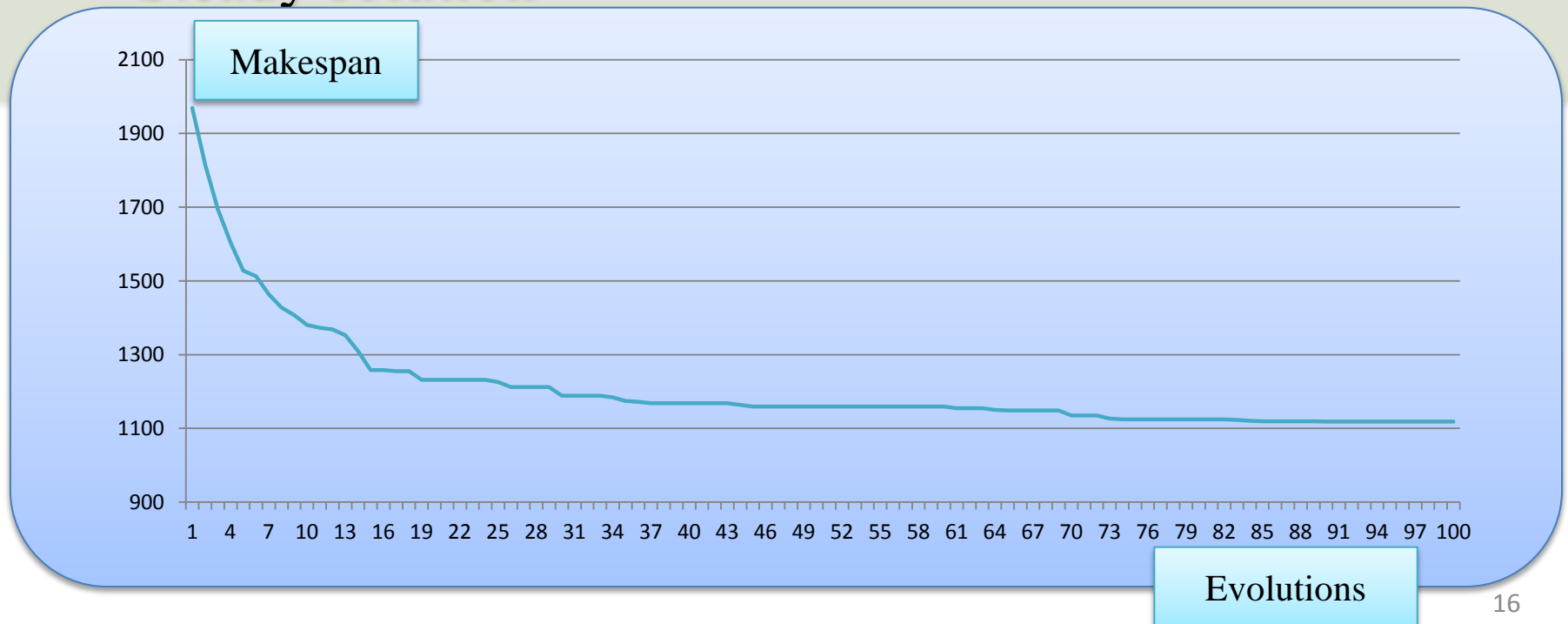
Question: Design for Production Scheduling
- Crossover and Mutation

Problem

10 Jobs and 3 Machines
Minimize Makespan

Job	PT	Job	PT
1	12	6	5
2	15	7	12
3	16	8	17
4	11	9	21
5	17	10	15

Setup Time	1	2	3	4	5	6	7	8	9	10
1	-	12	4	2	5	6	4	12	5	3
2	5	-	3	6	7	3	2	4	6	4
3	3	1	-	1	3	4	6	7	8	8
4	7	4	2	-	12	3	3	1	3	5
5	12	3	6	3	-	12	3	3	12	6
6	4	1	8	3	4	-	6	7	2	8
7	6	9	5	3	2	1	-	9	4	3
8	12	4	7	3	9	4	10	-	2	6
9	1	2	7	4	9	3	12	15	-	4
10	9	6	2	6	8	11	3	8	6	-

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Chromosome Encoding

m/c 1					m/c 2			m/c 3		
3	7	2	1	-1	9	5	-1	6	8	...

