

---

# Artificial Intelligence



**NAMAL INSTITUTE**

Report: Template Matching Problem

Instructor: DR. JUNAID AKHTAR

Group Members: Muhammad Rehan Ali,

Syed Uzair Ul Hassan, Usama Ali

& Muhammad Musawar Baig

---

## A) 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?**

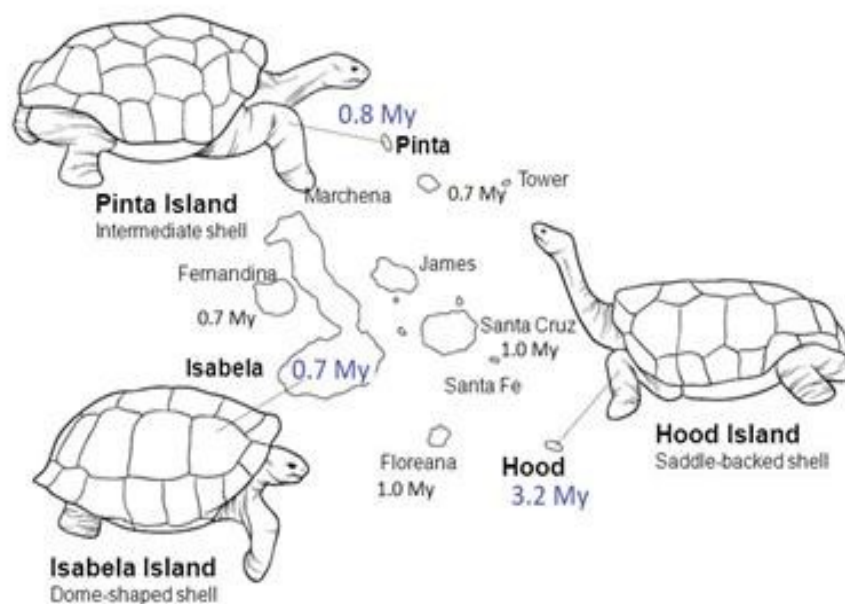
## B) Theory:

### • Background:

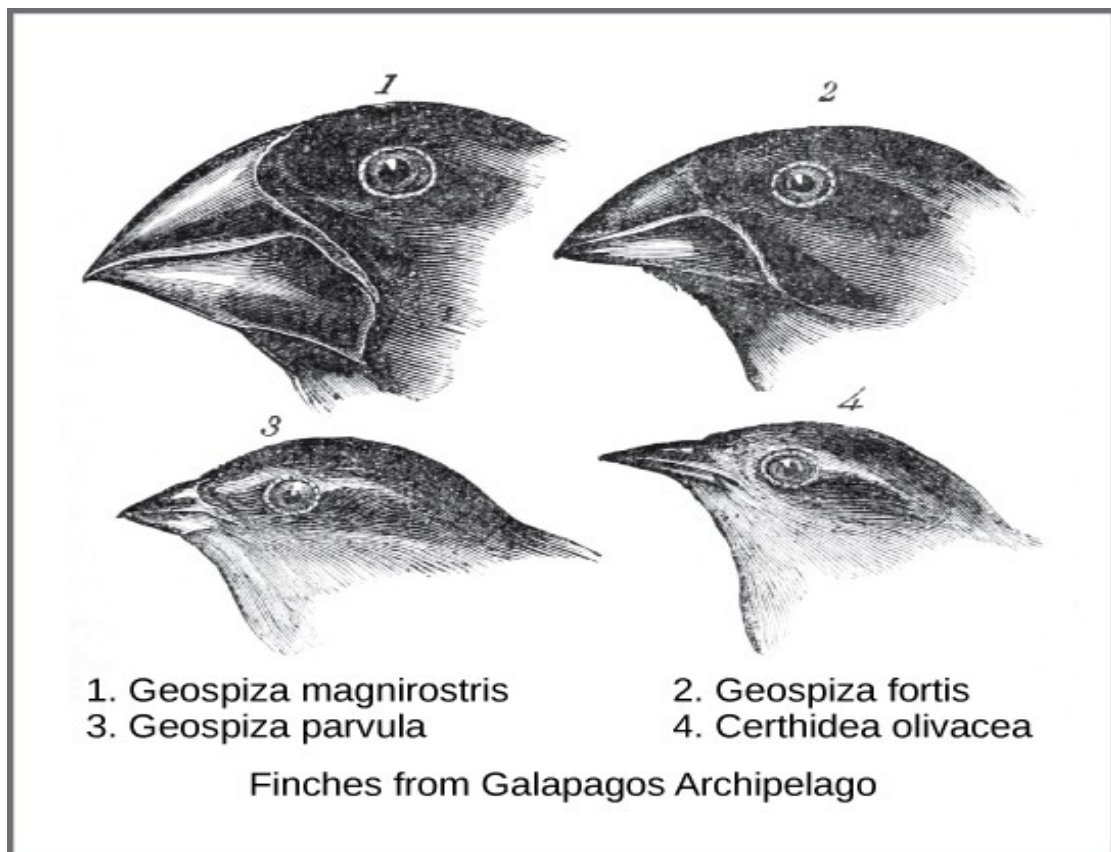
Why there is so much diversity and variety in nature? Charles Darwin has provided an answer to this question. When in 1831 Darwin was on the surveying ship Beagle, He observed dazzling wonders of nature.

