Vivekanand Education Society's Institute of Technology

Department of Computer Engineering

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Project Synopsis (2024-25) - Sem V

CRISIS CALL

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ABSTRACT:

This project investigates the application of advanced analytical techniques, including Association Rule Mining and Generative AI, to enhance the analysis of emergency 911 call data. By identifying frequent patterns and relationships within the data, such as common co-occurrences of call types, times, and locations, Association Rule Mining provides valuable insights. The incorporation of Weather and Google Maps APIs, along with hotspot analysis and satellite imagery, enriches the contextual understanding of emergency situations. Natural Language Processing (NLP) and Retrieval-Augmented Generation (RAG) techniques are utilized to extract and simulate information, enhancing scenario planning and decision-making processes.

The integration of these methodologies aims to improve predictive capabilities and optimize emergency response strategies, thereby enhancing public safety outcomes. By generating realistic synthetic data and providing a comprehensive analysis, the project seeks to support more informed decision-making in emergency management systems, ultimately contributing to more efficient and effective responses to emergencies.

INTRODUCTION:

Effective emergency response is essential for minimizing harm and ensuring public safety in critical situations such as road accidents, fire incidents, and health crises. The ability to analyze emergency 911 call data can greatly enhance the understanding of these events and improve the efficiency of emergency services.

For better road infrastructure or traffic management. Similarly, an elevated number of fire incidents in certain neighborhoods could indicate the need for enhanced fire prevention measures. Moreover, a recurring pattern of respiratory emergencies in particular regions might reflect environmental issues, such as high levels of air pollution, that require immediate attention.

By applying association rule mining to emergency call data, this project aims to identify these patterns and correlations. The insights gained will enable emergency response teams to better understand the demand for services in various areas and address underlying causes that contribute to frequent emergencies. Ultimately, this approach will lead to more informed decision-making, improved allocation of resources, and targeted interventions that enhance both emergency response and community safety.

Our project leverages advanced technologies such as Natural Language Processing (NLP), generative AI reports, and prediction through satellite images. The system will feature three dashboards: an Organization Dashboard for managing resources and receiving real-time notifications, a User Dashboard for reporting incidents and receiving safety alerts, and an Admin

Dashboard for monitoring and maintaining the platform. This multifaceted approach ensures a robust and responsive emergency management system, significantly contributing to public safety and wellbeing.

PROBLEM STATEMENT:

In the field of emergency response management, it is crucial to analyze patterns and trends in emergency 911 call data to enhance the efficiency and effectiveness of response strategies. The ultimate goal is to provide actionable intelligence to emergency services and policy makers to improve public safety and emergency response protocols.

PROPOSED SOLUTION:

Objective: To analyze and optimize emergency response by integrating 911 call data with weather conditions, geographic information, and advanced analytics. The goal is to improve response times, resource allocation, and predictive capabilities.

Components:

1. Natural Language Processing (NLP): Analyzes the text of 911 calls for sentiment and urgency.
2. RAG: Uses real-time data to dynamically prioritize emergency responses.
3. Weather API: Provides real-time and historical weather data (e.g., temperature, precipitation, wind speed).
4. Google Maps API: Offers geolocation services, route optimization, and traffic information.
5. Emergency 911 Call Data: Includes call logs with time, location, and nature of emergencies.Hotspots Analysis: Identifies high-frequency emergency locations.
6. Satellite Images: Provides current and historical imagery for analysis of affected areas.

METHODOLOGY:

1.Data Collection:

- ➔ Obtain the dataset containing Emergency 911 calls. You mentioned using a dataset from Kaggle, specifically from Montgomery County in Pennsylvania.
- ➔ The dataset attributes include the type of emergency, timestamp, and the township where the emergency occurred.

2.Data Preprocessing:

- ➔ Eliminate rows with missing values.
- ➔ Convert numerical values (such as timestamps) to categorical features (e.g., day of the week, month, and time of day).

3.Natural Language Processing (NLP):

- ➔ NLP techniques can enhance the analysis of emergency calls by extracting meaningful information from the textual content.

a.Text Extraction:

Extract relevant information from the call descriptions (e.g., keywords, phrases).

b.Feature Extraction:

Convert text data into numerical features (e.g., bag-of-words, TF-IDF vectors).

c.Named Entity Recognition (NER):

Identify entities such as locations, dates, and emergency types.

d.Sentiment Analysis (optional):

Determine the sentiment (positive, negative, neutral) expressed in the calls.

