**ASSIGNMENT 9**

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1. Explain:

Cell, Gene, Chromosomes, DNA

Human Genome Project?

Cell Nucleus

Genomic Language

DNA Mutations, name 3 mutations and explain

Answer ->

Cell – A cell is basic building block for all living things. It is the smallest unit that can live on its own that makes up all living organisms and tissues of the body.

Gene – A gene is the basic physical and functional unit of heredity. It is a sequence of nucleotides in DNA that encodes the synthesis of a gene product, either RNA or protein.

Chromosomes – It is long DNA molecule with part or all of the genetic material of an organism.

DNA – DNA – Deoxyribonucleic acid is a polymer composed of 2 polynucleotide chains that coil around each other to form a double helix carrying genetic instructions for the development.

Human Genome Project - The Human Genome Project was an international scientific research project with the goal of determining the base pairs that make up human DNA, and of identifying, mapping and sequencing all of the genes of the human genome from both a physical and a functional standpoint.

Cell Nucleus - the middle of the cell, and the nucleus contains all of the cell's chromosomes, which encode the genetic material

Genomic Language - The DNA molecule carries information in the form of a sequence of four nucleotide bases, adenine (A), cytosine (C), guanine (G) and thymine (T), which can be thought of as the letters of the genomic language.

DNA Mutations - mutation is an alteration in the nucleic acid sequence of the genome of an organism, virus, or extrachromosomal DNA

Name 3 mutations and explain –

|  |  |  |
| --- | --- | --- |
| Point mutation | Substitution | Sickle-cell anemia |
| Insertion | One form of beta-thalassemia |
| Deletion | Cystic fibrosis |

2. Consider the article on Genetic Algorithm (GA)

a) The following model describes the biology in human. Describe the Model,

How does it work?

Diagram

Description automatically generated

b) What is the goal of Genetic Algorithm? Explain with Example

c) Genetic Algorithm mimics its model from science of biology (True/False)? Explain

ANSWER –

a) Cells are the basic building block of all living things. Therefore in each cell, there is the same  
set of chromosomes. Chromosome are ba-sically the strings of DNA.Traditionally, these  
chromosomes are repre-sented in binary as strings of 0’s and 1’s.A chromosome consists of  
genes, commonly referred as blocks of DNA, where each gene encodes a specific trait, for  
example hair color or eye color.

b) Goal of a genetic algorithm, It is an optimisation technique, which tries to find out such  
values of input so that we get the best output values or results.The set of all possible solutions  
or values which the inputs can take make up the search space. In this search space, lies a  
point or a set of points which gives the optimal solution. The aim of optimization is to find  
that point or set of points in the search space. Let’s take a hypothetical situation where, you  
are head of a country, and in order to keep your city safe from bad things, you implement a  
policy like this. You select all the good people, and ask them to extend their generation by  
having their children. This repeats for a few generations. You will notice that now you have  
an entire population of good people

c) Nature has always been a great source of inspiration to all mankind. Genetic Algorithms  
(GAs) are search based algorithms based on the concepts of natural selection and  
genetics. GAs are a subset of a much larger branch of computation known  
as Evolutionary Computation. In GAs, we have a pool or a population of possible  
solutions to the given problem.  
These solutions then undergo recombination and mutation (like in natural genetics),  
producing new children, and the process is repeated over various generations. Each  
individual (or candidate solution) is assigned a fitness value (based on its objective  
function value) and the fitter individuals are given a higher chance to mate and yield  
more “fitter” individuals. This is in line with the Darwinian Theory of “Survival of the  
Fittest”. In this way we keep “evolving” better individuals or solutions over generations,  
till we reach a stopping criterion.

3. Genetic Algorithm:

` a) What are the steps of Genetic Algorithm?

b) Read the example Java code (Lecture10Notes) as how it relates to steps in (a)

c) Compile and run the code, explain the results.

d) What are possible termination points?

e) Change the code to consider for 8 genes. Compile and Run.

f) Compare (c) and (e), explain results

ANSWER –

a) Five phases are considered in a genetic algorithm.  
Initial population: The process begins with a set of individuals which is called a Population.  
Each individual is a solution to the problem you want to solve. An individual is  
characterized by a set of parameters (variables) known as Genes. Genes are joined into a  
string to form a Chromosome (solution).  
Fitness function: The fitness function determines how fit an individual is (the ability of an  
individual to compete with other individuals). It gives a fitness score to each individual. The  
probability that an individual will be selected for reproduction is based on its fitness score.  
Selection: select the fittest individuals and let them pass their genes to the next generation.  
are selected based on their fitness scores.  
Crossover: For each pair of parents to be mated, a crossover point is chosen at random from  
within the genes.  
Mutation: In certain new offspring formed, some of their genes can be subjected to  
a mutation with a low random probability. This implies that some of the bits in the bit  
string can be flipped.

b) **-** Class individual is created having genes as array of bits , fitness score, for loop population  
bit of genes with randomly assigned bits.  
**-** population class takes array of individuals and has functions to get the fitted and second  
fittest individual to return for mating. It has least fitness extraction on calculation of fitness  
using calcfitress of individual class  
**-** through main method we create initial population and assign fitness value to each. Then  
selection method is called which takes fittest and second fittest individual  
**-** cross over method is called where taking random crossver point in both genes new  
offspring is given value from both parents  
- Mutation method is called to perform flip on random index  
- In add fittest method fitness value is calculated to get best two fit off spring & replace  
least fittest off spring with best fit.  
- Print out must fit off springs.

c) Given a set of 5 genes, each gene can hold one of the binary values 0 and 1. The fitness value  
is calculated as the number of 1s present in the genome. If there are five 1s, then it is having  
maximum fitness. If there are no 1s, then it has the minimum fitness. This genetic algorithm  
tries to maximize the fitness function to provide a population consisting of the fittest  
individual, i.e. individuals with five 1s. In the result it has displayed all the generations which  
are taken along with number of fittest individuals which are then selected to further populate  
with fitter generation.

d) Text

Description automatically generated

The possible termination point is when the algorithm finds the fitness in the genes under the Generation.

f) As per the output in 5 genes code we can see in Generation 0 to 9 individuals with fitness  
score 4 existed and later it went down to 3 and finally reached the generation with fitness  
score = 5(highest score). So, in generation 19 fittest population is found with fitness score 5  
and genes = 1 1 1 1 1  
As per the output in 8 genes code we can see in Generation 0 to 8 individuals with fitness  
score 5  
existed and later it went down to 4 and finally reached the generation with fitness score =  
8(highest score).  
So, in generation 18 fittest population is found with fitness score 8 and genes = 1 1 1 1 1 1 1 1

4. Consider the following Text and Pattern

Text: ABCADBABCBABABCDABCDABDE

Pattern: DAB

a) Apply Brute-Force substring search algorithm to scan Pattern in

Text string. Show step-by-step of the algorithm. What is time complexity?

b) Apply Robin-Karp substring search algorithm to scan pattern in the

text string. Show step-by-step of algorithm. Write Java code

for the algorithm for input data. What is time complexity?

c) What is the difference between the two time complexity?