Stock News Classification, Prediction, & Analysis

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Outline

- Business Problem & Understanding
- Data
- Modeling Methodology & Metrics
- Results
  - Title and Text sentiment analyses are equally important for machine learning
  - Optimal weights to use to deal with class imbalance
  - Best model for stock news classification
- Conclusions
- Further Work

Business Problem

- Predicting stock prices is a highly valuable asset to have. Assuming high precision in our predictions, we can:
  - Profit from short or long term stock purchases
  - Analyze company projected growth or decline
  - Determine public sentiment toward a company or industry

- The Assumption of this project is that stock news is related to stock price. This assumption is based on:
  - How stock prices move up or down
  - Public sentiment toward a stock and stock price

Business Understanding

- Understanding the value that comes from stock prediction, I went into this project with the following goals:
  - Build various machine learning models predicting stock price with precision and accuracy as the goal metrics.
    - Value: If we have a model that can confidently predict a gain or loss for a given stock then we can invest company funds with higher confidence
  - Derive Importance Results
    - Value: Is the headline of a news article have more valuable information than the text? Knowing this will allow for more advanced models in the future
  - Visualize Relationships
    - Value: By creating a visual representation of the relationship between stock news and a given stock we can detect patterns which can be used to enhance model performance

Data

- All of the data was retrieved from the FMP Cloud API (https://fmpcloud.io/)
- Preprocessing:
  - Obtain Stock News using api key, limit (Number of News articles to retrieve) stock symbol list
    - This returns the title and text of the news, date + time published
    - Custom Features:
      - Vader_sentiment_scores (For first two models)
      - Boolean is_weekday (True if on Friday, Saturday, Sunday)
      - Weekday number (0 = Monday)
      - Stock Prediction Day
  - Obtain stock price using the date range from the stock news dataframe above

NLP

- For the recurrent networks and transformer model I took the following natural language process steps
  - Combine title and text of a news article
  - Count unique words
  - Determine max length of a given text
  - Tokenize words (removes punctuation)
  - Embed words using Glove word vector matrix
    - (https://nlp.stanford.edu/projects/glove/)

Methodology (Baseline Models)

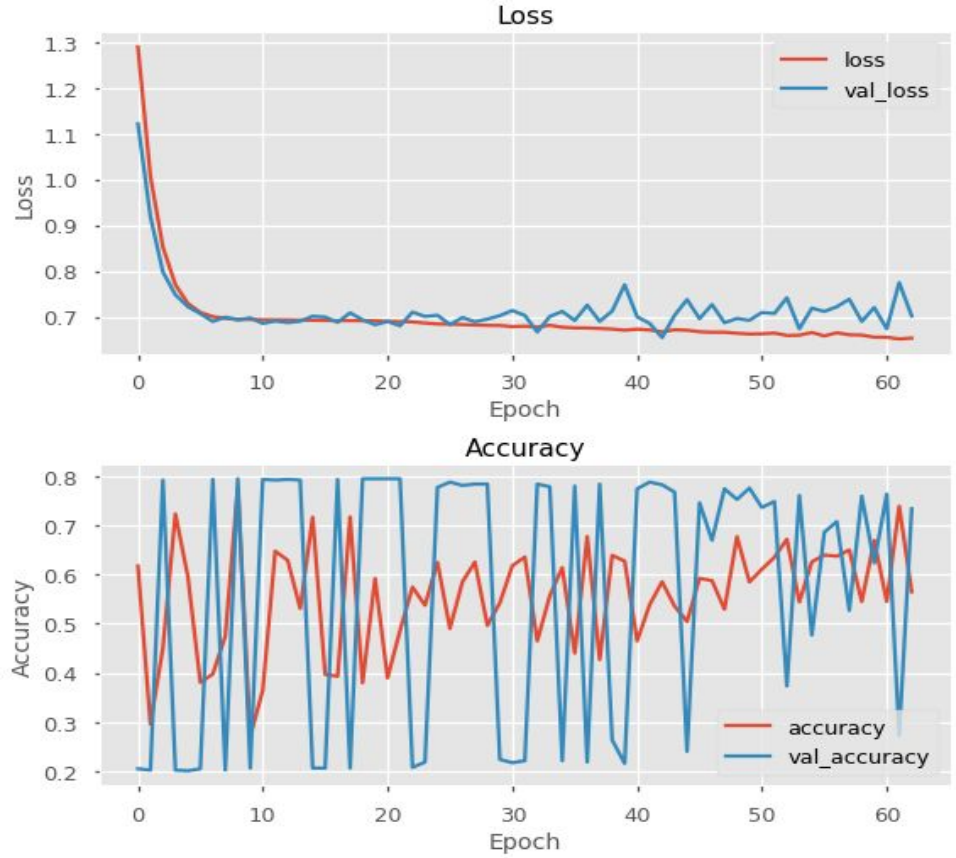
- I define gain/loss by change i.e. Stock Open Price - Stock Close Price
  - If change > 0 stock == gain
  - If change < 0 stock == loss
- Baseline Model (Vader Sentiment Scores)
  - Does not use machine learning
  - Predicts stock price using average score of title and text
- Baseline Model (XGBOOST with Vader Sentiment Scores)
  - Supervised binary classification machine learning
  - Predicts stock price using vader sentiment scores after being trained on actual gain/loss of a stock

