02. Small Example

Friday, September 12, 2025 5:05 PM

Problem: Maximize $f(x) = x^2$

where x can be any integer between -5 and +5.

Step 1: Initial Population (random guesses)

Suppose we randomly pick 3 solutions:

- $x = -3$ $f(x) = 9$
- $x = 1$ $f(x) = 1$
- $x = 4$ $f(x) = 16$

Fitness = function value. Best solution so far: $x = 4$ (fitness 16).

Step 2: Selection (survival of the fittest)

The best individuals are more likely to "reproduce."

- Here, $x = -3$ and $x = 4$ are better than $x = 1$.

Step 3: Crossover + Mutation (adaptation)

- Crossover: mix two parents. Example: take avg of -3 and 4 → new child $x = 0$.
- Mutation: add a small random change. Example: mutate $x = 4 \rightarrow x = 5$.

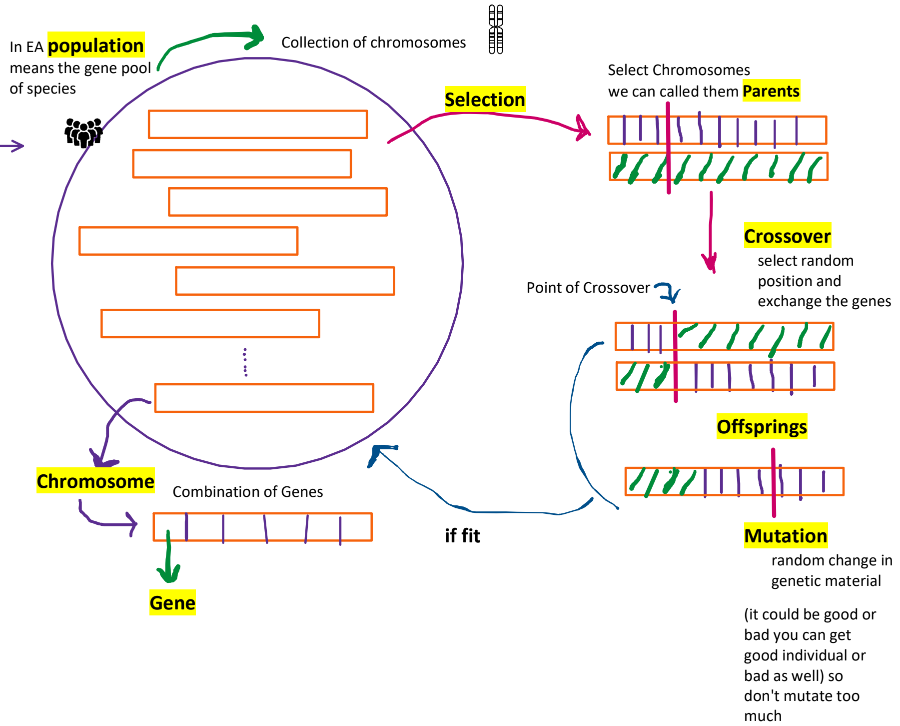
New population (3 solutions):

- $x = 0$ $f(x) = 0$
- $x = -3$ $f(x) = 9$
- $x = 5$ $f(x) = 25$

Step 4: Next Generation (evolution)

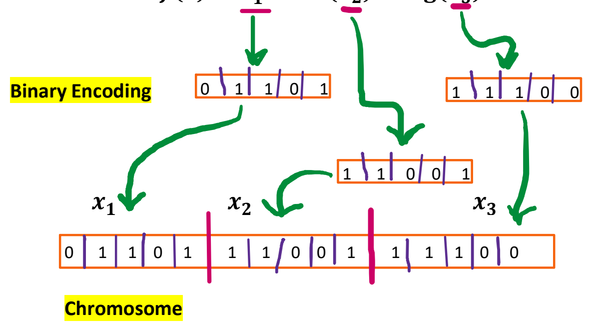
- Now the best is $x = 5$ with fitness = 25.
- Population is adapting —> solutions are getting better!

After just 2 generations, the population "evolved" from fitness 16 → 25, moving closer to the **optimal solution**.



How to apply this abstract idea to the real-valued optimization problem?

$$f(x) = x_1^2 + \sin(x_2) + \log(x_3)$$



PHENOTYPE: Raw solution space, real world solution space, not have proper representation in written form.

GENOTYPE: Required for Computation, Representation which our algo understand, fined input, encoded.

So, we are looking for the chromosome which gives the best value for x1, x2 and x3.