**In-Class Exercise: Implementing an Artificial Neural Network (ANN) for Customer Churn Prediction**

**Objective:**

In this exercise, you will **build, train, and evaluate an Artificial Neural Network (ANN) using TensorFlow and Keras** to predict customer churn. Follow the guided steps to preprocess the data, create an ANN model, and assess its performance.

**Part 1: Data Preprocessing**

1. **Importing Libraries:**
   * Load essential libraries like **NumPy, Pandas, and TensorFlow**.
   * Verify your **TensorFlow version** to ensure compatibility.
2. **Loading the Dataset:**
   * Read the dataset **Churn\_Modelling.csv** and inspect its structure.
   * Identify which columns are **input features (X) and the target variable (y)**.
3. **Handling Categorical Data:**
   * Apply **Label Encoding** to convert the **"Gender"** column into numerical values.
   * Use **One-Hot Encoding** for the **"Geography"** column to avoid ordinal relationships in categorical data.
4. **Splitting the Dataset:**
   * Use **train-test split** (80% training, 20% testing) to prepare the dataset for training.
5. **Feature Scaling:**
   * Apply **Standard Scaling** to normalize numerical features, ensuring faster convergence during training.

**Part 2: Building the ANN**

1. **Initialize an ANN model** using tf.keras.models.Sequential().
2. **Define the ANN Architecture:**
   * Add an **input layer** and a **hidden layer** with **6 neurons** and **ReLU activation**.
   * Add a **second hidden layer** with the same configuration.
   * Create an **output layer** with **sigmoid activation** (since we are performing binary classification).

**Part 3: Training the ANN**

1. **Compile the model** using the **Adam optimizer** and **binary cross-entropy loss function**.
2. **Train the ANN** on the training dataset with a batch size of **32** and **100 epochs**.
3. **Observe the loss and accuracy trends** during training.

**Part 4: Evaluating the Model**

1. **Make Predictions:**
   * Use the trained ANN to predict whether a **specific customer** will leave the bank.
   * Convert the categorical variables correctly for prediction (e.g., One-Hot Encoding for "Geography").
   * Apply **feature scaling** before making predictions.
2. **Evaluate on Test Data:**
   * Predict results on the **test dataset** and convert probabilities into binary values (True or False).
   * Compare predicted labels with actual labels.
3. **Analyze Performance:**
   * Compute the **confusion matrix** to check classification performance.
   * Calculate the **accuracy score** to measure the model’s effectiveness.

**Homework Assignment:**

Using your trained ANN model, **predict whether the following customer will leave the bank**:

* **Geography:** France
* **Credit Score:** 600
* **Gender:** Male
* **Age:** 40 years old
* **Tenure:** 3 years
* **Balance:** $60,000
* **Number of Products:** 2
* **Has Credit Card?** Yes
* **Is an Active Member?** Yes
* **Estimated Salary:** $50,000

**Should we say goodbye to this customer?** Use the **predict method** and interpret the results.

**Discussion Questions:**

1. How does **feature scaling** impact the training process?
2. Why do we use **ReLU activation** in hidden layers and **sigmoid activation** in the output layer?
3. What are the potential reasons for **false positives or false negatives** in your predictions?
4. How can we improve the model’s performance?

**Challenge:** Try modifying the **number of hidden layers or neurons** and observe how it affects model accuracy.