Evolutionary computation

- (loosely) Based on natural selection.
  - We have a problem to solve
  - Start with a random set of solutions
  - Find out how well they do
  - Mate the solutions, maybe giving more chances to reproduce to the better answers
  - Repeat until you get something good enough.
- Quite often you end up great things that look like nothing humans would have designed.
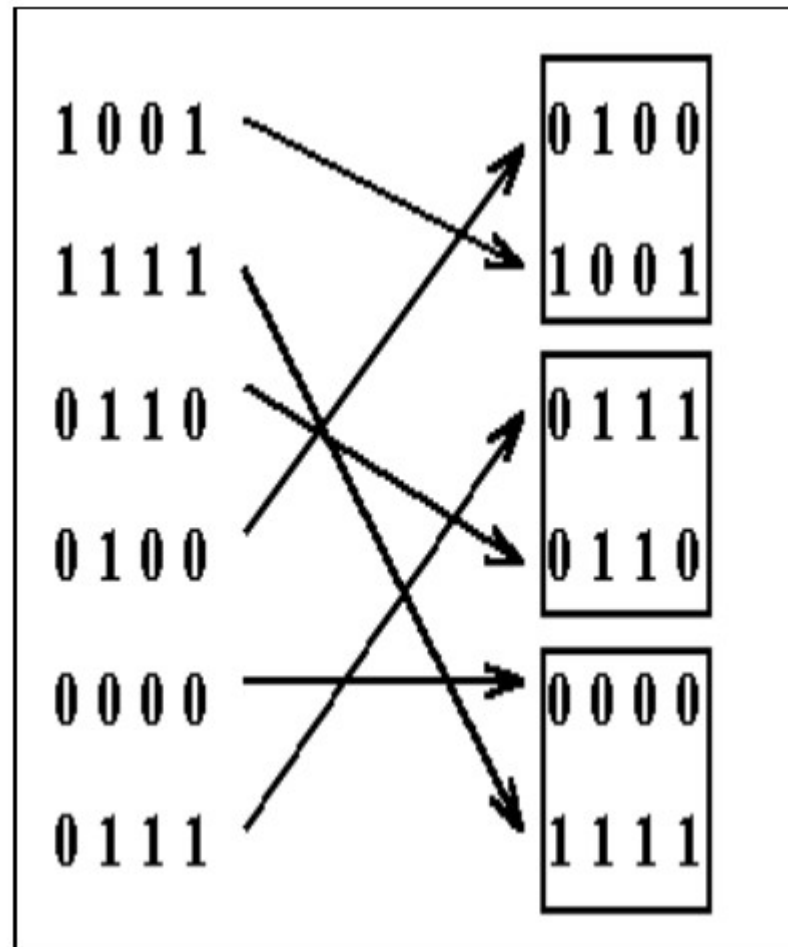
Evolutionary computation

