Experiment No:- 4

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EXPERIMENT: K-Nearest Neighbors (KNN) for Classification

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1. Dataset Source

Dataset Used: Iris Dataset
Type: Classification
Source:
https://scikit-learn.org/stable/datasets/toy_dataset.html#iris-dataset

Access Method:

```
from sklearn.datasets import load_iris
```

Justification:

- Standard real-world dataset
- Well suited for distance-based classifiers
- Allows easy evaluation of KNN performance

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2. Dataset Description

2.1 Iris Dataset

Objective:
Classify iris flowers into different species using the K-Nearest Neighbors algorithm.

Number of Instances: 150
Number of Features: 4

Features:

- Sepal length
- Sepal width
- Petal length
- Petal width

Target Variable:

- Species (Setosa, Versicolor, Virginica)

Characteristics:

- Numerical features
- No missing values
- Multiclass classification problem

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3. Mathematical Formulation of the Algorithm

3.1 K-Nearest Neighbors (KNN)

KNN is a **non-parametric, instance-based learning algorithm** that classifies data points based on similarity.

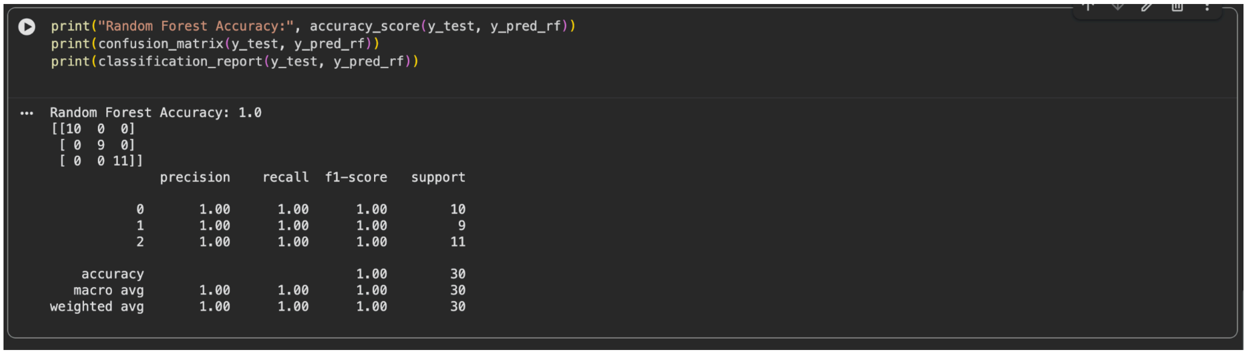
Distance Metric (Euclidean Distance):

$d(x,y)=\sum_{i=1}^{n}(x_i-y_i)^2$

Classification Rule:

- Identify the **K nearest neighbors**
- Assign the class by **majority voting**

$\hat{y}=\text{mode}(y_1,y_2,\dots,y_k)$



```
print("Random Forest Accuracy:", accuracy_score(y_test, y_pred_rf))
print(confusion_matrix(y_test, y_pred_rf))
print(classification_report(y_test, y_pred_rf))
```

```
Random Forest Accuracy: 1.0
[[10  0  0]
 [ 0  9  0]
 [ 0  0 11]]
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        10
           1       1.00      1.00      1.00         9
           2       1.00      1.00      1.00        11

    accuracy                           1.00        30
   macro avg       1.00      1.00      1.00        30
weighted avg       1.00      1.00      1.00        30
```

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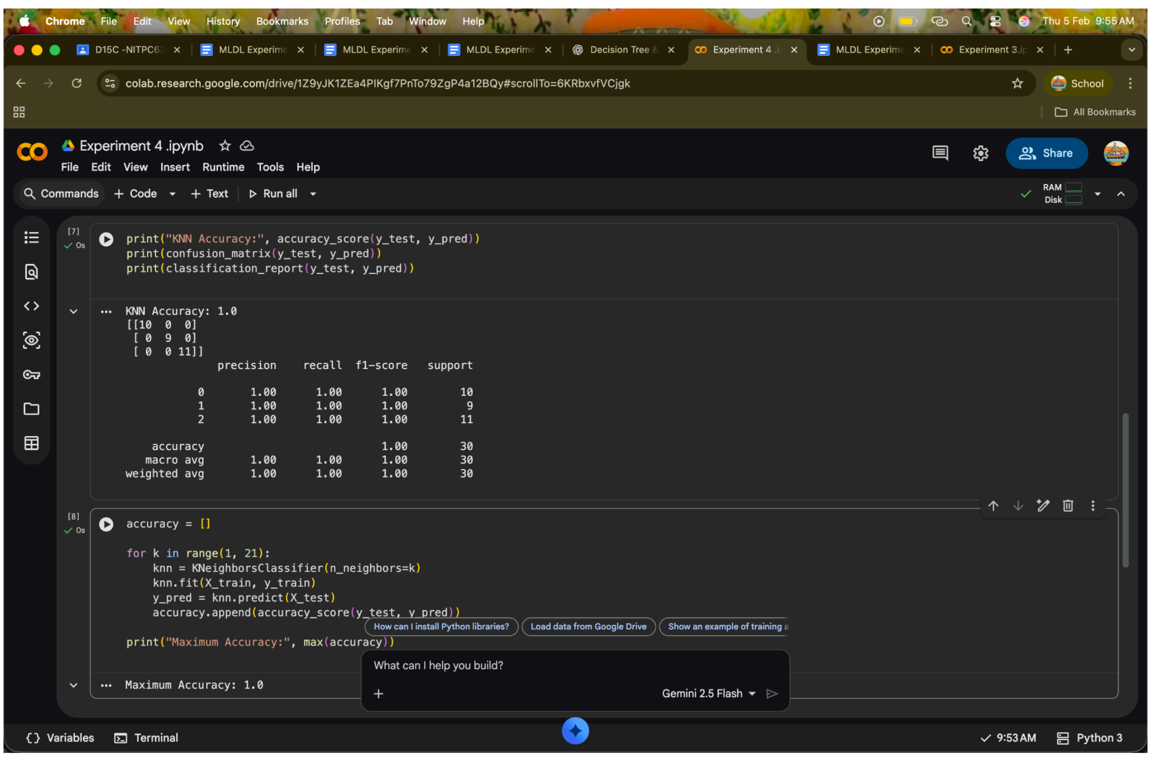
4. Algorithm Limitations

