Namal University Mianwali

Artificial Intelligence

Report Template Matching Problem

Instructor	Dr. Junaid Akhtar
Group Members	M.Ilyas (BSCS2020-02) M.Ramzan (BSCS2020-17)

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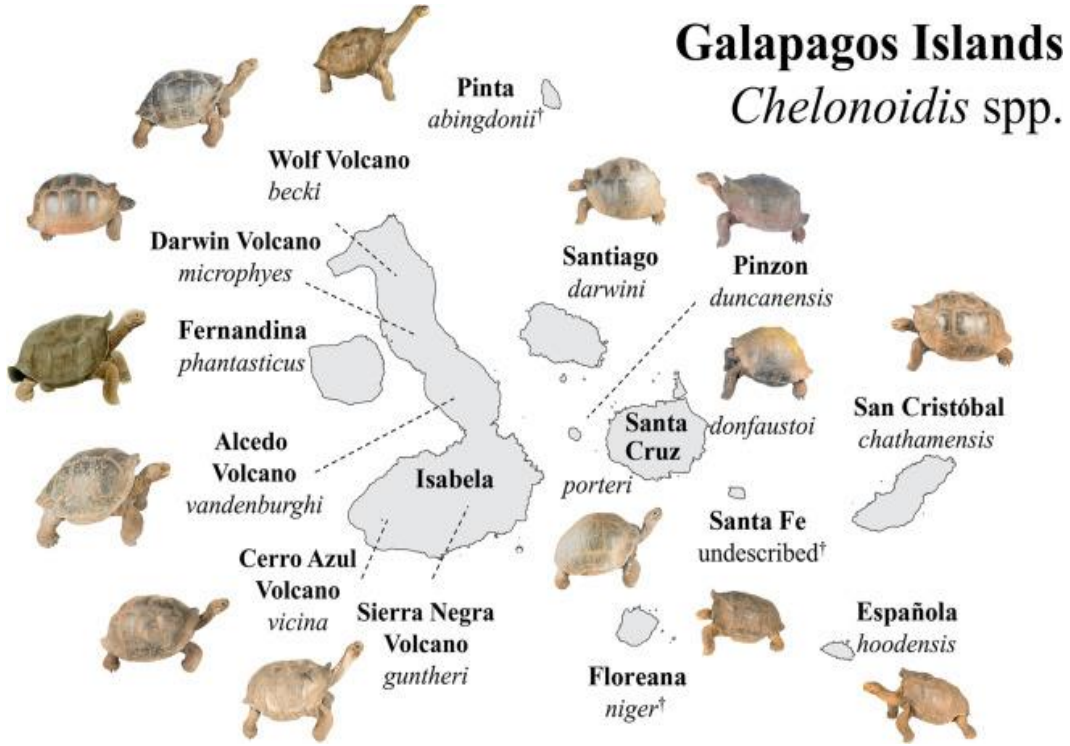
1- **Natural Phenomenon:**

When we observe nature, we find out that nature is diverse and there is a variety of species. A huge number of species are on a single pattern. To name a few, We have 315 kinds of hummingbirds, 200 known species of Monkeys, 1000 types of bats, and at least 350,000 known species of beetles. Now, one might ask **Why is there so much diversity and variety in nature?**