f(x) = 16 - x

Genome

1 0 0 1

1 1 1 1

0 1 1 0

0 1 0 0

0 0 0 0

0 1 1 1

Evolutionary computation

$f(x) = 16 - x$

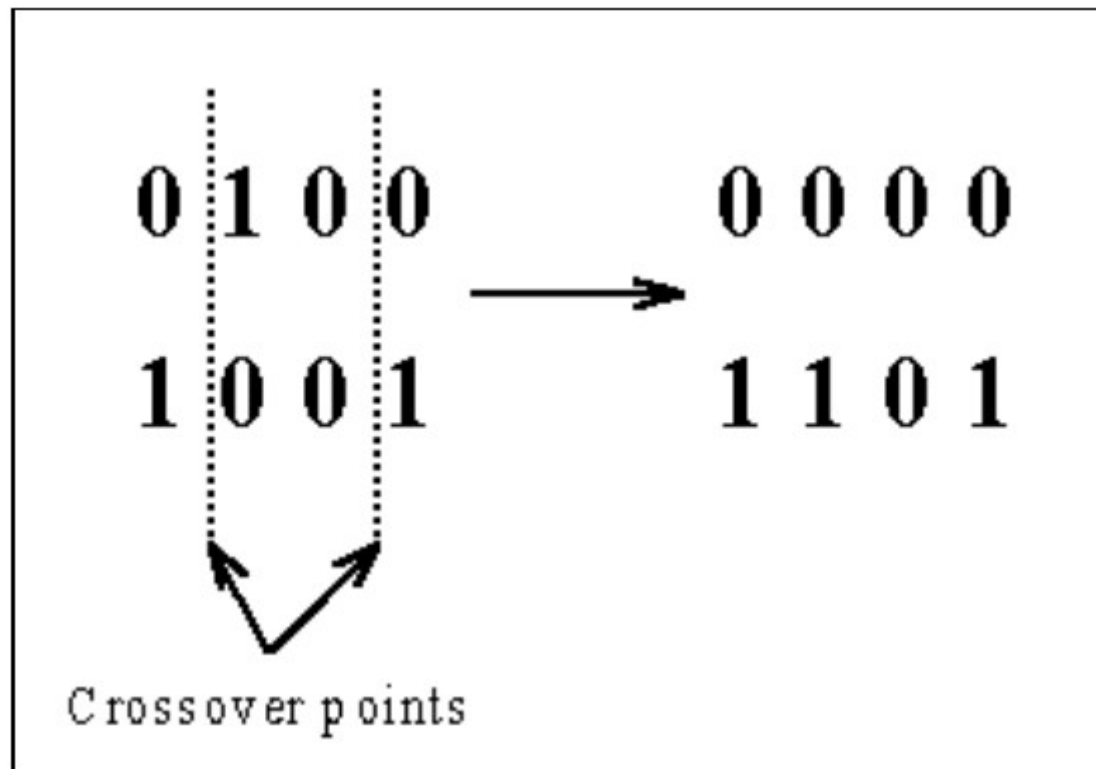| Genome	fitness
1 0 0 1	7
1 1 1 1	1
0 1 1 0	10
0 1 0 0	12
0 0 0 0	16
0 1 1 1	9

