

# Multilingual Emotion Detection

Natural Language Processing Project Report

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## Dataset Details

The project utilizes the **SemEval-2018 Task 1 (Affect in Tweets)** dataset, specifically focusing on the multi-label emotion classification task (Subtask E-c).

- **Source:** SemEval-2018 Task 1 (E-c).
- **Language:** Primary training data is in **English**, with evaluation capabilities extended to multilingual contexts (Spanish, French, German) using the multilingual model.
- **Size:**
  - **Total Samples:** 6,838 tweets
  - **Training Set:** 5,470 samples
  - **Validation Set:** 1,368 samples (20% split)
- **Labels:** The dataset is annotated for four distinct emotion labels:  
*Anger*                      *Joy*                      *Love*                      *Pessimism*

## Models and Rationale

Two transformer-based models were fine-tuned to compare performance between a specialized monolingual approach and a generalized multilingual approach.

### 1. Monolingual Model: DistilBERT-base-uncased

- **Rationale:** DistilBERT was selected for its efficiency. It retains 97% of BERT's performance while being 40% smaller and 60% faster. This makes it ideal for rapid prototyping and deployment where resources are constrained, without significantly sacrificing accuracy on English-only text.

### 2. Multilingual Model: BERT-base-multilingual-cased (mBERT)

- **Rationale:** mBERT was chosen to test zero-shot transfer capabilities. Trained on 104 languages, it allows the system to generalize emotion detection to languages (like Spanish or French) that were not present in the training set, offering a more robust global solution.

## Training Setup and Hyperparameters

Both models were fine-tuned using the Hugging Face Trainer API with the following consistent configuration to ensure a fair comparison.

| Parameter           | Value  |
|---------------------|--|
| Learning Rate       | $2 \times 10^{-5}$                             |
| Batch Size          | 16 (Train & Eval)                              |
| Epochs              | 3  |
| Weight Decay        | 0.01   |
| Loss Function       | BCEWithLogitsLoss (Multi-label classification) |
| Optimizer           | AdamW  |
| Evaluation Strategy | Per Epoch                                      |
| Metric              | F1-Score (Micro & Weighted)                    |

Table 1: Hyperparameters used for fine-tuning.

## Performance Comparison

The comparative results highlight specific strengths in each model. The table below summarizes the F1-scores achieved across the four target emotions.

| Emotion   | Monolingual F1-Score | Multilingual F1-Score |
|-----------|----------------------|-----------------------|
| Anger     | <b>0.779</b>         | 0.765                 |
| Joy       | <b>0.806</b>         | 0.776                 |
| Love      | 0.433                | <b>0.470</b>          |
| Pessimism | <b>0.324</b>         | 0.317                 |

Table 2: Comparative F1-Scores per Emotion.

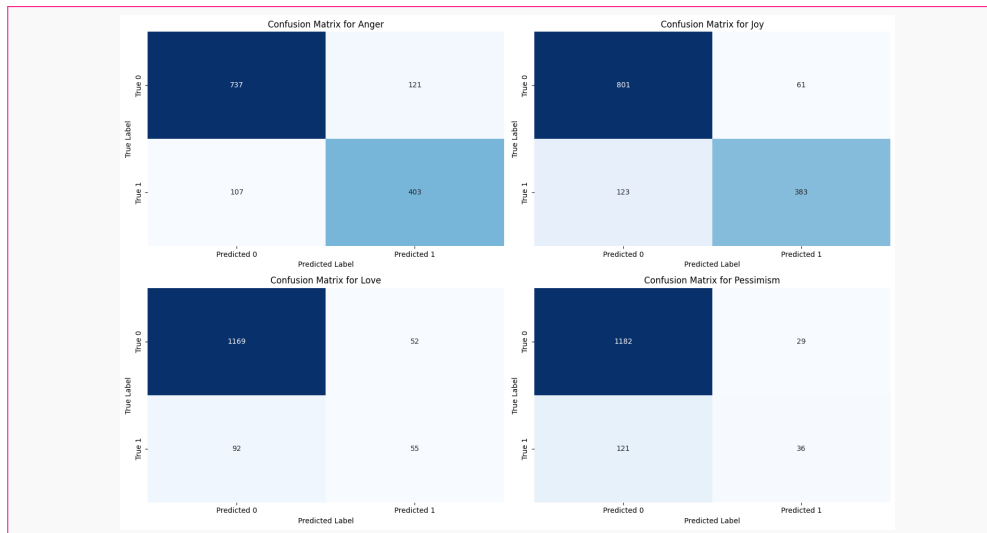


Figure 1: Confusion Matrices for the Monolingual Model (DistilBERT). Note the strong true positive rates for 'Anger' and 'Joy', but significant misclassification in 'Pessimism'.