KNN Limitations

- Computationally expensive for large datasets
- Sensitive to feature scaling
- Performance depends heavily on choice of K
- Affected by noisy and irrelevant features



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5. Methodology / Workflow

Step-by-Step Workflow

1. Import required libraries
2. Load dataset
3. Data exploration
4. Feature scaling
5. Train-test split
6. Train KNN model
7. Prediction
8. Performance evaluation
9. Hyperparameter tuning (K value)

Workflow Diagram (Conceptual):

```
Dataset → Scaling → Train/Test Split
→ Model Training → Prediction → Evaluation
```

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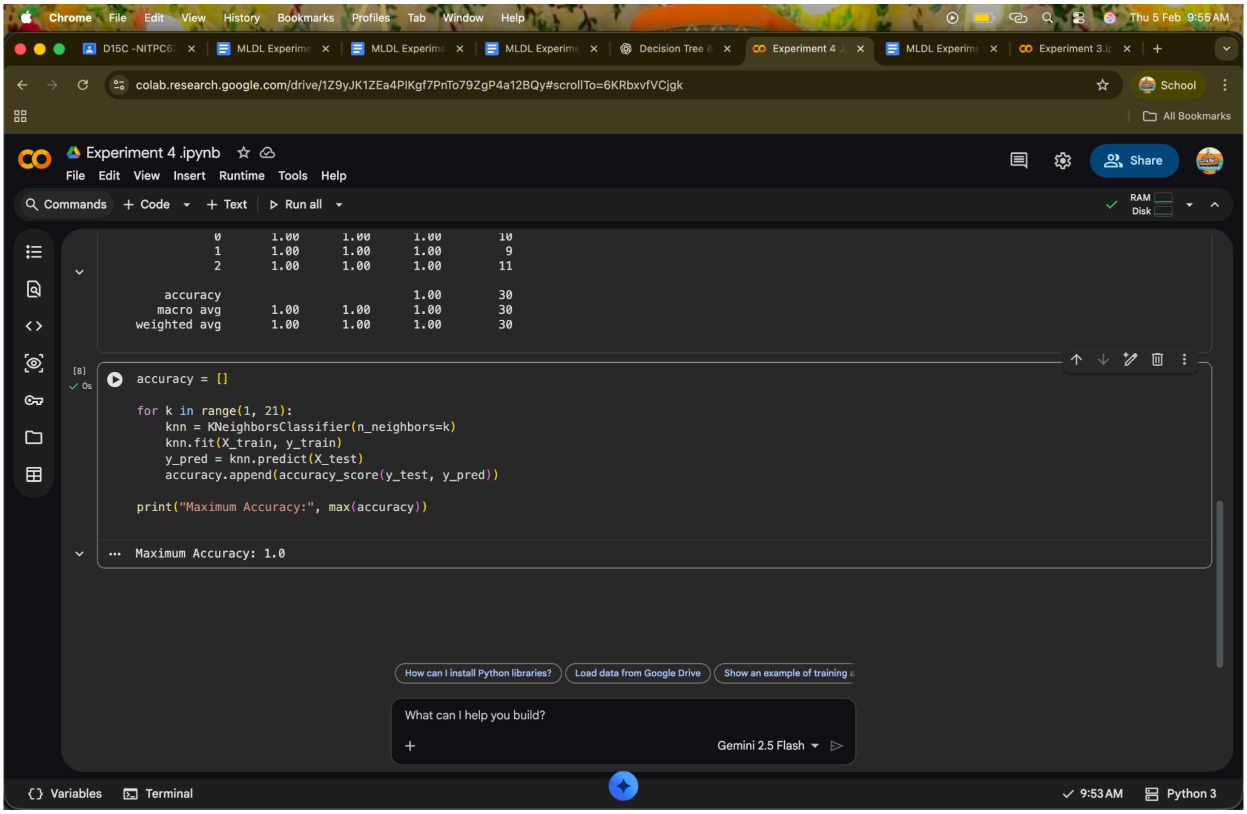
6. Performance Analysis

Metrics Used

- Accuracy
- Confusion Matrix
- Classification Report (Precision, Recall, F1-Score)

Interpretation:

- Higher accuracy indicates better classification
- Proper K selection improves model performance



Result and Conclusion

Result:

K-Nearest Neighbors achieved high classification accuracy on the Iris dataset. Performance varied with different values of K, with moderate values providing optimal results.

Conclusion:

The KNN algorithm was successfully implemented for multiclass classification. Proper feature scaling and optimal K selection significantly improved model performance, demonstrating the effectiveness of KNN for small-to-medium sized datasets