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 customer
- Need: Organizations struggle with scattered ML pipelines and lack of intelligent routing.
- Solution: Use Agentic AI solutions with MCP for coordination, A2A for agent communication, and ML and Transformer, Embedding models for analysis.

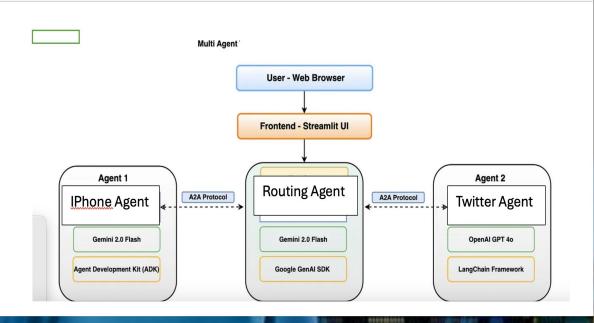
Project Dataset Summary

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

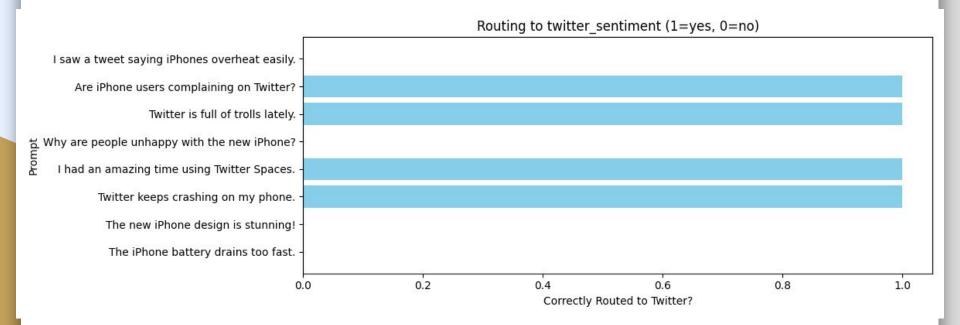
- Source: Pre-labeled tweets with sentiment classification (Positive, Negative, Neutral).
- Size: \sim 75,000 samples
- Fields: Tweet ID, Entity, Sentiment, Tweet Content



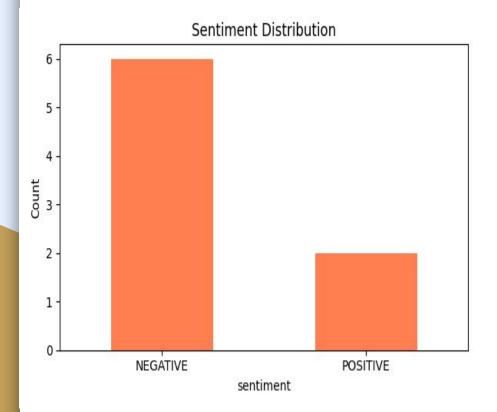
System Architecture

	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 (A2A)

A2A Overview

A2A (Agent-to-Agent) is a lightweight coordination SDK that enables modular and autonomous agent tools to be invoked via message-based or callable interfaces. Each agent runs as an independent process or module, exposing callable functions through a shared routing framework. Agents do not depend on each other directly, making the architecture fault-tolerant and extensible.

• Key Features:

- Stateless communication over stdio, sockets, or HTTP
- Lightweight and minimal overhead
- Integrates seamlessly with MCP for routing and service discovery

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
- **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 ke
- a2a_main.py uses mcp.call(tool_name, input) to route user query
- Routing Accuracy observed: 100% in test samples

System Architecture (MCP)

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.

