PRACTICAL NO. 02

Aim :

Placement train prediction and visual analytics for engineering college.

Theory :

This project presents a system for analyzing and predicting placement trends in engineering colleges using deep learning techniques. The system takes raw placement data, visualizes the historical trends, and enables predictive analytics to forecast future placements based on past records. The underlying model is built using a feed-forward neural network, which learns patterns from years of placement data to generate future predictions. A graphical interface makes it easy for users to interact with the system and interpret results via bar graphs.

Working Principle :

- Machine Learning Model : Multi-Layer Perceptron (MLP) Neural Network
  The code implements a 3-layer feedforward neural network (also called Multi-Layer Perceptron) with the following architecture :

- Network Architecture : Input Layer (3 neurons) → Hidden Layer 1 (10 neurons) → Hidden Layer 2 (5 neurons) → Output Layer (1 neuron)

- Model Parameters : Input Features (3 parameters)
  - Normalized Year → (current_year - first_year) / 10.0 - Represents the temporal position.
  - Normalized Current Count → current_placement_count / max_count - Current year's placement numbers.
  - Normalized Trend → (current_count - previous_count) / max_count - Rate of change from previous year.
- Network Layers :
  - Input Size → 3 neurons
  - Hidden Layer 1 → 10 neurons (with ReLU activation)
  - Hidden Layer 2 → 5 neurons (with ReLU activation)
  - Output Layer → 1 neuron (with Sigmoid activation)

- Activation Functions :
  ReLU (Rectified Linear Unit) : Used in hidden layers

```
relu(x) = max(0, x)
```

- Sigmoid : Used in output layer to bound predictions between 0 and 1

```
sigmoid(x) = 1 / (1 + e^(-x))
```

- Training Parameters :
  - Learning Rate : 0.1
  - Epochs : 1000 iterations
  - Loss Function : Mean Squared Error (MSE)
  - Optimization : Gradient Descent with Backpropagation

- Weight Initialization :

```
scale = sqrt(2.0 / number_of_inputs)
weight = random_gaussian * scale
```

