genetic algorithm

Genetic algorithm

- genetic algorithm imitates the natural genetic the parameter of the problem are mostly coded in DNA like linear data structure such as vector or string and for two or more dimensional problem corresponding array is used
- a set of these problem dependent parameter value vector which will be processed by the genetic algorithm is known as ***population.*** the size of the population can be dozen to thousands.
- to do optimization we need a ***fitness function*** by this we can select the best solution candidate from the population and delete the not good specimen.
- ***crossover operation*** for this we need to perform ***selection*** and we need to have balanced selection if we select **too strong** selection sub-optimal highly fit individual will take over the population. reducing the diversity and need for change and progress will be slow if we select **too weak** then this will result in slow evolution.

Basic terminology

▼ ***individual***

an individual is a single solution while population is a set of individual currently involved in search process.

Population	Chromosome 1	1 1 1 0 0 0 1 0
	Chromosome 2	0 1 1 1 1 0 1 1
	Chromosome 3	1 0 1 0 1 0 1 0
	Chromosome 4	1 1 0 0 1 1 0 0

Figure 15-12 Population.

▼ **types**

genotype: the chromosome which is the raw genetic information that ga deals
phenotype: the expressive chromosome in the term of model

▼ **chromosome**

Chromosome: a chromosome is the raw genetic information that genetic algorithm deals with.

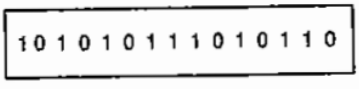

Figure 15-10 Representation of a chromosome.

- type of selection
  - roulette wheel selection
  - random selection
  - rank selection
  - tournament selection
  - boltzmann selection

- ***crossover operation (recombination)*** this is the process of taking two parent solutions and producing from them a child. After this the population is enriched with better individuals. Reproduction makes good strings but does not create new one.
  - crossover is done in three steps
    1. reproduction operator selects at random a pair of two individual string for mating.
    2. a cross site is selected along the string length
    3. the position value are swapped between the two string following the cross site.
  - various cross over technique are:
    - single point crossover
      - here a cross site is selected randomly and after the cut both chromosome exchange their change.

▼ **gene**

a gene is the single factor for a control factor. each factor in the solution set correspond to a gene in the chromosome.

genes are the basic **instruction** for building GA. a chromosome is a sequence of genes. genes may describe a possible solution to a problem. a gene is a bit of string.

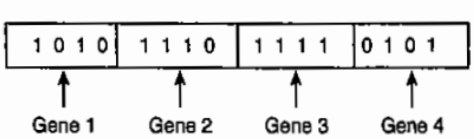

Figure 15-11 Representation of a gene.

▼ **selection**

selection is the process of choosing two parents from the population for ***crossing,*** this selection is for creating off spring for next generation who will be more fitter than current generation and also how many offspring each will create. Chromosome as selected from initial population.

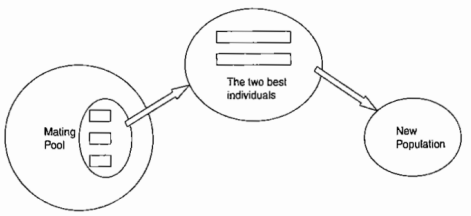

Figure 15-20 Selection.

▼ **mutation**

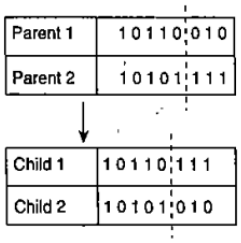

Figure 15-22 Single-point crossover.

- two point crossover
  - in this crossover more than one crossover site is created. **but it should be noted that adding further crossover point reduce the performance of GA.** here two points are chosen randomly and the content (gene) are exchanged.

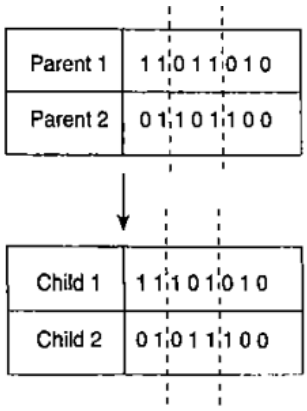

Figure 15-23 Two-point crossover.

- shuffle crossover is similar to single point crossover where after cross site genes are copied to each other. but in shuffle crossover genes are

after crossover the string are subject to mutation. mutation play the role of recovering the lost genetic material as well as for randomly distributing genetic information. mutation ensure ergodicity (cant be reduced or factor into smaller component) . it maintain the genetic diversity in the population.

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stopping condition for GA

1. maximum generations : when specific number of generation is evolved
2. elapsed time : after specific time.
3. no change in fitness : no change in population best fitness.
4. stall generation : no improvement in objective function.
5. stall in time limit : no improvement during a time interval .

        randomly shuffled in both parents. after recombination the variables are unshuffled in offspring.

    - cross over probabilty (Pc) this is the parameter which describe how often crossover should be performed. if there is no cross over offspring are exact copy of parents if there is crossover offspring are made from parents.
        - if crossover probabity (Pc) is 100% then all offspring are made by crossover.
        - if Pc is 0% whole new generation is made from exact copy of old population (but doesnt mean the new generation is same!)
    - crossover is made in hope of new chromosome contain good part of old chromosome therefore new chromosome will be better.
    - however it is good to leave some part of old population survive to next generation.

- mutation of bit involves flipping a bit changing 0 to 1 and vice-versa.
    - flipping: we choose one parent and a mutation chromosome(where genes are generated randomly) now in mutation

chromosome wherever we get 1 we change corresponding parent gene form 0 → 1 and vice versa then assign it to child.

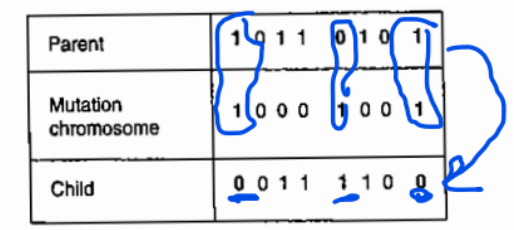

Figure 15-30 Mutation flipping.

- interchanging : two random position are selected and then we interchange 0 → 1 and vice versa those genes.

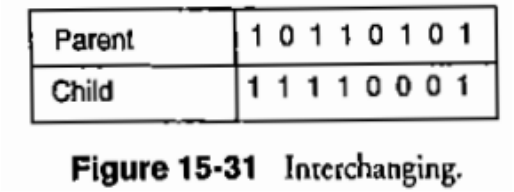

Figure 15-31 Interchanging.

- reversing: a random position is chosen and the bits next to that position are reversed and child chromosome is produced.

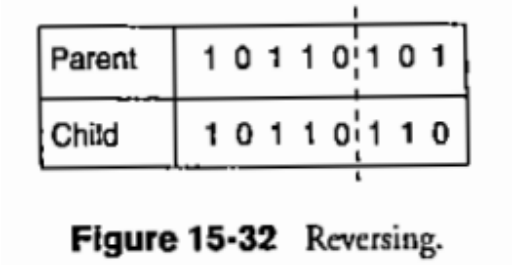

Figure 15-32 Reversing.

- mutation probabilty:
  this parameter decides how often mutation should take place. Pm. if

there is no mutation offspring are generated immediately after crossover without any change. if mutation performed some parts are changed.
if their is 100% mutation whole chromosome is changed. if their is 0% mutation nothing is changed. mutation generally prevents GA from falling into local extremes.