Darwin claimed that he knew from the shape of the tortoise's shell, which island it had come from. If it had a rounded front, it came from a well-watered island where it fed on lush green plants whereas one from a drier island had a peak at the front, which enables it to reach higher vegetation.

## Giant Tortoises of the Galápagos Islands



Darwin also noticed interesting differences in the same kind of finches that he found in the Galapagos Islands. They were similar except for their beaks; you can also observe this from the following figure:



Those finches whose survival depends on insects have small beaks and the ones whose survival depends on nuts, they have heavy beaks. The small beak is to eat insects and the big heavy beak is to crack nuts.

From the above example of finches and tortoises, We can say that the variations between different species can happen due to the environment to which they are exposed. It can happen in a long time that one species with gradual changes has turned itself into a very different form and we might compel it to even categorize it as a different species.

Darwin called this idea of gradual change "Evolution by Natural Selection".

## • Conclusion:

Evolution by Natural Selection is the process by which nature selects the individuals that are best suited for a particular environment. Natural Selection is the reason for diversity and the fascinating variety of life on our planet Earth.

Natural Selection is responsible for small changes like the change in size, some minor characteristics or color, etc. The idea of these small changes is called “microevolution”. The term “macroevolution” which happens over the vast length of geological time is also attributed to Natural Selection that states small accumulated changes can create new species.

## C) Computational Model(for template matching or face recognition):

The following are the steps that we will follow to solve our template matching problem:

1)Representation: Images are represented in the form of matrices and these matrices are filled with the number and these numbers correspond to all the individual pixels of the image.

2)Initial Population: We will randomly select a pre-defined number of points from our search space or the bigger image. All of these represent the location of our potential solutions in the bigger image. In the next step, we will be checking how good or bad is each of these solutions.

3)Fitness Function: Our fitness function will take three inputs(Bigger Image, Smaller Image, and the Initial Population). It will give us the fitness value. This value will tell us how fit is our potential solution by comparing it with the smaller image. The value will range between 0 to 1. 1 means 100% match and 0 means 0% or no match etc.

