ISSN 2278-3091
Volume 8, No.3, May - June 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse67832019.pdf
https://doi.org/10.30534/ijatcse/2019/67832019

# A Study on How Evolution Simulator Utilizes the Windows Operating System to Demonstrate Artificial Intelligence Learning

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## ABSTRACT

This paper aims to discuss the integration of the following concepts: artificial intelligence, evolution, and algorithms to produce simulations, specifically with the program “Evolution Simulator”. Also including the application of the “Evolutionary Algorithm”, Artificial Neural Networks, and probability in executing a virtually accurate evolution simulator. The effect of a computation-heavy program on hardware will also be expounded on as this program relies almost only on the system’s CPU. To observe machine learning using the Windows operating system, the program “Evolution Simulator” is installed and executed. Tools from the program such as the joint, bones and muscle tools were utilized to create a model that would be used to run 100 generations with 25 population for 5 seconds each to reach the furthest distance. Results of the simulation show that within these trials, the program was able to learn the most efficient combinations of movement to reach the maximum distance. Hence, the program has demonstrated simple artificial intelligence learning using the Windows operating system.

**Key words :** Evolution simulator, Neural Networks, Computational Algorithm, Artificial Intelligence.

## 1. INTRODUCTION

With the vast amount of technology being made today, various discoveries in the sciences may be more visual than ever before. Various simulations are made left and right; can pass as games or an advanced educational tool for an innovative learning experience. This research paper will specifically tackle the power of mathematical functions as well as algorithms in bringing forth these simulators that visually represent some of the theories of science many have learned throughout their lives. The theory is the theory of evolution and how the concept of evolution was integrated into mathematical functions and numerical algorithms to simulate effectively evolution and mutation as well as how long evolution would take to create a creature that optimizes all of its limbs. The major concept behind the simulation of evolution is the machine learning concept. This is a branch of artificial intelligence where the machine will rely only on the data that is presented to it and the machine will analyze this data and determine patterns; the machine will then be able to make decisions solely upon the information it has learned, without human intervention [1]. With machine learning is integrating the concept of evolution. According to Darwin's theory of evolution by natural selection, everything on Earth is connected and thereby diversify due to mutated populations based on location and environments [2]. Integrating the two will mainly involve the capability of an operating system. With a proper code or algorithm, an operating system should be able to recognize how the program should work and thereby execute a proper evolution simulator. Hardware is also a factor in being able to run an evolution simulator. Without the proper hardware, no matter how precise the algorithm is in making an evolution simulator if the hardware cannot handle running such a computational program, the computer may freeze among other incidents.

## 2. BACKGROUND OF THE STUDY

The creator of the program "Evolution Simulator" created such a program for experimental purposes, he states in the Evolution itch.io page "please be aware that this is more of an experimental simulator that a real game" [3]. It can be said that Evolution can be a creative platform for users to create and evolve their own creatures. Keiwan further discusses the different components behind Evolution in his Frequently Asked Questions page. An "Evolutionary Algorithm" is used in the program [4]. This evolutionary algorithm is a type of machine learning algorithm with the concept of the biological evolution process integrated into it. It is stated that the "goal of machine learning algorithms, in general, is to find an optimal solution to some optimization problem. In the case of this simulator, the goal is given by the task that you have chosen for your creature (e.g. run as fast as possible) [4]. So from this quote, there are some mathematical concepts taken into a note for a body or creature to reach its most optimum state as they evolve. Adding to the algorithm is the neural networks of the program. A neural network is akin to the abstract structure of the brain's neurons, they are a series of interconnected nodes that are able to process data through some inputs and generated outputs. With these working through the process of evolution, the mutation is also part of the process. The mutation rate is basically the chances of difference in a generation that may or may not help a creature in attaining its optimum state. "Adding such a completely random factor into each generation can be enough to result in new solutions that are different enough from a local solution that they might be able to sway the population away from getting stuck in that local optimum" [4]. With mutation, multiple generations will have that one difference that would continue to be different until an evolved population is "stuck" in that mutated but optimized state. [5]