Evolutionary computation

f(x) = 16 - x

Evolutionary computation

f(x) = 16 - x

0 1 0 0   0 1 0 1

→

1 0 0 1   1 0 0 0

Crossover point

Evolutionary computation

f(x) = 16 - x

0 1 0 0   0 0 0 0

1 0 0 1   1 1 0 1

Crossover points
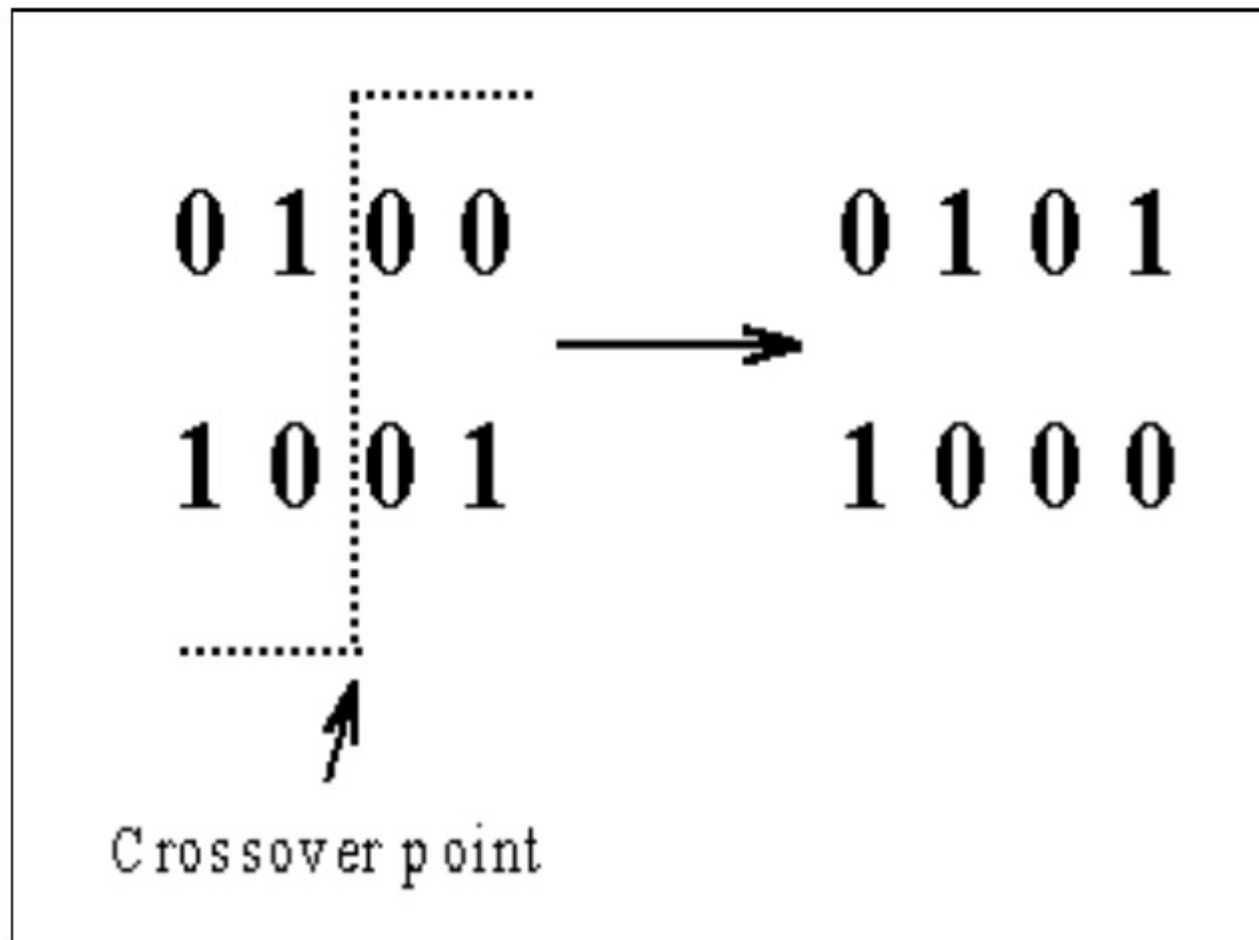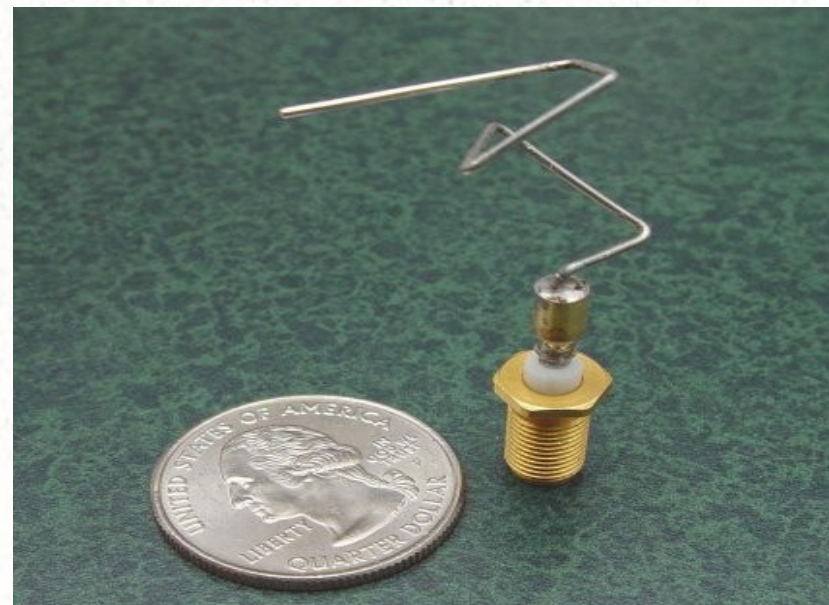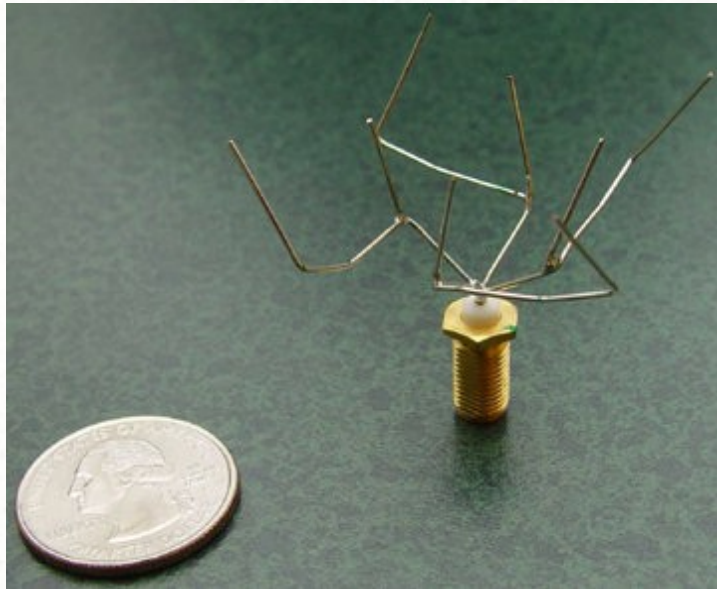
Design a new antenna

- Project developed by NASA
- Evolve the direction a new piece starts off at the end of the previous piece
- Evolved a design not considered by experts
- Took 3 person-months of work, as opposed to 5.
- Redesign, when the needs changed, took only 4 weeks.

