PROJECT REPORT

AI-Powered Virtual Assistant for Mental Health Support

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Components covered:

- Emotional Recognition
- Sentiment Analysis

Sentiment Analysis

Sentiment analysis involves classifying the sentiment expressed in a given piece of text as positive or negative. In the context of mental health support, understanding the sentiment of user inputs can be crucial for providing appropriate responses and recommendations. The dataset used for sentiment analysis is the IMDB Movie Reviews dataset, which contains labelled data indicating whether a movie review is positive or negative.

Approach

Data Pre-processing

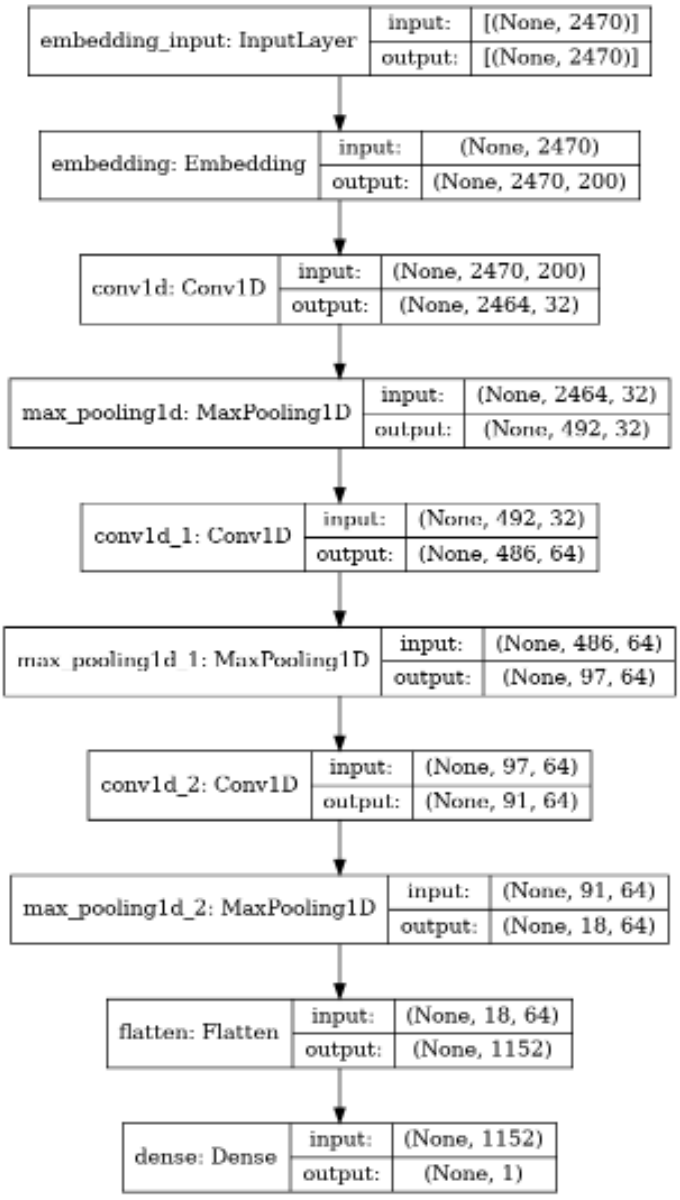
The initial step involved loading the IMDB Movie Reviews dataset and exploring its structure. The dataset was then examined to determine the appropriate length of input sequences for the neural network. The text data underwent pre-processing, including the removal of punctuation, to ensure consistent and clean input.

Tokenization

To facilitate the training of the deep neural network, a tokenization function was created to assign a unique integer to each word in the dataset. This tokenization process allowed the representation of words in a numerical format, essential for the subsequent stages of the deep learning model.

Model Development

The sentiment analysis model is based on a 1D convolutional neural network (CNN) implemented using TensorFlow and Keras. The model includes embedding layers to reduce the dimensionality of the data, convolutional layers for feature extraction, max-pooling layers for down-sampling, and a dense layer with a sigmoid activation function for binary classification. The model was trained using the Adam optimizer and binary cross entropy loss function.



Training and Evaluation

The dataset was split into training and testing sets, with the model trained over ten epochs. During training, the model's performance was evaluated on a validation set. The accuracy metric was used to assess the model's ability to correctly classify sentiments in the test set.