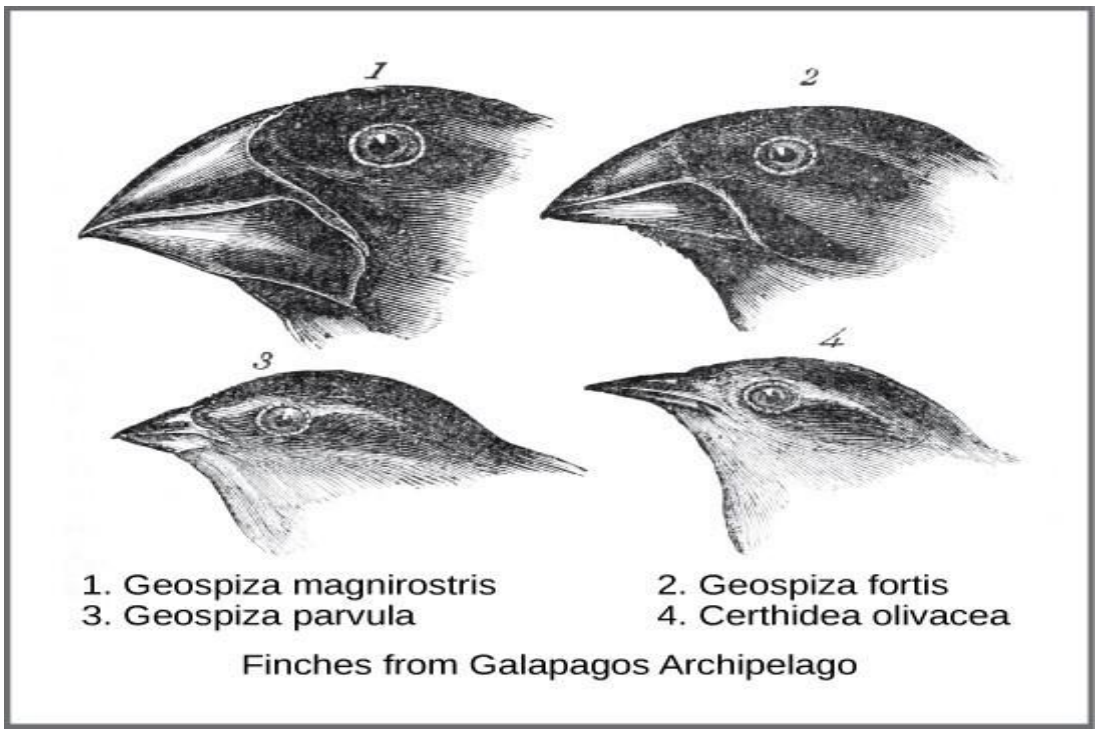
2- **Theory:**

➢ 2.1 **Background:**

As we see in our surroundings and when we visited new places, we see that there is so much diversity in nature. The first question arise in our mind is why there is so much diversity in nature? Charles Darwin has provided an answer to our question. When he was visited to island and saw the difference between tortoise of that island and the other where he come from. On this island tortoise has peek at the front which means that it came from a drier island and the other one from a well-watered island.



As we see in the documentary of that theory that there is so much diversity in same kind of finches. There is a difference in their beaks over the time. Following figure shows the difference.



Those who have small beaks have used their beaks for eating insects to survive and those

who have big beaks have used their beaks to cut nuts for their survival.
From the above examples it shown that species are cautiously evolving to new species after a long time and due to their environment changes. Darwin called this phenomenon “Evolution by natural selection”.
I have a one question here. If this theory is true and species are cautiously evolving according to Darwin then what is the possibility that **we (humans) change into new species?**

➢ 2.2 **Conclusion:**

Evolution by natural selection is a phenomenon by which nature selects the fittest individuals from population for a particular environment and for the new generation.
Nature selection is the main reason of diversity and the changes in our environment and species after a long time. As we observe that there is so much people in the world but after certain range there is a difference between environment and language of people etc.

3- Evolutionary algorithm for template matching problem.

Here are following steps we follow to solve the template matching problem.

3.1 **Image Representation:**

First, we represent the images in the form of matrices in which each number shows each individual pixel of number.

3.2 **Population Initialization:**

we generate 1000 points randomly from big image. In which each point represents the pixel which further represents an individual according to algorithm.

3.3 **Fitness Evaluation:**

Then I check fitness level using correlation of each individual of current population with small image. That tell how each individual is good or bad for our solution.

3.4 **Selection:**

As according to natural phenomenon or theory best fittest of environment are responsible to generate new generation. Same as we sort the fitness values of individuals to select the best ones for our new generation.

