Computational Intelligence Applications in **Healthcare** and **Corporate Finance**

Vinayaka Gude
Assistant Professor, Business Analytics

Real-time fetal monitoring system using Deep Learning

Ongoing Research

Problem Statement

Fetal Acidosis:

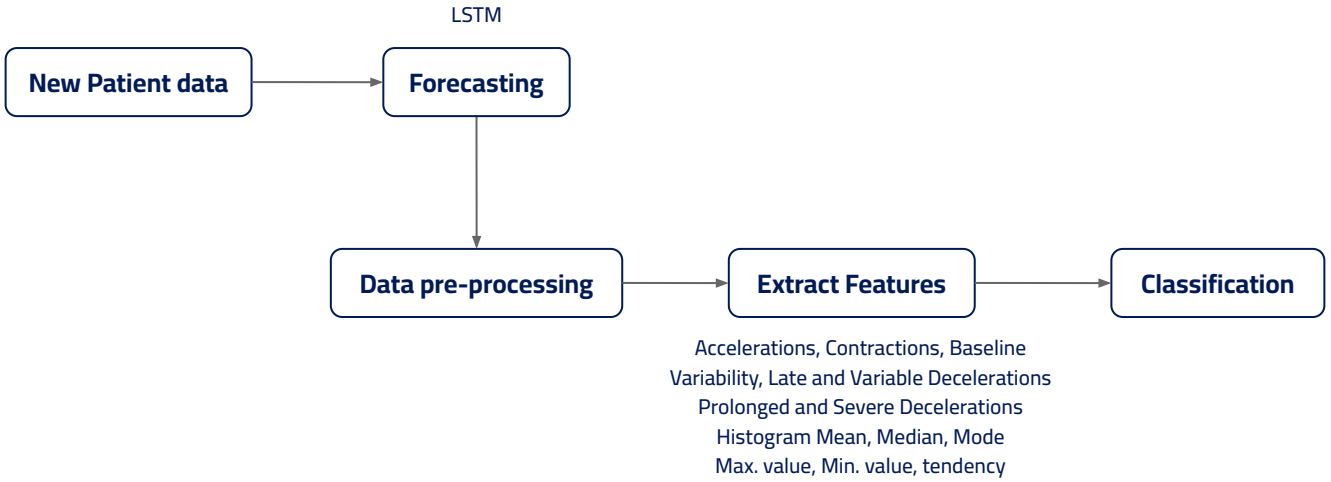
- 25 out of 1000 infants are affected with metabolic acidosis, 4 with severe acidosis
- Acidosis - Low pH in fetus' blood(<7.2)
- Causes - uterine artery damage, hypotension and umbilical cord compression
- Improper Diagnosis lead to over 40% of the deaths.
- Can lead to:
  - Insufficient blood flow → oxygen
  - fetal brain injury, organ failures and epilepsy

Existing Methodologies

- Classification (entire data)
- Use extracted features (current window)