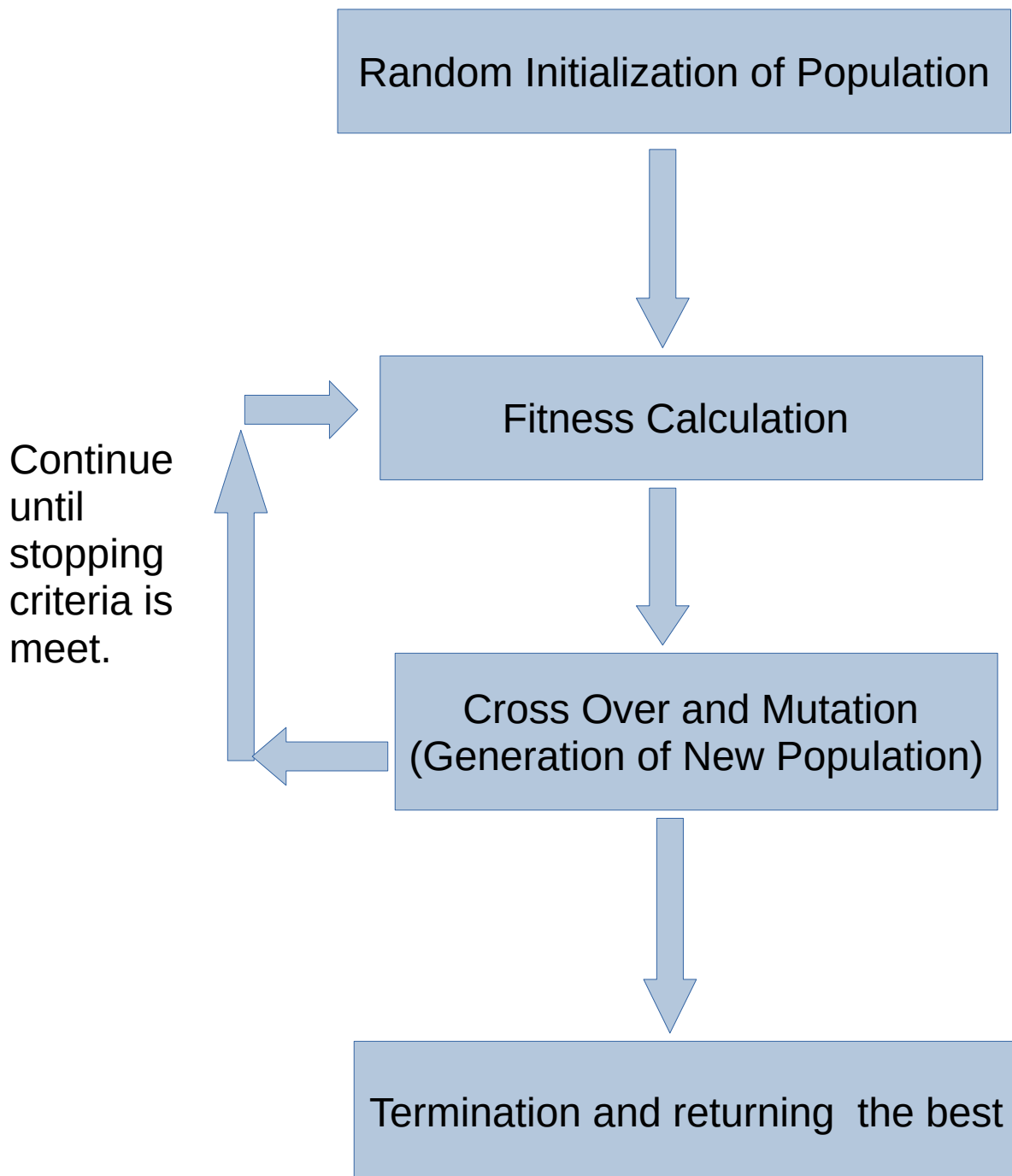
4)Sorting and Saving the Fittest Solution: We will sort our potential solutions based on their fitness value and save the fittest solution of the whole generation. Here we are artificially selecting the best fit and in the case of the theory of evolution, this was done naturally by Natural Selection.

5)CrossOver and Mutation: After saving the fittest solution from our sorted Array, We will cross the pairs in our population to create a new population. We will cross 1st solution and 2nd solution, then 2nd solution and 3rd solution,..., then lastly 2nd last solution with the last solution in our ranked population. Here a new population will be generated.

By doing CrossOver and Mutation our new population is actually being evolved from the older population. This same concept of evolution was given in our Evolutionary theory for living species.

6) After creating a new population, We will jump on Step 3 of fitness calculation and continue this process until a certain threshold is met. A threshold hold could be a matching percentage based on the output of fitness function or a particular number of generations.

The following figure represents the main stages of our Evolutionary Algorithm:



The above are the main stages of our Evolutionary Algorithm.

## D) Application

- **Problem**

We are supposed to solve an image processing or pattern recognition problem using our computational model. e.g, In our case, We are finding the location of a small image(Fig A) in the bigger image(Fig B). These images can be any other object or patterns like maps, tables, windows, and doors, etc.



