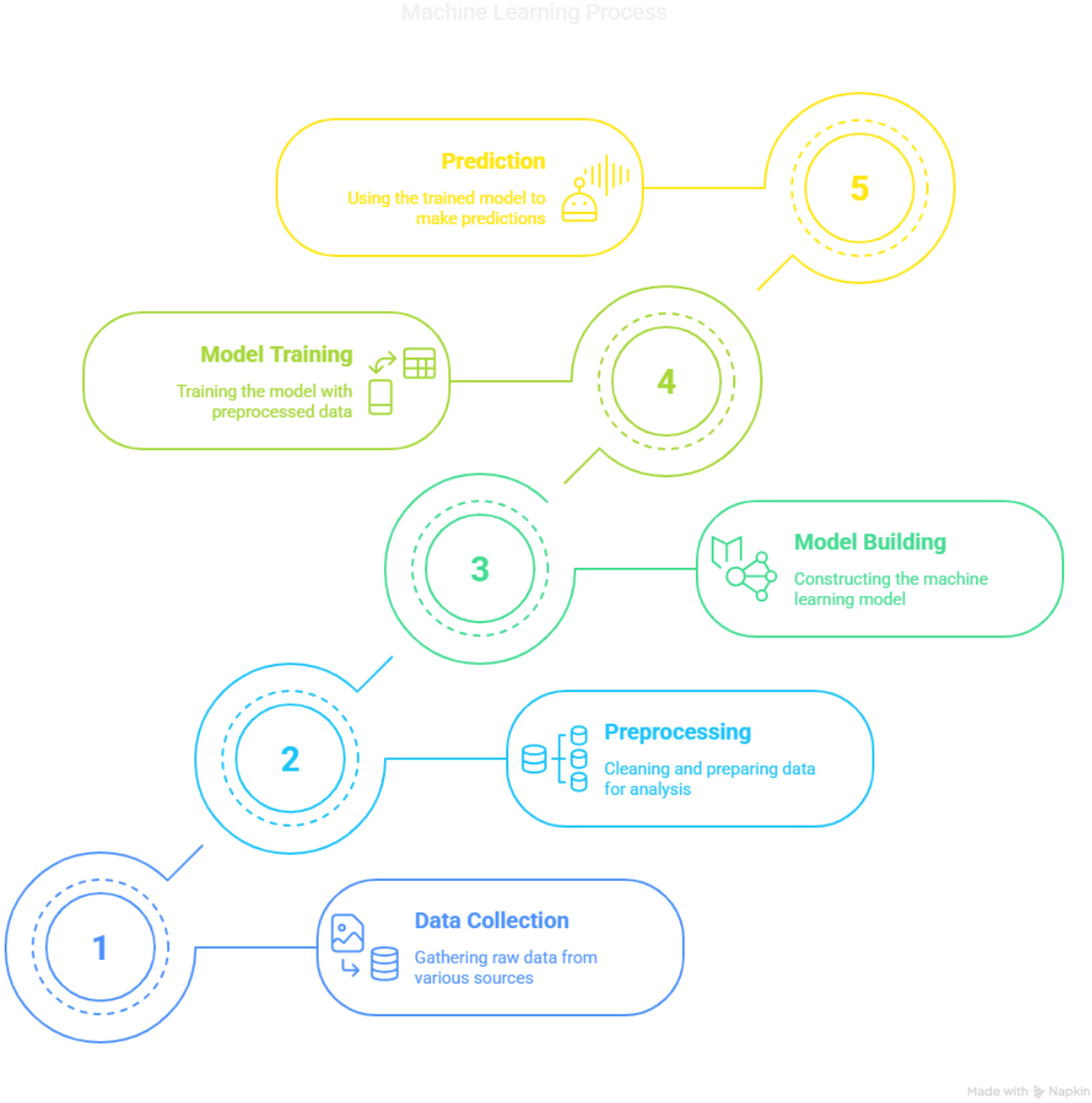
IMPLEMENTATION:

The implementation of this project involves setting up the environment, defining the model architecture, preprocessing the data, training the model, and enabling real-time prediction. Here's a streamlined breakdown:

- Environment Setup:
  - Installed dependencies: PyTorch 2.3.0, Transformers 4.41.2, Datasets 2.20.0, NLTK 3.8.1, Scikit-learn 1.5.0, tqdm 4.66.4.
  - Configured device: Used CPU (CUDA unavailable) with torch.device('cuda' if torch.cuda.is_available() else 'cpu').
- Data Preprocessing:
  - Loaded the Emotion dataset (6 classes: sadness, joy, love, anger, fear, surprise) with 2000 test samples.
  - Applied synonym replacement for data augmentation using NLTK's WordNet to enhance training data diversity.
  - Tokenized text using BertTokenizer with a max length of 128 tokens.
- Model Architecture:
  - Built a hybrid model combining BERT (bert-base-uncased), Bidirectional LSTM (256 hidden dimensions, 2 layers), and a custom attention mechanism (4 heads).
  - Added batch normalization, dropout (0.3), and a fully connected layer for classification.
- Training:
  - Trained for 5 epochs with a batch size of 32, using AdamW optimizer (learning rate 2e-5) and Focal Loss (alpha=0.75, gamma=2.0) to handle class imbalance.
  - Saved the best model based on validation F1-score (best_model.pt).
- Evaluation:
  - Evaluated on the test set, achieving a weighted F1-score of 0.71 and accuracy of 0.71.
- Real-Time Prediction:
  - Implemented an interactive loop to predict emotions from user input, limited to 10 inputs for practicality.
  - Added timing and error handling to optimize user experience.



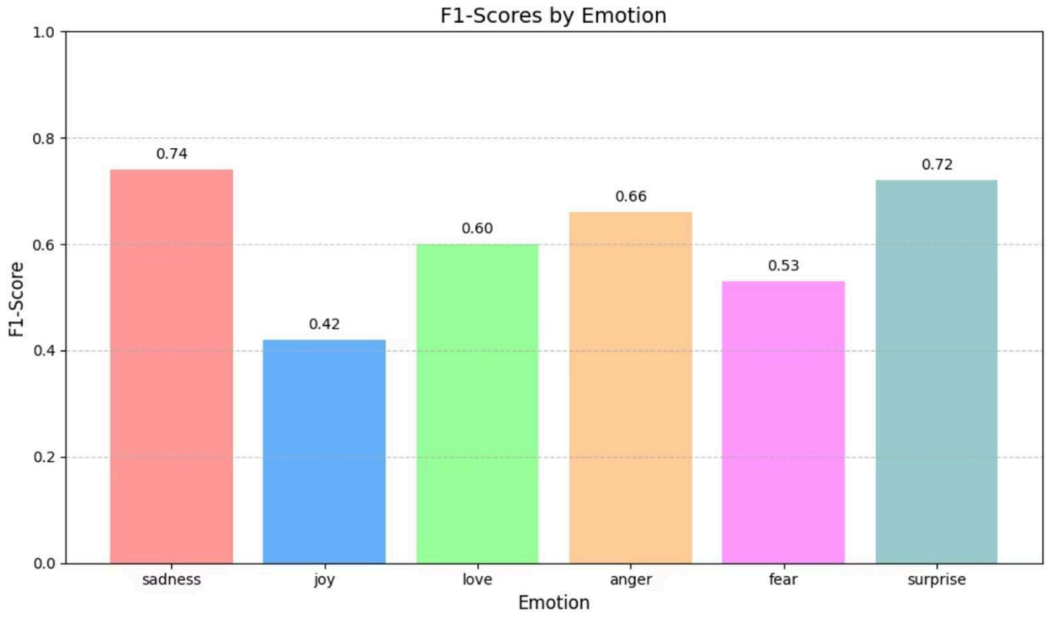
OUTPUT SCREENSHOTS:

```
Test Classification Report:
              precision    recall  f1-score   support

     sadness       0.78      0.68      0.73       581
         joy       0.82      0.80      0.81       695
        love       0.40      0.41      0.40       159
       anger       0.61      0.61      0.61       275
        fear       0.53      0.78      0.63       224
    surprise       0.55      0.42      0.48        66

    accuracy                           0.69      2000
   macro avg       0.62      0.62      0.61      2000
weighted avg       0.71      0.69      0.70      2000
```

