# Background

To start reading into the area of evolution simulation we first looked at the biology behind the process. This was followed by a look at the area of Artificial Life and followed by looking at other examples of how these ideas have been implemented.

## Biology

Biologically the process of evolution is both simple and overwhelmingly complex.

Simply, environmental selection pressures favour certain characteristics in organisms. The organisms with favourable adaptations for a particular environment have a higher chance of mating to produce offspring, passing on their DNA and their favourable features to the next generation. Organisms with unfavourable adaptations are less likely to survive and therefore not pass on their genes to the next generation, shaping a particular species to have better characteristics to survive their environment.

Though the process has more factors and complexity than described above, simplifying evolution to base elements such as these allow it to be modelled by a computer and, as in Conway’s game of life, be used to explore evolution and how the process works.

## Artificial life

Artificial life is the field of study focusing on modelling natural life and its processes though computerised systems in order to gain an insight into the workings of evolution, adaptation, and other natural systems. Artificial life often deals with using genetic crossover algorithms to model how random changes in a DNA base will affect gene production and mutate an organism to develop an adaptation. (https://www.britannica.com/technology/artificial-life).

## Game of life

One such example of an evolution simulation is Conway's Game of Life. Created in 1970 by John Conway, the simulation takes place on an infinitely sized grid where each cell is either live or dead. It progresses according to a set of simple rules \cite{guardian}:

\begin{itemize}

\item A live cell with less than two live neighbours becomes dead

\item A live cell with more than four live neighbours becomes dead

\item A dead cell with three live neighbours becomes alive

\end{itemize}

Conway's Game of Life is often praised for its ability to show how simple rules can spawn complex evolutionary patterns \cite{callahan}. This project will tackle evolution simulating by taking inspiration from Conway's Game of Life to produce a piece of software it terms an ``evolution sandbox``; a simulation with emphasis on real-time manipulation and customization which will allow the user to observe the outcome of their actions on the ecosystem.

TESTING TABLE

\begin{table}[]

\begin{tabular}{llllll}

& MOSCOW ANALYSIS & Testing notes & & & \\

Must & & & & & \\

& \begin{tabular}[c]{@{}l@{}}Organism\\ life cycle\end{tabular} & \begin{tabular}[c]{@{}l@{}}Organisms are created at first by the user. After that they need food\\ to survive and die if their hunger reaches 0. Once the organism reaches its\\ maximum age it dies.\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}Genetic\\ crossover algorithm\end{tabular} & \begin{tabular}[c]{@{}l@{}}They can mate producing an offspring of the same species and their\\ individual attributes appear to crossover to produce the offspring\\ attributes.\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}Organism\\ attributes\end{tabular} & & & & \\

& \begin{tabular}[c]{@{}l@{}}Live\\ edit of organisms\end{tabular} & \begin{tabular}[c]{@{}l@{}}This is possible and editing the organisms results in them being\\ affected while on screen. For instance, setting hunger to 0 slowly kills the\\ organism and setting the speed increases the organisms moving speed around\\ the map.\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}Simple\\ 2D graphics\end{tabular} & \begin{tabular}[c]{@{}l@{}}The graphics are good quality with 2D particle effects when food or\\ an organism is placed into the world. The organisms do not overlap and occupy\\ the same grid tile and when they die their sprite is replaced with meat.\end{tabular} & & & \\

& Herbivores and natural food sources & \begin{tabular}[c]{@{}l@{}}Plant material can be added to the map and organisms will consume it,\\ increasing their own hunger and removing the plant from the world.\\ \\ When organisms die they\\ are turned into a meat source which other organisms can eat.\end{tabular} & & & \\

Should & & & & & \\

& \begin{tabular}[c]{@{}l@{}}Weather/disease\\ system\end{tabular} & \begin{tabular}[c]{@{}l@{}}If the environment becomes too cold or hot, some organisms will start\\ to die from the environment and if the temperature does not change then this\\ can kill many the organisms on the map.\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}Advanced\\ path finding algorithm\end{tabular} & \begin{tabular}[c]{@{}l@{}}During testing and observance, when searching for food or a mate the\\ organisms will avoid paths with take them over mountains or water. They will\\ also avoid moving to the same tile as other organisms.\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}Terrain\\ variation, e.g. grass, mountains, water\end{tabular} & & & & \\

& \begin{tabular}[c]{@{}l@{}}Ability\\ to pause, speed up and slow down simulation\end{tabular} & Implemented and seems to work. & & & \\

Could & & & & & \\

& \begin{tabular}[c]{@{}l@{}}Natural\\ disasters\end{tabular} & \begin{tabular}[c]{@{}l@{}}Not\\ implemented\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}Speciation\\ (new species forming from heavily mutated organisms over time)\end{tabular} & \begin{tabular}[c]{@{}l@{}}The species do change\\ over time and form new organisms through reproduction. However, there is no\\ clustering of organisms to make set populations around the map.\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}A game\\ log with charts and text output\end{tabular} & \begin{tabular}[c]{@{}l@{}}Not\\ implemented\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}Sprite\\ sheet animation\end{tabular} & \begin{tabular}[c]{@{}l@{}}Not\\ implemented\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}Particle\\ effects, e.g. weather effects, running water, blood\end{tabular} & \begin{tabular}[c]{@{}l@{}}There\\ is blood\end{tabular} & & & \\

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& \begin{tabular}[c]{@{}l@{}}3D\\ graphics\end{tabular} & \begin{tabular}[c]{@{}l@{}}Not\\ implemented\end{tabular} & & & \\

& \begin{tabular}[c]{@{}l@{}}Scale\\ realism\end{tabular} & \begin{tabular}[c]{@{}l@{}}Not\\ implemented\end{tabular} & & &

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