AI Email Automation Agent – Architecture Document

1. Introduction

This document provides a detailed overview of the architecture, workflow, and model design of the AI-powered Email Automation Agent. The agent automatically categorizes incoming emails into predefined classes such as career, scheduled, promotional, and personal, and performs automated actions using the Gmail API (e.g., starring, labeling, or deleting emails).

2. System Components

Dataset Creation

A synthetic dataset is generated with four categories: Career, Scheduled, Promotion, and Personal.

Each class includes representative email subject lines and bodies. The data is augmented using text variations (lowercasing, Re:, Fwd:) to improve model generalization.

Model Training

The BERT-base-uncased model from Hugging Face Transformers is fine-tuned using this dataset.

It is trained for 3 epochs with a learning rate of 2e-5 and batch size of 4. Evaluation metrics include accuracy, precision, recall, and F1-score.

Email Classification Pipeline

After training, the model is saved locally and used via the Hugging Face pipeline API for text classification.

Gmail API Integration

The Gmail API connects through OAuth 2.0 authentication.
First, an OAuth client ID and secret are created in Google Cloud and saved in credentials.json.
Using OAuth Playground or a script, we exchange an authorization code for an access and refresh token.
These tokens authenticate the app, allowing secure access to Gmail services through the API.

OAuth2 authentication is implemented using Google Auth libraries. The agent fetches unread emails, extracts their subjects and bodies, predicts categories using the model, and performs actions such as starring career mails, labeling scheduled ones, and moving promotional mails to trash.

Rule-based automation defines what to do for each predicted label. For example, 'career' emails are starred, 'scheduled' are labeled, and 'promotions' or 'spam' are moved to Trash.

3. Interaction Flow

1. The agent authenticates with Gmail using OAuth2 credentials.
2. It retrieves unread messages via the Gmail API.
3. The text (subject + body) of each email is preprocessed.
4. The fine-tuned BERT classifier predicts the email category.
5. Based on the label, the system performs corresponding Gmail operations (star, label, or trash).
6. The process repeats periodically to handle new emails automatically.

4. Workflow Diagram (Text Representation)

The system architecture follows this flow:

[User Inbox] — [Gmail API] — [Text Preprocessor] — [BERT Classifier] — [Automation Rules] — [Gmail Actions]

Components interact as follows:
- The Gmail API provides access to email metadata and content.
- The Hugging Face pipeline classifies each message.
- The Decision Logic triggers appropriate Gmail API methods (modify, label, trash).
- Logs or console outputs record each processed email.

Detailed Process Flow

Phase 1: Authentication

 User Credentials → OAuth2 Flow → Access Token → Gmail API Client

Phase 2: Email Processing Pipeline

Gmail API → Message List → Message Details → Text Extraction → Cleaned Text

Phase 3: Classification Pipeline

Cleaned Text → Tokenizer → BERT Model → Softmax → Prediction + Confidence

Phase 4: Action Router

Prediction → Label Router → Gmail API Action → Result Logging

- "career" → STAR email
- "scheduled" → LABEL as "Scheduled"
- "promotion" → TRASH email

- "personal" → KEEP in inbox

Phase 5: Continuous Operation

Process Complete → Wait Interval → Check New Emails → Repeat Process

5. Model Selection

The BERT-base-uncased model was chosen for its balance between accuracy and efficiency in text classification. Its bidirectional transformer architecture captures contextual meaning in both subject and body text. Fine-tuning it on a custom dataset enables reliable detection of nuanced email intents such as scheduling, promotion, and career-related communication.

6. Future Enhancements

- Integrate DeepSeek or OpenAI models for improved understanding and multilingual support.
- Add a web dashboard for visualizing email statistics and model predictions.
- Implement daily automation using Google Cloud Functions or Apps Script.
- Enhance the dataset with real user emails (with anonymization) for better generalization.

The following diagram illustrate the architecture and operational flow of the AI Email Automation Agent.
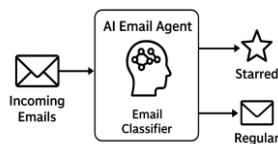

Figure: The AI Email Agent processes incoming emails using the Gmail API, classifies them using a fine-tuned BERT model, and triggers Gmail actions such as starring, labeling, or deleting emails based on their predicted category.