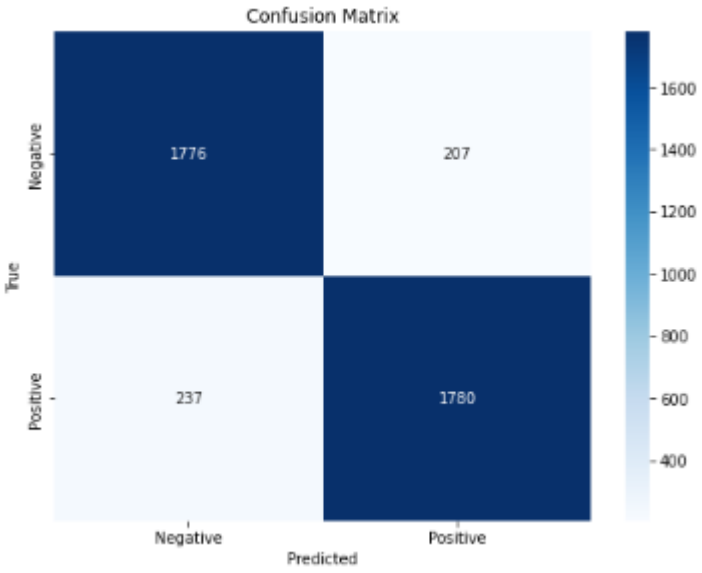
Results

The trained sentiment analysis model achieved a certain level of accuracy on the test set, indicating its capability to classify positive and negative sentiments in movie reviews. The accuracy was calculated based on the comparison of predicted and actual labels in the test set.

The final accuracy on the test set: **Accuracy: 89.975%**

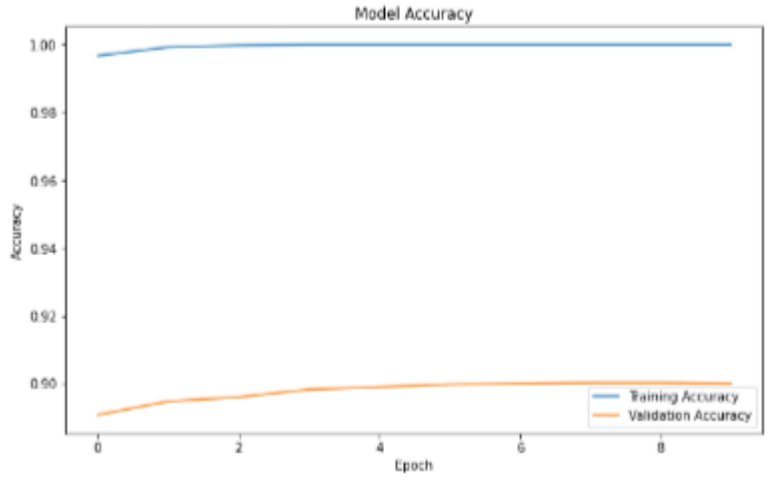
Confusion Matrix

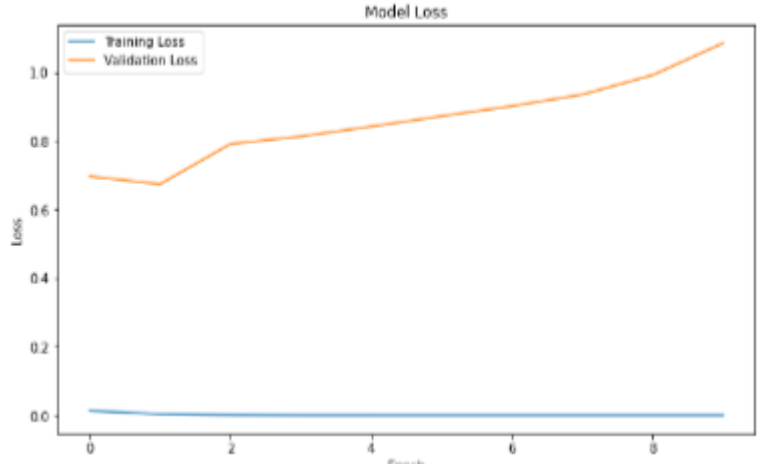
A confusion matrix was generated to provide a detailed breakdown of the model's performance, showcasing true positives, true negatives, false positives, and false negatives.



Loss and Accuracy Graphs

Graphs depicting the model's training and validation loss/accuracy over epochs are presented below:





Classification Report

	precision	recall	f1-score	support
Negative	0.88	0.90	0.89	1983
Positive	0.90	0.88	0.89	2017
accuracy			0.89	4000
macro avg	0.89	0.89	0.89	4000
weighted avg	0.89	0.89	0.89	4000

Challenges Faced

Throughout the development and training process, several challenges were encountered:

1. **Data Pre-processing:** Determining the optimal length for input sequences and handling punctuation required careful consideration to ensure meaningful tokenization.
2. **Model Tuning:** Adjusting hyperparameters and architecture to achieve optimal performance and prevent overfitting posed challenges during the training phase.
3. **Evaluation:** Assessing model performance and interpreting results, particularly in the context of sentiment analysis, involved addressing nuances in the dataset.