Lack of a **real-time predictive fetal state assessment**

Earlier Work

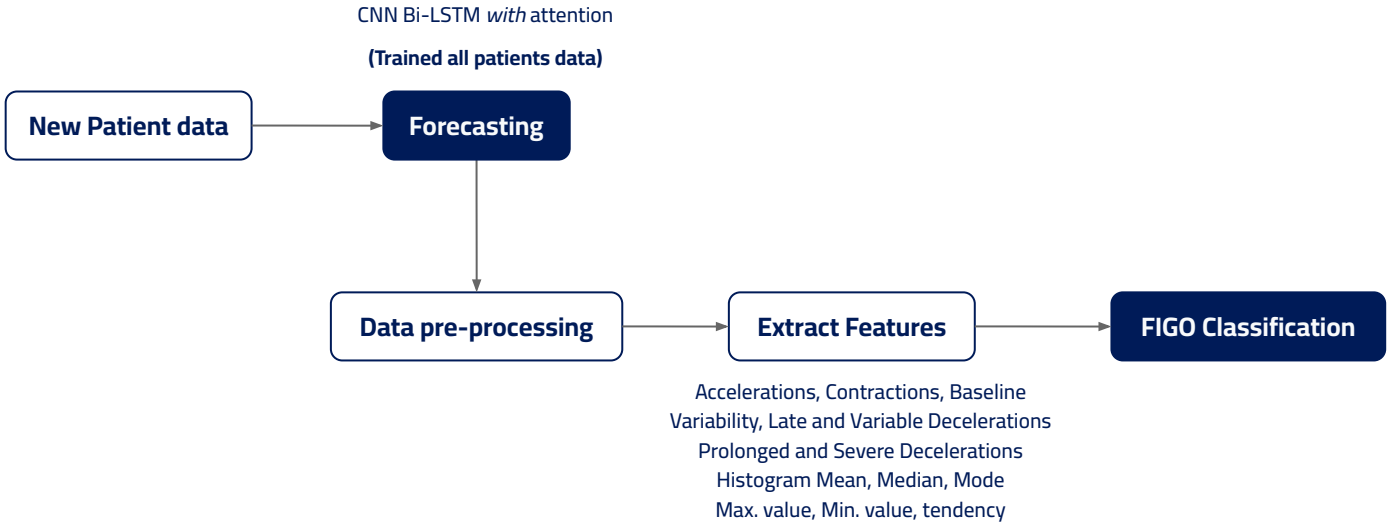


- **Forecasts limited to 2 min (240 observations) - limiting the overall usability**
- **LSTM trained on individual data - limiting generalizability**

FIGO Classification instead of ML

Interpretation	Baseline fetal heart rate	Variability	Decelerations and accelerations
Normal	110-160 bpm	5-25 bpm	No repetitive (if they occur at >50% contractions) decelerations
Suspicious	Lacking at least one of normal characteristics but with no pathological features		
Pathological	<100 bpm	Reduced increased variability, sinusoidal pattern	Repetitive late or prolonged decelerations lasting >30 min (or 20 min if reduced variability) or one prolonged deceleration lasting >5 min

Proposed Methodology



- **Improve forecasting capabilities and reduce computational complexity with fetal state prediction**
- **Improve Generalizability**

Data Pre-processing

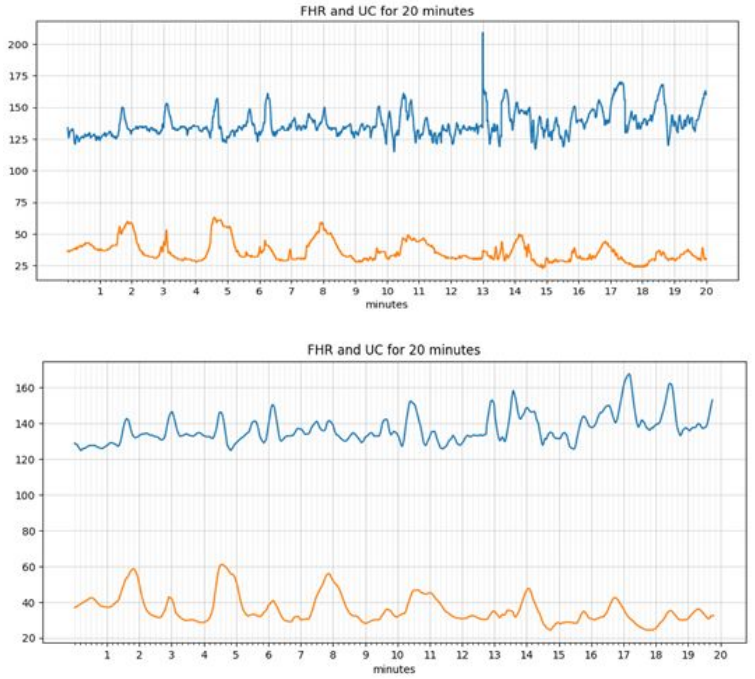
CTU-CHB database (552)

Between 30- 90 min (Frequency - 4 Hz)