## 3. STATEMENT OF THE PROBLEM

This paper will explore the limits of the Windows Operating System as it manages and operates simulators that makes use of complex Machine Learning. It is known that the Windows Operating System is capable of executing multiple systems at the same time. Therefore, the research group will test and briefly describe the effects of an Artificial Intelligence Learning Software on a gaming laptop. The research group will also tackle the specifications on a laptop or a desktop in order for the simulator to run smoothly without making the computer overheat or slowing down the system's performance. This paper will also assess the system design of the program Evolution Simulator. The research group will check whether the simulator's design has the following factors: spatial imaging, application of the rough set theory, electronic sensors, logic scoring of preference, artificial neural network, database monitoring, and data transfer. The factors mentioned above may not be all the factors involved in a system design, but the research group will briefly describe how the mentioned factors are seen in the system.

## 4. SIGNIFICANCE OF THE STUDY

The main idea of the study is to learn how AI learns when performing a certain task. To do this, the group will be using Evolution Simulator, which is a program developed by Keiwan that demonstrates how a certain type of creature slowly learns how to function properly. The program does this by repeating a simulation of a creature attempting to do an activity repeatedly until it functions properly. The logic of the program basically describes the capabilities of AI to learn how to do an activity until it is near perfect or perfect in performing that activity. Using the program allows for a more graphical and interactive representation of AI learning that can be performed by the researchers. By AI learning, tasks in the future can be performed more concisely and more efficiently, which is important because of the way that technology is improving in the current times. Using it also allows for better systems in the devices that are used in the current times, which is why device manufacturers like Google use it in their devices today [6]. For this reason, the group believes that studying AI learning is important, as more and more technologies use it to improve the usage of their devices and to help in performing tasks that can be performed by the devices of today.

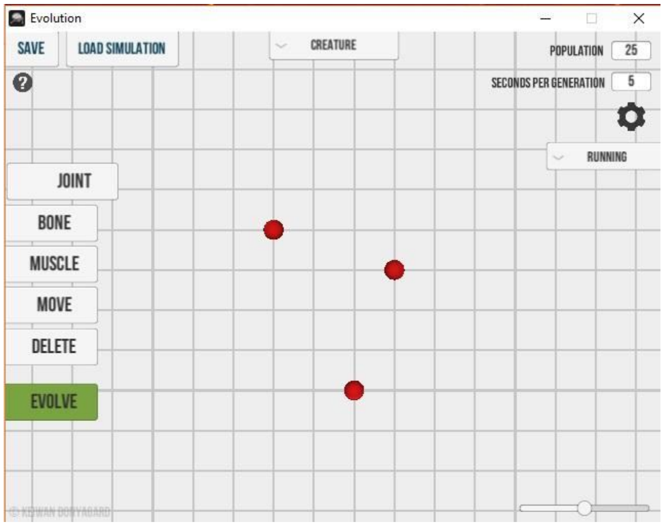
## 5. DESCRIPTION OF THE SYSTEM

The program is downloaded as a zip file containing all of its necessary resources from the website: https://keiwan.itch.io/evolution. Since the program is made in the Unity engine, most of these files are formatted and encrypted in the Unity language.

When the folder is extracted, 3 items will be present, a folder that contains the assets, an extension for the unity engine and lastly, the program that will run the simulator entitled "Evolulution.exe".

A startup menu will open when Evolution.exe has been selected. First, you will have to select the resolution in which the program will run as well as an option to run it on windowed mode. Next, you will have to select a graphics quality, fastest allows the program to run smoother but at a lower graphics while fantastic increases the graphics but reduces the performance. There is also an option to select which monitor the program would run on if there are more than 1 monitors in your computer. When configurations are set, the play button will open the program. Otherwise, the quit button will close the startup menu.

When the program runs, the main creation menu will appear. In this menu, various tools and sub menus are available to customize the simulator as well as a workspace to create the desired model for the simulator.



