Classification and Predictions of the Palestine - Israel Conflict: An ML and Econometrics Approach

Arya Amarnath

Figure 1, slides-go

Motivation and Background

History On this Ongoing Conflict Since 1948

- Rise of Zionism + Jewish Immigration to Palestine after WW2
- Israel Formed as a State in 1948 Sparking First Israeli-Arab War
- Six-Day War, First and Second Intifada
- Hundreds of Failed Peace Negotiations
- Over 6 Million Palestinians Displaced

Since October 7 2023, Israel - Hamas ‘War’:

- 35,000 Palestinian and 1400 Israeli Dead
- 2 Million Palestinians Trapped

How can Data Science Be Used For Peacemaking and Conflict Resolution?

- Forecasting and Early Warning Systems

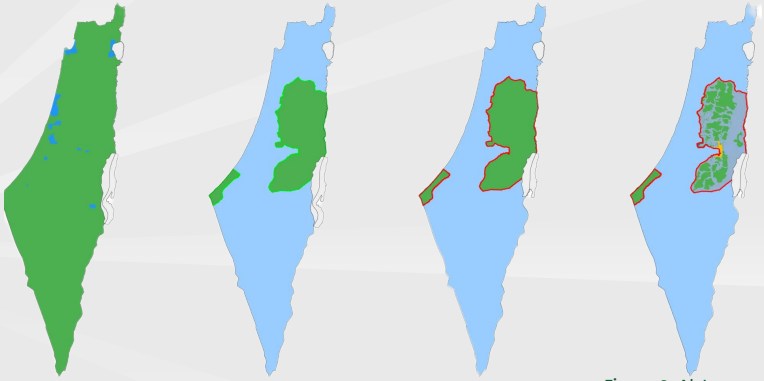


Figure 2, Al-Jazeera

Goals

Main Objective: Classify and Predict the ‘Sub-Event Type’ Variable

Sub Objective: Utilizing Predictions, Create a Time-Series Forecast of Sub-Event Type

Data

Sourced From: Armed Conflict Location & Event Data Project (ACLED)

Utilizing Data Export Tool:

- April 20 2021 -> April 19, 2024
  - Israel Conflict Data
  - Palestine Conflict Data

38,130 Rows + 32 Columns

Table 2: ACLED Event Types

Event type	Sub-event type	Disorder type
Battles	*Government regains territory*	Political violence
	Non-state actor overtakes territory	
	Armed clash	
Protests	*Excessive force against protesters*	Political violence; Demonstrations
	Protest with intervention	Demonstrations
	Peaceful protest	
Riots	*Violent demonstration*	
	Mob violence	Political violence
Explosions/ Remote violence	*Chemical weapon*	
	Air/drone strike	
	Suicide bomb	
	Shelling/artillery/missile attack	
	Remote explosive/landmine/IED	
	Grenade	
Violence against civilians	*Sexual violence*	
	Attack	
	Abduction/forced disappearance	
Strategic developments	*Agreement*	Strategic developments
	Arrests	
	Change to group/activity	
	Disrupted weapons use	
	Headquarters or base established	
	Looting/property destruction	
	Non-violent transfer of territory	
	Other	

Figure 3, ACLED Codebook

Data

Event Date	Interaction	Year	Disorder Type	Civilian Targeting	Event Type	Region	Sub Event Type	Country	Admin1	Latitude	Actor2	Fatalities
19-Apr-24	20	2024	Political violence	0	Explosions/Remote violence	Middle East	Shelling/artillery/missile attack	Israel	Haifa District	32.825	Military Forces of Israel	0
19-Apr-24	60	2024	Demonstrations	0	Protests	Middle East	Peaceful protest	Israel	Haifa (Israel)	32.6363		0
19-Apr-24	57	2024	Demonstrations	0	Riots	Middle East	Violent demonstration	Israel	HaMerkaz (Israel)	31.8766	Rioters (Israel)	0