Partition Indicator
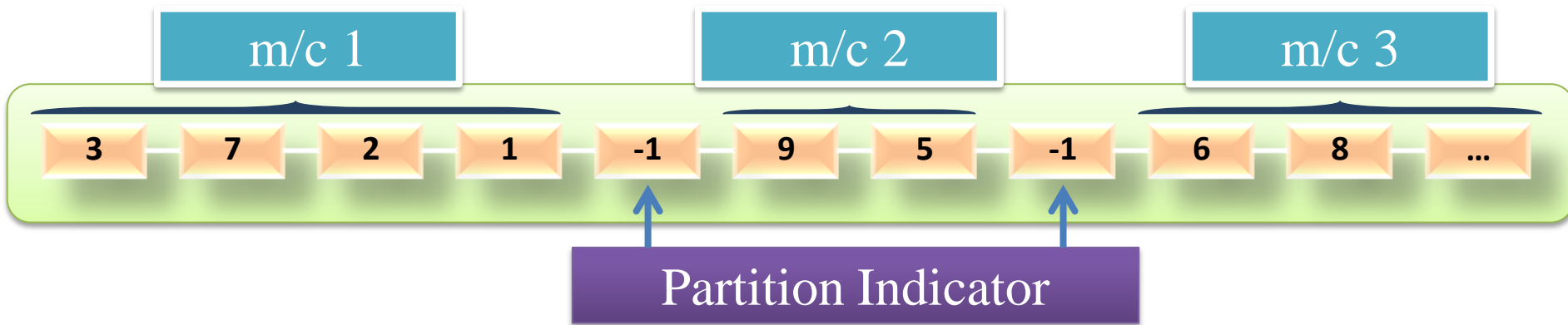
Fitness Value of Chromosome i = 1-1/makespan of i

Crossover

Partition Indicator

m/c 1　　　　　m/c 2　　　　　m/c 3

| 3 | 7 | 2 | 1 | -1 | 9 | 5 | -1 | 6 | 8 | ... |

| 4 | 5 | -1 | 6 | 9 | 3 | -1 | 2 | 10 | 8 | ... |

| 3 | 7 | 2 | 1 | -1 | 6 | 9 | 3 | -1 | 6 | ... |

| 4 | 5 | -1 | 9 | 5 | -1 | 2 | 10 | 8 | 1 | ... |

Invalid

Validation
- Discard duplicated
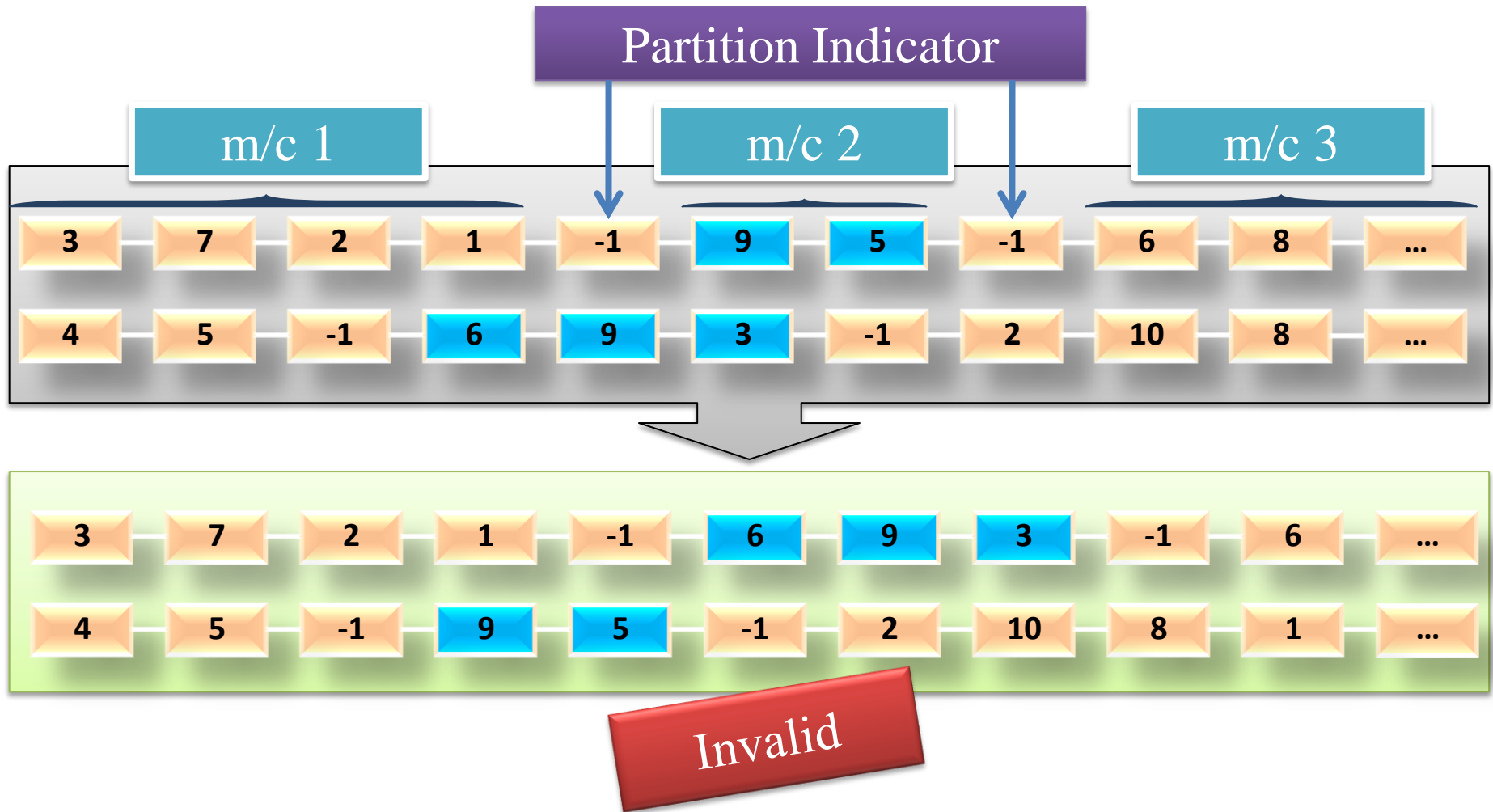
Discard Import
- Retain most origin structure