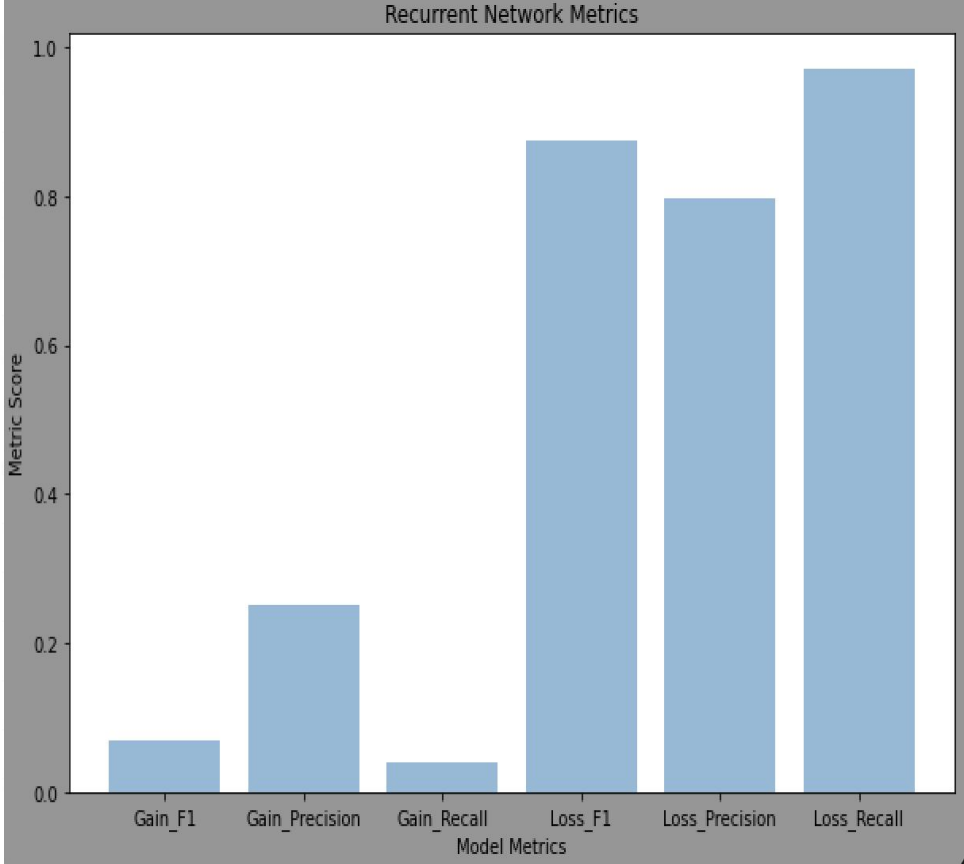
Methodology (Recurrent Neural Networks)

