SPEAK

Sentiment and Pattern Evaluation of ATC Keywords

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Category: Improve Aviation Safety

Introduction

Air traffic control (ATC) communications play a critical role in aviation safety. Miscommunication or the presence of hazardous attitudes—anti-authority, impulsivity, invulnerability, macho, and resignation—can contribute to unsafe situations. Identifying these attitudes in real-time can enhance situational awareness and reduce risks in the National Airspace System (NAS).

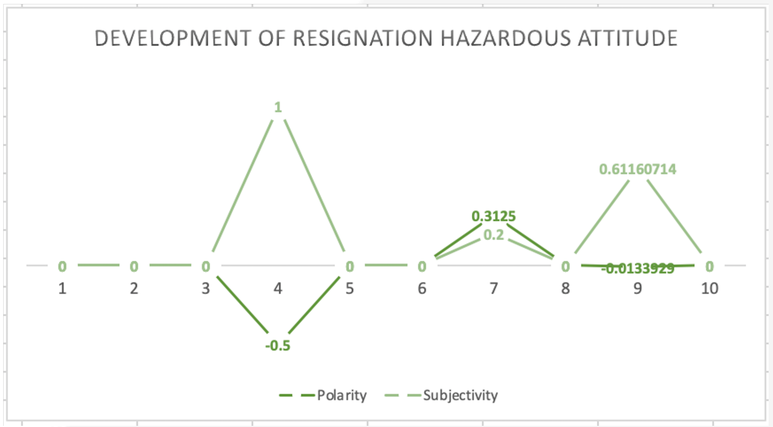
This project explores how artificial intelligence (AI) and machine learning (ML) can be used to detect hazardous attitudes in ATC transcripts, providing a proactive approach to aviation safety.

Objective

The goal of this research is to develop an AI-driven model that can analyze ATC transcripts and classify hazardous attitudes to improve aviation safety.

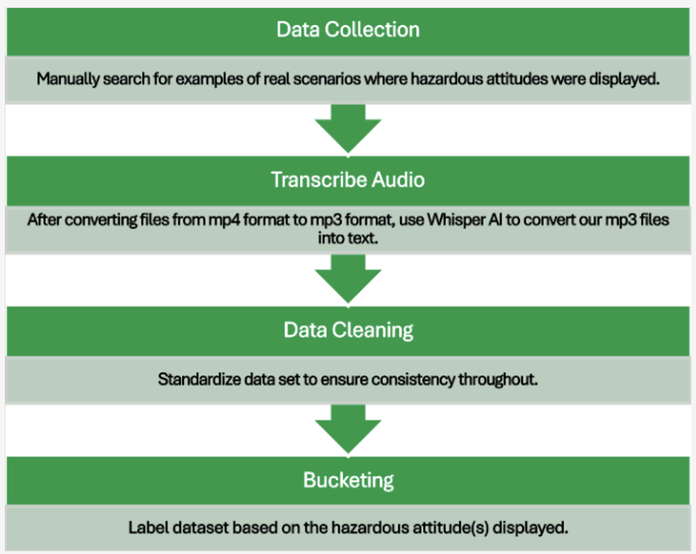
Goals:

- Train an ML model to detect hazardous attitudes in ATC conversations.
- Enhance safety monitoring by identifying linguistic patterns associated with risky decision-making.
- Develop a scalable system that can assist safety teams and regulators in improving communication standards.



Data Collection & Preprocessing

- **Data Sources:** Multiple sources, including publicly available archives and incident reports.
- **Transcription:** Background noise, overlapping speech, and phraseology made transcription difficult.
  - Whisper AI improved transcription accuracy.
- **Text Preprocessing:** Standardized text format and removed extraneous data.
- **Text Bucketing:** Assigned hazardous attitudes to text excerpts and prepared data for model training.



Implementation

- **Sentiment Capture:** Python TextBlob library assessed polarity and subjectivity of text.

- **Model: Fi**ne-tuned BERT-based natural language processing (NLP) model trained to classify hazardous attitudes in ATC communications.
- **Pipeline:**
  - Normalized and tokenized dataset and converted to tensors for machine-readable format
  - Split dataset into groups for training and validation
  - Created and trained model
  - Evaluated model performance
  - Used BERT model to analyze and classify attitudes

Results and Key Findings

Model Performance:

- Initial model achieved 25% accuracy, 17.9% precision, and 25% recall.
- Model successfully identified hazardous attitudes with a moderate level of confidence.

Eval_Loss	Eval_Accuracy	Eval_Precision	Eval_Recall	Eval_F1
1.60619497	0.125	0.015625	0.125	0.02777778
1.52267909	0.625	0.390625	0.625	0.48076923
1.57243431	0.25	0.068181818	0.25	0.10714286
1.52013719	0.25	0.178571429	0.25	0.20833333

Challenges and Mitigations

Challenges	Mitigations
Limited dataset	Expand dataset with more labeled examples
Class imbalance	Data augmentation/synthetic data generation
Contextual ambiguity	Increase text window size
Speaker inflection	Personnel discretion

Summary:

This study demonstrates that AI can effectively detect hazardous attitudes in ATC communications, providing valuable insights for aviation safety during operations in the NAS.

Future Improvements:

- Expand dataset to include more diverse ATC scenarios.
- Refine the model using context-aware NLP techniques.
- Convert the model to a cloud-based system for real-time results.
- Validate results with aviation safety experts for real-world applicability.

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