Validation
- Discard duplicated

Discard Origin
- Retain most import structure

3	7	2	1	-1	6	9	3	-1	6	...
4	5	-1	9	5	-1	2	10	8	...	...

7	2	1	-1	6	9	3	-1	6	...	...
4	-1	9	5	-1	2	10	8	,,,	...	...
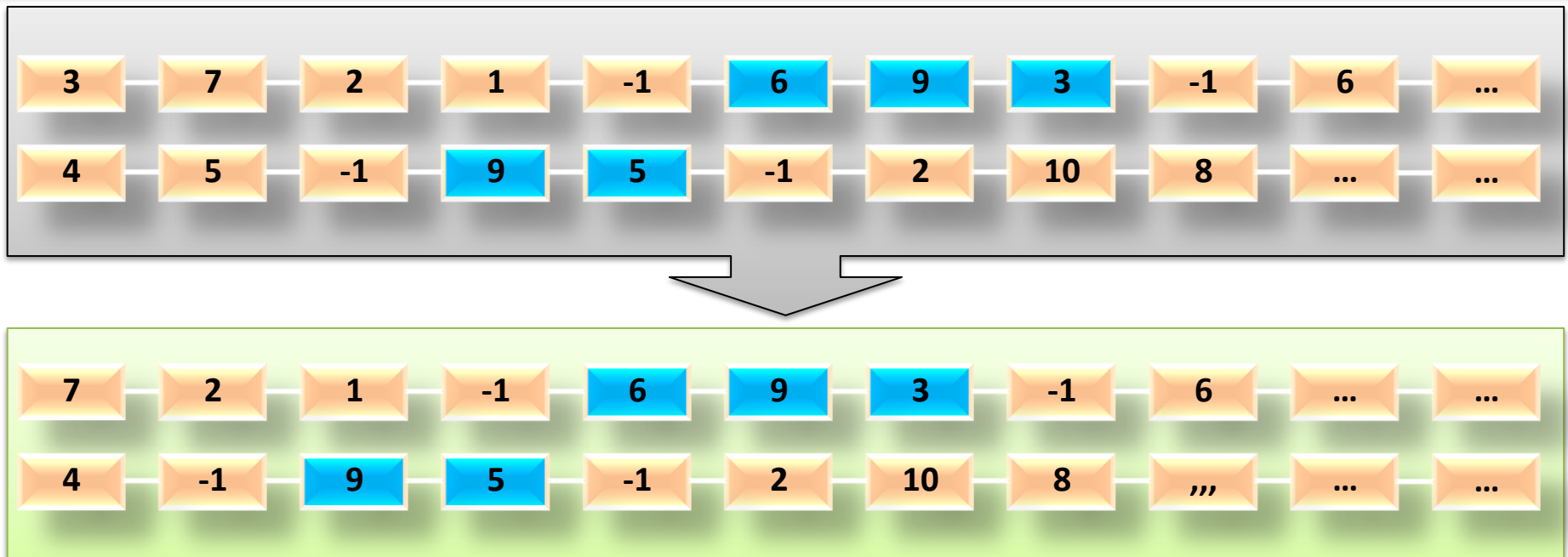
Validation
- Add missing