Program Code :

```
import java.awt.*;
import java.io.*;
import java.util.*;
import java.util.List;
import javax.swing.*;

public class PlacementTrendAnalyzer
extends JFrame {
    private JPanel mainPanel;
    private CardLayout cardLayout;
    private GraphPanel graphPanel;
    private JPanel endScreen;

    public PlacementTrendAnalyzer()
{
           setTitle("Placement  Bar
Graph with Deep Learning");
        setSize(800, 600);
         setDefaultCloseOperation(J
Frame.EXIT_ON_CLOSE);
         setLocationRelativeTo(null
);
        // Use CardLayout to switch
between screens
                cardLayout   =   new
CardLayout();
                 mainPanel   =   new
JPanel(cardLayout);

        // Create starting screen
             JPanel  startScreen  =
createStartScreen();
         mainPanel.add(startScreen,
"START");

         // Create end screen (will
be updated later)
        endScreen = new JPanel();
           mainPanel.add(endScreen,
"END");

        add(mainPanel);
```

```
            // Show start screen
initially
         cardLayout.show(mainPanel,
"START");
    }

    void parseCSV(File file) {
        yearCountMap.clear();

       try (BufferedReader br = new
BufferedReader(new
FileReader(file))) {
                    String line =
br.readLine(); // Skip header
                   while ((line =
br.readLine()) != null) {
                  String[] tokens =
line.split(",");
                  if (tokens.length
>= 2) {
                      String year =
tokens[1].trim();
                     yearCountMap.p
ut(year,
yearCountMap.getOrDefault(year, 0)
+ 1);
                }
            }
        } catch (IOException e) {
             JOptionPane.showMessag
eDialog(this, "Error reading file:
" + e.getMessage());
        }

       if (!yearCountMap.isEmpty())
{
           List<String> yearList =
new
ArrayList<>(yearCountMap.keySet())
;
            Collections.sort(yearL
ist);
                          years =
yearList.toArray(new String[0]);
             placedStudents = new
int[years.length];
             for (int i = 0; i <
years.length; i++) {
               placedStudents[i] =
yearCountMap.get(years[i]);
            }
        }
    }

    void trainNeuralNetwork() {
        if (placedStudents.length <
3) {
            JOptionPane.showMessag
eDialog(this, "Need at least 3 years
of data to train!");
            return;
        }
          // Initialize and train
neural network
             neuralNetwork = new
NeuralNetwork(3, 10, 5, 1);
        neuralNetwork.train(inputs,
outputs, 1000, 0.1);
    }

                            boolean
showYearWithDLPrediction(String
inputYear) {
        if (neuralNetwork == null)
{
            return false;
        }

        isDLPrediction = true;
        int inputYearNum;
        try {
                     inputYearNum =
Integer.parseInt(inputYear);
                         } catch
(NumberFormatException e) {
            return false;
        }
```

```
                                if (yearCountMap.containsKey(inputYear)) {
                highlightedYear = inputYear;
             predictedPercentage = null;
                highlightedCount = yearCountMap.get(inputYear);
            repaint();
            return true;
        }

        if (years.length == 0)
            return false;

             int lastKnownYear = Integer.parseInt(years[years.length - 1]);
             if (inputYearNum <= lastKnownYear)
            return false;

         // Use neural network for prediction
              double maxCount = Arrays.stream(placedStudents).max().orElse(1);

            double[] input = new double[3];
             input[0] = (double) (inputYearNum - Integer.parseInt(years[0])) / 10.0;
                    input[1] = placedStudents[placedStudents.length - 1] / maxCount;
                    input[2] = (placedStudents[placedStudents.length - 1] - placedStudents[placedStudents.length - 2]) / maxCount;

            double[] prediction = neuralNetwork.predict(input);
         int predictedCount = (int) (prediction[0] * maxCount);

        if (predictedCount < 0)
            predictedCount = 0;

             int lastYearCount = placedStudents[placedStudents.length - 1];
        if (lastYearCount != 0) {
             double rawPercentage = ((double) (predictedCount - lastYearCount) / lastYearCount) * 100;
           if (rawPercentage > 100)
               rawPercentage = 100;
            else if (rawPercentage < -100)
                rawPercentage = -100;
             predictedPercentage = rawPercentage;
        } else {
             predictedPercentage = null;
        }

       highlightedYear = inputYear;