- GRU Model
  - Embedding layer with 50 vector size
  - GRU layer
    - 64 neurons
    - L2 regularizer
  - Dense Layer
    - 128 neurons
    - Tanh activation
  - Output Layer
    - Sigmoid activation
  - Loss: binary_crossentropy
  - Optimizer : Adam

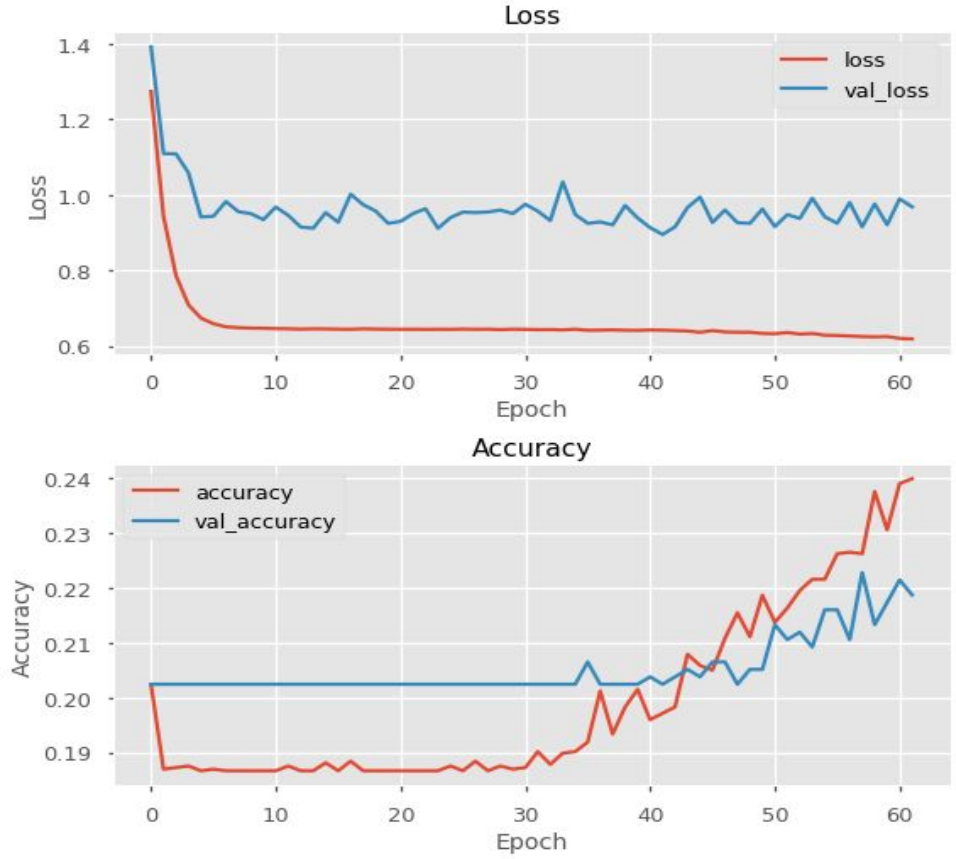
- LSTM Model
  - Embedding layer with 50 vector size
  - LSTM Layer
    - 64 neurons
    - L2 regularizer
  - Dropout Layer
    - Rate : .2
  - Dense Layer
    - 128 neurons
    - Tanh activation
  - Output Layer
    - Sigmoid Activation
  - Loss: binary_crossentropy
  - Optimizer : Adam