POPULATION 25

SECONDS PER GENERATION 5

**Figure 1:** Joint Tool

The first tool available is the joint tool. Using this, you are able to place points on the workspace. These joints are the pivot points of the model. This is the first to be placed and is necessary before the other elements are added.

The advance interface is in the top right corner of the interface. It can be observed that there are areas where numbers can be adjusted. These areas control the population number and the seconds that each generation will take. The population will determine the number of copies of the model the simulation will make at a given generation. The seconds per generation will determine the amount of time each generation will take. A generation refers to an instance where each model is tested by contracting and expanding each muscle, the best model of that generation will be carried on to the next and will be duplicated. Below that is the button for the advanced settings menu. Below the settings button is a drop down that will determine the type of test the simulation will run. Running will measure the furthest distance while jumping will measure the highest jump the model can do.

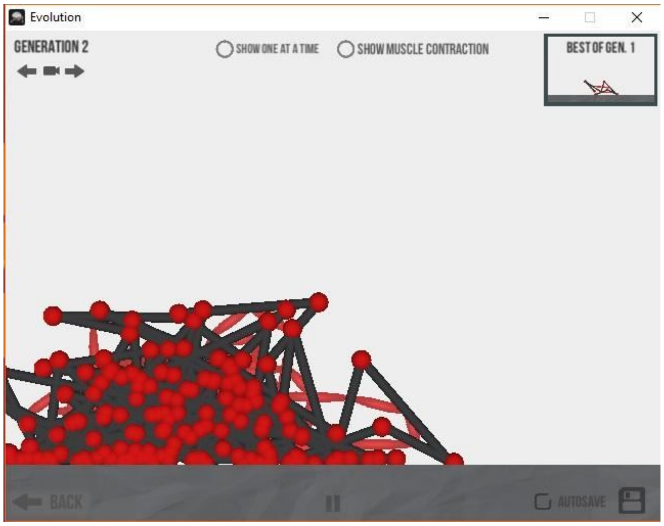


**Figure 2:** Beginning Simulation

When the model is complete and the modifiers are set, the evolve button will run the simulation. Default settings will put each instance of unit overlapping each other but not colliding as seen in Figure 2.

Buttons at the top of the interface will allow the user to view a single unit at a time. Users can switch from each unit by clicking on the directional arrows on the top left of the interface. The top right will also show the best unit from previous generations.

## 6. METHODOLOGY

The way in which the group plans to explore the capabilities of AI learning is by using Evolution Simulator. The research group chose to use this program because it essentially a program that utilizes AI learning in order to optimize a creature until it is able to perform a task such as running or jumping properly. The program does this by repeated simulations of a certain configurable amount of a creature performing a task as a certain amount of time goes on. For example, a simulation of 50 spiders walking can be performed. The time that each simulation goes on can be changed, and for each generation, one of the creatures will perform the task the best, which will be the basis for the next generation of creatures to perform the task. This is essentially a program or "game" that uses AI learning to show optimization in a more creative manner. To run the simulation, the group used the parameters of 25 populations per 100 generations per 5 seconds. Using these values, the group believes that the optimization of the creature is observable.

Parameters used by the group:

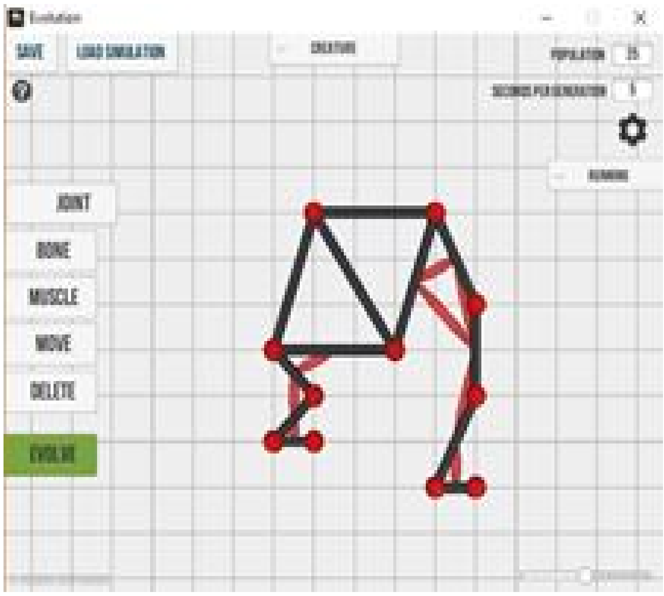
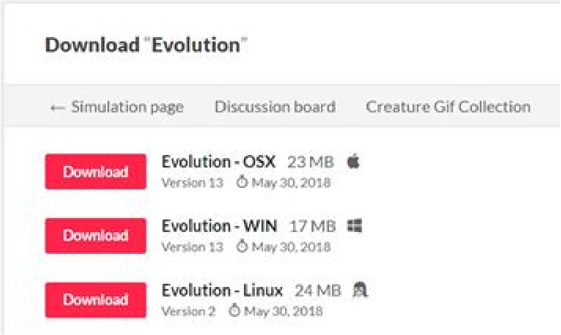


**Figure 3:** Parameters used by the group to gather data

To be able to use the program, the following steps have to be performed:

1. Download Evolution Simulator by Keiwan by going to https://keiwan.itch.io/evolution?download
2. Download the version appropriate to the OS in use.



Download "Evolution"

← Simulation page Discussion board Creature Gif Collection

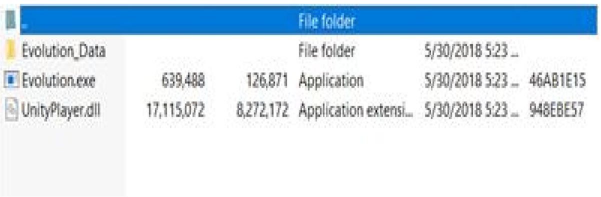
Download Evolution - OSX 23 MB
Version 13 May 30, 2018

Download Evolution - WIN 17 MB
Version 13 May 30, 2018

Download Evolution - Linux 24 MB
Version 2 May 30, 2018

**Figure 4:** OS options to download Evolution Simulator

3. After installing, open the .zip file and extract the files inside the .zip file.



| | | | | | |
|---|---|---|---|---|---|
| .. | | | File folder | | |
| Evolution_Data | | | File folder | 5/30/2018 5:23 ... | |
| Evolution.exe | 639,488 | 126,871 | Application | 5/30/2018 5:23 ... | 46AB1E15 |
| UnityPlayer.dll | 17,115,072 | 8,272,172 | Application extensi... | 5/30/2018 5:23 ... | 948EBE57 |

**Figure 5:** Files in .zip file

4. After extracting the files, run Evolution.exe. When it is run, the program will display a configuration

screen for the resolution and graphics quality that it will be running. Select the appropriate settings (appropriate settings are to run the program with graphics quality set to fastest, as the program uses a lot of resources) and run the program.

5. The screen of the program is where you are to configure the amount the population (number of creatures), the amount of time in which it will run the simulation again, the creature creation/selection, and the task that the creatures will perform.
6. When the settings that the user is happy with are reached, run the simulation by clicking the evolve button.
7. When the simulation has been launched, the user just has to observe as the AI learns how to perform the task by optimization.

## 7. REVIEW OF RELATED LITERATURE

### 7.1. Evolution

According to Wang, Hou, Chen, and Liu [7], evolution is defined to be an effective way to achieve the best or optimum performance. As seen in nature, the evolution of life is what keeps life alive [8]. For instance, the survival of a certain species depends whether they can be seen by their predators or not [9] . Those who are easily spotted will be preyed upon first. However, those that camouflage into the surroundings are hidden from their predators, allowing them to reproduce and prevent its species from extinction. Another instance is when the predators form or remove certain parts of their body so that it will help them hunt for their prey. Despite this, [7] continues that evolution is time-consuming and it is not efficient. This is because there are not enough mutations that can determine which traits are the ones that will, in their case, help the Bacillus subtilis survive.

