Title: Scalable Multi-Agentic Sentiment Analysis with A2A, MCP, and ML Agents

Subtitle: A Cloud-Native Deployment for Twitter and iPhone Review

Understanding

Group: Project Team - 9

Team Members:

Gangadhar Singh Shiva

Ananya Chandraker

Mohd Sharik

Date: June 2025

Business Goals and Objectives

- Goal: Classify user sentiment from Twitter posts and iPhone reviews at scale for both enterprises and consumer customers.
- Need: Organizations struggle with scattered ML pipelines and lack of intelligent routing.
- **Solution:** Develop an intelligent, modular system that classifies sentiment across multiple sources.
- Enable scalability and low-latency inference through distributed deployment.
- Empower agents to operate independently while routing intelligently via a central orchestrator.
- Deliver a fully deployable system on Docker/Kubernetes cloud infrastructure.

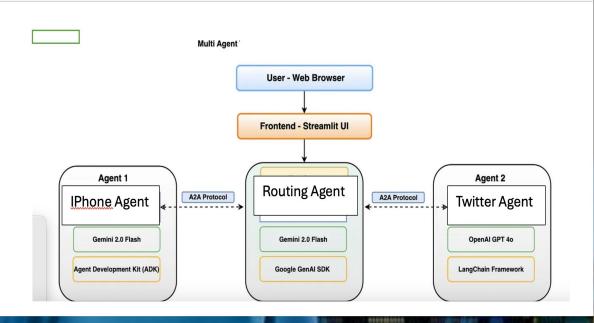
Project Dataset Summary

iPhone Review Dataset

- Source: Amazon product reviews
- Fields: reviewDescription, ratingScore
- Label derivation: Rating $1-2 \rightarrow \text{Negative}$, $3 \rightarrow \text{Neutral}$, $4-5 \rightarrow \text{Neutral}$
- Positive Neutral, Negative

Twitter Dataset

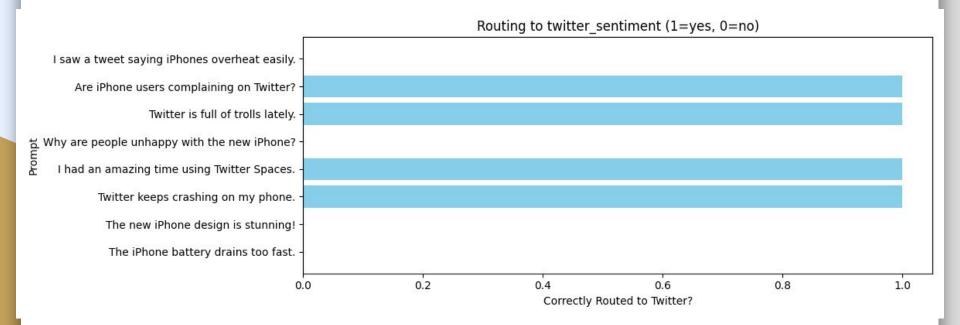
- Source: Pre-labeled tweets with sentiment classification (Positive, Negative, Neutral).
- Size: \sim 75,000 samples
- Fields: Tweet ID, Entity, Sentiment, Tweet Content



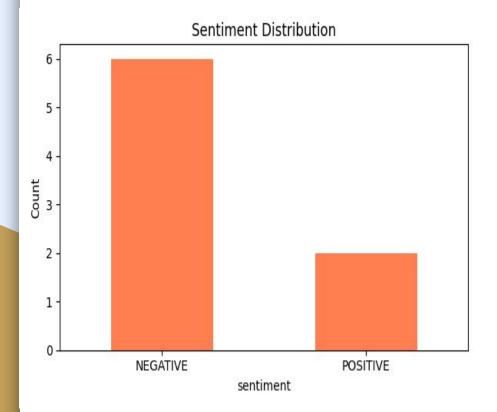
System Architecture

	Agent	Model	Input	Output
	iPhone Agent	Random Forest / TextBlob	Review text	Sentiment
•	Twitter Agent	BERTweet	Tweet content	Sentiment
ı	Router Agent	Keyword/Embe dding	Query	Routes to Agent
	MCP Server	FastMCP	Agent requests	Manages routing/Sentime nts

Performance Metrics



Performance Metrics



Agent	Accura cy	Notes
iPhone ML Agent	-86%	RF + TF-IDF
Twitter BERT Agent	-88%	BERTweet fine-tuned
Routing Accuracy	100%	On test queries

System Architecture (ML Model)

ML Models

Twitter Agent: Fine-tuned BERTweet Transformer (HuggingFace)

- a2a_twitter_sentiment_agent.py handles loading the model, tokenizing input,
 and returning prediction
- Uses Hugging Face's AutoModelForSequenceClassification
- Optimized for short-text sentiment classification
- Example Query: "Twitter keeps crashing on my phone."
- Output: Negative sentiment with ~88% classification confidence

System Architecture (ML Model)

ML Models

- **iPhone Agent**: Random Forest with TF-IDF vectorization and optional TextBlob sentiment analysis
 - a2a_iphone_sentiment_agent.py loads review CSVs, vectorizes reviews, applies
 RandomForestClassifier
 - Sentiment is derived from Amazon star ratings and review content
 - Alternative lightweight path uses TextBlob polarity scoring
 - Example Query: "The iPhone battery drains too fast."
 - Output: Negative sentiment (probability from RF classifier or polarity < -0.1 from TextBlob)
 - Routing Agent Uses keyw

- ence embeddings to
- a2a_main.py uses mcp.call(tool_name, input) to route user query
- Routing Accuracy observed: 100% in test samples
- Uses keyword classification or sentence embeddings to identify target agent
- a2a_main.py uses mcp.call(tool_name, input) to route user query
- Routing Accuracy observed: 100% in test samples

System Architecture (ML Model)

ML Models

- Routing Agent Uses keyv
- a2a_main.py uses mcp.call(tool_name, input) to route user query
- Routing Accuracy observed: 100% in test samples
- Uses keyword classification or sentence embeddings to identify target agent
- a2a_main.py uses mcp.call(tool_name, input) to route user query
- Routing Accuracy observed: **100%** in test samples

System Architecture (MCP) Workflow

MCP Client and Server Integration

The system is structured such that the MCP server listens for function calls from agent clients. MCP clients act as wrappers for the agents and route communication using either standard input/output (for terminal-based tools) or HTTP. The client uses schema definitions and registered MCP decorators (@mcp.tool) to facilitate execution.

- MCP Server: Hosts service registration, manages message routing, handles execution lifecycle.
- MCP Client: Sends query via CLI or embedded API (e.g., FastMCP.run("tool_name", input))
- Embedding Support: For routing, sentence transformers or keyword-based vector encoders are used to transform queries into semantic space and match the most appropriate agent.

Deployment Strategy

- Containerized with Docker
- Microservices on Kubernetes
- Option for FastAPI-based REST
- Deployable via Helm or
- Docker Compose

Twitter iPhone Routing Agent Agent Agent Fine-Tuning A2 and **MCP** Cloud, Docker, or Kubernetes Acretuture ond process

Summarize

Modular agents for domain-specific sentiment MCP for orchestration

A2A for clean tool communication

ML, LLM for Sentimental Analysis

 Architecture can power scalable, domain-aware Al assistants — whether for enterprise analytics, customer service, or real-time monitoring.