ACLED, 2024

Exploratory Data Analysis

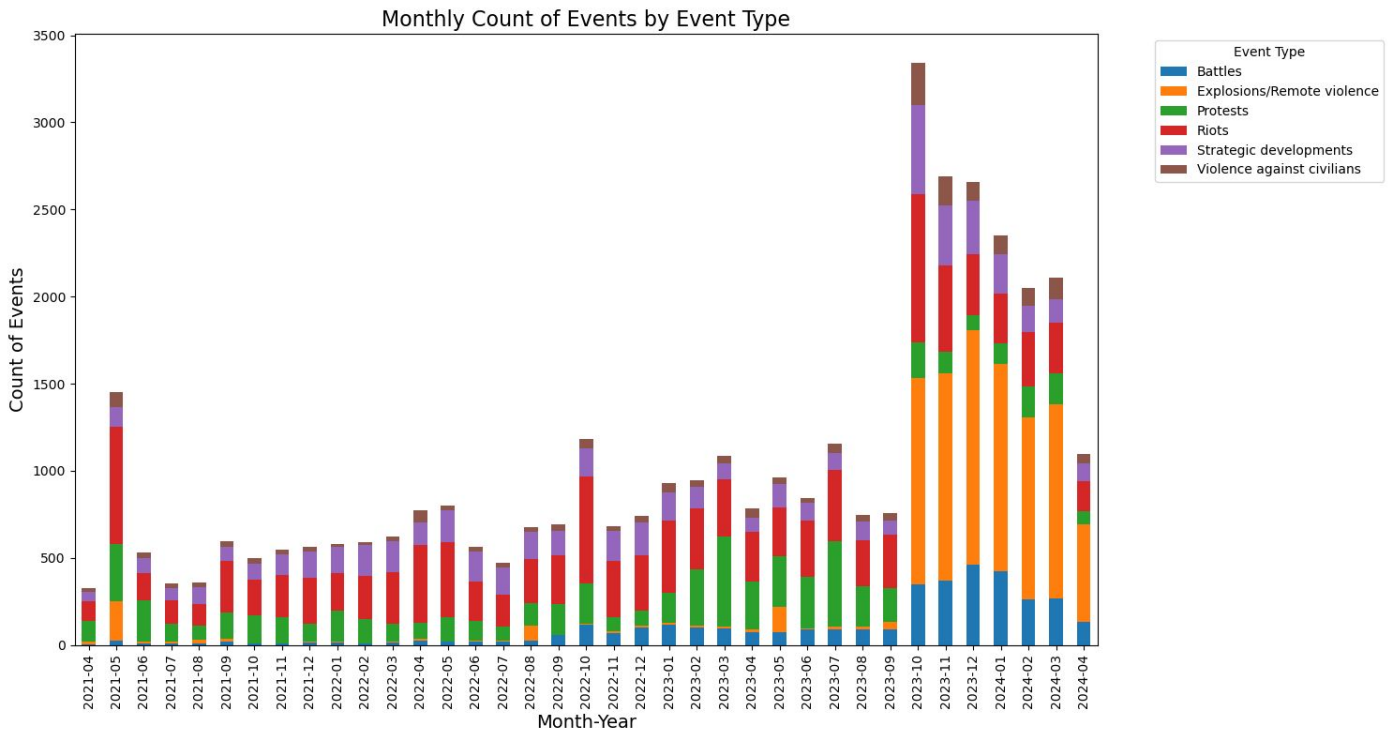
