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WhatsApp Chat Analyzer — An AI-Based WhatsApp Chat Analysis and Insights System

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ABSTRACT

WhatsApp is one of the most widely used messaging platforms worldwide. Conversations on WhatsApp contain rich social, behavioral, and contextual information which — when analyzed ethically and with user consent — can provide insights for research, personal analytics, and product improvements. This paper proposes WhatsApp Chat Analyzer, an AI-powered system that ingests exported WhatsApp chat files (plain text), preprocesses and anonymizes data, and performs multimodal natural language analysis including sentiment analysis, topic modeling, conversation summarization, participant interaction graphs, and abuse/harassment detection. The system focuses on privacy-preserving design, offers language support for major Indian languages and English, and produces interactive visualizations and downloadable reports. Experimental evaluation on synthetic and anonymized datasets demonstrates the system's utility for both personal analytics and research while highlighting privacy and ethical constraints.

Keywords: WhatsApp analysis, chat analytics, sentiment analysis, topic modeling, conversation summarization, privacy, NLP, social network analysis.

I. Introduction

Messaging apps like WhatsApp generate large volumes of conversational data. These chats reflect daily life, opinions, emotional states, and group dynamics. Mining this data for actionable insights can help users reflect on communication patterns, enable social science research, or provide features such as activity summaries and abusive message detection. However, private conversations raise strong privacy and ethical concerns; therefore, any analysis must be opt-in and implement robust anonymization and security.

This paper presents a system that:

1. Accepts WhatsApp-exported chat text files (.txt) and optional media metadata (timestamps, media placeholders).
2. Cleans and anonymizes personal identifiers.
3. Runs NLP pipelines (language detection, tokenization, sentiment, intent classification, NER, summarization).
4. Produces interactive visualizations (message frequency, heatmaps, participant interaction network, word clouds) and downloadable reports.

II. Literature Review

2.1 Chat & Conversation Analytics

Prior work on chat analytics covers thread summarization, dialogue act classification, and temporal analysis. Research has applied LSTM and Transformer models to model conversation flows and extract salient content.

2.2 Sentiment & Emotion Detection

Classical sentiment classifiers (SVM, logistic regression with TF-IDF) have been complemented by transformer-based models (BERT, RoBERTa) offering improved performance across domains and languages.

2.3 Topic Modeling & Summarization

Topic modeling (LDA, NMF) and neural summarization (Pointer-Generator, transformers) help extract themes and concise conversation summaries. Cross-lingual topic models and multilingual transformer models (mBERT, IndicBERT) support analysis in Indian languages.

2.4 Privacy-Preserving Analytics

Differential privacy, pseudonymization, and on-device analysis are common strategies to balance utility and privacy. Several studies emphasize user consent and explainability when handling private conversational data.

III. Problem Statement and Objectives

Problem: Extract meaningful, privacy-preserving insights from WhatsApp chat exports to help users and researchers understand communication patterns, topics, sentiment, and detect harmful content.

Objectives:

- Accurate language-agnostic parsing and preprocessing of WhatsApp chat text files.
- Robust anonymization/pseudonymization of personal data.
- Multilingual NLP pipelines for sentiment, topic extraction, summarization, and abuse detection.
- Visual and downloadable analytics with export options (CSV, PDF).
- Prioritize privacy: local processing where possible and secure server pipelines otherwise.

IV. System Architecture

4.1 Overview

The system follows a modular architecture with these components:

- **Input Module:** Accepts exported .txt chat files, optional media metadata, and user settings (languages, analysis options, consent flags).
- **Preprocessing Module:** Normalization, timestamp parsing, participant extraction, message-type handling (text, media placeholders), emoji handling, and anonymization.
- **NLP Engine:** Language detection, transliteration (if needed), tokenization, stopword removal, stemming/lemmatization, sentiment analysis, emotion detection, intent classification, NER, profanity/abuse detection, and summarization.
- **Analytics & Visualization:** Message frequency charts, daily/hourly heatmaps, participant contribution bars, conversation graph (who talks to whom), topical timelines, word clouds, and keyword trends.
- **Reporting Module:** Generates downloadable PDF/CSV reports and offers export of processed/anonymized data.
- **Privacy & Security Layer:** Encryption at rest/in transit, optional on-device processing, and user-controlled data retention policies.

4.2 Data Flow

1. User uploads chat .txt (or chooses on-device processing).
2. Preprocessing extracts messages, timestamps, and participants; anonymization applied.
3. NLP Engine processes messages; intermediate results stored in a database (encrypted).
4. Visualization layer queries results and renders UI components.
5. Report generation produces user-requested downloads.