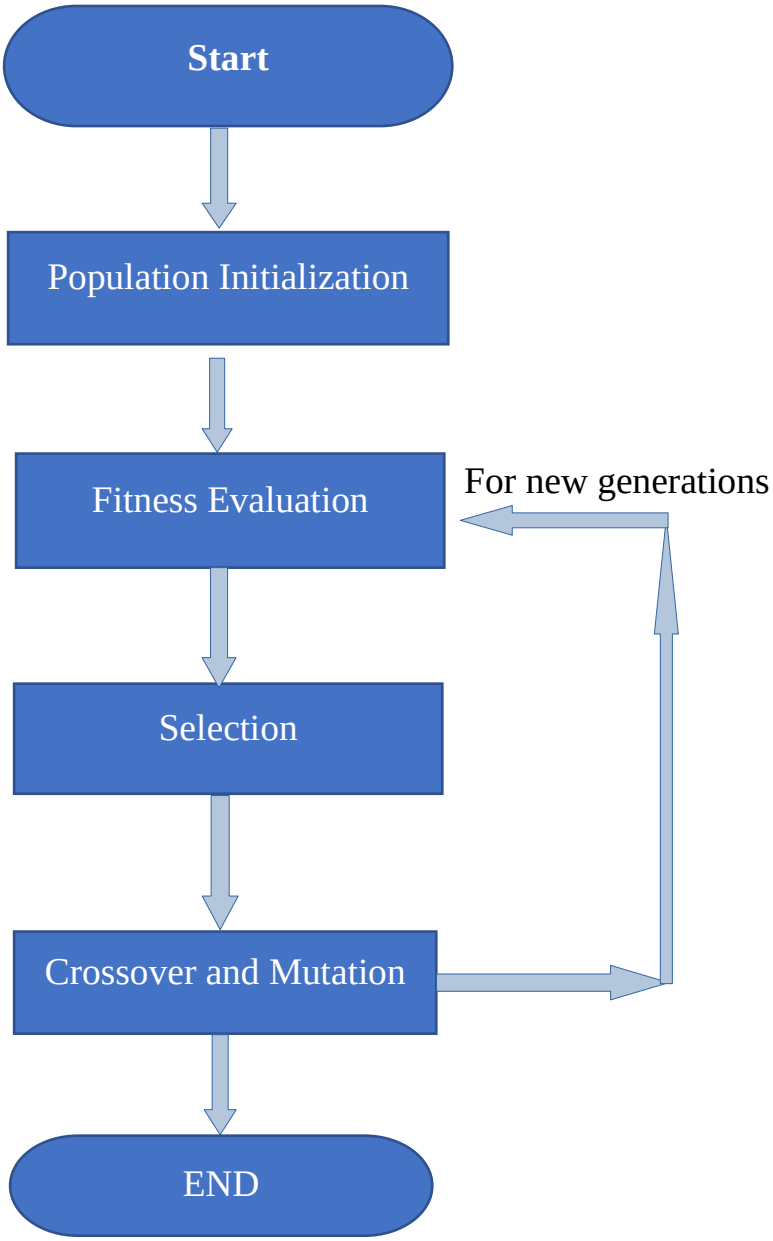
3.5 **Crossover and Mutation:**

After selecting the fittest individuals, we crossover the individuals with others and mutate them for the creation of new generation. That’s how new generation evolve from old generation according to our theory.

3.6 **Stopping Criteria:**

We set a particular threshold value when this threshold meets then our system should exit the execution and shows the results otherwise repeat this process until it fulfills our requirements.

3.7 **Flowchart** of evolutionary algorithm we follow to solve the problem.



This process continuous until our threshold meets or we get the requires results.

4- **Problem statement:**

We are supposed to solve a template matching problem using computational model. We have a group image and we have to find a face from that group image using evolutionary algorithm.

Figure 1

Figure 2

4.1 **Steps that we follow to solve this problem are given below:**

1. First, we convert both images into 2D array and find the number of rows and columns of both images.

2. Then we initialize a function name populationintialization who take group image and rows and population size as parameters in which we generate a 1000 random points of group image and append them in list.
   This function returns current generation list.