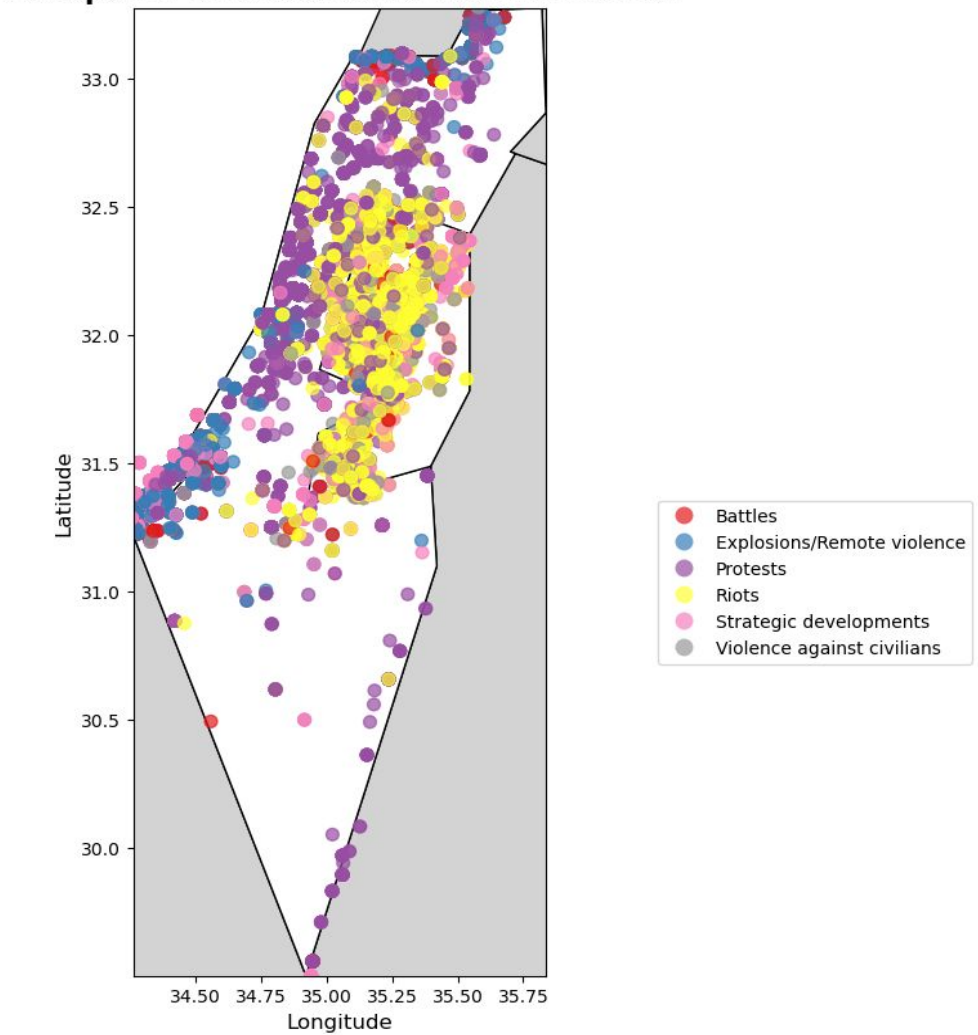