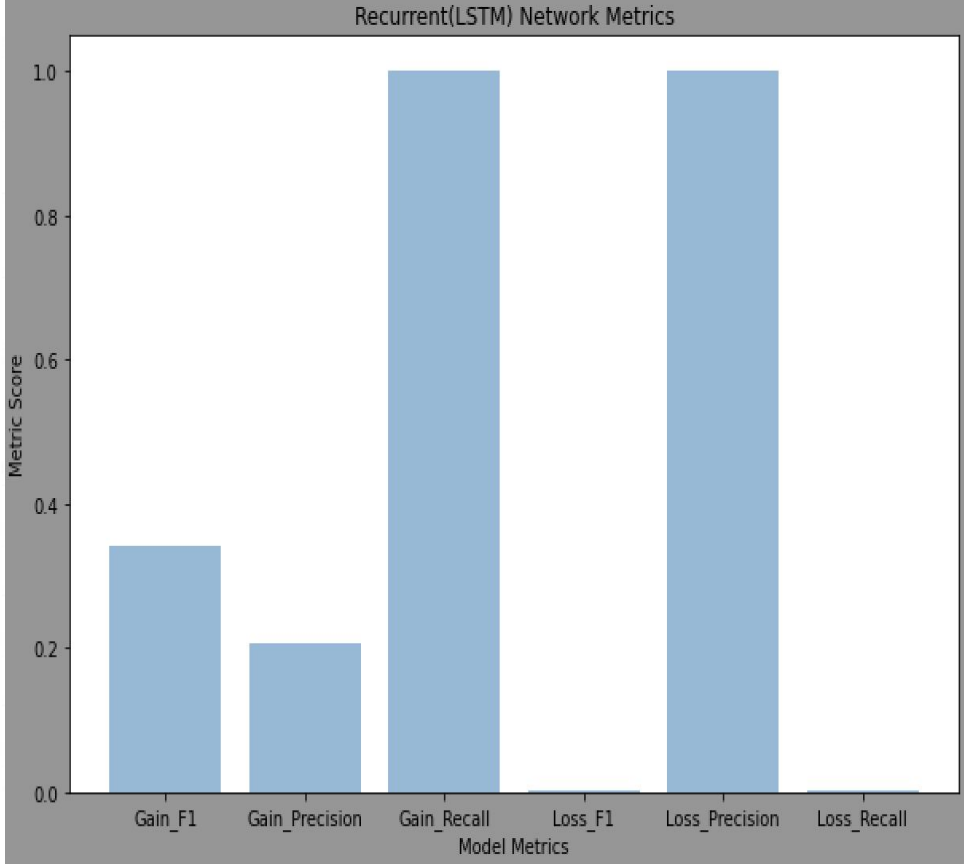
Metrics (GRU Recurrent Network)