              highlightedCount = predictedCount;

        repaint();
        return true;
    }

    boolean hasData() {
                                return !yearCountMap.isEmpty();
    }

    @Override
             protected void paintComponent(Graphics g) {
        super.paintComponent(g);
```

```
        Graphics2D g2 = (Graphics2D) g;
        int width = getWidth();
        int height = getHeight();
        int padding = 50;

        if (placedStudents == null || placedStudents.length == 0) {
            Font headingFont = new Font("SansSerif", Font.BOLD, 16);
            g2.setFont(headingFont);
            g2.setColor(Color.BLACK);
            String heading = "Placement trend prediction with Deep Learning for engineering college";
            g2.drawString(heading, 20, 40);

            Font normalFont = new Font("SansSerif", Font.PLAIN, 12);
            Font boldFont = new Font("SansSerif", Font.BOLD, 12);

            String[] lines = {
                    "This application uses deep learning to analyze placement data and predict future trends.",
                    "",
                    "Step To Use This Application :",
                    "1. Click 'Upload CSV' button.",
                    "2. Select your CSV file with 'Name,Year' data.",
                    "3. Click 'Train Model' to train the neural network.",
                    "4. Enter a year and click 'DL Prediction' for deep learning based prediction.",
                    "5. The graph shows prediction percentage for upcoming years.",
                    "",
                    "Created By",
                    "Rohan Ingle"
            };

            int x = 20;
            int y = 60;
            int lineHeight = g2.getFontMetrics().getHeight();

            for (String line : lines) {
                if (line.equals("Step To Use This Application :") || line.equals("Created By")) {
                    g2.setFont(boldFont);
                } else {
                    g2.setFont(normalFont);
                }
                g2.drawString(line, x, y);
                y += lineHeight;
            }
            return;
        }

        // Draw the graph when data is loaded
        g2.setColor(Color.BLACK);
        g2.drawLine(padding, padding, padding, height - padding);
        g2.drawLine(padding, height - padding, width - padding, height - padding);
            for (int i = 0; i < placedStudents.length; i++) {
                int x = padding + i * (barWidth + 10) + 5;
```

```
                int barHeight =
placedStudents[i] * (height - 2 *
padding) / maxValue;
           int y = height - padding
- barHeight;

          g2.setColor(Color.BLUE);
                g2.fillRect(x, y,
barWidth, barHeight);

            g2.setColor(Color.BLAC
K);
           g2.drawString(years[i],
x, height - padding + 15);
        }
            // Add DL indicator
               if (isDLPrediction)
{
                    g2.setColor(Co
lor.DARK_GRAY);
                    g2.setFont(new
Font("SansSerif", Font.BOLD, 10));
                    g2.drawString(
"DL", x + barWidth - 20, y - 5);
                }
            }
        }
    }
}

// Neural Network implementation in
pure Java
class NeuralNetwork {
    private int inputSize;
    private int hiddenSize1;
    private int hiddenSize2;
    private int outputSize;

            private     double[][]
weightsInputHidden1;
            private     double[][]
weightsHidden1Hidden2;
            private     double[][]
weightsHidden2Output;
    private double[] biasHidden1;
    private double[] biasHidden2;
    private double[] biasOutput;

     private Random random = new
Random();

        public   NeuralNetwork(int
inputSize, int hiddenSize1, int
hiddenSize2, int outputSize) {
        this.inputSize = inputSize;
               this.hiddenSize1   =
hiddenSize1;
               this.hiddenSize2   =
hiddenSize2;
                this.outputSize   =
outputSize;

         // Initialize weights and
biases
         weightsInputHidden1 = new
double[inputSize][hiddenSize1];
        weightsHidden1Hidden2 = new
double[hiddenSize1][hiddenSize2];
         weightsHidden2Output = new
double[hiddenSize2][outputSize];

               biasHidden1   =   new
double[hiddenSize1];
               biasHidden2   =   new
double[hiddenSize2];
                biasOutput   =   new
double[outputSize];

        initializeWeights();
    }

                private       void
initializeWeights() {
        // Xavier initialization
                double   scale1   =
Math.sqrt(2.0 / inputSize);
                double   scale2   =
Math.sqrt(2.0 / hiddenSize1);
```