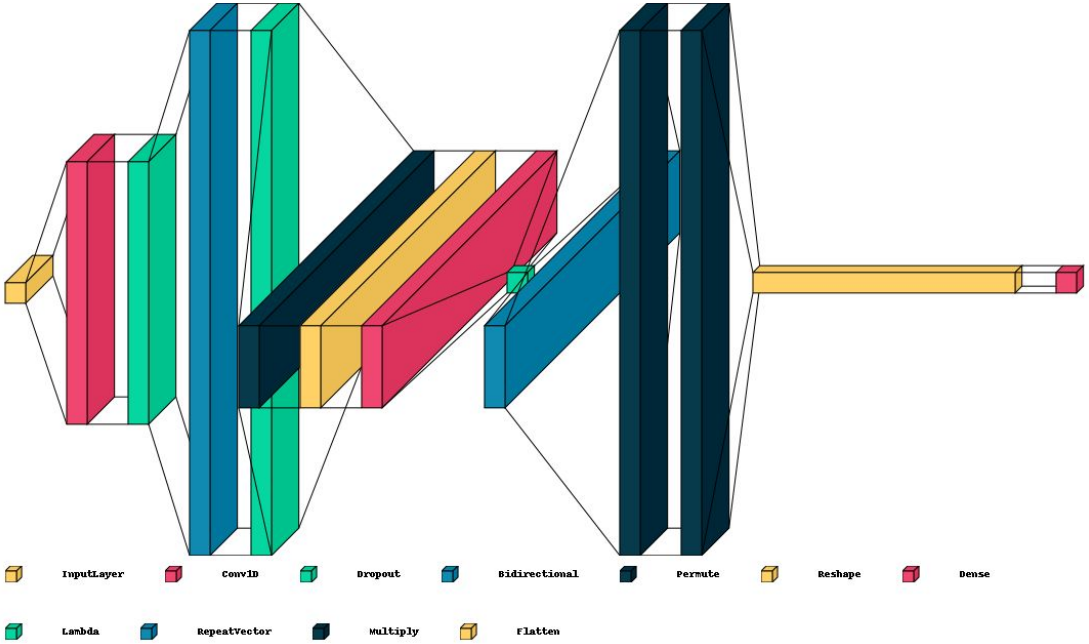
Data Collected from PCMRC (1044)

Between 50- 320 min (Frequency - 4 Hz)

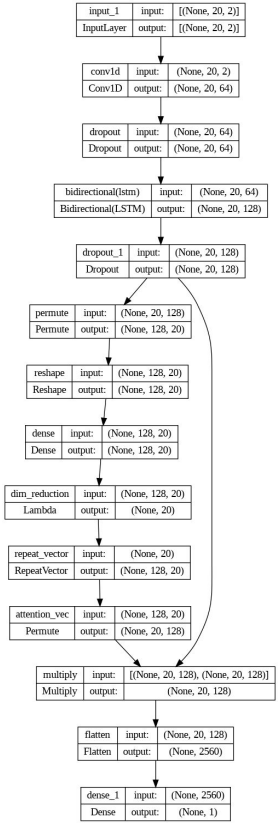
Smoothing - Gaussian



Architecture



CNN Bi-directional LSTM with attention



Results Discussion

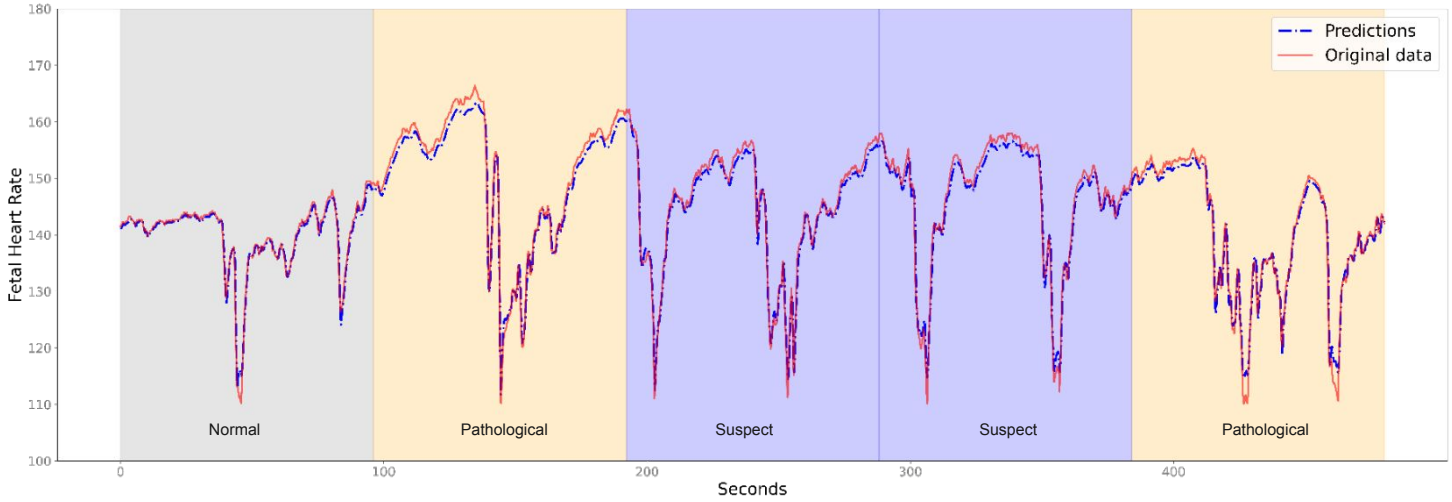
Performance metrics of the CNN-Bi-LSTM over time:

Time	MSE	MAE	MAPE
480	0.980725	0.625063	0.004605
960	1.759534	1.029887	0.007085
1440	1.84954	1.073104	0.007441
1920	2.080126	1.142128	0.00794
2400	2.232828	1.165585	0.008221

Comparison with other forecasting models (480 steps):

Model	MSE	MAE
ARIMA	3.186557	2.159021
LSTM	1.855268	1.664305
RNN	1.403397	1.742968
CNN-LSTM	1.17076	0.913701
CNN-Bi-LSTM	0.980725	0.625063

Conclusion



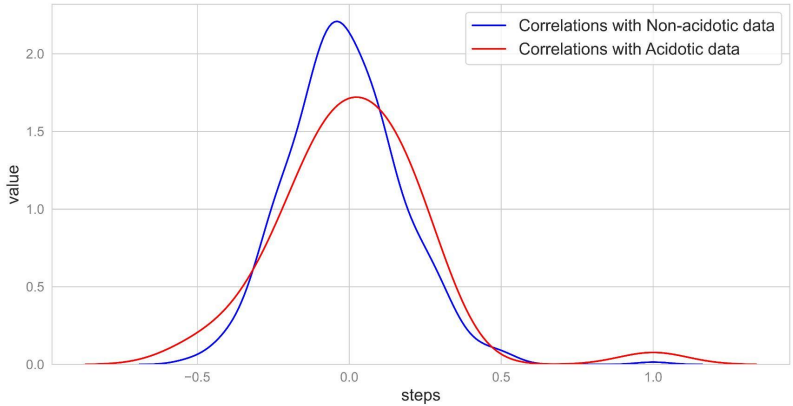
FIGO classification relies on original CTG data, do not translate well to the processed signals.

Future work

Increase the window size for fetal state assessments

Downsample and use clustering instead of the traditional CTG classification.

