Exercise 01
Due Data: 07-Sep-2022, 13:30 PM

GENETIC ALGORITHM (15%)

A genetic algorithm is a search heuristic inspired by Charles Darwin's theory of natural evolution. This algorithm reflects the process of natural selection, where the fittest individuals are selected for reproduction to produce offspring of the next generation.

Natural selection begins with the selection of the fittest individuals from a population. They have offspring who inherit the characteristics of their parents and are passed down to the next generation. If parents are more fit, their children will be fitter than their parents and have a better chance of survival. This process is repeated until a generation of the fittest individuals is discovered.

Five phases are considered in a genetic algorithm.

1. Initial population
2. Fitness function
3. Selection
4. Crossover
5. Mutation

1) Initial Population (10 Pts)

The process starts with a group of individuals known as a Population. Each individual is a solution to the problem at hand. A person is defined by a set of parameters (variables) known as Genes. A Chromosome is formed by stringing together genes (solution). We call this encoding the genes on a chromosome. Table 1 shows numbers represented as decimal and binary. The binary representation is the chromosome, and each bit is the gene that used to solve the (Equation 1).

	Decimal	Binary	Gen 1	Gen 2	Gen 3	Gen 4	Gen 5	Gen 6	Gen 7	Gen 8
Set 1	8	00001000	0	0	0	0	1	0	0	0
Set 2	5	00000101	0	0	0	0	0	1	0	1
Set 3	50	00110010	0	0	1	1	0	0	1	0
Set 4	250	11111010	1	1	1	1	1	0	1	0

Table 1: Displays an example for solutions decimal numbers.

$$(x+3)^2 - 25 = 0 \qquad \text{Equation 1}$$

2) Fitness Function (20 Pts)

The fitness function determines an individual's fitness level (the ability of an individual to compete with others). Each individual receives a fitness score. The fitness score of an individual determines the likelihood that it will be selected for reproduction.

3) Selection (10 Pts)

The concept behind the selection phase is to choose the fittest individuals and allow them to pass on their genes to the next generation. Two pairs of people (parents) are chosen based on their fitness levels. Individuals with high fitness have a better chance of being chosen for reproduction.

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4) Crossover (20 Pts)

The most important phase of a genetic algorithm is crossover. A crossover point is chosen randomly from within the genes for each pair of parents to be mated.

Consider the crossover point to be 3, as shown below Figure 1.

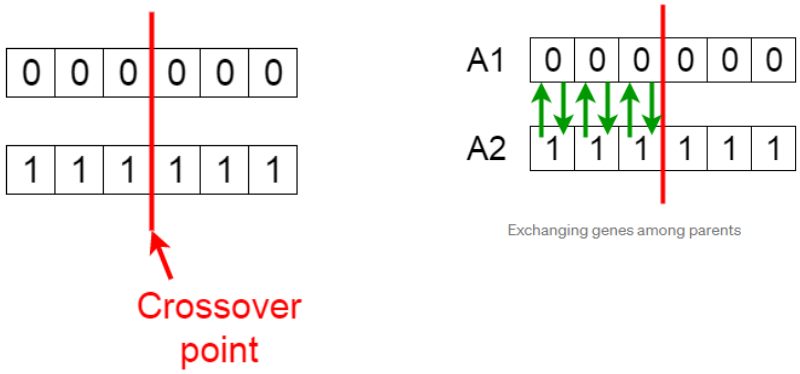

Figure 1: crossover steps.

Offspring are produced by exchanging their parents' genes until the crossover point is reached. The new offspring are incorporated into the population.

5) Mutation (20 Pts)

Some of the genes in certain newly formed offspring can be subjected to a mutation with a low random probability. It means that some of the bits in the bit string can be flipped. Mutation occurs to maintain population diversity and prevent premature convergence.

Decimal	Binary	Gen 1	Gen 2	Gen 3	Gen 4	Gen 5	Gen 6	Gen 7	Gen 8
8	00001000	0	0	0	0	1	0	0	0
Decimal	Binary	Gen 1	Gen 2	Gen 3	Gen 4	Gen 5	Gen 6	Gen 7	Gen 8
8	00001000	0	0	1	0	1	0	0	0

6) Termination (10 Pts)

If the population has converged, the algorithm will be terminated (it does not produce significantly different offspring from the previous generation). The genetic algorithm is said to have then provided solutions to our problem.

7) Presentation (10 Pts)

The team needs to do a presentation for 5 minutes deadline date for assignment. The assignment must be done by group of students.