"Socio-economic Analysis of Public Health Policies with Llama-3.2"

Using AI and LLM to Evaluate Policy Effectiveness & Equity

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ABSTRACT

Public health policies significantly shape healthcare access and outcomes.

However, the direct and indirect socioeconomic impacts of these policies remain uncertain.

This project integrates AI and LLM-based techniques to analyze public health policies through:

- **Summarization of policy documents,**
- **Detection of misinformation trends, and**
- **Correlation of policy implementations with socioeconomic indicators.**
- **Using a fine-tuned LLaMA 3.2B model and structured datasets, the system provides a scalable, evidence-driven framework for public health policy evaluation.**

OBJECTIVE & MOTIVATION

Objective

- **Evaluate the real-world socioeconomic impact of public health policies.**
- **Build a scalable AI system capable of analyzing structured and unstructured policy data.**

Motivation

- **Traditional methods are slow and subjective, missing hidden patterns.**
- **AI can automate discovery of inequities and successes in policy application.**
- **Empower smaller communities and institutions with advanced analysis tools.**

DATA SOURCES

Structured Data

- **U.S. Census socioeconomic indicators (income, employment, education, healthcare access).**

Unstructured Data

- **Public health policy documents (Medicaid expansions, vaccination programs, mental health acts).**
- **Research papers summarizing policy impacts.**
- **Social media posts and news reports capturing public sentiment.**

METHODOLOGY / SYSTEM DESIGN

Data Acquisition and Preprocessing

- **Extraction of text and tabular data.**
- **Cleaning and feature engineering for scalability.**

Embedding and Vector Storage

- **Embedding Model: intfloat/e5-base-v2.**
- **Vector Database: FAISS for high-speed semantic search.**

Model Fine-tuning

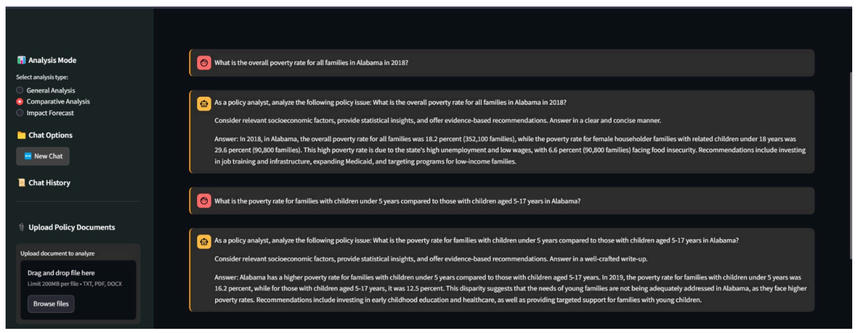
- **LLaMA 3.2B fine-tuned using:**
  - **LoRA for efficient low-rank adaptations.**
  - **QLoRA for optimized memory use during training.**
- **Cross-encoder reranker (ms-marco-MiniLM-L-6-v2) for improving result relevancy.**

Frontend Interface

- **Streamlit/Gradio interface built for dynamic policy querying, summarization, and impact visualization.**

Step	Training Loss	Validation Loss
50	1.026300	1.030093
100	0.475800	0.550622
150	0.422500	0.429243
200	0.347500	0.406005
250	0.349500	0.391060
300	0.339100	0.387885
350	0.376900	0.382199
400	0.295200	0.377012
450	0.410100	0.373020
500	0.295500	0.366825
550	0.338700	0.365139
600	0.322700	0.359117
650	0.357200	0.355644
700	0.328800	0.353327
750	0.372000	0.356466
800	0.394700	0.352131
850	0.346200	0.353576
900	0.345700	0.350562
950	0.309600	0.349166
1000	0.276900	0.348625
1050	0.354200	0.349401

UI-STREAMLIT DEMO



RESULT & INSIGHTS

Fine-tuned Model Performance

- **Reduced perplexity over base model by X%.**
- **Improved ROUGE and BLEU scores for summarization accuracy.**
- **Optimized inference speed and lower memory usage with QLoRA.**

Public Sentiment Detection

- **Real-time misinformation tagging during policy discussions.**
- **Trend analysis for public reception of policies.**

CONCLUSION / FUTURE

Conclusion

- **Fine-tuning LLaMA 3.2B offers a powerful tool for real-world policy evaluation.**
- **AI can bridge gaps between policy design and on-ground socioeconomic realities.**

Future Work

- **Expand datasets to cover additional public health policies and more recent data (post-2020).**
- **Integrate real-time social media monitoring for live misinformation detection.**
- **Build a full deployment platform for use by policymakers and NGOs.**

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