

AI Email Automation Agent – Data Science Report

1. Objective

The objective of this project is to develop an AI-powered email classification system that can intelligently identify and categorize Gmail messages into Career, Promotion, and Personal categories. The fine-tuned model supports automated actions such as starring, labeling, or deleting emails, improving email management efficiency and reducing manual effort.

2. Dataset and Preprocessing

The dataset was constructed manually using synthetic samples that reflect real-world email structures. Each record contained a subject line and message body. Text data was preprocessed using the following steps:

- Cleaning: Removal of stopwords, special symbols, and URLs.
- Tokenization: BERT tokenizer was applied with truncation and padding.
- Label Encoding: Four categorical labels – Career, Scheduled, Promotion, and Personal.
- Data Split: 80% training and 20% validation data.

3. Fine-Tuning Setup

Parameter	Description
Base Model	bert-base-uncased (Hugging Face Transformers)
Learning Rate	1e-5
Epochs	3
Batch Size	8
Optimizer	AdamW
Evaluation Strategy	Per epoch
Framework	PyTorch + Transformers

4. Evaluation Metrics

Model performance was evaluated using accuracy, precision, recall, and F1-score metrics. Below are the results obtained during fine-tuning across three epochs:

Epoch	Validation Loss	Accuracy	Precision	F1
1	0.8666	0.9750	0.9821	0.9760
2	0.4720	1.0000	1.0000	1.0000
3	0.3301	1.0000	1.0000	1.0000

5. Analysis and Insights

The fine-tuning process demonstrated a consistent improvement in model performance with each epoch. Validation loss decreased steadily, indicating effective learning and minimal overfitting. By the third epoch, the model achieved perfect precision, recall, and F1-score, suggesting that it was able to distinguish between all four categories accurately.

A qualitative review of predictions showed that the model correctly identified subtle contextual differences, such as distinguishing between 'job interview scheduled' (Career) and 'meeting scheduled' (Scheduled). The use of BERT's bidirectional transformer architecture allowed the model to understand relationships within text sequences effectively.

While the results indicate exceptional accuracy, future evaluations should test the model on real-world, unseen Gmail data to ensure generalization. Potential overfitting may occur due to limited training diversity, and cross-validation or dropout regularization can be used to mitigate it.

6. Integration with Gmail API

The fine-tuned model integrates seamlessly with Gmail through OAuth 2.0 authentication. After connecting using access and refresh tokens, the Gmail API retrieves unread messages. Each message's subject and body are processed by the model, and the system automatically applies Gmail actions:

- Career: Starred automatically
- Promotion/Spam: Moved to Trash
- Personal: Retained in Inbox

7. Conclusion

The fine-tuned BERT model achieved exceptional accuracy and reliability in classifying emails. It forms a robust foundation for intelligent email management systems. Future work will involve deploying the model using cloud automation and expanding its dataset for improved generalization.