# Applying the Genetic Algorithm for Neural Network Architecture Selection and Comparing with Standard MLP

## Introduction

This project aims to explore the effectiveness of the genetic algorithm in selecting an optimal neural network architecture. Specifically, the project focuses on constructing a neural network architecture with a flexible structure: an input layer, up to three hidden layers, and an output layer. The architecture selection process includes choosing appropriate activation functions for the hidden and output layers, utilizing Mean Squared Error (MSE) as the loss function, and training the network using the backpropagation algorithm over 50 epochs initially. Additionally, a standard multilayer perceptron (MLP) will be defined and trained, and its performance will be compared with the architecture derived from the genetic algorithm.

## Objectives

Implement the Genetic Algorithm: Apply the genetic algorithm to select the architecture of a neural network, including the number of hidden layers (up to a maximum of 3) and the choice of activation functions.

Construct the Neural Network: Build the selected neural network architecture with the chosen activation functions.

Train the Network: Train the neural network using backpropagation and MSE as the criterion function over 50 epochs during the genetic algorithm process.

Define and Train a Standard MLP: Create a standard MLP with a comparable structure, train it using the same dataset and parameters.

Compare Results: Evaluate the performance of both networks by comparing their outputs to the real target values and visually compare the learned functions with the actual function.

## Methodology

### Genetic Algorithm Implementation:

* The genetic algorithm will be used to determine the specific architecture of the neural network, including the number of neurons in each hidden layer and the activation functions for the hidden and output layers.
* Common activation functions like ReLU, Sigmoid, and Tanh will be considered.

### Neural Network Construction:

* Based on the architecture suggested by the genetic algorithm, a neural network will be constructed.
* This network will consist of an input layer, up to three hidden layers, and an output layer.

### Training Process:

* The network will be trained using the backpropagation algorithm.
* MSE will be used as the loss function to evaluate the performance during training.
* During the genetic algorithm process, each neural network will be trained over 50 epochs to ensure adequate learning.
* Once the genetic algorithm identifies the best architecture, this neural network will be trained for as long as needed to achieve optimal performance.

### Standard MLP Definition:

* A standard MLP with a similar structure will be defined for comparison.
* The standard MLP will also be trained using backpropagation and MSE, with extended training duration as needed to achieve optimal performance.

### Performance Evaluation:

* The performance of both networks will be evaluated by comparing their outputs with the real target values.
* Metrics such as MSE will be used to assess and compare the effectiveness of the two architectures.
* A graphical comparison will be conducted by plotting the learned functions of both MLPs against the actual function used to generate the dataset.

## Expected Outcomes

Architecture Comparison: Insights into how the genetic algorithm impacts the architecture and performance of a neural network compared to a manually defined MLP.

Performance Metrics: Detailed analysis of MSE for both networks, providing a clear comparison of their effectiveness.

Graphical Comparison: Visual comparison of the functions learned by both networks against the actual function.

Practical Implications: Understanding the practical benefits of using the genetic algorithm for neural network design in real-world applications.

## Conclusion

The project will demonstrate the utility of the genetic algorithm in selecting neural network architectures and its impact on performance. By comparing it with a standard MLP, the project aims to provide valuable insights into the effectiveness of automated architecture selection algorithms in machine learning. This structured approach will highlight both the theoretical aspects and practical implications of using a genetic algorithm for neural network design and performance optimization.