Figure 4, Amarnath

Upsurge in Conflict Events since October 7th, 2023 -> Hamas-led Attack on Israel in response to Illegal Israeli Occupation of Palestinian Territories



EDA Continued

Figure 5, Amarnath

Data Wrangling

38,130 Rows + 32 Features

Renaming NA's, Dropping Duplicates and Irrelevant Features

9878 Duplicates

'event_type', 'assoc_actor_1', 'latitude/longitude', 'source', 'notes'...

All Removed

28,252 Rows + 14 Features

Creating Temporal Features, Lagged Variables and Log Transform

Temporal Features -> Date-Related, Time Since Last 'X', Rolling Average, Cumulative Count of 'X'

Lag Factor of 3 -> Value of a Predictor Variable 3 Days Prior

Log Transformations -> Stabilize Variance and Reduce Extreme Values

28,252 Rows + 36 Features

Encoding

1 Label Encoding

Converts each value within a categorical column into a unique integer

Used On -> Actor 1 and Actor 2

Actor Before	Actor After
Military Forces of Israel	1
Civilians (Pal.)	2
Civilians (Isr.)	3

2 One-Hot Encoding

Transforms each categorical variable into a set of binary variables, shown through 1's and 0's

Used On -> All Other Features

Disorder Type Before
Demonstrations
Political Violence
Strategic Developments

Disorder Type Demonstrations	Disorder Type Political Violence	Disorder Type Strategic Developments
0	1	0
0	0	1
1	0	0

