Part 1: Record of LLM Usage

Project Title: A Multimodal Approach for Trend-Adjusted Offset Prediction via Dynamic Gated Fusion1.

Date: January 11, 2026.

Group: 10

Task Category	Specific LLM Application	Description of Interaction
Code Architecture	**News Encoder (Bi-RCNN)**	Used LLM to design a hybrid NewsRCNN module that combines 1D Convolutional layers for local feature extraction with a Bidirectional LSTM for temporal dependency.
Model Optimization	**Gate Initialization**	Implemented a negative bias initialization for the gated fusion layer to prioritize news signals during the initial training phase.
Data Engineering	**FinBERT Embedding**	Developed a script using LLM to extract 768-dimensional embeddings from ProsusAI/finbert, utilizing the CLS token for news sentiment representation.
Feature Integration	**Temporal Alignment**	Designed a Bag of Embeddings Centroid (BoEC) approach to aggregate hourly news vectors and implemented a forward-fill mechanism to simulate news sentiment decay over 8 hours.
Advanced Modeling	**Samba/Mamba Integration**	Created an experimental SAMBA_Encoder utilizing Mamba blocks and Adaptive Graph Convolution (AGC) to explore alternatives to standard LSTMs.

Part 2: Final Report

1. Executive Summary

This research addresses the "lag effect" inherent in technical stock indicators by proposing a multimodal framework that integrates market data with real-time financial news. By utilizing a **Dynamic Gated Fusion** mechanism, the model adaptively weights news and price signals based on market volatility. The approach achieved a **12.60% reduction in Mean Absolute Error (MAE)** during high-volatility regimes.

2. Methodology

The proposed architecture consists of three core components:

- **Market Encoder:** A standard LSTM network processes OHLCV (Open, High, Low, Close, Volume) time-series data to extract market features Vs.
- **News Encoder (Bi-RCNN):** Utilizes **FinBERT** (768-dim) to process headline text, followed by 1D-CNN and Bi-LSTM layers to generate news vectors Vn.
- Dynamic Gated Fusion: A sigmoid-activated gating network calculates a weight z.

3. Implementation Details

The model was trained on **TSMC stock data** and corresponding financial news from March 2025 to June 2025.

- **Optimizer:** Adam (Learning Rate: 0.001).
- **Loss Function:** Mean Squared Error (MSE).
- **News Processing:** News sentiment was modeled to persist for up to 8 hours using a forward-fill strategy to bridge gaps in reporting.

4. Experimental Results

The model's performance was evaluated across different market regimes:

Market Regime	**Baseline MAE**	**Gated MAE**	**Improvement**	**Significance (p<0.05)**

Market Regime	Baseline MAE	Gated MAE	Improvement	Significance (p<0.05)
High Volatility (Top 20%)	11.14	**9.74**	**+12.60%**	**Yes (0.019)**
Low Volatility (Bottom 80%)	4.3	4.22	+1.96%	No (0.441)
Overall	5.67	5.32	+6.14%	No (0.156)

5. Conclusion

The study validates that the **Dynamic Gate** successfully shifts focus to news signals during periods of market turbulence, acting as an effective risk-mitigation tool. By adopting **Trend-Adjusted Offset prediction**, the system overcomes the non-stationarity of stock data and significantly reduces the prediction lag typically found in technical-only models.