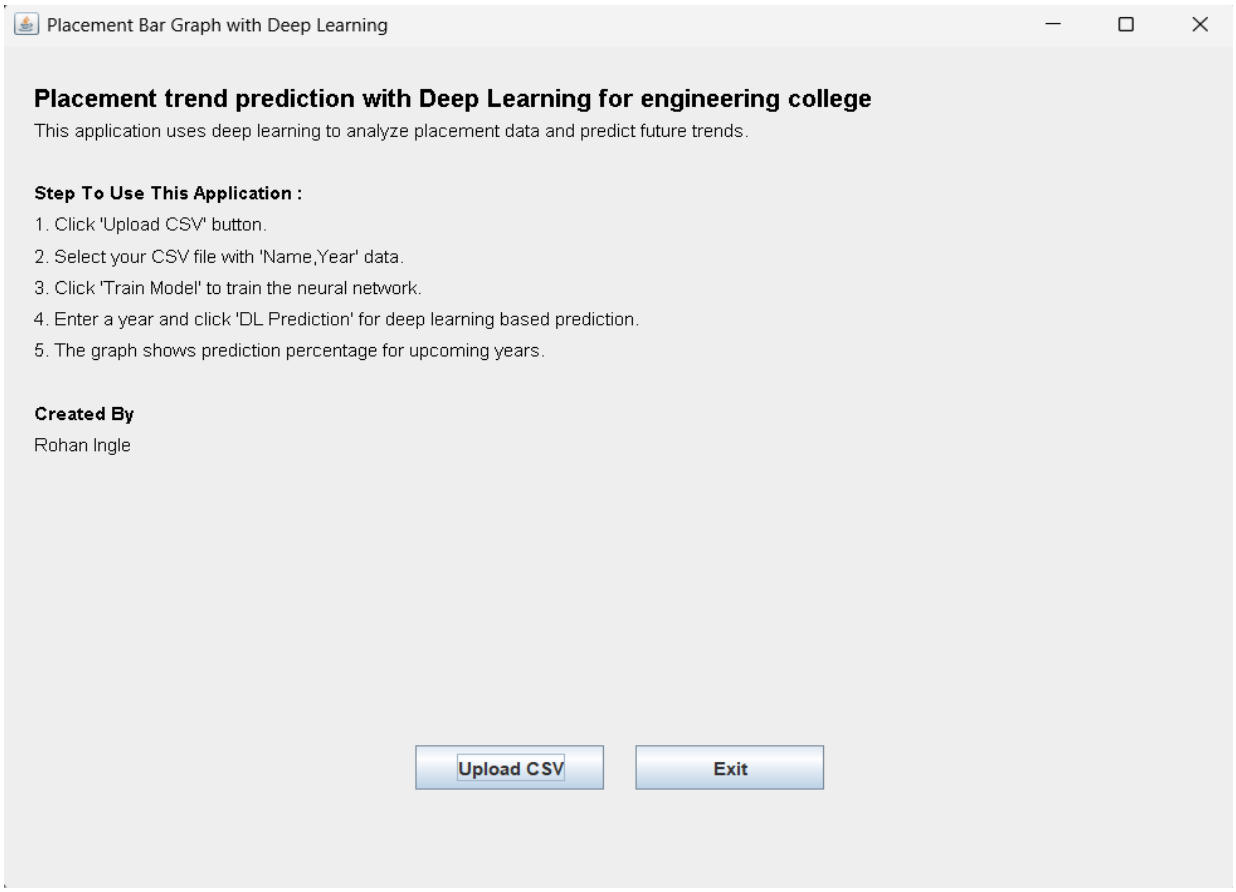
```
                double scale3 =
Math.sqrt(2.0 / hiddenSize2);

            for (int i = 0; i <
inputSize; i++) {
                for (int j = 0; j <
hiddenSize1; j++) {
                    weightsInputHidden
1[i][j] = random.nextGaussian() *
scale1;
                }
            }

            for (int i = 0; i <
hiddenSize1; i++) {
                for (int j = 0; j <
hiddenSize2; j++) {
                    weightsHidden1Hidd
en2[i][j] = random.nextGaussian() *
scale2;
                }
            }

            for (int i = 0; i <
hiddenSize2; i++) {
                for (int j = 0; j <
outputSize; j++) {
                    weightsHidden2Outp
ut[i][j] = random.nextGaussian() *
scale3;
                }
            }

            for (int i = 0; i <
hiddenSize1; i++) {
                biasHidden1[i] = 0.01;
            }
            for (int i = 0; i <
hiddenSize2; i++) {
                biasHidden2[i] = 0.01;
            }
            for (int i = 0; i <
outputSize; i++) {
                biasOutput[i] = 0.01;
            }
        }

        private double relu(double x) {
            return Math.max(0, x);
        }

                private      double
reluDerivative(double x) {
            return x > 0 ? 1 : 0;
        }

         private double sigmoid(double
x) {
                return 1.0 / (1.0 +
Math.exp(-x));
        }

                public      double[]
predict(double[] input) {
            // Forward propagation
                double[] hidden1 = new
double[hiddenSize1];
                double[] hidden2 = new
double[hiddenSize2];
                double[] output = new
double[outputSize];

            // Input to Hidden1
                for (int j = 0; j <
hiddenSize1; j++) {
                        double sum =
biasHidden1[j];
                  for (int i = 0; i <
inputSize; i++) {
                      sum += input[i] *
weightsInputHidden1[i][j];
                }
                hidden1[j] = relu(sum);
            }

            // Hidden1 to Hidden2
                for (int j = 0; j <
hiddenSize2; j++) {
                        double sum =
biasHidden2[j];
```