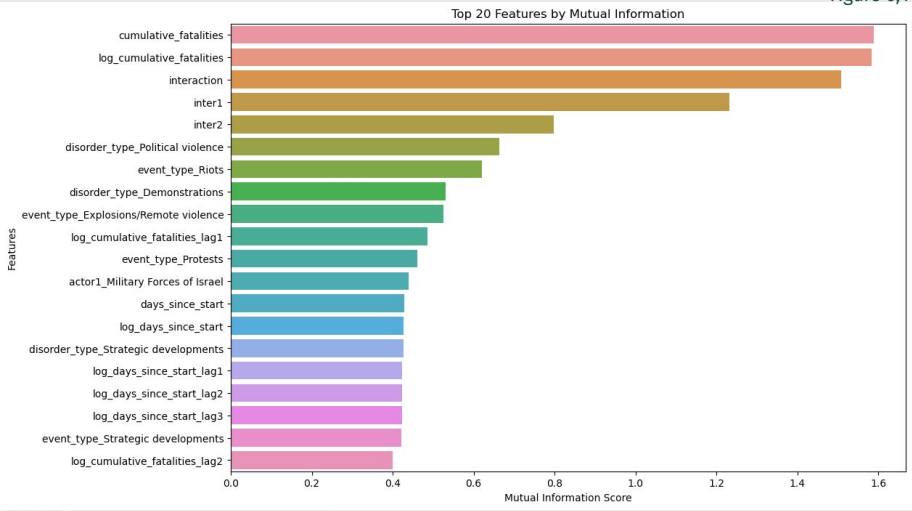
Feature Selection

Combined Top Features ->

Top 20% of Selected Features From Mutual Information and Random Forest Importance

155 Features down to 19 Features

Figure 6, Amarnath



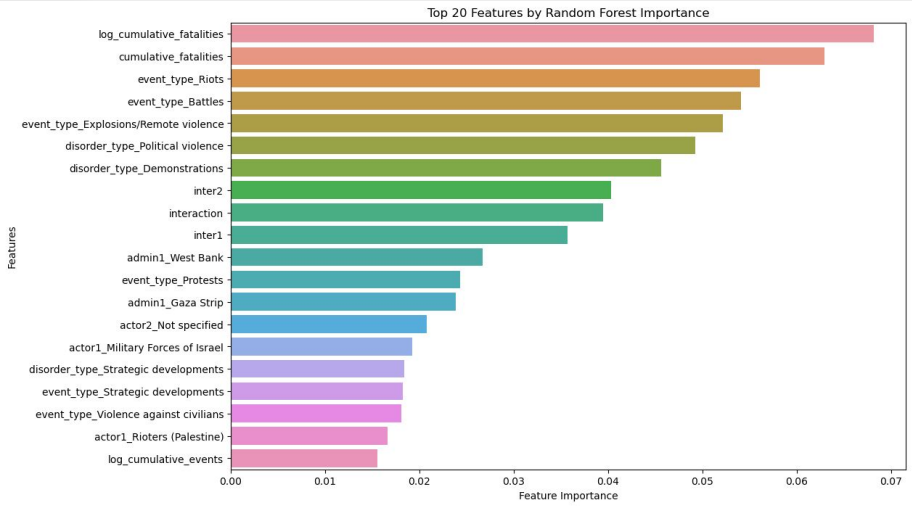
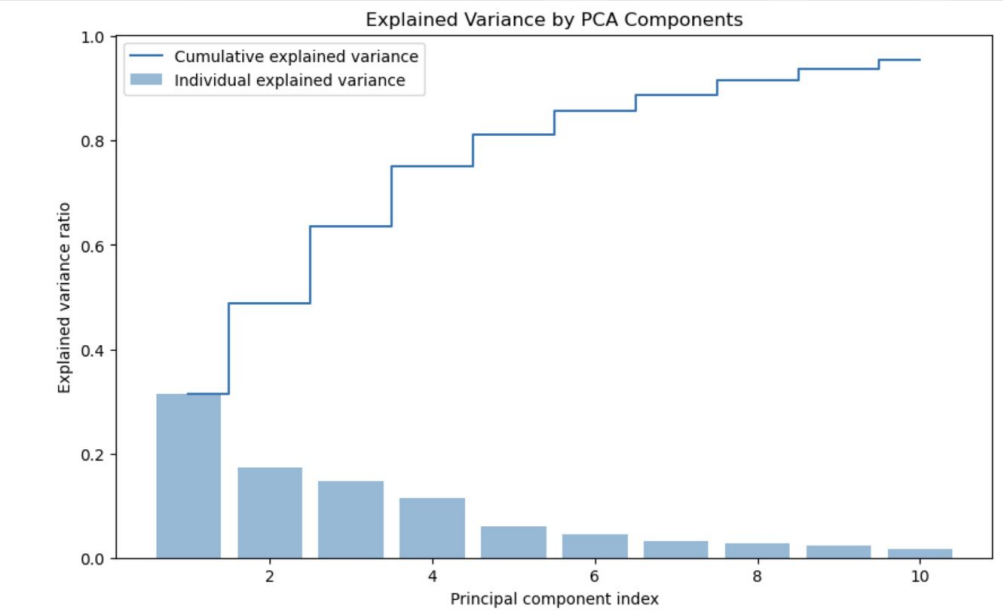