Conclusion

The sentiment analysis component of the AI-powered virtual assistant for mental health support represents a crucial step in understanding user sentiments and tailoring responses accordingly. The model developed demonstrates promising results on movie reviews and lays the foundation for the broader mental health support system.

References

- Cambria, E., Cambria, J., & Kosinski, M. (2019). Sentiment analysis using tensor network propagation. Neural Networks, 111, 84-98.
- De Choudhury, M., Gamon, M., & Counts, S. (2013). A survey of work on automatic detection of online mental health expressions. In Proceedings of the HCOMP and IUI workshops on social and emotional analysis of user generated content (pp. 5-10).

Emotional Recognition

Emotion recognition is a crucial component of mental health support, enabling the AI-powered virtual assistant to understand the user's emotional state. The AffectNet FER 2013 dataset was utilized for training the model, containing facial images annotated with seven different emotions: angry, disgust, fear, happy, neutral, sad, and surprise.

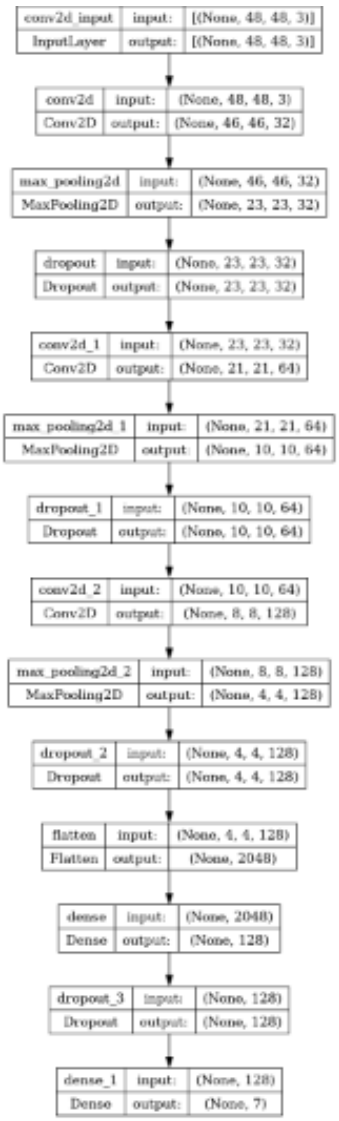
Approach

Data Preprocessing

The emotion labels were extracted from the file paths, and distinct labels were assigned to each emotion. Images were loaded from the AffectNet dataset directory, resized to 48x48 pixels, and preprocessed.

Model Development

The emotional recognition model is a Convolutional Neural Network (CNN) with dropout layers to prevent overfitting. The model consists of multiple convolutional layers, max-pooling layers, and dense layers. The final layer employs a softmax activation function to classify images into one of the seven emotion categories.