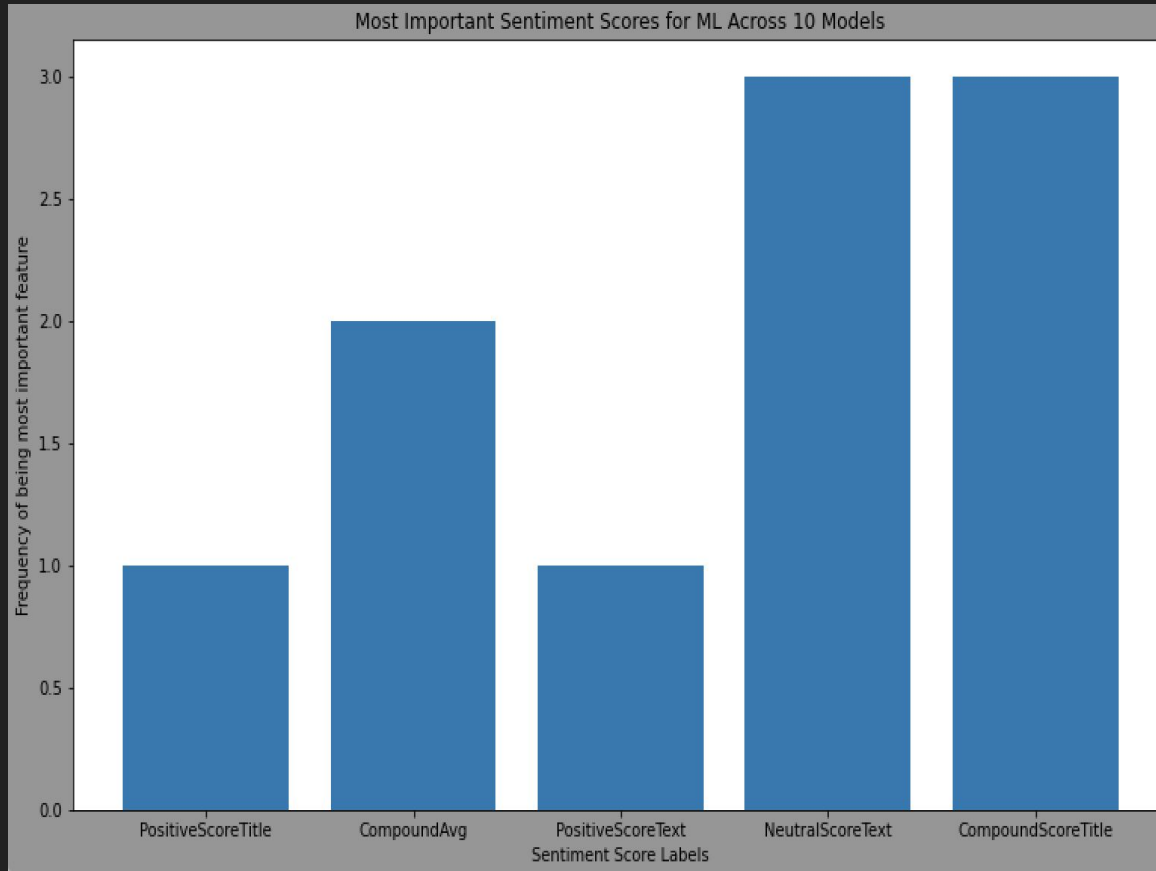
Metrics (LSTM Recurrent Network)