Figure 7, Amarnath

Principal Component Analysis



Reducing the Dimensional Size While Retaining 95% of Variance Explained

19 Features to 11 Principal Components

Figure 8, Amarnath

Problems Within Data

Heteroskedasticity -> Consistent Variance of Residuals

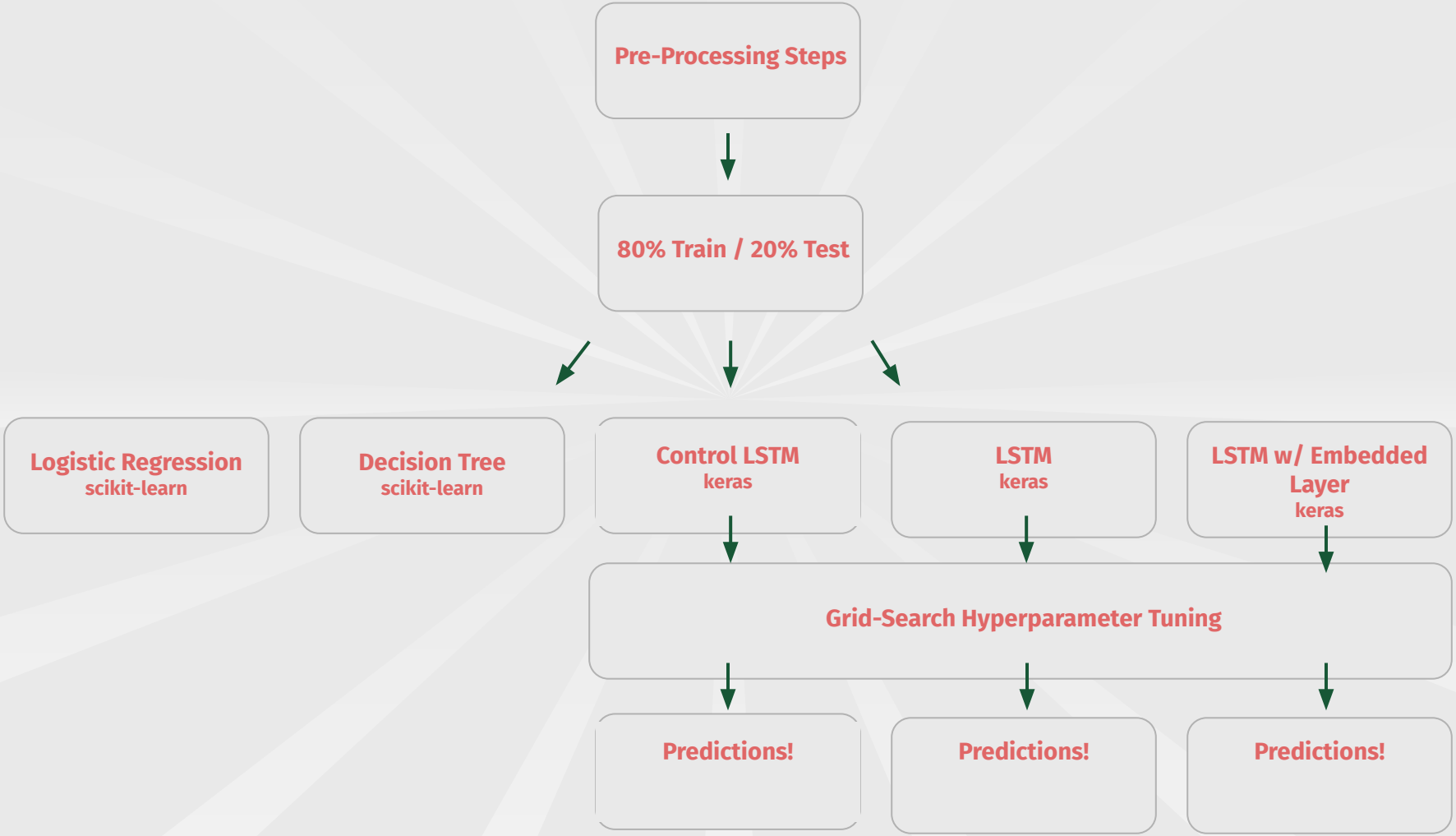
- Breusch-Pagan Test
- Not Solved

Multicollinearity -> Highly Correlated Features

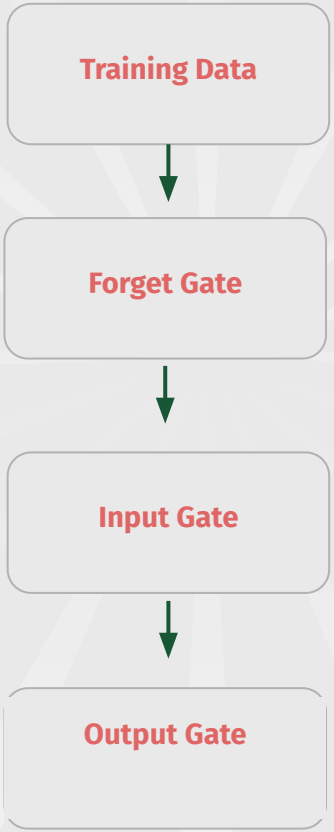
- Variance Inflation Factor
- Somewhat Addressed Through Removal of Collinear Values > 0.75

Ensuring Data is Stationary -> Constant mean, variance, autocorrelation

- Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test
- Solved with Majority P-Values > 0.05


Pre-Processing Steps
80% Train / 20% Test
Logistic Regression
scikit-learn
Decision Tree
scikit-learn
Control LSTM
keras
LSTM
keras
LSTM w/ Embedded Layer
keras
Grid-Search Hyperparameter Tuning
Predictions!
Predictions!
Predictions!

LSTM Parameters



Constants

Epochs -> 50

Batch Size -> 64

Validation Split -> 0.1

Early Stopping -> 10 or 5

Grid Search

Time steps -> 7, 14, 24, 30

# of Features per time step -> 11

Neurons -> 50, 100, 200

Dropout Rate -> 0.1 - 0.5

Output Class -> 20

Model Results

	Logistic Regression	Decision Tree	Control LSTM	LSTM w/ No Embedded	LSTM w/ Embedded Layer
Test Accuracy	86.0%	77.0%	65.0%	81.9%	85.0%
Test MAE	-	-	3.58	1.93	1.93
Test MSE	-	-	48.43	26.53	25.42
Test RMSE	-	-	6.96	4.96	4.96