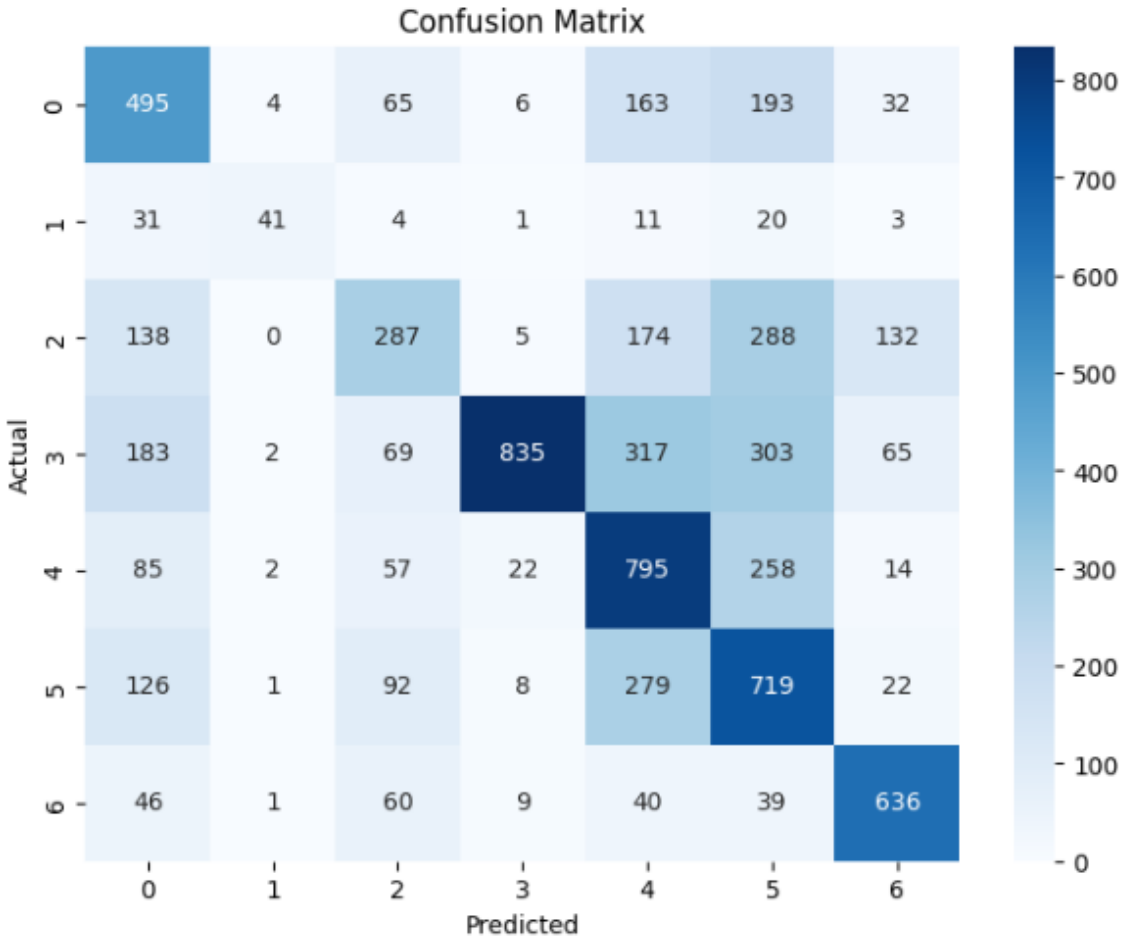
Training and Evaluation

The AffectNet dataset was divided into training and testing sets. Images were preprocessed by normalizing pixel values to the range [0, 1]. The model was trained for 30 epochs using the Adagrad optimizer and sparse categorical crossentropy loss. The training history was monitored for accuracy and loss metrics.

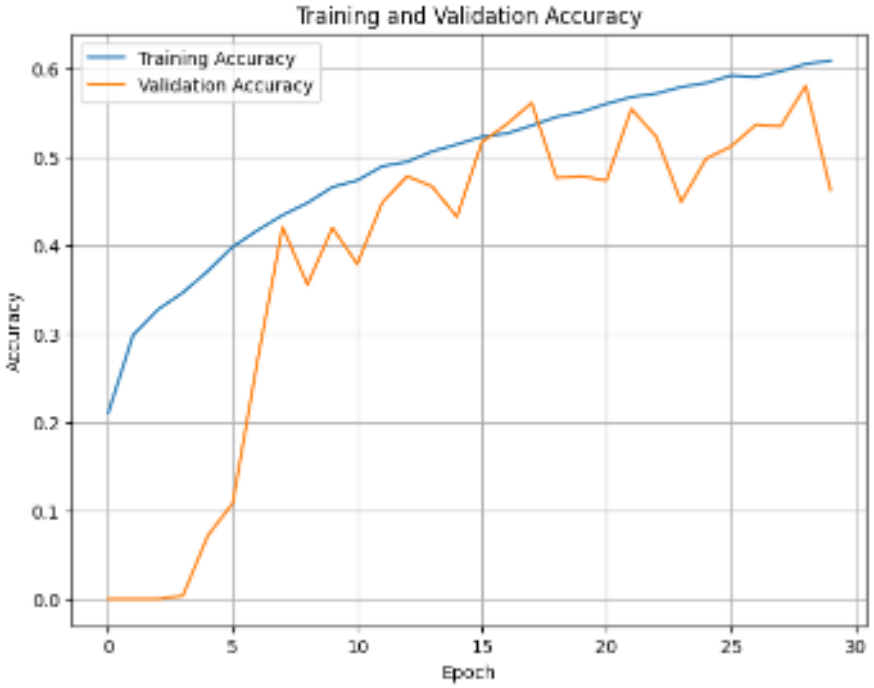
Results

The trained emotional recognition model achieved a **test accuracy of 53.05%**. While this accuracy may seem lower than the 60.90% achieved during validation, it still represents a reasonable performance in identifying facial expressions.

Confusion Matrix



Loss and accuracy graphs



Challenges Faced

Several challenges were encountered during the development and training process:

1. **Class Imbalance:** Addressing potential class imbalances among different emotions in the dataset.
2. **Overfitting:** Implementing dropout layers to mitigate overfitting and enhance the model's generalization.
3. **Training Time:** Balancing the trade-off between model complexity and training time.

Conclusion

The emotional recognition model represents a critical component of the AI-powered virtual assistant for mental health support. By accurately identifying user emotions, the system can provide more personalized and empathetic responses. While the achieved test accuracy of 53.05% may be slightly lower than the validation accuracy of 60.90%, it still demonstrates a reasonable performance in identifying facial expressions. This lays a foundation for future improvements and integration into the broader mental health support system.