GA Operators

- **Methods of representation**
- **Methods of selection**
- **Methods of Reproduction**

Common representation methods

- Binary strings.
- Arrays of integers (usually bound)
- Arrays of letters
- ….

Methods of Selection

There are many different strategies to select the individuals to be copied over into the next generation

Methods of Selection

- *Roulette-wheel selection.*
- *Elitist selection.*
- *Fitness-proportionate selection.*
- *Scaling selection.*
- *Rank selection.*
- *...*

Roulette wheel selection

- Conceptually, this can be represented as a game of roulette - each individual gets a slice of the wheel, but more fit ones get larger slices than less fit ones.

Other selection methods

- *Elitist selection*:

  Chose only the most fit members of each generation.
- *Cutoff selection*:

  Select only those that are above a certain cutoff for the target function.

Methods of Reproduction

- There are primary methods:
  - *Crossover*
  - *Mutation*

Methods of Reproduction: Crossover

- Two parents produce two offspring
- Two options:

  1. The chromosomes of the two parents are copied to the next generation

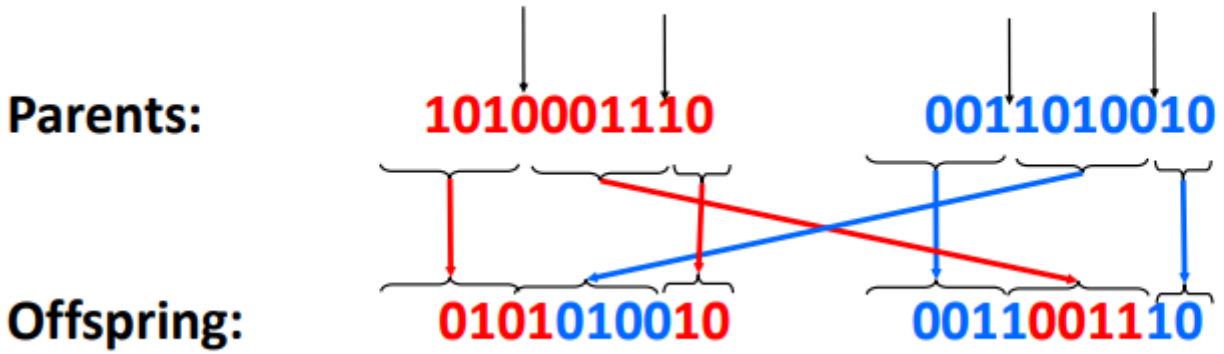
  2. The two parents are randomly recombined (crossed-over) to form new offsprings

Several possible crossover strategies

- Randomly select a single point for a crossover
- Multi point crossover
- Uniform crossover

Two-point crossover

- Avoids cases where genes at the beginning and end of a chromosome are always split



Crossover

- Single point crossover

- Two point crossover (Multi point crossover)

Uniform crossover

- A random subset is chosen
- The subset is taken from parent 1 and the other bits from parent 2.

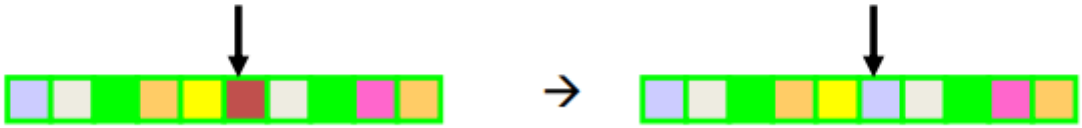
Subset: **BAABBAABBB** **(Randomly generated)**

Parents: **1010001110** **0011010010**

Offspring: **0011001010** **1010010110**

Methods of Reproduction: Mutations

– Generating new offspring from single parent



A (slightly more involved) example

The Traveling Salesman Problem:

Find a tour of a given set of cities so that

- each city is visited only once
- the total distance traveled is minimized

Representation

Representation is an ordered list of city numbers known as an *order-based* GA.

1) London	3) Dunedin	5) Beijing	7) Tokyo
2) Venice	4) Singapore	6) Phoenix	8) Victoria

CityList1 (3 5 7 2 1 6 4 8)

CityList2 (2 5 7 6 8 1 3 4)

Crossover

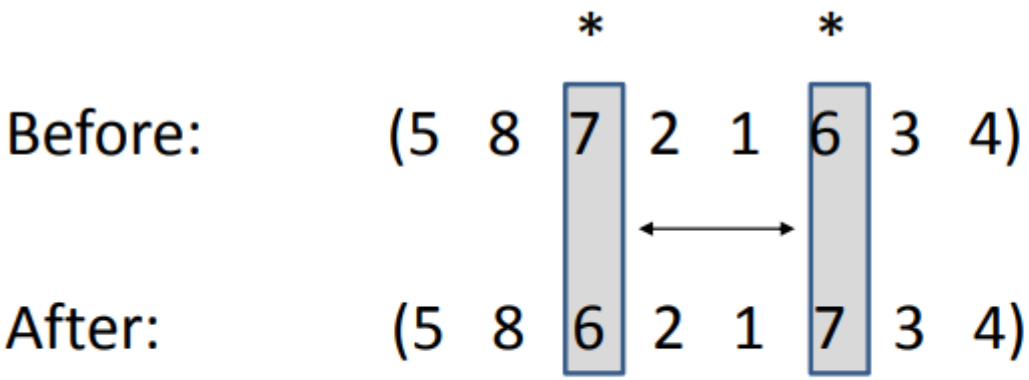
Crossover combines inversion and recombination:

			*			*		
Parent1	(3	5	7	2	1	6	4	8)
Parent2	(2	5	7	6	8	1	3	4)
Child	(5	8	7	2	1	6	3	4)

This operator is called the *Order1* crossover.

Mutation

Mutation involves reordering of the list:



GA Applications

Domain	Application Type
Control	Gas pipeline, missile evasion
Design	Aircraft design, keyboard configuration, communication networks
Game playing	Poker, checkers
Security	Encryption and Decryption
Robotics	Trajectory planning