Zhong and Liu [10] also agrees that evolution can be studied to determine the principles of adaptation. By adapting to the environment, better versions of the species gets produced. However, traditional method of evolution does not produce so much information to study on. Therefore, they have suggested that extensive replication will allow evolution to continue continuously.

This concept is important for this study since the system the research group will study is about evolution. The evolution simulator will essentially create multiple organisms and it will copy the organism that has progressed the furthest in the simulation.

### 7.2. Simulation

Simulations are processing that models or imitates a given situation. Machine learning is used to simulate the given situations. Today, simulations are not only used in the gaming industry but in education, in medicine, in mental health, in medical training, in translation, in electronics, as well as traffic safety [11-14]. Simulations each have their own benefits and drawbacks, depending on where it is used. Nevertheless, simulators can be very easy to use and it is helpful in evaluating data it produces [15].

For instance, in nursing education, experience in clinical skills is an important part in nursing education [16]. However, there are only limited opportunities to engage in these areas, more so for specialty areas. For instance, Verkuyl, Lapum, St-Amant, Hughes, Romanium, and Mastrilli [17] developed virtual gaming simulations to allow educators to enhance learning experiences through this creative medium.

Simulations are also used to simulate traffic control and car crashes. A paper by Astarita and Giofre suggests simulating and consider driver errors while simulating traffic crashes [18]. They mentioned that to introduce human error into the simulations, it will give the researchers and engineers an evaluation on what should be adjusted to give way to the simulated traffic crashes caused by human error. The information gathered and studied will be very large. However, they mention that this method is feasible and may help in evaluating traffic safety.

Simulations are important in this study because the system to be studied by the student is a simulator. Again, the evolution simulator will simulate the evolution of organisms in a period of time. However, instead of testing the evolution in real time, the simulator is used to mimic the organism’s learning capabilities in a few seconds.

### 7.3. Artificial Intelligence

In recent years, computers are able to perform tasks that humans were only capable of. This capability is termed to be Artificial Intelligence. This allows computers to, and not limited to, process visual information, recognize speech, think on its own, translate languages, and many more. In addition to that, its capabilities keep expanding and artificial intelligence is seen in many fields of study and social movements [19]. It can either help humans understand data or it is directly used by humans to understand something. Though there are some ethical issues when Artificial Intelligence is used in the medical field [20], artificial intelligence is still playing a big role in the improvement of the society, such as the economy [21].

According to Allam and Dhunny [22], humans are developing and turning towards technologies that are related to the study of society, ecology, and many others. To assess and study the data gathered, artificial intelligence is used to do so. This creates great sustainability to humans. However, the current system of using AI is not sustainable for the computers that run it. Therefore, Allam and Dhunny has suggested a new framework to be used so that the AI technology is efficient while being beneficial to the human culture, metabolism, and governance.

In the medical aspect, artificial intelligence was used starting from the mid-1900's. It was first used to assess and cover topics on medicine only. As time progressed, it was mainly used for assessing the risk of disease and the chances for its treatment, managing possible complications, ensuring patient care, and creating data for treatment research [23]. Becker continues that artificial intelligence does have its own advantages and drawbacks, though Becker emphasizes the preparations made so that AI can be made useful in this field.

The concept of artificial intelligence is important in this study because the program that the research group will study continuously learns and copies the organism that travels the furthest. The system must be able to determine the concept of travelling the furthest, given a set of organisms. Moreover, the system should be able to know how to replicate the best organism in a given set. Moreover, if humans were to manually replicate this system, it would be very taxing ang impractical.

## 8. THEORETICAL CONSIDERATIONS

### 8.1. Spatial Imaging

The interface of the program utilizes spatial imaging to allow the user to understand the different components present in the programs various menus. There are certain guidelines that need to be followed for the user to understand the elements on the interface [24]. An example would show an empty space in the middle of the interface to signify that that area is a workspace. The simulation also gives the user an understanding on the program's directions. A constant acceleration of elements towards the bottom part of the interface gives the user an idea that there is gravity pulling the figure towards the bottom which would mean the floor is towards that direction [25].