3. Then this current generation is given to fitness evaluation function who find the correlation value of each individual by mapping on our boothi image. We find correlation value by using built in library scipy and store both the individual and its

correlation value in a tuple. Then find an average fitness of each generation and append it in list. Each time when this function called it find the average fitness of each generation for plot.

4. After fitness evaluation we write a function of selection in which we sort the fitness values and select a value those have high correlation (fitter which take part to generate a new generation). This function returns selected generation for crossover and mutation.

5. After selection then we select a one point generate its binary and then select another random point and then crossover these two and perform mutation on it.

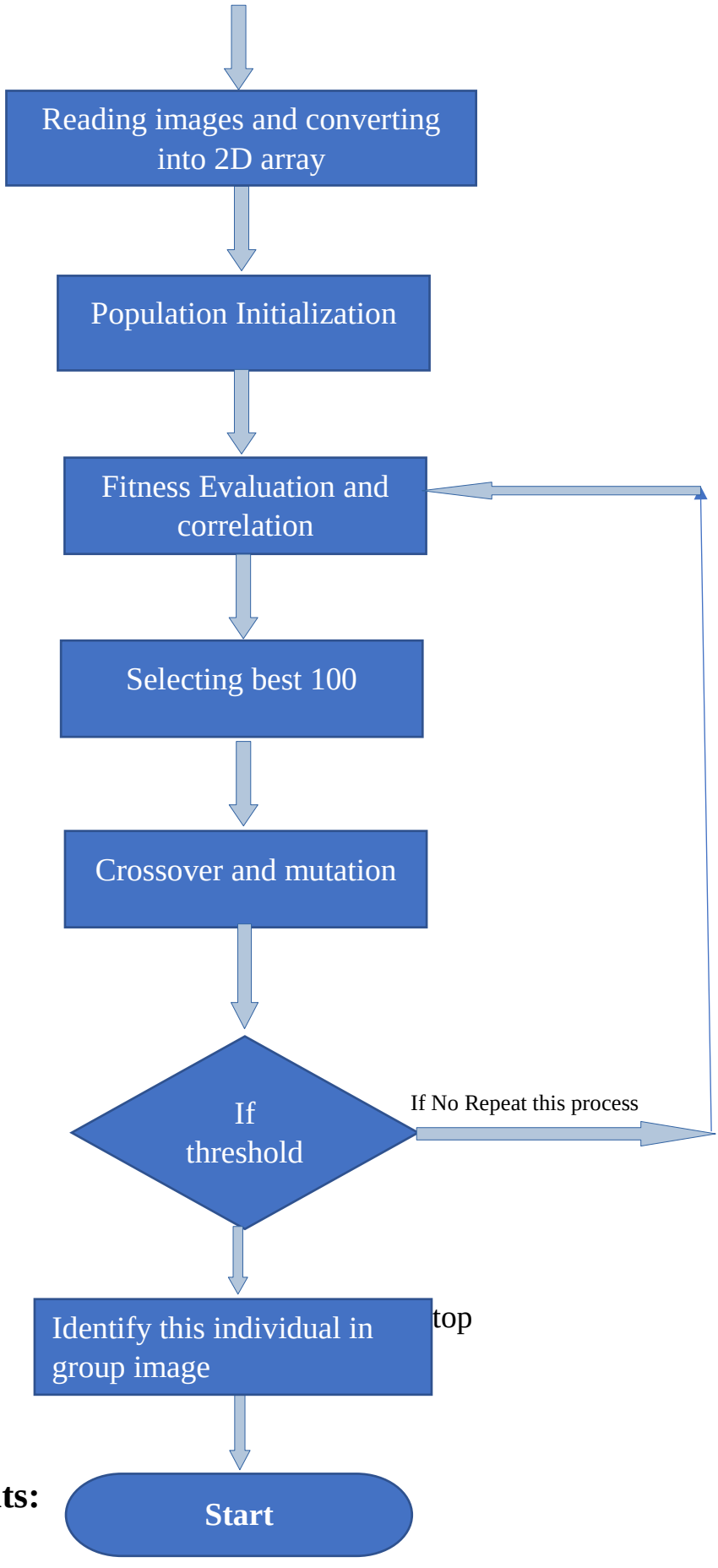
6. There is stopping criteria function which stops this process when we met with certain threshold value and then select the point.