Missing after crossover

| 3 | 7 | 2 | 1 | -1 | 9 | 5 | -1 | 6 | 8 | … |

| 4 | 5 | -1 | 6 | 9 | 3 | -1 | 2 | 10 | 8 | … |

Missing after crossover

| 3 | 7 | 2 | 1 | -1 | 6 | 9 | 3 | -1 | 6 | … |

| 4 | 5 | -1 | 9 | 5 | -1 | 2 | 10 | 8 | 1 | … |
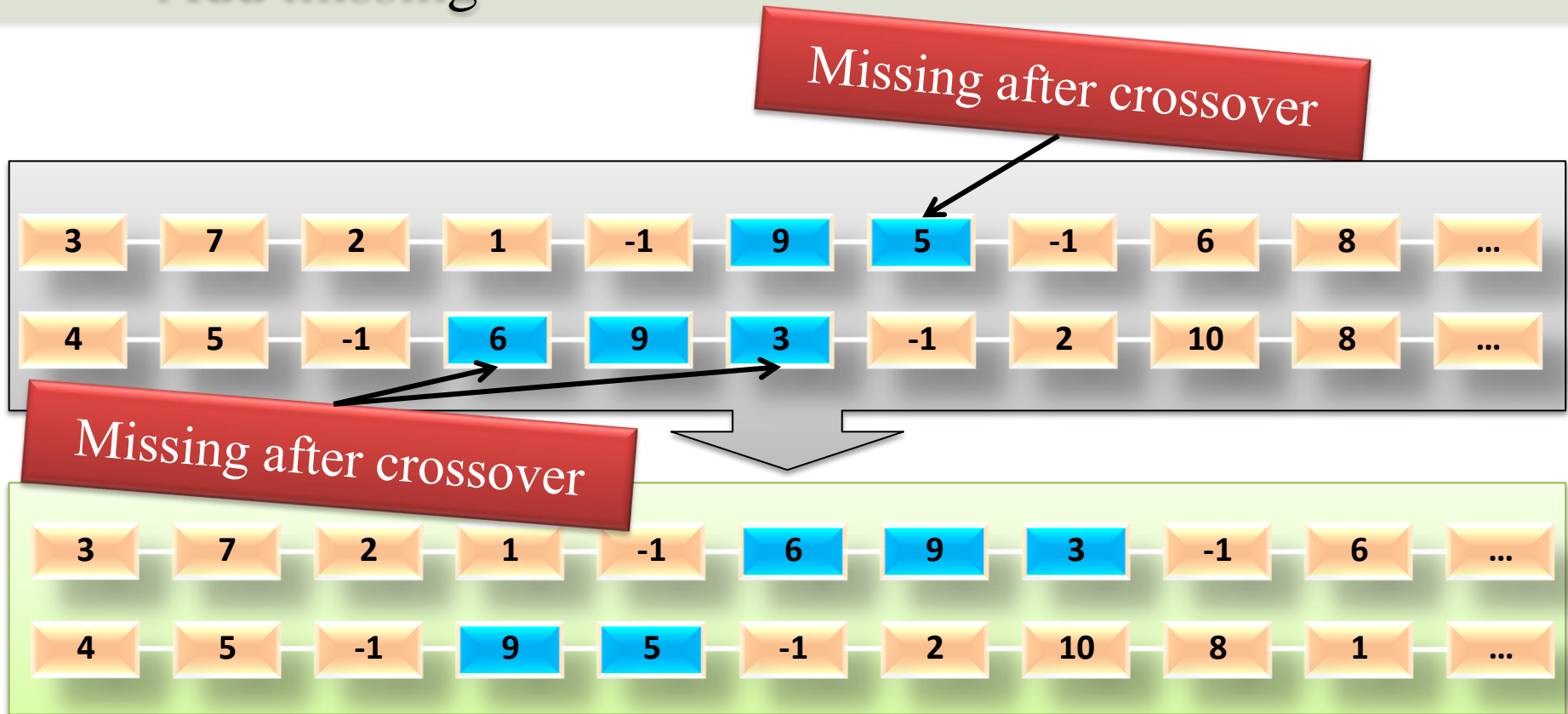
Mutation
- Change to any value (Swapping)

| 3 | 7 | 2 | 1 | -1 | 9 | 5 | -1 | 6 | 8 | ... |

| 3 | 7 | 5 | 1 | -1 | 9 | 2 | -1 | 6 | 8 | ... |