### 8.2. Rough Set Theory (For optimization technique)

The program utilizes the rough set theory when determining which figure is chosen at a given generation to be transferred to the next by taking the variable's upper and lower limit [26, 27,28]. The figure with the furthest distance travelled is rounded up to be the upper limit of each generation and will be used as a variable to the next generation while the rest are counted as lower limits and will not be used for the next generations [29, 30, 31].

### 8.3. Electronic Sensors

Most notable electronic sensors used in this program are the inputs of the mouse buttons, more specifically the left click. Moving the mouse around allows the cursor to travel around the interface and cover the element in which the user desires to choose. The selection is then confirmed using the left click of the mouse. This is observable throughout the entire process such as the creation of the model as well as the options available. Another sensor used is the keyboard. Keys are pushed and send signals to the computer to enter symbols or values [32]. This is more evident when names are being entered in the saving of creations as well as input values for the time and number of populations per generation [33].

### 8.4. Logic Scoring of Preference

The logic scoring of the program is based on what type of test the user is using. A running test would use the distance traveled by the model as a reference to which is a winner or loser. A jumping test, on the other hand, would measure the model based on its vertical movement. These preferences are the basis of the win condition of each model. The highest or the furthest will be recorded as the winner while the rest are recorded as a loser [34]. This win-lose condition is comparable to binary when decision making, winners are flagged with 1 while the losers are flagged with 0 [35].

### 8.5. Artificial Neural Network

A simple artificial neural network is demonstrated by the program itself [36]. It simulates artificial intelligence learning with the use of simple movement mechanisms to be able to reach greater distances more efficiently [37]. It uses trial and error to test the possible outcomes of each movement and improves upon whether the movement was beneficial or detrimental to the overall performance. This neural network is the program's ability to run procedures in parallel with each other [38].

### 8.6. Database Monitoring

Database monitoring is utilized mostly when it comes to saving creations and simulations [39]. The user is capable of label and records the instances in the program as well as move the data files around the folders of the system much like a database system [40]. It is also seen when the best of each generation is saved and is played back in a monitor during the simulation. Each of these allows the user to view stored data and algorithms within the program [41].

### 8.7. Data / Information Transfer

When the user creates a model, that data is transferred to the simulation. All the information involving the joints, muscles, and bones are placed from the workspace to the simulation aspect of the program. No measurements or connections are altered when this transfer occurs. Information is also transferred from one generation to another. All the algorithms used from the best model will be used as a template for the next set of population. Information such as the files of the program may also be transferred between systems [42]

## 9. DATA AND RESULTS

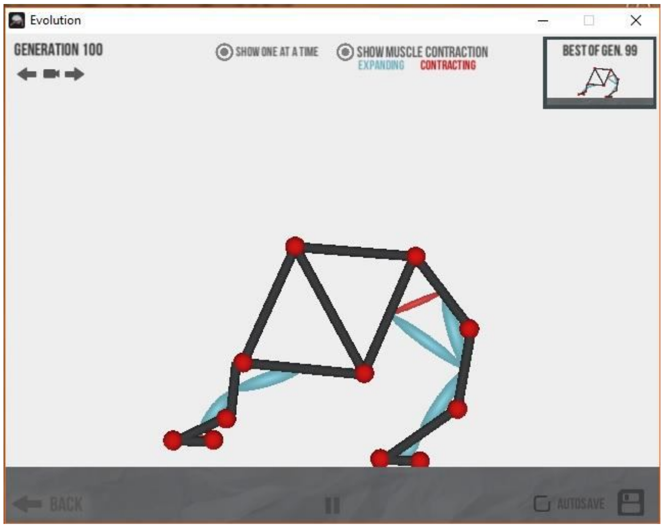


**Figure 6:** 100 Generation Result

After 100 generations, the model is able to travel a distance much further than the first generation. The model utilizes the muscles to contract and expand to move the legs. Each leg moves alternately to propel the figure forward. This is a result of 100 generations with 25 population each. a total of 2500 units.