4.Association Rule Mining (ARM):

- ➔ ARM is a rule-based machine learning method for discovering interesting relations between variables in large databases.
- ➔ Use algorithms like Apriori or FP-Growth to generate frequent itemsets and association rules.
- ➔ Set appropriate thresholds for support and confidence:
- ➔ Higher support for small databases ensures significant item sets.

- ➔ Lower support for large databases ensures enough item sets are found.
- ➔ Consider the concept of “lift”:
- ➔ Lift > 1 indicates dependency between antecedent and consequent.
- ➔ Higher confidence and lower lift may still be valuable for prediction.

5.Rule Application Graph (RAG):

- ➔ RAG is a powerful tool for representing and reasoning about complex rules.

a.Rule Preparation:

- ➔ Define rules based on patterns discovered from ARM or NLP.
- ➔ Express rules in a structured format (e.g., IF-THEN statements).

b.Rule Generation:

Construct a graph where nodes represent rules and edges indicate dependencies.

c.Rule Evaluation:

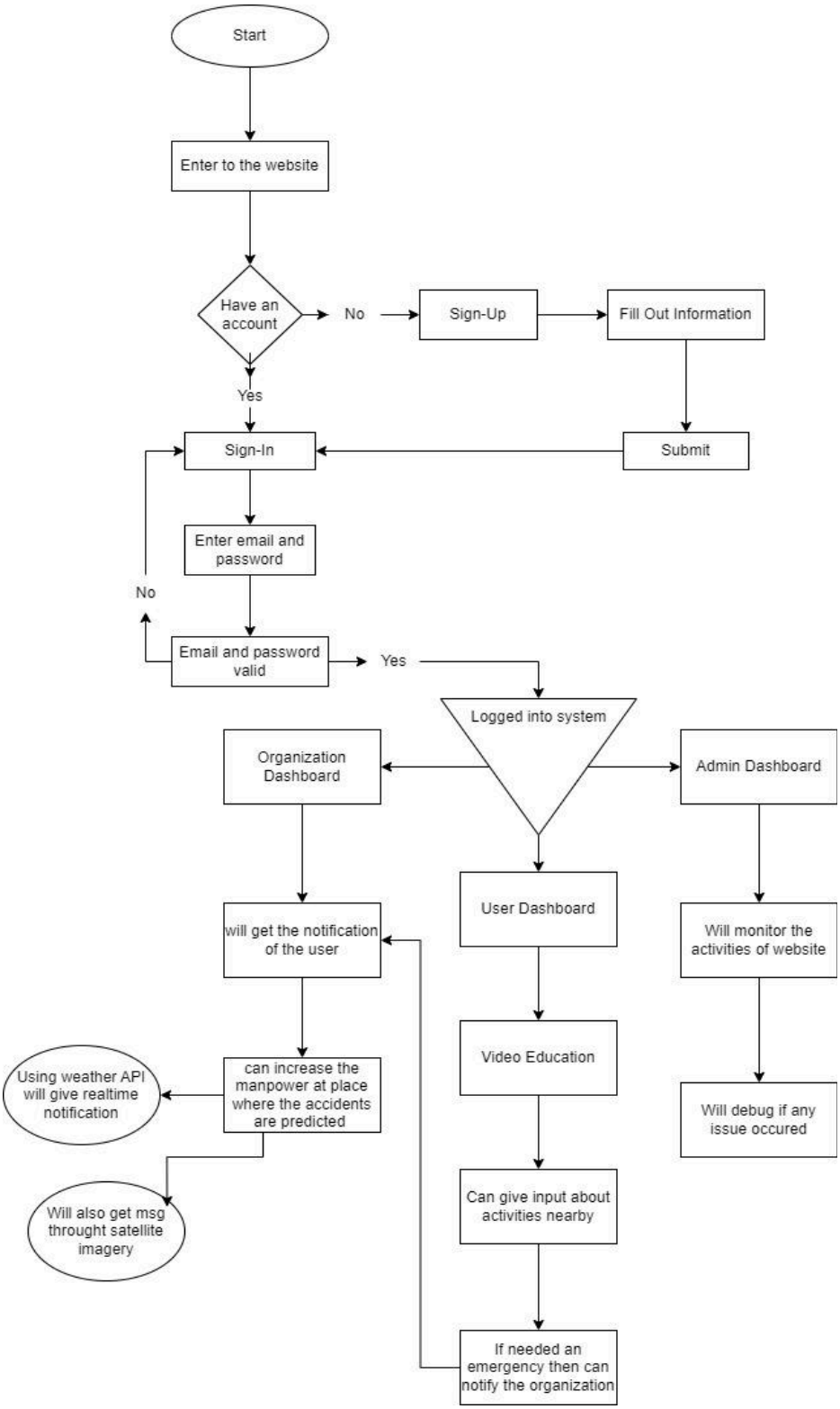
- ➔ Evaluate the rules against the dataset.
- ➔ Consider the order of rule application (priority).