Varied forecast performance across the dataset

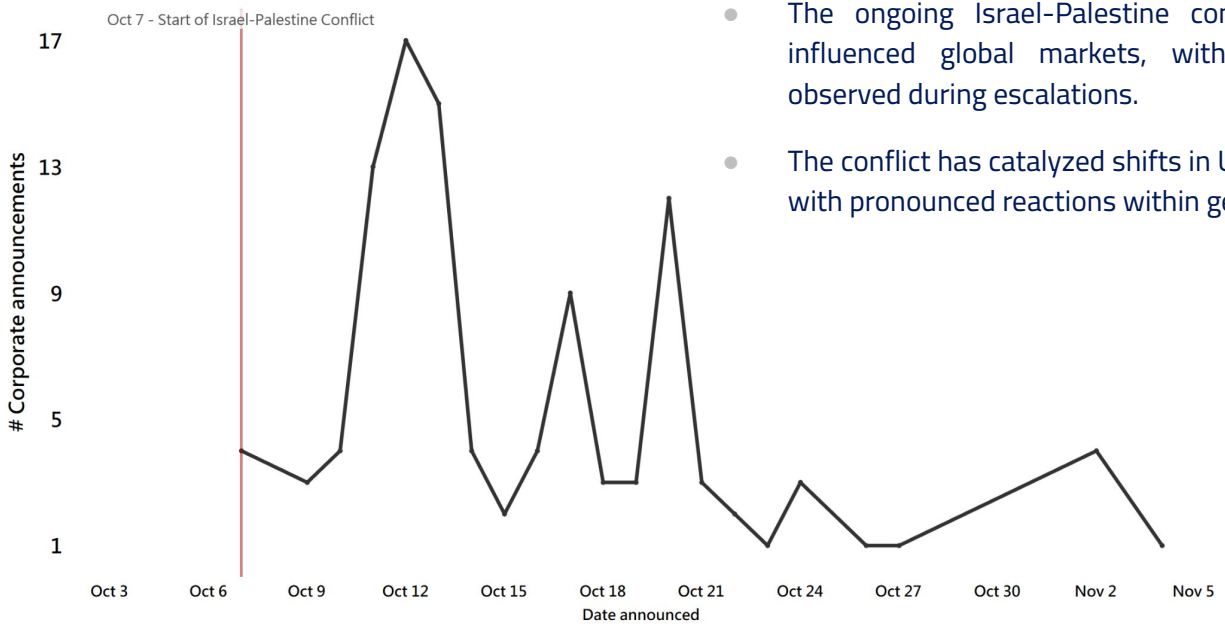


Navigating Market Sentiment: The Interplay of Corporate Announcements, Media Coverage, and Machine Learning in Predicting Stock Fluctuations

Vinayaka Gude, Daniel Hsiao

(Ready to be submitted)

Introduction



- The ongoing Israel-Palestine conflict has historically influenced global markets, with significant impacts observed during escalations.
- The conflict has catalyzed shifts in U.S. corporate stances, with pronounced reactions within general public.

Objectives

- To determine the impact of U.S. corporate public positions on stock performance amid the Israel-Palestine conflict.
- To evaluate the effectiveness of traditional statistical methods versus advanced machine learning models in predicting stock fluctuations based on **corporate actions/announcements** , **Israeli ties** and **media sentiment**.

Corporate Announcements:

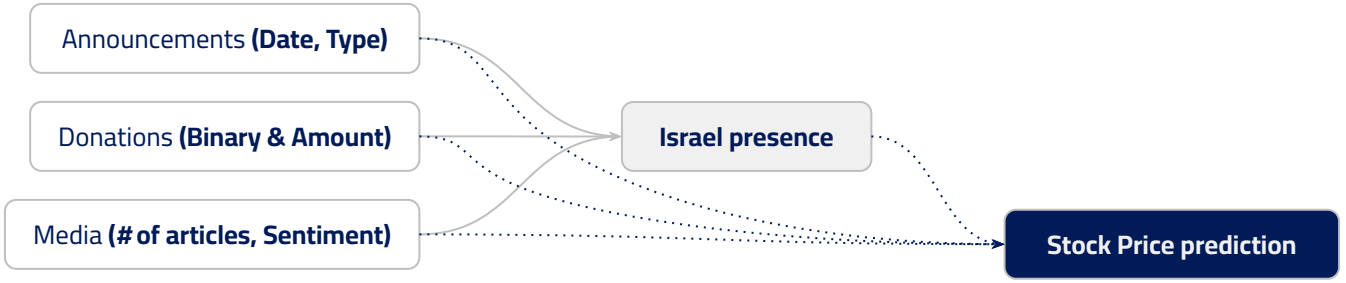
- Business Update
- Support
- Aid
- Call for Action

Data

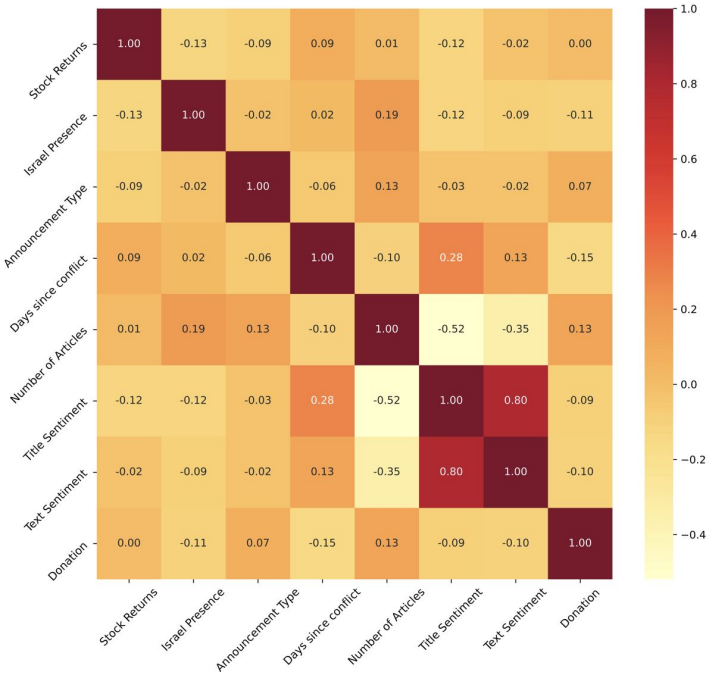
Daily average abnormal returns across companies with Israel ties and philanthropic efforts compared with S&P 500

