Genetic Algorithm

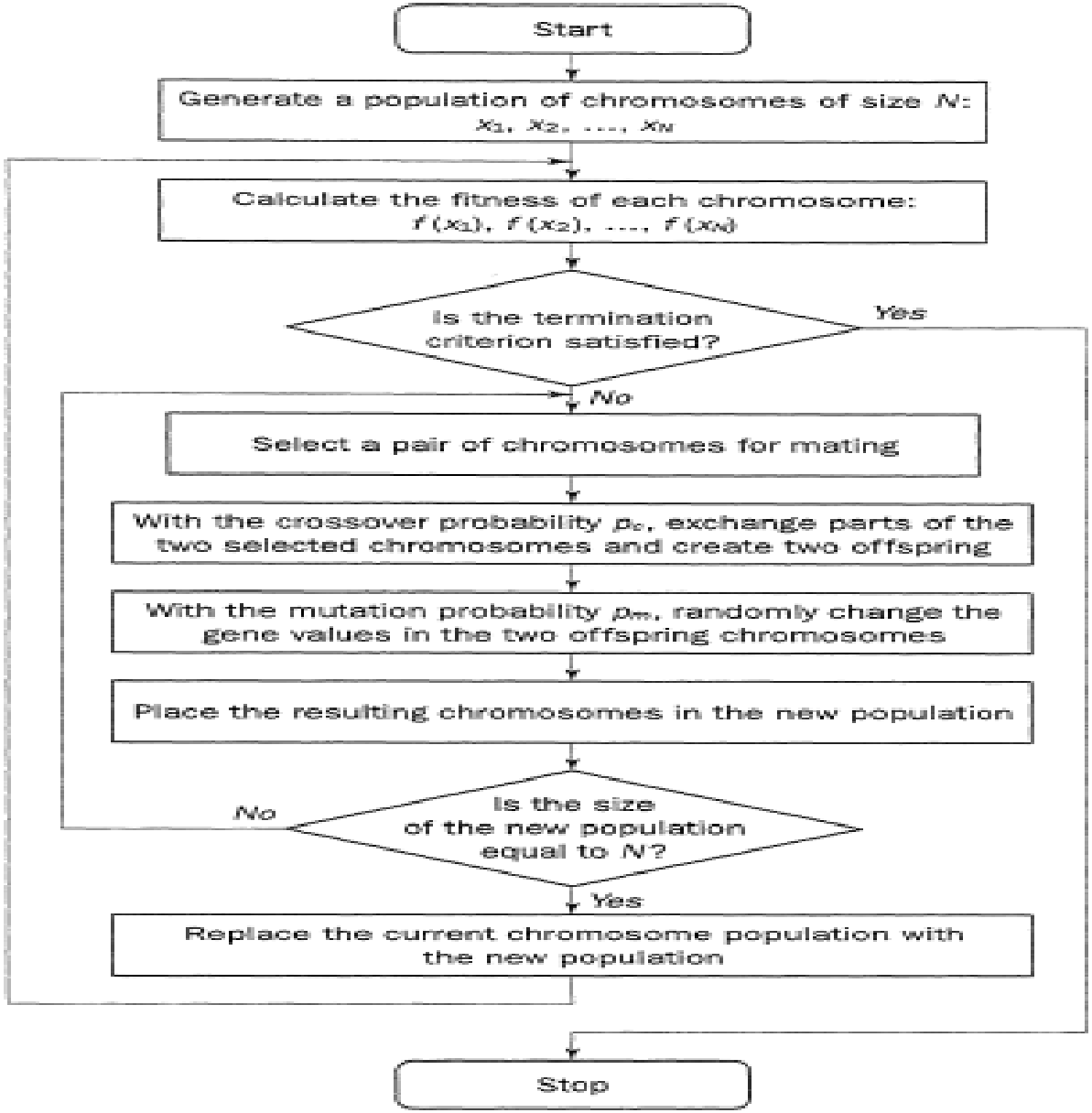
Introduction

- Intelligence can be defined as the capability of a system to adapt its behavior to ever-changing environment.
- After scientists became disillusioned with classical attempts at modeling intelligence, they looked in other directions.
- Two prominent fields arose, connectionism (neural networking, parallel processing) and evolutionary computing.
- Evolutionary computing is an umbrella which combines genetic algorithms, genetic programming and evolution strategies.

Introduction

- Evolutionary Computing is basically inspired from the nature and follow the Charles Darwin philosophy of evolution (presented before the Linnean society of London on 1 July 1858).
- Darwin theory is based on the processes of reproduction, mutation, competition and selection.
- In the year of 1970s, John Holland, one of the founders of evolutionary computing, introduced the concept of genetic algorithm.

How it Works – Flow Chart



How It Works- Algorithm

Step 1: Represent the problem variable domain as a chromosome of a fixed length, choose the size of a chromosome population N, the crossover probability p_c and the mutation probability p_m.

Step 2: Define a fitness function to measure the performance, or fitness, of an individual chromosome in the problem domain. The fitness function establishes the basis for selecting chromosomes that will be mated during reproduction.