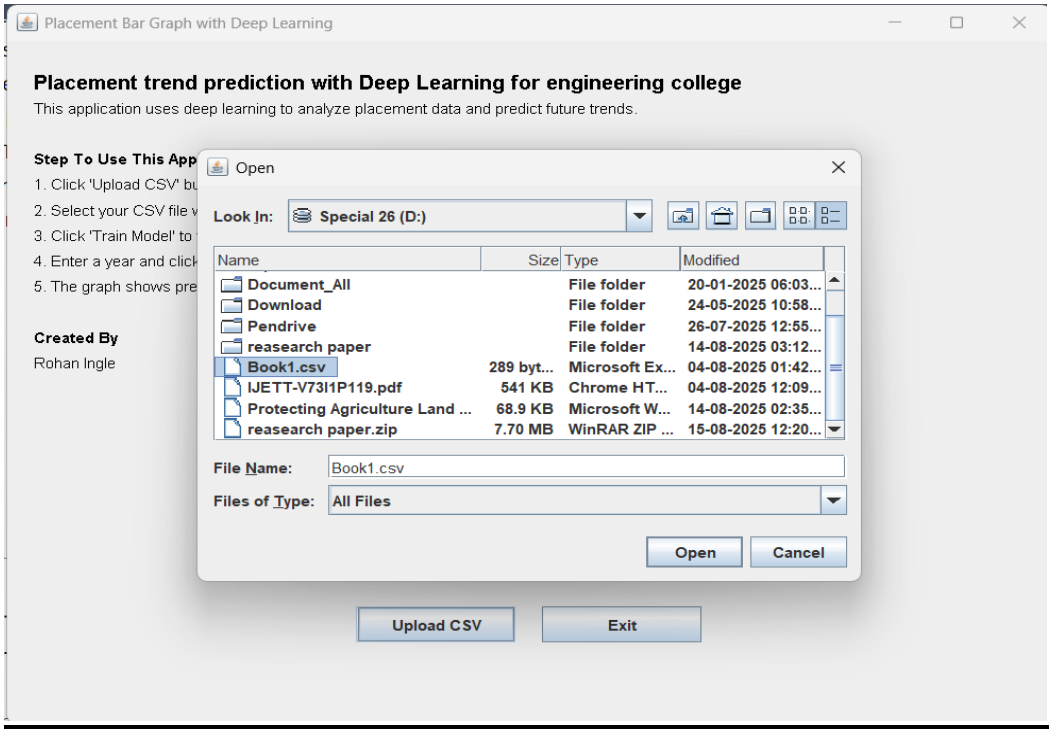
```
            for (int i = 0; i < hiddenSize1; i++) {
                sum += hidden1[i] * weightsHidden1Hidden2[i][j];
            }
            hidden2[j] = relu(sum);
        }

        // Hidden2 to Output
        for (int j = 0; j < outputSize; j++) {
            double sum = biasOutput[j];
            for (int i = 0; i < hiddenSize2; i++) {
                sum += hidden2[i] * weightsHidden2Output[i][j];
            }
            output[j] = sigmoid(sum);
        }

        return output;
    }

    public void train(List<double[]> inputs, List<double[]> outputs, int epochs, double learningRate) {
        for (int epoch = 0; epoch < epochs; epoch++) {
            double totalLoss = 0;

            for (int sample = 0; sample < inputs.size(); sample++) {
                double[] input = inputs.get(sample);
                double[] target = outputs.get(sample);

                // Forward propagation
                double[] hidden1 = new double[hiddenSize1];
                double[] hidden1Raw = new double[hiddenSize1];
                double[] hidden2 = new double[hiddenSize2];
                double[] hidden2Raw = new double[hiddenSize2];
                double[] output = new double[outputSize];

                // Input to Hidden1
                for (int j = 0; j < hiddenSize1; j++) {
                    double sum = biasHidden1[j];
                    for (int i = 0; i < inputSize; i++) {
                        sum += input[i] * weightsInputHidden1[i][j];
                    }
                    hidden1Raw[j] = sum;
                    hidden1[j] = relu(sum);
                }

                // Hidden1 to Hidden2
                for (int j = 0; j < hiddenSize2; j++) {
                    double sum = biasHidden2[j];
                    for (int i = 0; i < hiddenSize1; i++) {
                        sum += hidden1[i] * weightsHidden1Hidden2[i][j];
                    }
                    hidden2Raw[j] = sum;
                    hidden2[j] = relu(sum);
                }

                // Hidden2 to Output
```