	All	Israel (yes)	Israel (no)	Donation (yes)	Donation (no)
[-5, -1]	-2.92***	-2.48**	-3.43***	-0.19	-2.82***
[-3, -1]	0.04	0.53	-3.27**	0.4	-0.97
[+1, +3]	-1.04	-0.91	0.94	-1.33	-0.81
[+1, +5]	-0.63	-0.64	2.13*	2.31*	-0.76
[+1, +7]	1.56	1.57	0.51	-0.79	1.75*
[+1, +10]	-0.9	-0.64	0	-1.18	-0.55
[+1, +15]	-0.39	-0.13	-1.98*	-0.73	-0.13
[+1, +20]	-2.50*	-2.58*	-1.22	-2.05*	-1.97*
[+1, +25]	-0.64	-0.81	1.17	-0.45	-0.74
[+1, +30]	-0.03	0.09	-2.63*	-0.7	0.1

Methodology



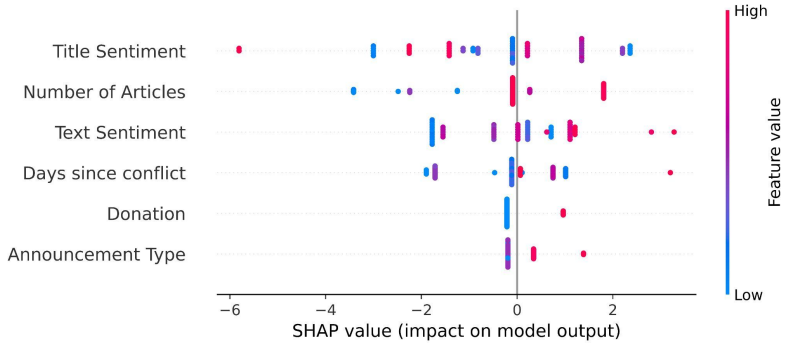
Correlation



- 'Israel Presence' is analyzed as a dependent variable for the classification problem
- 'Stock Returns' is considered a dependent variable in regression contexts.
- Both 'Stock Returns' and 'Israel Presence' show weak correlations with other variables (coefficients are not close to 0.7 or -0.7).
- The lack of strong linear relationships implies a challenge for traditional predictive modeling, which often depends on such correlations for accuracy.

Classification Results

Classifier	Accuracy	Sensitivity	Specificity	ROC AUC	F1 Score
Decision Tree	0.86	0.93	0.79	0.86	0.85
Gradient Boosting	**0.9**	**0.97**	**0.83**	**0.9**	**0.89**
K-Nearest Neighbors	0.76	0.83	0.69	0.76	0.74
Logistic Regression	0.74	0.86	0.62	0.74	0.71
Naive Bayes	0.59	1	0.17	0.59	0.29
Neural Network	0.84	1	0.69	0.84	0.82
Random Forest	0.88	0.97	0.79	0.88	0.87



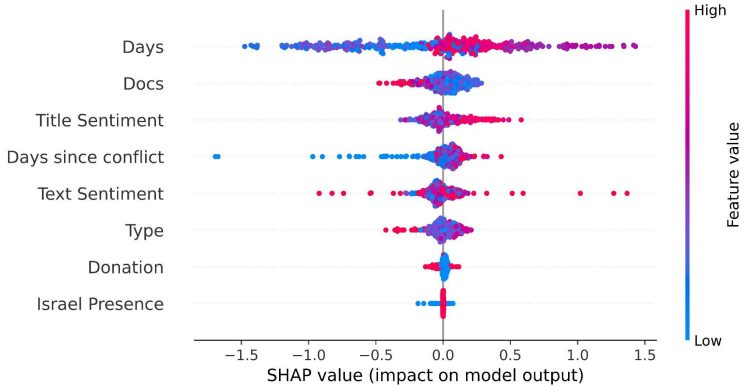
- **Title Sentiment:** Exhibits a negative skew, indicating an inverse relationship.
- **Number of Articles:** Higher article counts increase the probability of a company being linked to Israel.
- **Text Sentiment:** Follows a similar pattern to 'Title Sentiment', where positive sentiments in article texts are associated with a reduced prediction of a company's presence in Israel.
- **Days Since Conflict:** Shows a centralized cluster of SHAP values, suggesting a moderate influence on predictions; time elapsed since the conflict began affects the model's output less significantly.

