Confusion Matrix Documentation

Overview

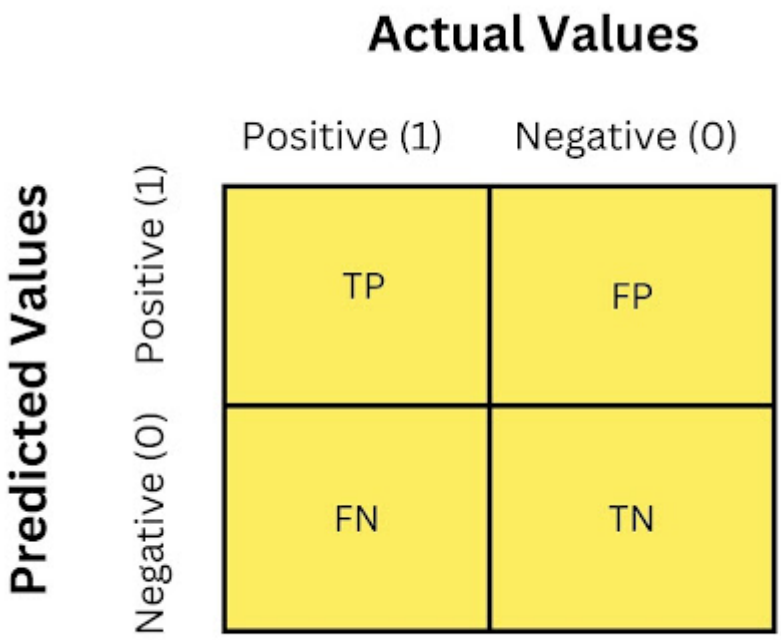
This project implements a **K-Nearest Neighbors (KNN)** classifier to predict whether a user will purchase a product based on the features:

- **Age**
- **EstimatedSalary**
- **Gender** (encoded as 0 = Female, 1 = Male)

The model was trained on the `Social_Network_Ads.csv` dataset and evaluated using a test set. The trained model is saved as `models/knn_model.pkl` for reuse in predictions.

Confusion Matrix

The confusion matrix for the test set:




```
[[64  4]
 [ 3 29]]
```

Structure

For a **binary classification problem** (`Purchased = 1`, `Not Purchased = 0`):

	Predicted 0	Predicted 1
Actual 0	True Negative (TN)	False Positive (FP)
Actual 1	False Negative (FN)	True Positive (TP)

- **TN = 64** → Correctly predicted 64 users **did NOT purchase**.
- **FP = 4** → Predicted purchase incorrectly for 4 non-purchasers.
- **FN = 3** → Missed 3 actual purchasers.
- **TP = 29** → Correctly predicted 29 users **did purchase**.

Key Metrics

1. **Accuracy**:

$$
\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} = \frac{29 + 64}{29 + 64 + 4 + 3} = 0.93
$$

- The model correctly predicts **93%** of cases.

2. **Precision (Purchased = 1)**:

$$
\text{Precision} = \frac{TP}{TP + FP} = \frac{29}{29 + 4} \approx 0.879
$$

- ~88% of predicted purchasers are correct.

3. **Recall (Purchased = 1)**:

$$
\text{Recall} = \frac{TP}{TP + FN} = \frac{29}{29 + 3} \approx 0.906
$$

- ~91% of actual purchasers are correctly identified.

4. **F1-score**:

$$
F1 = 2 * \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}} \approx 0.892
$$

- A balanced measure of precision and recall.

Interpretation

- The model demonstrates **excellent performance** with high accuracy, precision, and recall.
- Misclassifications are minimal:

    - **4 false positives**: non-purchasers predicted as purchasers.
    - **3 false negatives**: purchasers predicted as non-purchasers.
- High recall indicates the model is effective at detecting buyers.
- High precision indicates the predictions of purchase are reliable.

Usage

- The trained model can be loaded using `pickle`:

```
import pickle

with open('models/knn_model.pkl', 'rb') as file:
    model = pickle.load(file)
```

- Predict for new users:

```
import numpy as np

X_new = np.array([[30, 50000, 1]])  # Age, EstimatedSalary, Gender
prediction = model.predict(X_new)
print("Purchase" if prediction[0] == 1 else "Not Purchase")
```