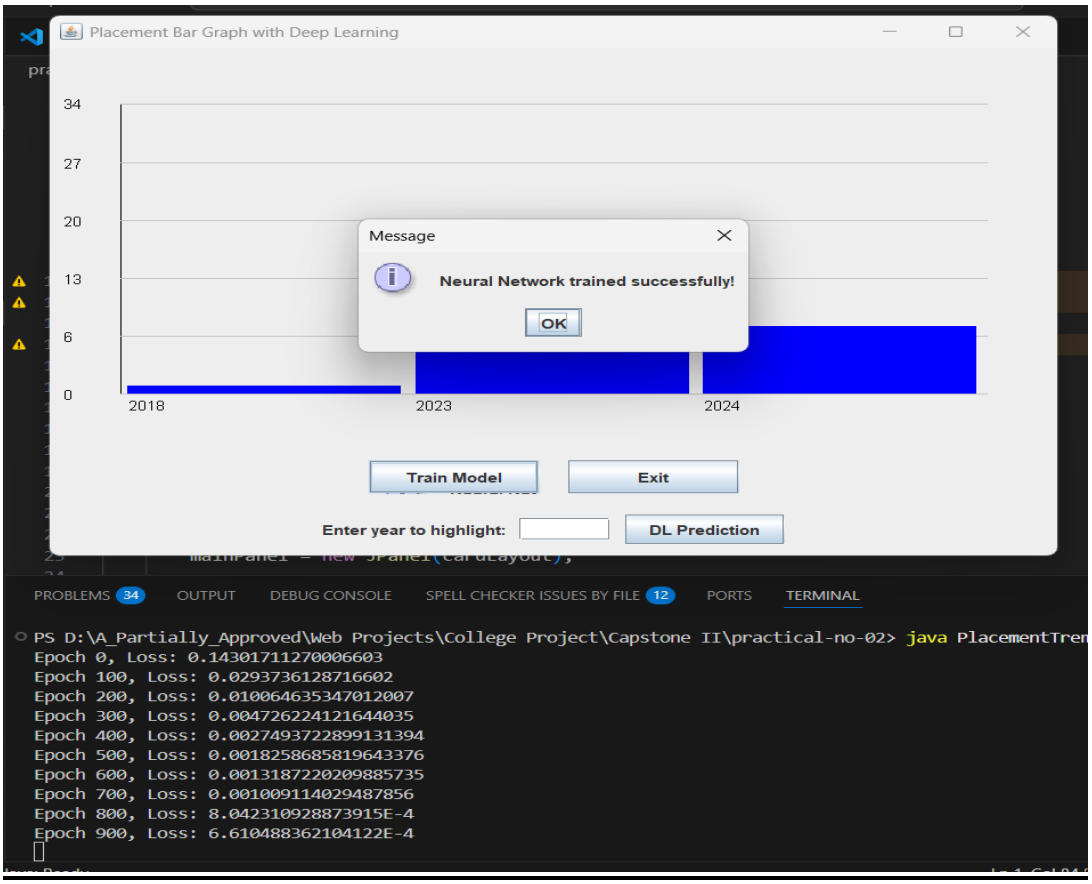
```
                for (int j = 0; j < outputSize; j++) {
                    double sum = biasOutput[j];
                    for (int i = 0; i < hiddenSize2; i++) {
                        sum += hidden2[i] * weightsHidden2Output[i][j];
                    }
                    output[j] = sigmoid(sum);
                }

                // Calculate loss
                for (int i = 0; i < outputSize; i++) {
                    totalLoss += Math.pow(target[i] - output[i], 2);
                }

                // Backpropagation
                double[] outputError = new double[outputSize];
                double[] hidden2Error = new double[hiddenSize2];
                double[] hidden1Error = new double[hiddenSize1];

                // Output layer error
                for (int i = 0; i < outputSize; i++) {
                    outputError[i] = (output[i] - target[i]) * output[i] * (1 - output[i]);
                }

                // Hidden2 layer error
                for (int i = 0; i < hiddenSize2; i++) {
                    double error = 0;
                    for (int j = 0; j < outputSize; j++) {
                        error += outputError[j] * weightsHidden2Output[i][j];
                    }
                    hidden2Error[i] = error * reluDerivative(hidden2Raw[i]);
                }

                // Hidden1 layer error
                for (int i = 0; i < hiddenSize1; i++) {
                    double error = 0;
                    for (int j = 0; j < hiddenSize2; j++) {
                        error += hidden2Error[j] * weightsHidden1Hidden2[i][j];
                    }
                    hidden1Error[i] = error * reluDerivative(hidden1Raw[i]);
                }

                // Update weights and biases
                // Hidden2 to Output
                for (int i = 0; i < hiddenSize2; i++) {
                    for (int j = 0; j < outputSize; j++) {
                        weightsHidden2Output[i][j] -= learningRate * outputError[j] * hidden2[i];
                    }
                }
                for (int i = 0; i < outputSize; i++) {
                    biasOutput[i] -= learningRate * outputError[i];
                }
```