Classification Predictions

```
Actual: Looting/property destruction, Predicted: Looting/property destruction
Actual: Disrupted weapons use, Predicted: Disrupted weapons use
Actual: Shelling/artillery/missile attack, Predicted: Armed clash
Actual: Grenade, Predicted: Grenade
Actual: Armed clash, Predicted: Armed clash
Actual: Mob violence, Predicted: Mob violence
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```

Figure 9, Amarnath

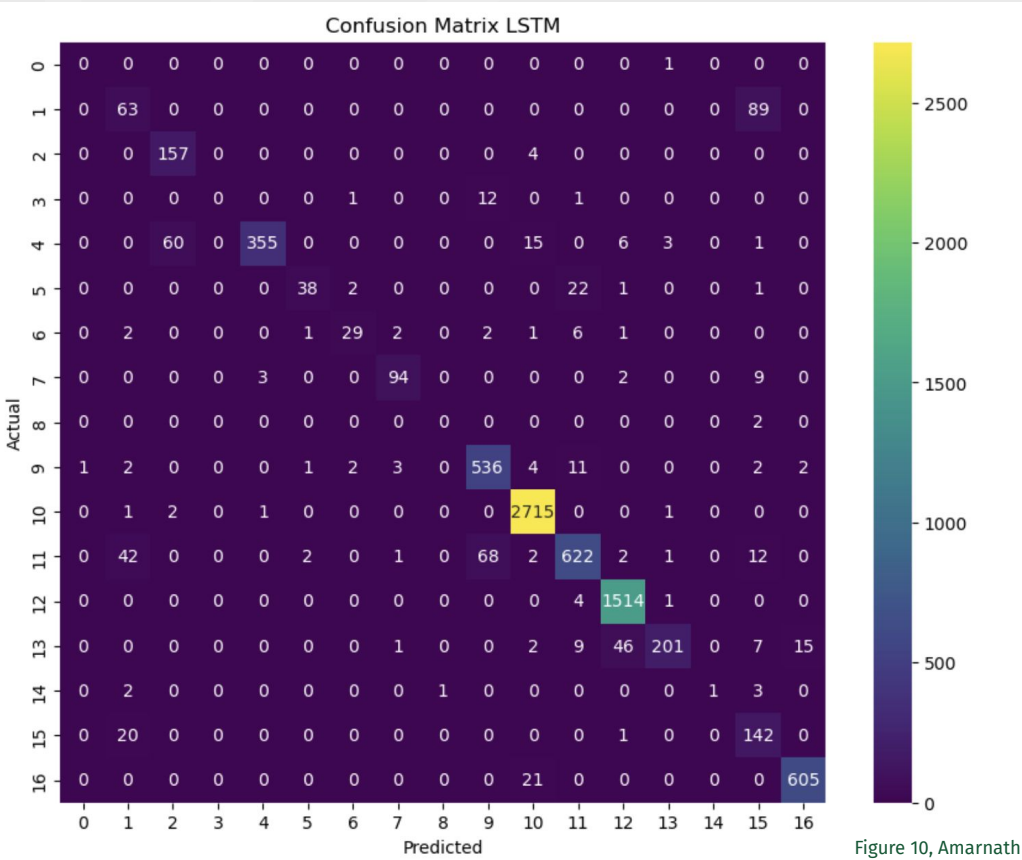

Figure 10, Amarnath

Time-Series Prediction

Multicollinearity, Heteroscedastic data and **Class Imbalance** ->

Inaccurate Predictions

Unsuccessful in **Generating Accurate Predictions**

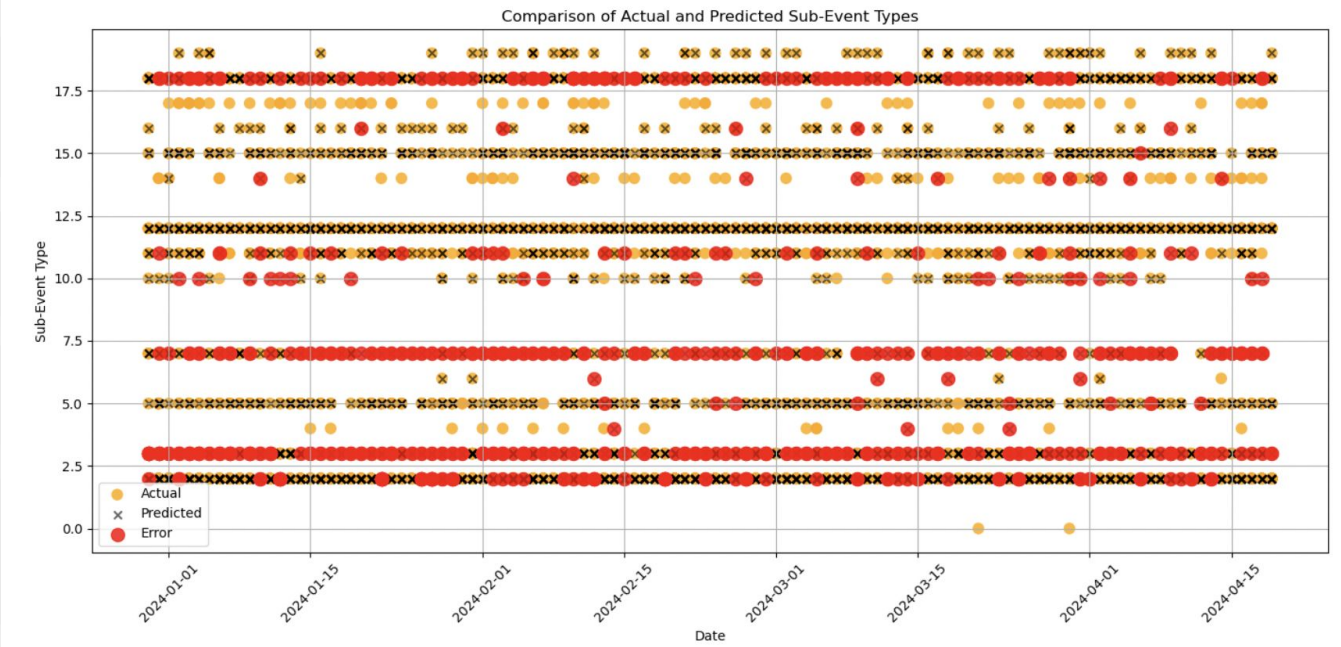

Figure 11, Amarnath

Inconsistency