Design a new antenna

Placement of Communication Satellites

- Low orbit satellites are cheaper.
- But Earth's curvature sometimes "gets in the way."
- A GA can optimize:
    - how far apart the satellites are from each other .
    - the heading of the satellites as they cross the equator.
    - how high they are above the Earth's surface.

Placement of Communication Satellites

- "For example, the constellations might have two satellites spaced very far apart, and the third one will be very close to the second one," Crossley said, noting that engineers with years of aerospace experience were surprised by the higher performance offered by the unconventional design."
-

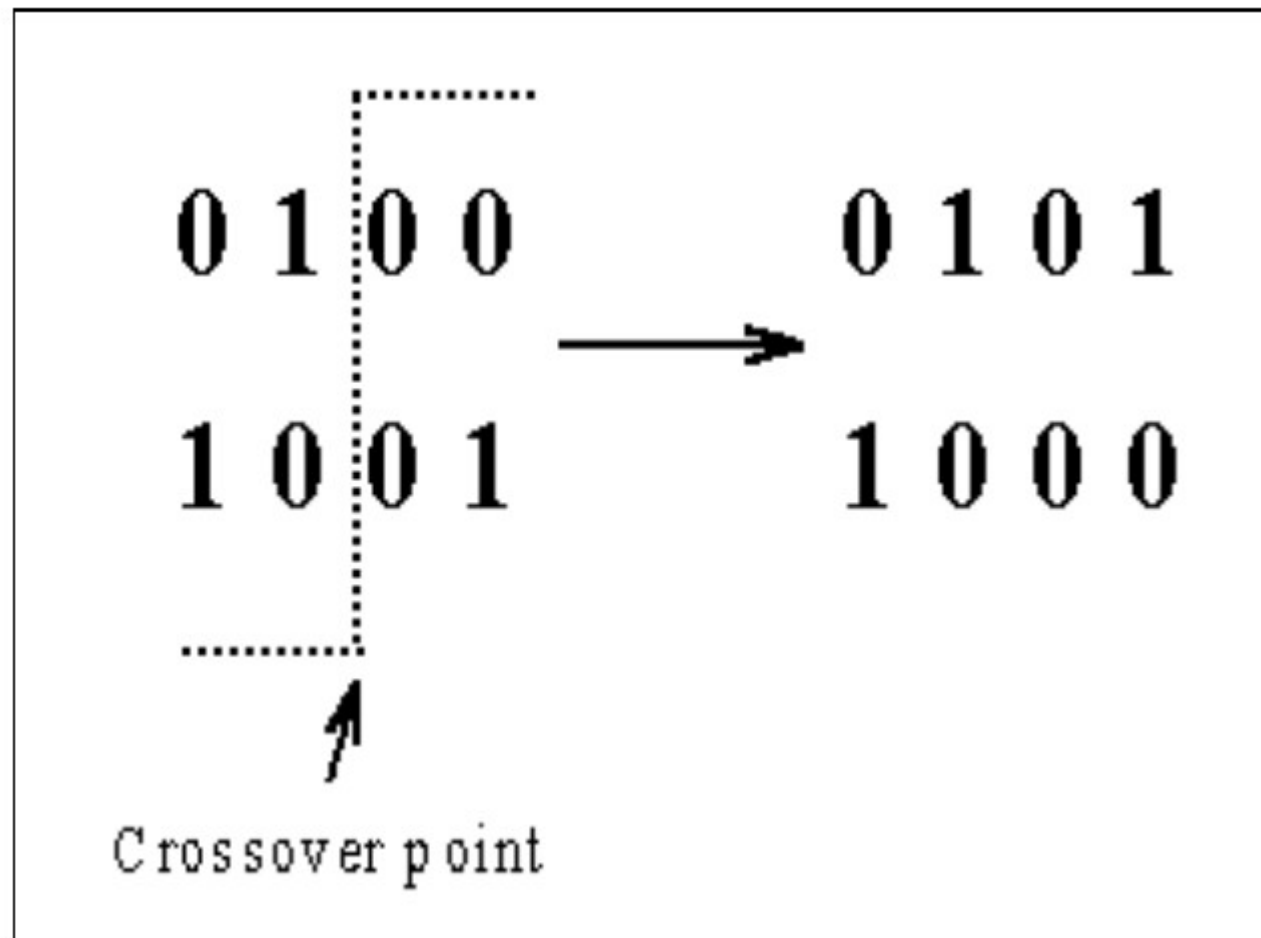# Terms you want to be familiar with

- population
- generation
- genotype
- phenotype
- crossover
  - one point
  - two point
  - uniform
- crossover rate
- Mutation rate
- stopping criteria
- selection methods
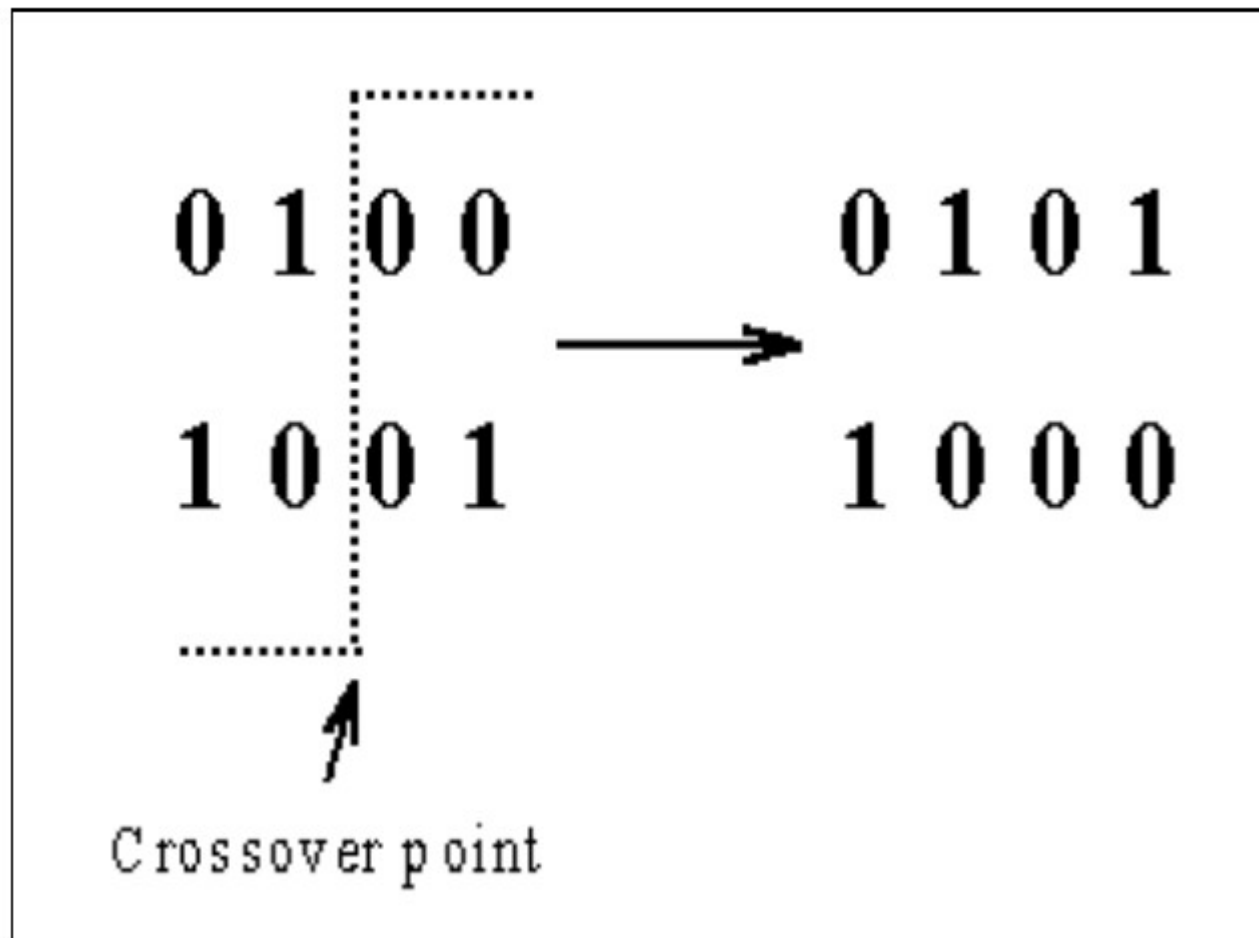
Selection methods

- http://www.obitko.com/tutorials/genetic-algorithms/selection.php

Evolutionary computation

f(x) = 16 - x

Evolutionary computation

f(x) = 16 - x

Crossover point

Evolutionary computation

f(x) = 16 - x