7. Now, draw a rectangle around this point similar to the length of boothi rows and columns.

8. At the end we plot a graph of each generation against its fitness value and max fitness.

That’s how we found a baba g boothi from a group image.

Here is the flowchart of that steps.


Reading images and converting into 2D array
Population Initialization
Fitness Evaluation and correlation
Selecting best 100
Crossover and mutation
If threshold
If No Repeat this process
Identify this individual in group image
top
Start

4.2 **Results:**

5- Experimental Analysis:

5.1 Phase I

5.1.1 Hypothesis:

We decided to select 50 individuals from randomly generated population of 1000. My expectations from my algorithm are it should find a small image from a group image and each time when it selecting the fittest individual from every generation must have fittest individual from his generation and new generation should evolve from previous generation according to algorithm. New generation has more fittest individuals than parent generation and fitness graph must be in increasing order. And average fitness values are also in increasing trend.

5.1.2 Experiment:

We select 50 individuals from randomly generated population of 1000. Which gives us the right answer but no the right graph. Because the individuals we select are fit but when they generate new population their fitness values are less than their parent fitness values. Which means that our new generation is not evolving and not bringing any change. But according to evolutionary algorithm, Evolution continuously taking place and the new generation is better than from their parent. Where as in our case it is opposite new generation is not fitter than parent at some points and at some points its better than parents. Average fitness values are almost the same and decreasing at some points and also increasing at some points. But not the right answer we want.

5.1.3 **Results:**

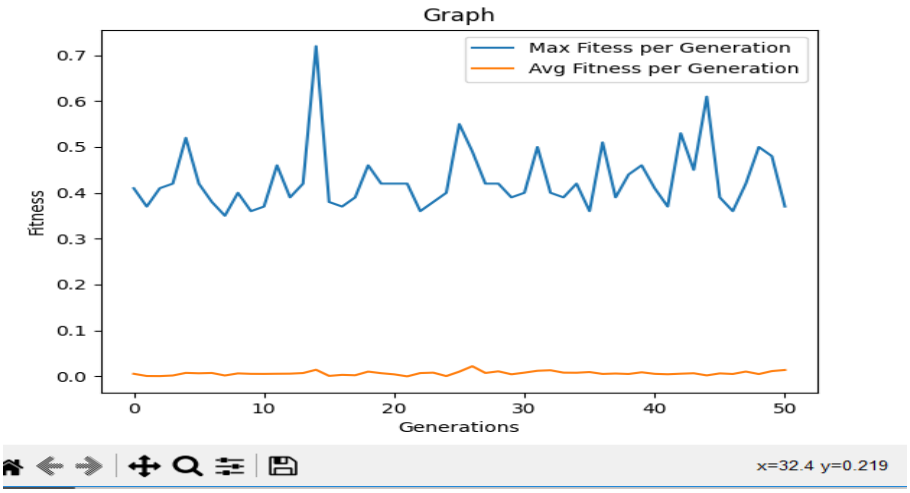


Figure 3

Figure 4

5.2 **Phase II:**

5.2.1 **Hypothesis:**

As we see the results of phase I, we decide to increase the size of selected population to 100 and making some changes in the code (preserve the fittest from each population for our graph). And expect the same results that we did in our first phase.

5.2.2 **Experiment:**

When we select a population of 100 results are not much changes as we except but it shows some positive behavior to our changes. We found the small image but the graph of maximum fitness of each generation almost remain same as of phase I graph. But the

positive thing is that our average fitness per generation continuously increasing. But the max fitness behavior remains same.