```
Number of errors With Embed: 764 / 5628
Index: 2, Predicted: 3, Actual: 18
Index: 18, Predicted: 3, Actual: 18
Index: 19, Predicted: 3, Actual: 18
Index: 20, Predicted: 3, Actual: 18
Index: 35, Predicted: 2, Actual: 18
Index: 39, Predicted: 3, Actual: 18
Index: 40, Predicted: 3, Actual: 18
Index: 45, Predicted: 2, Actual: 18
Index: 57, Predicted: 3, Actual: 18
Index: 70, Predicted: 18, Actual: 5
```

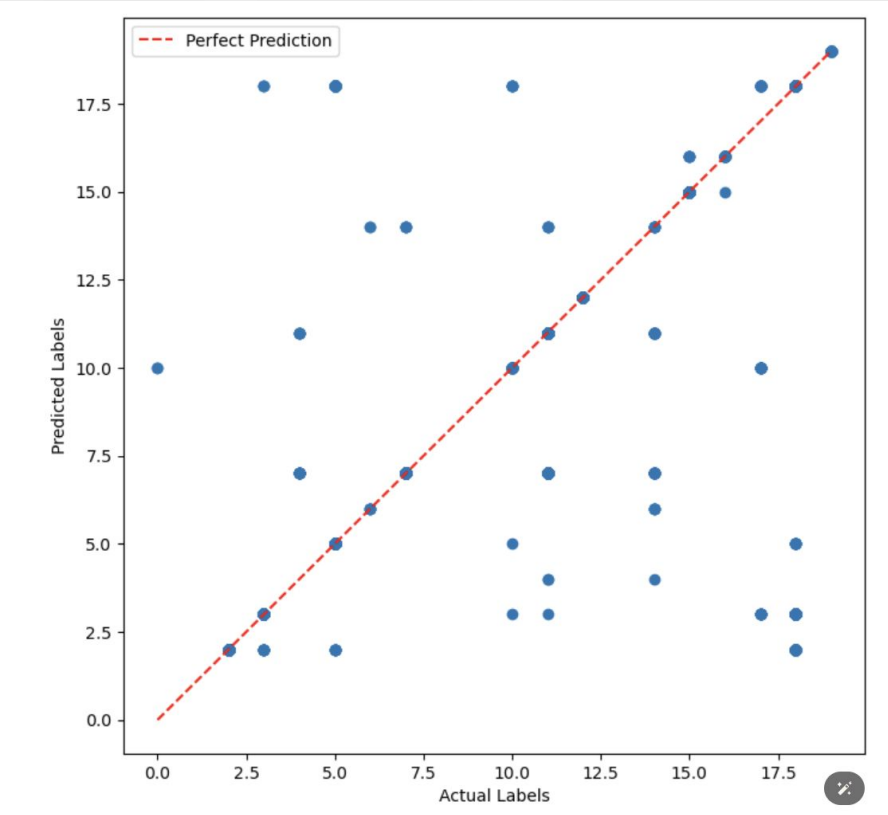

Figure 12, Amarnath

Future Work:

Properly Addressing Time-Series Data Issues

Swapping Datasets or Adding in External Temporal Variables

Thank you!

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