Muhammad Hamza (1602028)

Mahad Asif (1602009)

Evolutionary Algorithm

Natural Phenomenon:

Evolutionary algorithms are non-deterministic optimization problems of computation which are generally included in NP-hard problems. NP-hard problems are those which take exponential time to provide with the desired optimal output. These problems are derived from the evolutionary computation and may or may not be ideal to produce the ideal output because usually, non-determinism arises when going through the steps of these typical problems. There is some significant probability that the problems in processing commonly arises in choosing the best and fittest component in whole class to farther continue the generations. This process takes a long time arriving at the fittest conclusion and this fittest conclusion is not ideal but through estimation. On the contrary, unfit components will die off and not contribute in this process. This phenomenon corresponds to the process of natural selection.

There are many applications of evolutionary algorithms like image processing which undergoes through these steps to make an algorithm efficient and capable enough to examine the right position in an image and consequently outputs a suitable result.

Theory:

The theoretical interpretation provides the detail analysis undergoing through several steps which are:

- Initialization
- Selection (Mutation and Crossover)
- Termination

In initialization process, data set is provided and this data set contains an arbitrary set of possible cases or solutions. The population is often created randomly through the acknowledgement of the given scenario or case. This randomly created population consists of pool of sets which may lead to different solutions.

In selection process after the initialization has been made, several countable data sets are extracted from the pool for the analysis based on some technique or mathematical equation or through some any fitness function. The values of the fitness function of selected members will give us some idea for how the selection process could be made better through worthy mutations and crossovers. These changes in fitness values will tell us how much the solution is viable. These mutations (alteration of data) and may be crossover lead us to some better approximations or results. This process is iterated repeatedly while best expected approximation is not found. In each iteration, the best top members are selected based on their fitness results to make the solution more optimal in next iteration.

At the end in termination step, the algorithm ends with the most optimal solution with the hope that it is the best estimated solution. Now, the algorithm has reached some specific threshold of performance or maximum runtime after which the values may drop which may lead to some inefficient result.

Model:

This model is the manifestation of the given case and its solution. We have to find the best or maximum matching member located at the desired position in the group photo.

We are provided with two images. One is called **group photo (512*1024)** termed as a population consisting of pictures of multiple men and **small photo (35*29)** containing the facial image of a man. We will get these images in the form of 2D matrices from which we have to undergo through mutation of the population by following the selection from a group photo. We have to find the position of a targeted facial image of a man in a given group photo by the correlation process. The correlation will give us some conception of how much a matrix of small photo and selected matrix from a population are closely related. This correlation result is called a fitness value in this specific scenario conditionally. More suitable conclusion through correlation process will lead to much better closeness of both the matrices which will surely be of same size i.e. **35*29**.

Application:

The application will give some detailed information of how the population is created through initialization and how the selection is being made by matching the targeted submatrix and small photo values. Two data matrices are initialized by reading the image of the group photo (512*1024) and small photo (35*29) through the function of image reading. Small photo matrix is also initialized for further maximum matching process.

As we all know that each pixel in a particular image has its own x and y coordinates which indicate the specific position of that pixel in a whole 2D image. We create the matrix (100*2) in which first column contains the x coordinates and the second column consists of just y coordinates of the corresponding pixels. This matrix is initialized randomly but following the limited range (number of rows and columns) of a group photo. So, the first column in a matrix have random numbers ranged from 0 to 1024 and second column from 0 to 512 because the given data set have a size of (512*1024) respectively. Meanwhile, each row in this matrix indicates the position of a pixel in a given group photo by its x and y coordinates. Consequently, the positions of hundred pixels are initialized in this matrix randomly. This is how the population is created in this scenario conditionally by using a rand function.

Now in the matching process, hundred submatrices (35*29) are initialized starting from their hundred starting points in a group photo correspondingly through the population and each submatrix will have its own fitness value when undergo through the correlation function with small photo matrix. The correlation function returns a value ranged from -1 to 1 indicating minimum to maximum.

Afterwards, sorting will be done to get the top most submatrices with maximum fitness results. Here, mutation phenomenon is applied to follow the crossovers between adjacent sorted x coordinates in accordance with their fitness values. Now, a new population is created depending upon the sorted correlation values. This selection, mutation, crossover is processed again and again in a loop until the best correlation value closest to 1 is not calculated.