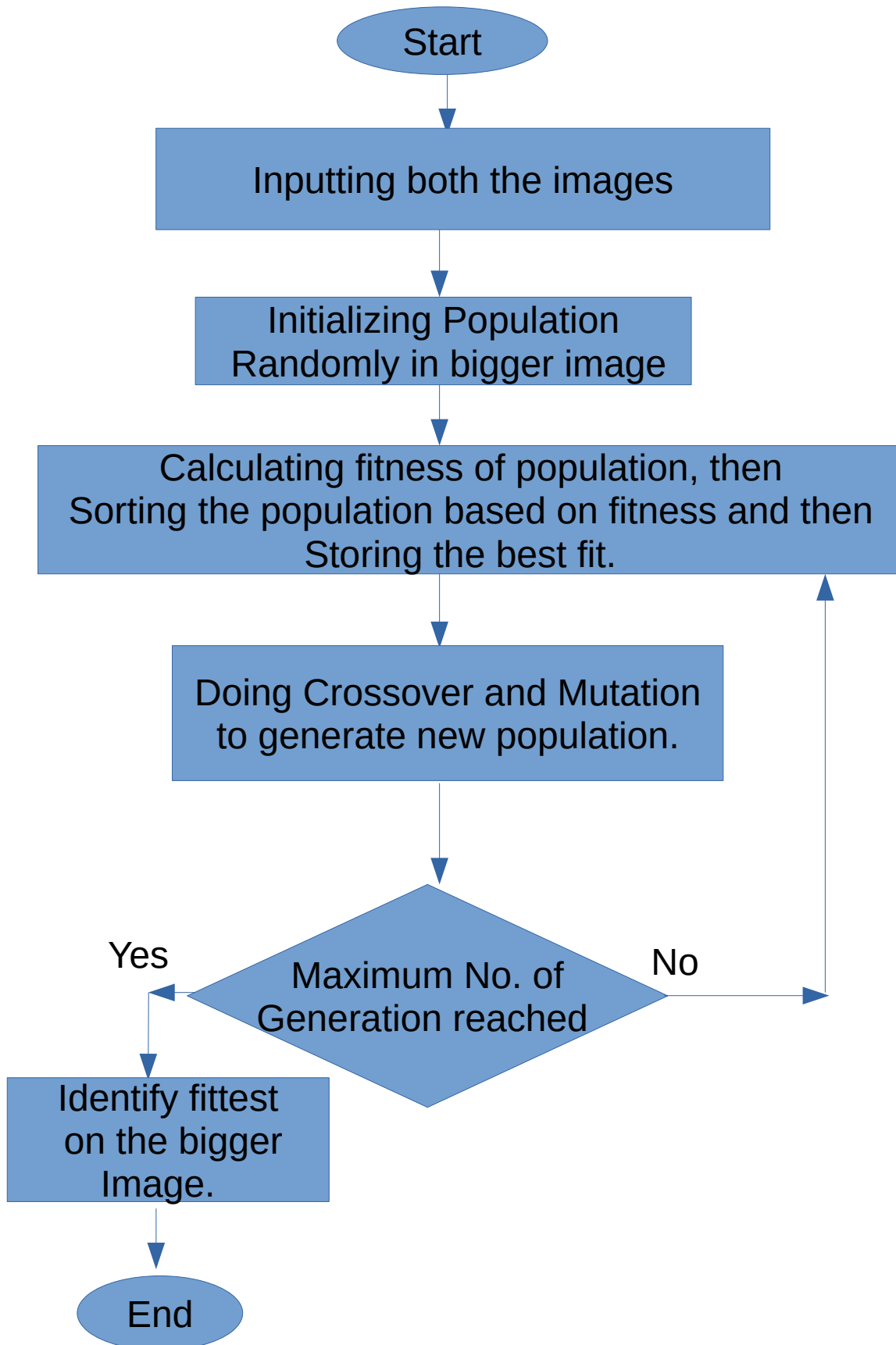
*Figure A*



*Figure B:*

- **Description**

We have added descriptive comments in our code that can be analyzed in the **code.py** file to have a better understanding of our code. The following flowchart concisely represents the overall flow of our code:



The above is the flowchart of our code to solve image recognition problem.