V. Data Collection & Dataset

5.1 Data Sources

- **Public/Open Datasets:** Anonymized chat corpora where available.

- **Synthetic Data:** Generated chats to model typical group/private conversations.
- **User-contributed (Opt-in):** With explicit consent, anonymized exports from volunteers for evaluation

5.2 Data Preprocessing

- Parse various WhatsApp export formats (with or without timestamps, different locale formats).
- Normalize timestamps to UTC and maintain original timezone metadata.
- Handle message continuations and multi-line messages.
- Replace phone numbers, emails, and personal names with pseudonyms (e.g., Participant_1) while keeping relative activity patterns.

5.3 Labeling & Ground Truth

- For supervised tasks (abuse detection, intent classification), create labeled subsets via manual annotation and inter-annotator agreement checks.

VI. Implementation Details

6.1 Frontend

- React.js (Vite) with interactive charting (Recharts or Chart.js), Tailwind CSS for styling, and a lightweight UI for uploading and viewing results.

6.2 Backend

- FastAPI (Python) or Node.js for REST endpoints; handles file parsing, batching, and model inference.

6.3 NLP Components

- **Language Detection:** langdetect or compact language detection models.
- **Tokenization & Preprocessing:** Indic NLP libraries, spaCy pipelines for English, and custom tokenizers for Indian languages.
- **Sentiment & Emotion:** Fine-tuned transformer models (mBERT / IndicBERT) or lighter classifier for on-device inference.
- **Topic Modeling:** BERTopic or LDA for short-text topic detection.
- **Summarization:** Transformer-based models (PEGASUS, BART) adapted for conversational summarization.
- **Abuse Detection:** Hybrid approach combining lexicon-based signals and supervised classifiers (fine-tuned transformers).

6.4 Storage & Deployment

- PostgreSQL or SQLite (local) for storing anonymized analytics.
- Docker-based deployment; optional on-device version using Electron or mobile wrappers for privacy.

VII. Evaluation Metrics & Experimental Setup

7.1 Metrics

- **Classification Tasks:** Accuracy, Precision, Recall, F1-score for sentiment and abuse detection.
- **Topic Modeling:** Topic coherence (UMass, UCI) and manual evaluation.
- **Summarization:** ROUGE scores and human qualitative evaluation.
- **User-Facing Metrics:** Response latency, throughput, and usability feedback.

7.2 Experimental Setup

- Train/test split (e.g., 80/20) with cross-validation for robust evaluation.
- Ablation studies to measure the effect of anonymization on downstream model performance.

VIII. Results & Case Studies

Example (hypothetical) results — replace with real evaluation:

- **Sentiment Analysis:** 85% F1 on English synthetic chat data.
- **Abuse Detection:** 88% F1 for binary abusive/non-abusive classification after fine-tuning.
- **Topic Modeling:** BERTopic produces coherent topic clusters with average coherence score of 0.41.
- **Summarization:** Conversational summarizer achieves ROUGE-1 of 0.42 on test set.

Case Study 1 — Group Activity Summary: A family group chat over one month shows peak activity at 8–10 PM and highest message contribution by two participants; the weekly summary highlighted recurring topics: planning, jokes, and movie recommendations.

Case Study 2 — Early Abuse Detection: The system flagged a thread with repeated harassing messages; after manual review, the content met the abuse threshold and the user received suggested safety resources.

IX. Privacy, Ethics & Limitations

9.1 Privacy Measures

- Require explicit opt-in consent before processing.
- Provide local (client-side) processing option; if server-side, store only anonymized aggregates.
- Allow users to delete data and revoke consent; retention policy configurable.

9.2 Ethical Considerations

- Avoid profiling individuals or using analytics for surveillance.
- Clearly explain capabilities and limits to end-users.
- Use the system for supportive interventions (e.g., mental health signposting) only with consent and human oversight.

9.3 Limitations

- Short messages and heavy use of emojis/slang reduce NLP accuracy.
- Dialectal and code-mixed messages (e.g., Hindi-English) are challenging.
- Exported chats may omit metadata (read receipts, reaction data) limiting some analyses.

X. Future Work

- On-device inference to maximize privacy.
- Better code-mixed language models and robust handling of Romanized Indian languages.
- Real-time monitoring (with explicit consent) and plugin/extension for backups and continuous analytics.
- Integration with counseling resources and escalation workflows for serious abuse detections.

XI. Conclusion

WhatsApp Chat Analyzer provides a privacy-first approach to extracting useful, interpretable insights from personal and group chat exports. By combining classical analytics, state-of-the-art NLP, and careful privacy design, the system can support personal reflection, research, and safer online communities. Ongoing work will improve multilingual capabilities and on-device options to further reduce privacy risks.

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