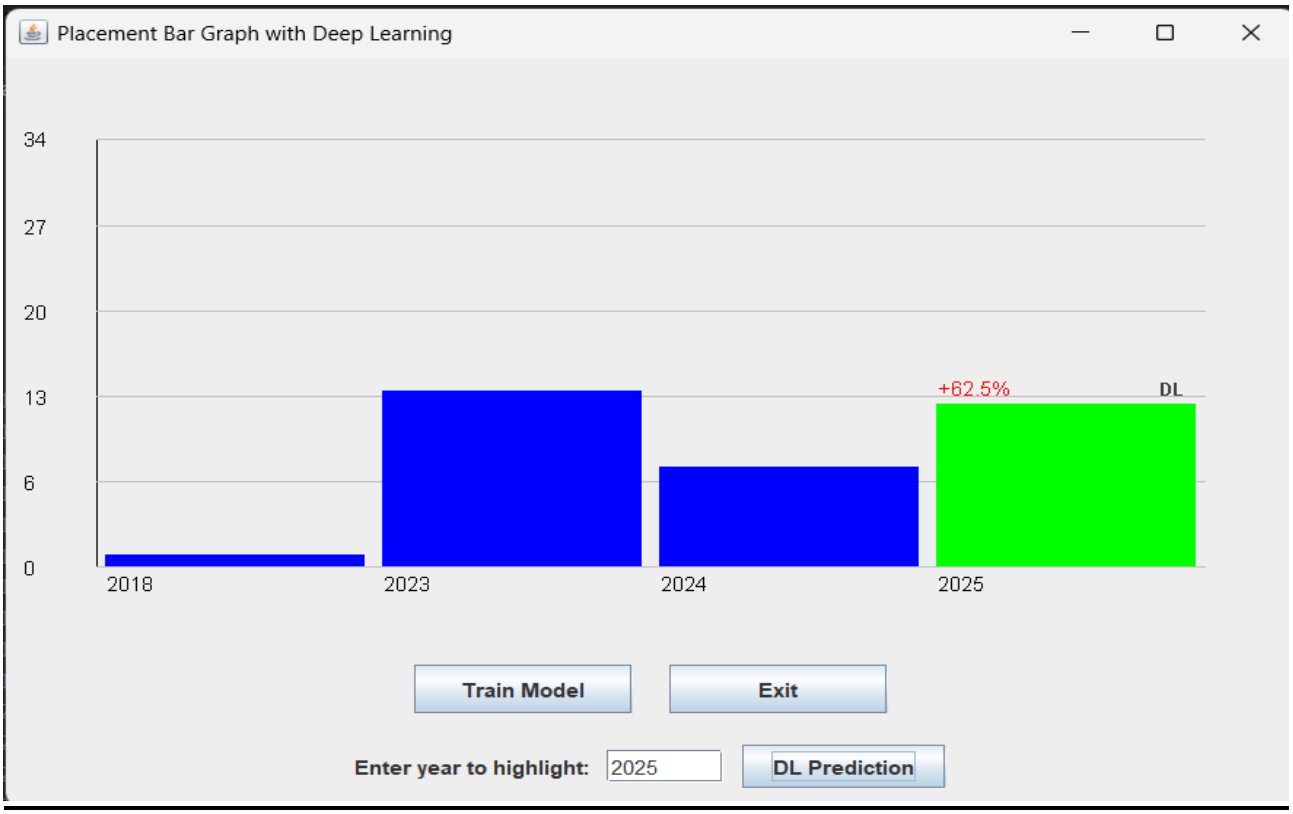
```
                // Hidden1 to Hidden2
                for (int i = 0; i < hiddenSize1; i++) {
                    for (int j = 0; j < hiddenSize2; j++) {
                        weightsHidden1Hidden2[i][j] -= learningRate * hidden2Error[j] * hidden1[i];
                    }
                }
                for (int i = 0; i < hiddenSize2; i++) {
                    biasHidden2[i] -= learningRate * hidden2Error[i];
                }

                // Input to Hidden1
                for (int i = 0; i < inputSize; i++) {
                    for (int j = 0; j < hiddenSize1; j++) {
                        weightsInputHidden1[i][j] -= learningRate * hidden1Error[j] * input[i];
                    }
                }
                for (int i = 0; i < hiddenSize1; i++) {
                    biasHidden1[i] -= learningRate * hidden1Error[i];
                }
            }

            // Print progress every 100 epochs
            if (epoch % 100 == 0) {
                System.out.println("Epoch " + epoch + ", Loss: " + totalLoss / inputs.size());
            }
        }
    }
}
```