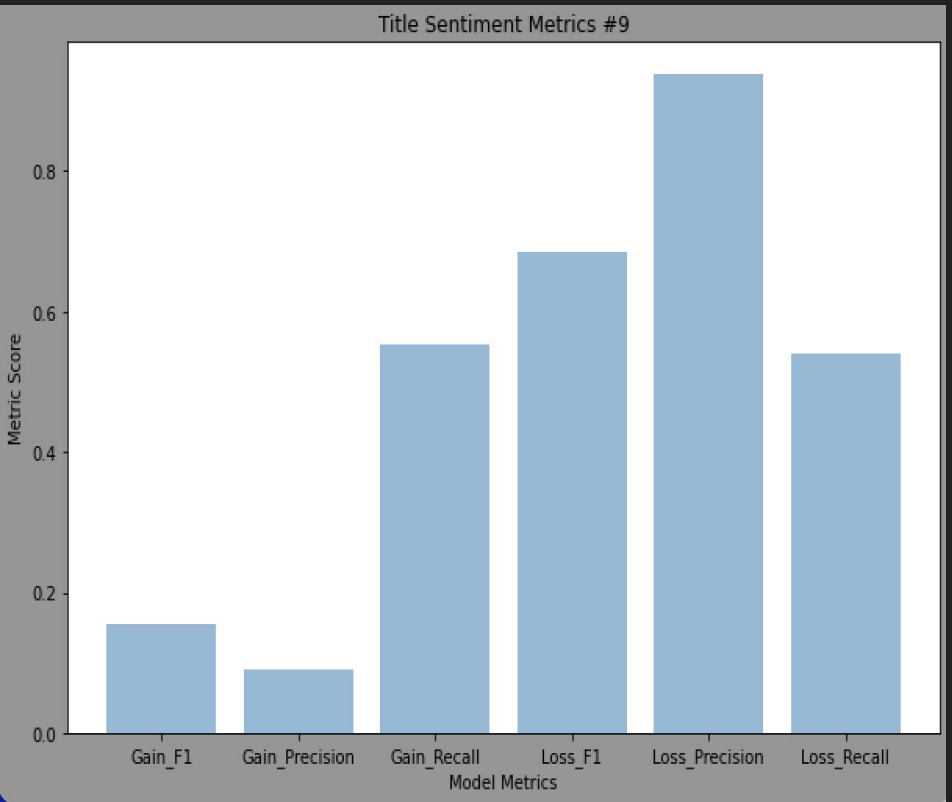


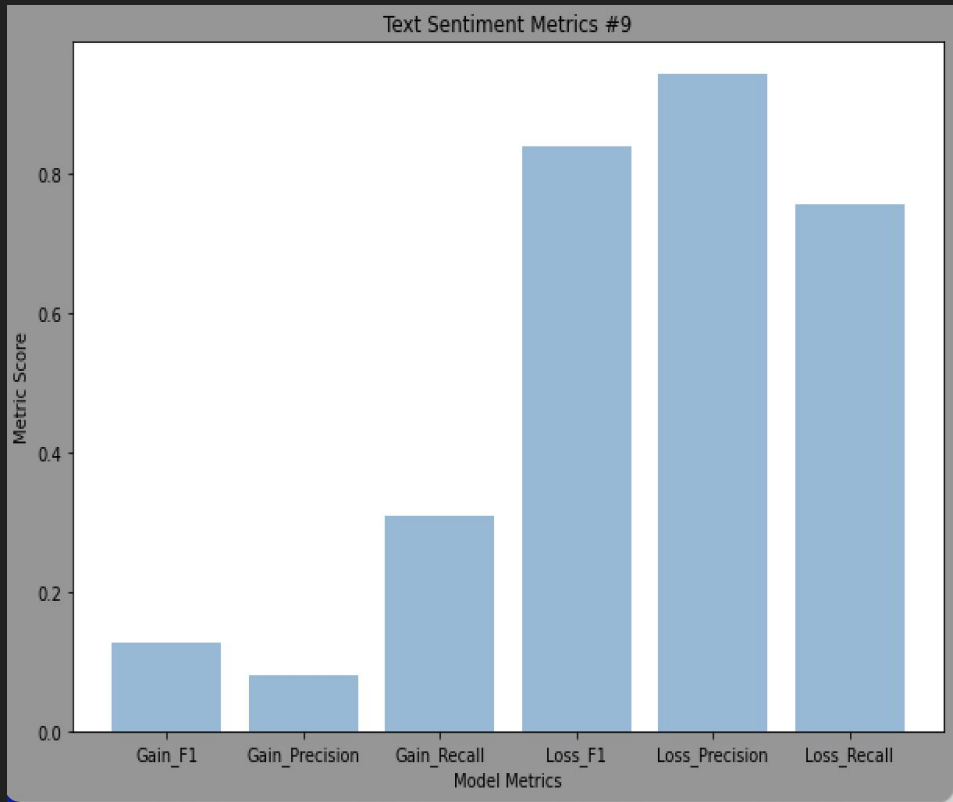
Results #1

- Text & Title are equally important when classifying stock news data



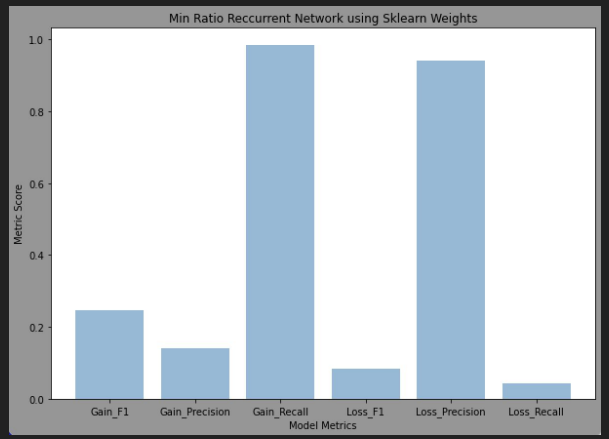
Results #1 Additional Evidence