5.2.3 **Results:**

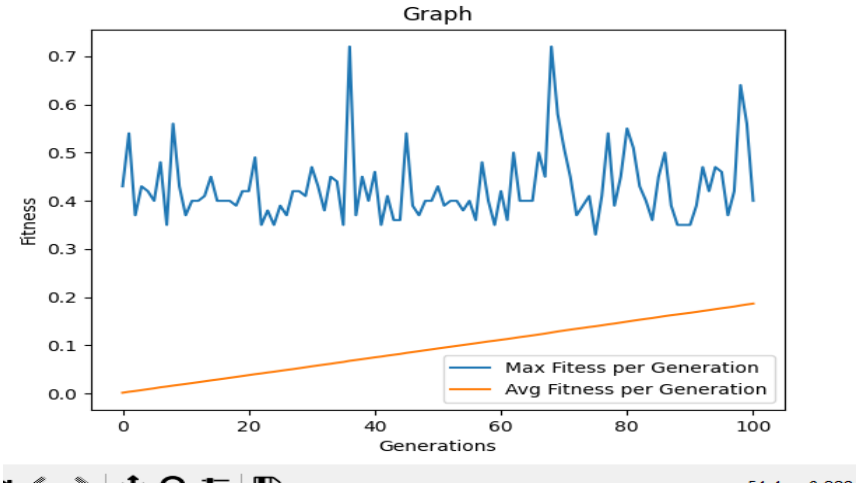


Figure 4

5.3 **Phase III**

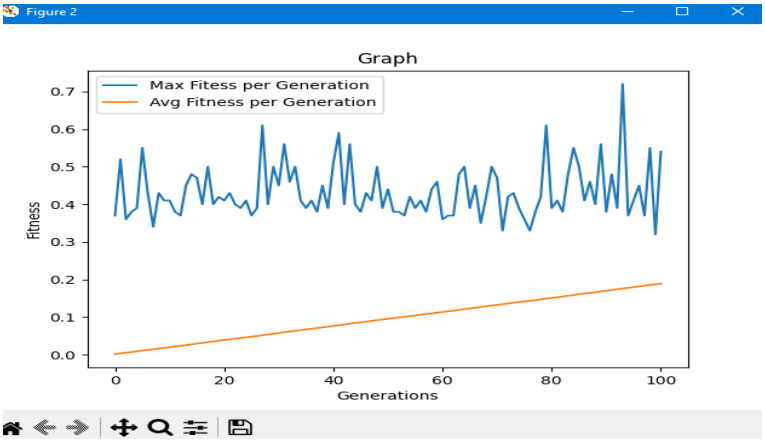
5.3.1 **Hypothesis:**

The results produce by phase II also not acceptable because it cannot produce the requirements of evolutionary algorithm or theory. So, this time we went for a new change by changing the crossover cuts and perform mutations of pairs with highest fitness and expecting the results as before we did.

5.3.2 **Experiment:**

In this experiment, again we select a population of 100 individuals from 1000 and this time we change the cuts of crossover and mutation. We perform crossover of every individual with other one in an increasing order and then mutate them. And get new species for next generation and so on. But this process again fails to produce good results. At this time, average fitness value increasing but the max fitness value gives us the same results. This time graph is worse than others.

5.3.3 **Results:**



5.4 **Phase IV:**

5.4.1 **Hypothesis:**

This time we have a same population size and we changed the crossover cuts again and perform mutation. And again, we are looking for a better result this.

