Step-by-Step Replication Instructions

Step 1: Environment Configuration

- Python 3.9.12 and all dependencies as listed in `requirements.pdf`.

Step 2: Running Experiments

Execute scripts individually using the following commands:

Baseline (Naive Bayes without oversampling):

```
python baseline_nb_tfidf.py
```

Recommended Experiment (Logistic Regression + SMOTE):

```
python multiclass_lr_tuning_smote.py
```

Step 3: Confirming Experimental Results

Upon execution, each script will display:

- **Accuracy**
- **Macro F1-score**
- **Detailed classification report** (precision, recall, F1-score for each category)

Baseline (Naive Bayes without oversampling):

```
Test Accuracy: 0.5203585447302127
Test Macro F1-score: 0.313027693912912
Classification Report:
               precision    recall  f1-score   support

     blocker       0.12      0.48      0.19       159
    critical       0.43      0.69      0.53      1067
       major       0.13      0.39      0.19       894
       minor       0.09      0.32      0.14       579
      normal       0.92      0.53      0.67     13951
     trivial       0.10      0.41      0.17       419

    accuracy                           0.52     17069
   macro avg       0.30      0.47      0.31     17069
weighted avg       0.79      0.52      0.60     17069
```

Recommended Experiment (Logistic Regression + SMOTE):

```
Test Accuracy: 0.8112984157411062
Test Macro F1-score: 0.39888889313404946
Classification Report:
               precision    recall  f1-score   support
```

```
              precision    recall  f1-score   support

     blocker       0.34      0.31      0.32       160
    critical       0.66      0.71      0.68      1157
       major       0.23      0.14      0.18       935
       minor       0.16      0.08      0.11       598
      normal       0.88      0.92      0.90     14478
     trivial       0.25      0.18      0.21       409

    accuracy                           0.81     17737
   macro avg       0.42      0.39      0.40     17737
weighted avg       0.78      0.81      0.80     17737
```