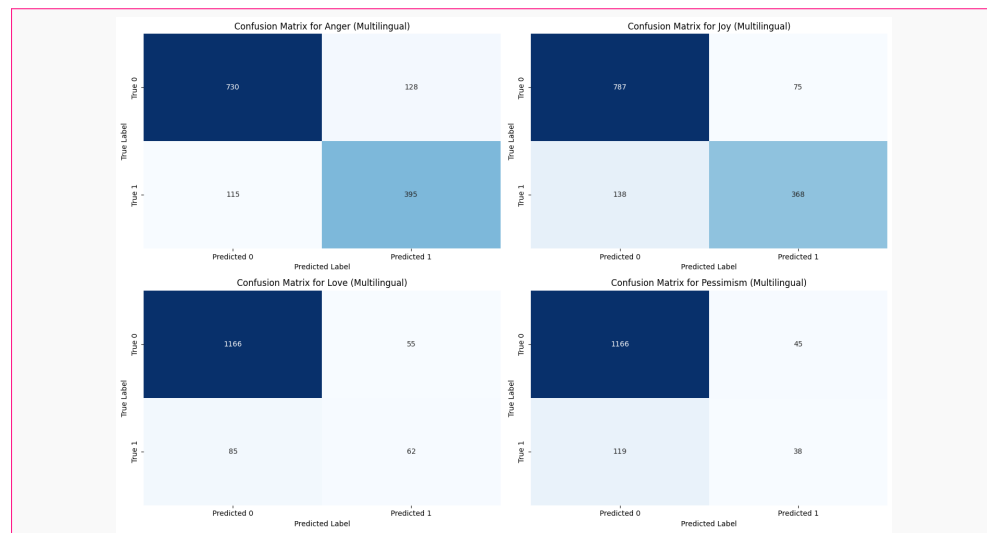


Figure 2: Confusion Matrices for the Multilingual Model (mBERT). The model maintains consistent performance patterns across classes, with slightly improved handling of the 'Love' category.

## Analysis

As seen in Figure 1, the results indicate distinct behavioral patterns:

- **Dominant Emotions:** The Monolingual model outperformed mBERT in detecting "Anger" (+1.4%) and "Joy" (+3%), suggesting that for the primary language (English), the specialized vocabulary of DistilBERT yields better feature extraction.
- **Nuanced Emotions:** Surprisingly, the Multilingual model performed better on "Love" (+3.7%). This may indicate that mBERT's broader training corpus captures semantic nuances of affection that overlap across languages.
- **Data Imbalance:** Both models struggled significantly with "Pessimism" ( $F1 \approx 0.32$ ), likely due to fewer training samples and the subjective complexity of identifying pessimism compared to distinct emotions like anger.

## Key Insights on Multilingual Generalization

1. **Trade-off for Universality:** While mBERT lagged slightly behind the monolingual model in English accuracy, the drop in performance was minimal ( $< 3\%$  average). This validates mBERT as a viable candidate for production systems needing to support non-English users without training separate models.
2. **Semantic Overlap:** The successful zero-shot transfer (demonstrated by the model's ability to classify translated queries like "*Estoy muy feliz*" correctly) confirms that emotion-heavy embeddings align well across languages in the vector space.
3. **Difficulty with Subtlety:** The low scores on "Pessimism" across both architectures highlight a limitation in current Transformer models when dealing with abstract or context-heavy sentiments, regardless of the language base. Future improvements should focus on data augmentation for underrepresented classes.

## References

SemEval-2018 Task 1 (E-c) Dataset.

Available at: <https://www.kaggle.com/datasets/context/semEval-2018-task-ec>