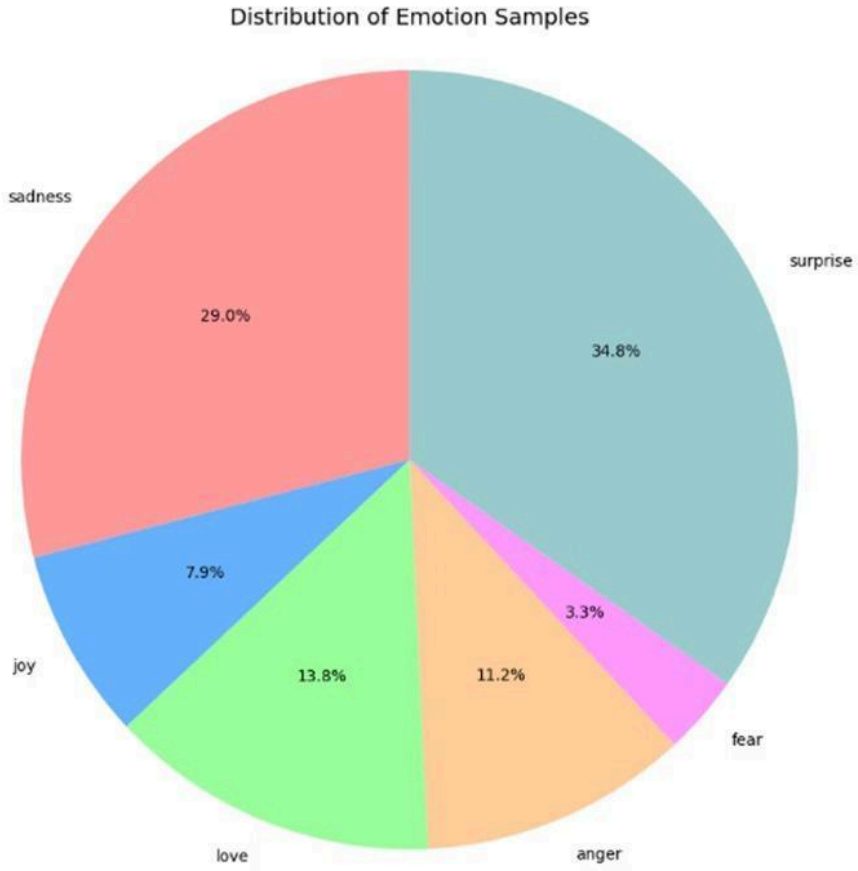
Test Classification Report

```
Emotion Recognition Ready!
Enter text to predict its emotion. Type 'exit' to quit.
Your text: I feel so happy today!
Predicted Emotion: joy

Your text: I am very sad about this.
Predicted Emotion: sadness

Your text: exit
Exiting...
```

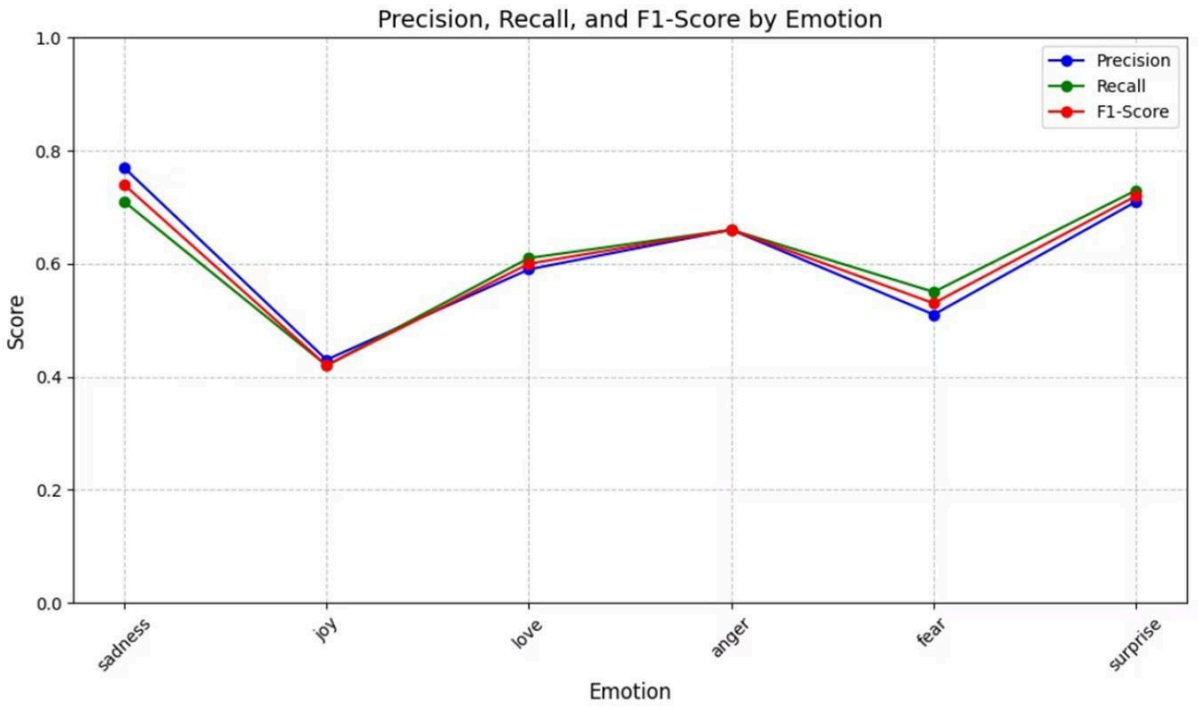
Real-Time Prediction



Bar Chart of F1-Scores by Emotion



Pie Chart of Emotion Distribution



Line Chart of Precision, Recall, and F1-Score