## 10. ANALYSIS OF DATA

Comparing the results of the simulation after 100 generations in contrast with the first generation, it can observe that the latest figure has improved in terms of distance traveled. As each generation passes, the program was able to learn how to use the contraction and expansion of each muscle to move the bones and joints which allows the figure to move forward. Each muscle moves simultaneously to utilize the designs limbs to propel the figure forward. The movement of the model can be compared to the movement of a frog which leaps forward which would suggest that this is the most efficient way of movement determined by the algorithms present in the coding of the program.

The simulator proves how machines are capable of learning through trial and error. Each generation takes the best instance and duplicates it for the next generation. Each instance will be slightly tweaked, and the same process will be repeated. It is possible that these slight tweaks do not benefit the model and will not be carried on to the next generation.

As the options of the program suggest, many variables will affect the rate in which the model learns to travel a longer distance more efficiently. One variable may be the model that was built. No matter how much artificial intelligence learns, it is only limited to the movements of the model. An example would be if no muscles were added, the model will never be able to move without a force to push the bones and joints. Another possible variable is the number of population at a given instance. It is possible to increase the number of populations per generation. This would increase the efficiency of the program to learn since it has more trials. However, increasing the population will cost the performance of the computer since more equations will have to run simultaneously. Likewise, the number of generations will also limit the amount of learning the program will do.

## 11. CONCLUSION

The program is effective in simulating a wide variety of creatures a user may make. The algorithms used to make the program executes the evolution concept of the program excellently. The way the creator of this program constructed the syntax is highly mathematical to be able to execute or simulate evolution of a certain species scientifically accurate. Functions of the program that contributed to this were, as the creator stated, the "Evolutionary Algorithm", "Artificial Neural Network", and the consideration of mutation (which naturally occurs in the evolution of creatures on the Earth). Although the program has essentially been able to simulate the evolution process through optimization, as well as being able to manipulate the mutation rate per generation of evolving, each setting in this program also has an equivalent impact on a user's hardware. The creator of the program "Evolution", Keiwan, [4] states that the program needs "computational power" to run without the program lagging or slowing down significantly. Incidentally, running the program on a laptop with a CPU of i7 6500u caused the hardware to increase its temperature after reaching over one hundred generations. It has also been stated by the creator that the program will run "almost exclusively on the CPU" [4]. In the creator's website, they tested the compatibility of their program on different operating systems and different iterations or versions of that operating system; namely Windows, Mac, Linux, as well as iOS and Android for Mobile, meaning the program is not limited to just personal computers or laptops. The program was stated to be able to run on one gigabyte of RAM but more is recommended by the creator for longer periods of simulation. But even though one has great specifications to run the program there have been incidents wherein the mobile application crashes. The Linux build of this program is also very limited and lacks some support and features according to the creator [4].

## 12. RECOMMENDATIONS

The group recommends that the user who plans to explore more about using Evolution Simulator to observe AI learning should do so while considering the following:

- The program uses a lot of resources (CPU, memory, etc.).
- The program should not be run with the best quality graphics setting because it may cause the PC being used to be too warm for safe operation.
- The user should select the appropriate settings for his PC.

By following the above recommendations, the user should be able to run Evolution Simulator and observe how optimization works for solving a problem and not run into any hardware or software issues. Using the wrong settings to run the program may cause some issues to occur, such as thermal throttling (CPU running slowly in order to protect itself from running too hot) and other issues involving temperature. This is because of the way that PC components work. These components have to run with a safe temperature because they are made to work the best within a temperature of about 45 -50 degrees Celsius. If they exceed that, they will attempt to run slowly in order to cool itself down until it reaches that temperature window. The user can allow the components to run properly without reaching extremely high temperatures by setting the program up to run with a less resource intensive setup. This will allow for better user experience and protect the components of the user's PC from running at an unsafe operating window. The user can also learn about how temperature affects the components that are inside a PC and to setup other resource-intensive programs properly. Using the correct components also allows for better user experience for observing how AI learning and optimization work while solving problems or performing tasks assigned by users.

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