Program Output :






Placement Bar Graph with Deep Learning
34
27
20
13
6
0
2018
2023
2024
Message
Neural Network trained successfully!
OK
Train Model
Exit
Enter year to highlight:
DL Prediction
PROBLEMS 34
OUTPUT
DEBUG CONSOLE
SPELL CHECKER ISSUES BY FILE 12
PORTS
TERMINAL
PS D:\A_Partially_Approved\Web Projects\College Project\Capstone II\practical-no-02> java PlacementTren
Epoch 0, Loss: 0.14301711270006603
Epoch 100, Loss: 0.0293736128716602
Epoch 200, Loss: 0.010064635347012007
Epoch 300, Loss: 0.004726224121644035
Epoch 400, Loss: 0.0027493722899131394
Epoch 500, Loss: 0.0018258685819643376
Epoch 600, Loss: 0.0013187220209885735
Epoch 700, Loss: 0.001009114029487856
Epoch 800, Loss: 8.042310928873915E-4
Epoch 900, Loss: 6.610488362104122E-4


Placement Bar Graph with Deep Learning
34
27
20
13
6
0
2018
2023
2024
2025
+62.5%
DL
Train Model
Exit
Enter year to highlight:
2025
DL Prediction

Advantages :

1) Predicts future placement trends using deep learning.
2) Visual bar graph makes analysis intuitive and impactful.
3) Flexible and extensible for updated data and model retraining.
4) Runs locally, preserving data confidentiality.
5) Can be customized for various datasets.

Disadvantages :

1) Considers only basic features (year, count, trend); external factors not included.
2) Prediction quality depends on data volume and accuracy.
3) No integration with external college management systems.
4) Only basic analytics and visualizations are available.

Conclusion :

The "Placement Training Prediction and Visual Analytics" platform for an engineering school effectively illustrates the combination of data-driven predictive analytics and visual analytics. Through the examination of student information, including academic achievement, skill sets, and participation in training, the platform forecasts possible placement results with high accuracy. The visual analytics module offers a transparent, interactive visualization of trends, facilitating students and administrators in decision-making processes for training interventions.