6.Results Visualization and Reporting:

- ➔ Visualize the combined insights (e.g., graphs, tables).
- ➔ Summarize the impact of rules and NLP features.
- ➔ Include this information in your project report.

BLOCK DIAGRAM:

Frontend-



Backend-


Data
Data Preprocessing
Data Normalization
Data Cleaning
Data Transformations
Natural Language Processing (NLP)
Text Extraction
Named Entity Recognition (NER)
Text Cleaning
Feature Extraction
Association Rule Mining (ARM)
Data Preparation
Rule Generation
Rule Evaluation
Association Rule Mining (ARM)
Data Preparation
Rule Generation
Rule Evaluation
Retrieval-Augmented Generation (RAG)
Contextual Retrieval
Generative Analysis
Report Generation
Analyze Association Rules
Results Interpretation
Evaluate Findings
Visualization
Results Interpretation
Analyze Association Rules
Evaluate Findings
Visualization

HARDWARE , SOFTWARE & TOOLS REQUIREMENT:

1. Machine Learning and Data Analysis:
    - Python and R programming languages.
    - Libraries such as Pandas, NumPy, SciPy, scikit-learn for data analysis and machine learning.
    - TensorFlow or PyTorch for training NLP and generative AI models.
2. Natural Language Processing:
    - NLP libraries such as spaCy, NLTK, or Hugging Face Transformers.
    - Text preprocessing tools and libraries.
3. Satellite Image Processing:
    - Libraries like OpenCV, GDAL, or Rasterio.
    - Satellite imagery sources like Google Earth Engine or Sentinel Hub.
4. Association Rule Mining:
    - Libraries like MLxtend for association rule mining.
    - Data mining tools such as Weka.
5. Dashboards and Visualization:
    - Web development frameworks such as Django for backend development.
    - Front-end libraries/frameworks like HTML,CSS,Javascript.
6. Generative AI Reports:
    - Libraries and frameworks like Gemini for generating AI reports.
    - Integration tools for embedding generative AI into dashboards.

PROPOSED EVALUATION MEASURES:

To evaluate the effectiveness of the methodologies in analyzing emergency 911 calls, several key metrics are considered across different components. For Association Rule Mining, measures like support, confidence, and lift are used to identify and assess the strength of patterns in call data. The integration of Weather and Google Maps APIs is evaluated through correlation analysis and predictive accuracy, assessing the relationship between weather conditions and call volumes, as well as the impact of geospatial analysis on response times and hotspot identification. Satellite images are evaluated based on the accuracy of damage assessments and the timeliness of information extraction, crucial for effective emergency response.

Natural Language Processing (NLP) techniques are assessed using text classification accuracy and sentiment analysis, ensuring accurate prioritization of calls based on urgency. The Retrieval-Augmented Generation (RAG) approach is evaluated by the quality of synthetic data generated and the validity of scenario simulations. Overall system effectiveness is measured through response time reduction, resource optimization, and improvements in public safety

outcomes, such as reduced fatalities or injuries. These comprehensive evaluation measures ensure the project's methodologies significantly enhance emergency response strategies and public safety.

CONCLUSION:

This project aims to provide an advanced analytical tool for organizations to systematically analyze emergency 911 call data. This project facilitates the identification of patterns and trends in emergencies occurring across different regions and time periods. This comprehensive analysis will enable organizations to not only understand the underlying causes of frequent incidents but also to proactively prepare for and mitigate future emergencies.

Through detailed insights and predictive analytics, this project will empower emergency management teams to allocate resources more effectively, implement targeted preventative measures, and enhance overall response strategies. Ultimately, this project will contribute significantly to reducing the occurrence of emergencies and improving the efficiency and efficacy of emergency response operations.

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Group mentor signature

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