Step 3: Randomly generate an initial population of chromosomes of size N:

$$x_1, x_2, \ldots, x_N$$

Step 4: Calculate the fitness of each individual chromosome:

$$f(x_1), f(x_2), \ldots, f(x_N)$$

Step 5: Select a pair of chromosomes for mating from the current population. Parent chromosomes are selected with a probability related to their fitness. Highly fit chromosomes have a higher probability of being selected for mating than less fit chromosomes.

Step 6: Create a pair of offspring chromosomes by applying the genetic operators – crossover and mutation.

Step 7: Place the created offspring chromosomes in the new population.

Step 8: Repeat Step 5 until the size of the new chromosome population becomes equal to the size of the initial population, N.

Step 9: Replace the initial (parent) chromosome population with the new (offspring) population.

Step 10: Go to Step 4, and repeat the process until the termination criterion is satisfied.

How It Works- Algorithm

Operations used:

1. **Fitness Function:** It guarantee that only who is eligible for survival will go for the nest generation.

   Example: f(x)= $15^{*}x - x^{2}$

2. **Fitness Ratio:**

   $$y_i = \frac{x_i * 100}{\sum x_i}$$ where x_i is the fitness value of each chromosome

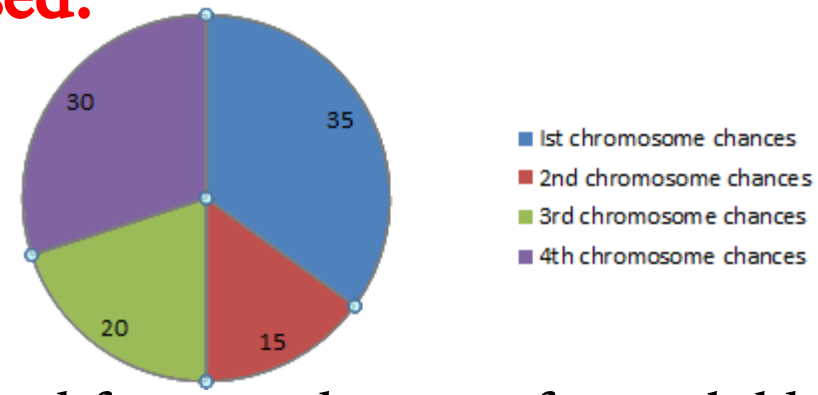
3. **Selection** : Here we select those chromosomes which have higher chances for survival. Most widely used selection technique is roulette wheel selection suggested by Goldberg 1989.

How It Works- Algorithm

Operations used:

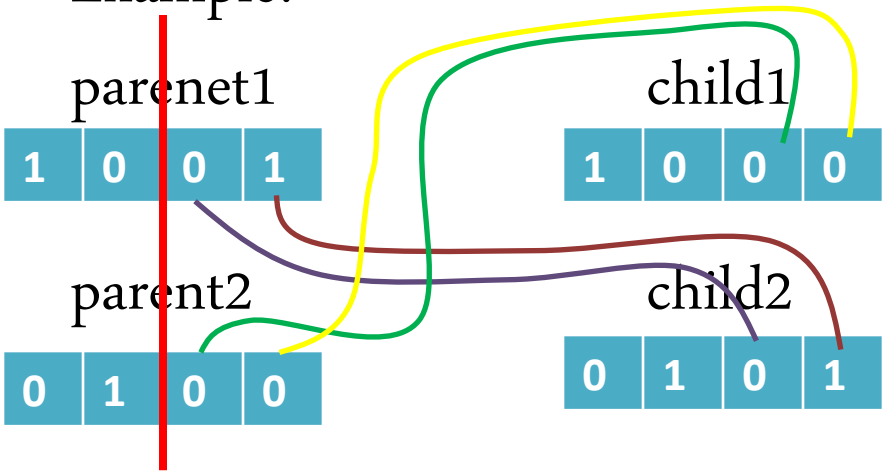
Roullete Wheel

Selection



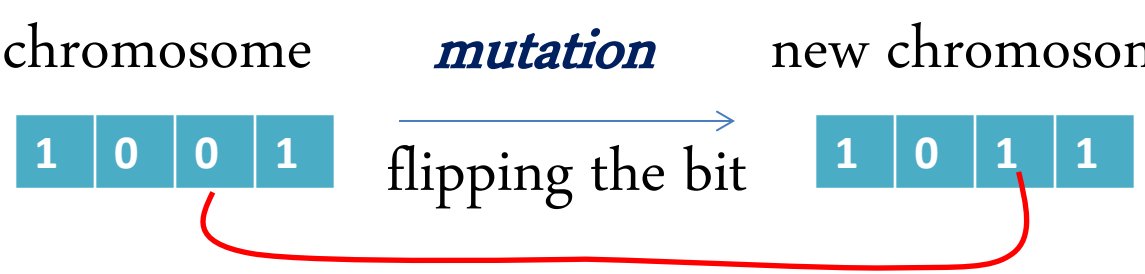
Crossover: It is used for reproduction of new children.

Example:



How It Works- Algorithm

Mutation : Mutation which is rare (less used), represents the change in gene.



Assignment

Thanks