5.4.2 **Experiment:**

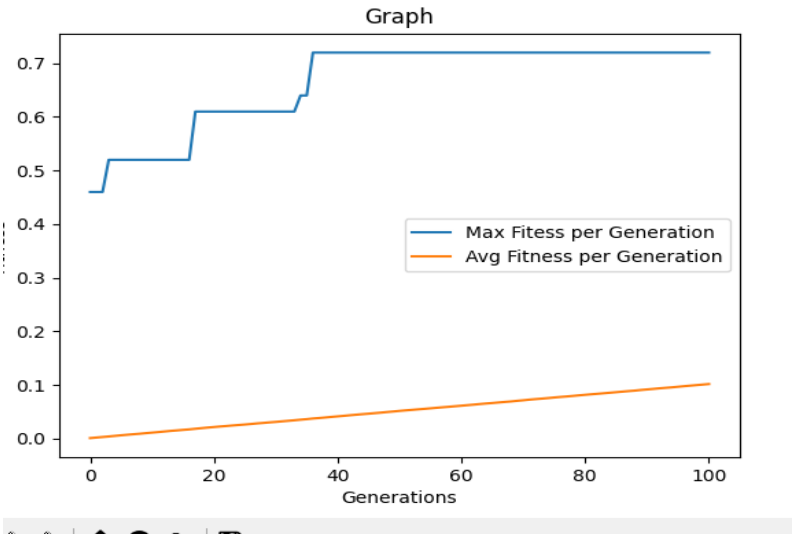
We select a population of 100 individuals again and perform the same steps. But this time, we perform crossover of species by a way that first we select an individual and then generate a random index and select an individual present on this index and perform crossover and mutation. First, we generate binary of these individuals and cut them into parts and replace them with another but this we cut the binary again by generating the random and replace the binary of two species according to that. Finally, this works, and our graph is much better than previous ones by showing that max fitness also increasing this time.

```
def crossover(array):
    current_Generation.clear()
    for row in range(0,total_population,2):
        x=array[row][0]
        y=array[row][1]
        x1=np.binary_repr(x,width=11)  # 11 digit binary
        y1=np.binary_repr(y,width=11)
        # converting the string to list for performing the crossover
        x1 = list(x1)
        y1 = list(y1)
        specie_1=x1+y1       #concatinate x1 and y1

        x=array[row+1][0]
        y=array[row+1][1]
        # conversion into binary
        x2=np.binary_repr(x,width=11)
        y2=np.binary_repr(y,width=11)
        # converting the string to list for performing the crossover
        x2 = list(x2)
        y2 = list(y2)
        specie_2=x2+y2     #concatinate x2 and y2

        # generating the random point to perform crossover
```

```
# generating the random point to perform crossover
k = random.randint(1,21)

# interchanging the values randomly
for i in range(k, len(specie_1)):
    specie_1[i], specie_2[i] = specie_2[i], specie_1[i] #swaping
specie_1 = ''.join(specie_1)
specie_2 = ''.join(specie_2)

x1=specie_1[0:12]
y1=specie_1[12:23]
x2=specie_2[0:12]
y2=specie_2[12:23]

#conversion back to decimal
int_x1=int(x1,2)
int_y1=int(y1,2)
int_x2=int(x2,2)
int_y2=int(y2,2)

height = len(group_image)-len(boothi)
width = len(group_image[0])-len(boothi[0])
```

```
# if values remain same after crossover mutate

if int_y1==int_y2 and int_y1<(height):
    int_y1+=1
if int_x1==int_x2 and int_x1<(width):
    int_x1+=1
# Checking Corner cases
if int_x1>(width):
    int_x1=random.randint(1,width)
        #int_x1=len(group_image[0])//2
if int_x2>(width):
    int_x2=random.randint(1,width)
if int_y1>(height):
    int_y1=random.randint(1,height)
if int_y2>(height):
    int_y2=random.randint(1,height)

current_Generation.append([int_x1,int_y1])
current_Generation.append([int_x2,int_y2])
```

5.4.3 **Results:**



6- References:

https://www.google.com/search?q=galapagos+island+tortoise+evolution&rlz=1C1GCEA_enPK1015PK1015&sxsrf=ALiCzsaVPD7uh-AYUAUPzCUBXYysD-

bImw:1666375967332&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiEgeGc9vH6AhUBPuwKHWAbCgAQ_AUoAXoECAEQAw&biw=1366&bih=663&dpr=1#imgrc=kLf-ULHCHAjCLM

https://www.google.com/search?q=tortoise+evolution+based+on+natural+selection&rlz=1C1GCEA_enPK1015PK1015&sxsrf=ALiCzsYUHH4yH86y4vBc4mZzy2cECArEGQ:1666369552154&source=lnms&tbm=isch&sa=X&ved=2ahUKEwif1OGp3vH6AhUS3qQKHT-hACwQ_AUoAXoECAIQAw&biw=1366&bih=663&dpr=1#imgrc=dFwoVZRypDttQM