Ablation Study

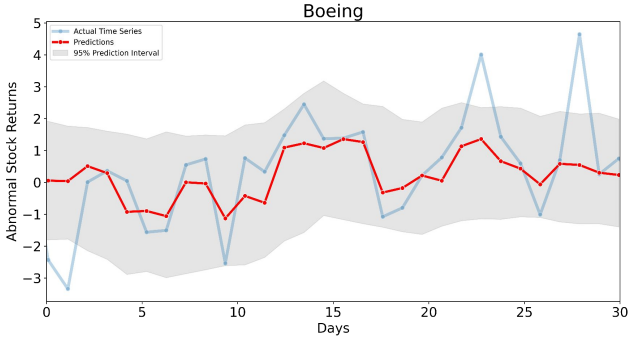
Ablation	Accuracy	Sensitivity	Specificity	ROC AUC	F1 Score
Actions	0.86	0.93	0.79	0.86	0.85
News Articles	0.86	0.93	0.79	0.86	0.85
Donations	0.69	0.62	0.76	0.69	0.71
Actions & News Articles	**0.93**	**0.93**	**0.93**	**0.93**	**0.93**
Actions & Donations	0.83	0.9	0.76	0.83	0.81
News Articles & Donations	0.79	0.76	0.83	0.79	0.8
Actions & News Articles & Donations	0.86	0.97	0.76	0.86	0.85

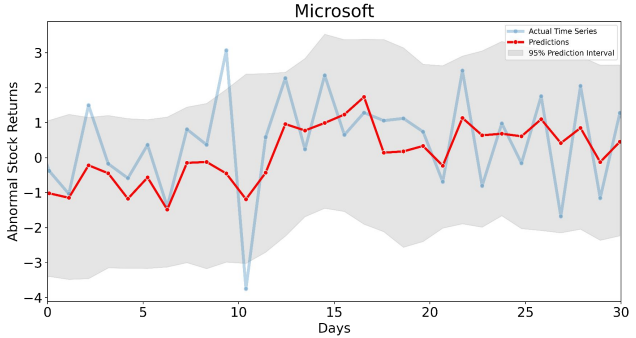
Regression results

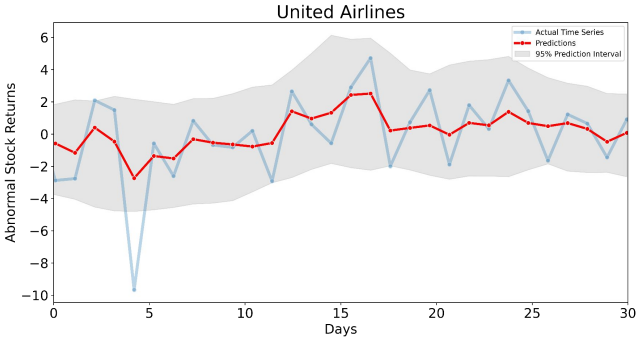
Model	MSE	RMSE	MAE
Decision Tree Regression	6.351626	2.520243	1.659985
ElasticNet Regression	6.298975	2.509776	1.65848
Lasso Regression	6.334736	2.51689	1.664831
Linear Regression	6.320273	2.514015	1.668235
Multi-Layer Perceptron	6.189603	2.487891	1.654718
Random Forest Regression	**5.664972**	**2.38012**	**1.537133**
Ridge Regression	6.286555	2.5073	1.658495
Support Vector Regression	6.260752	2.502149	1.658584
Gradient Boosting Regression	8.076482	2.841915	1.546229
Voting Regressor	6.215899	2.493171	1.649071
Stacking Regressor	6.145218	2.478955	1.628611



Out-of-sample Forecasting results







Conclusion

- Provides empirical evidence on how corporate responses to geopolitical conflicts influence stock returns.
- Enhances existing literature on financial forecasting by integrating machine learning models to assess the predictive power of media sentiment and corporate positions.
- Machine Learning models performed better and linear and logistic models. Further, ensemble approaches have slightly better performance in both classification and regression tasks.
- Forecasting models accurately track upward and downward trends but in some occasions struggled to predict instances of sharp declines or increases on the out-of-sample stock returns.

Any Questions?