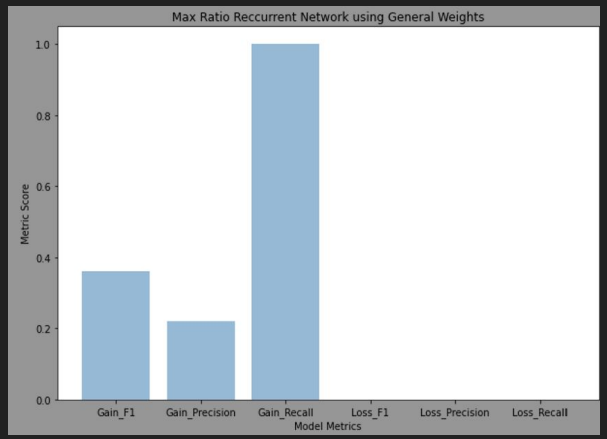


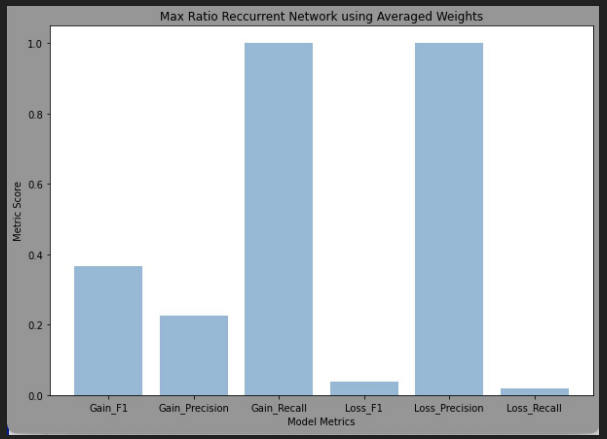


Results #2

The best weighting system for larger ratios, loss/gain, is the averaged weights

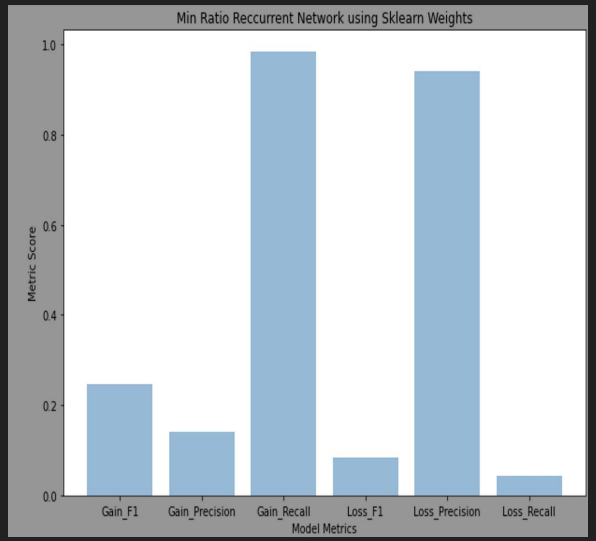


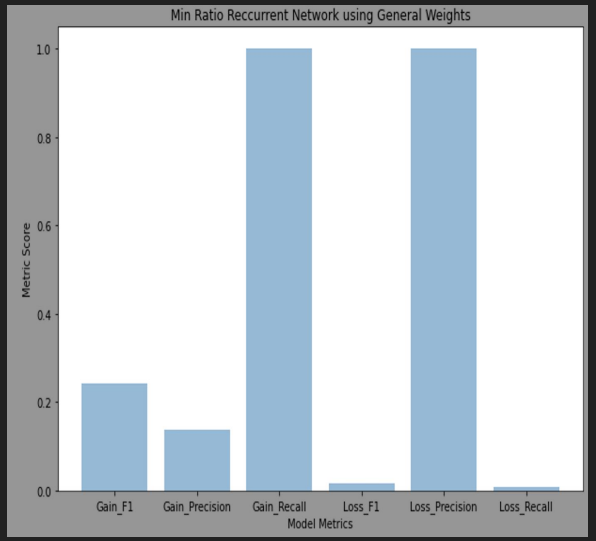


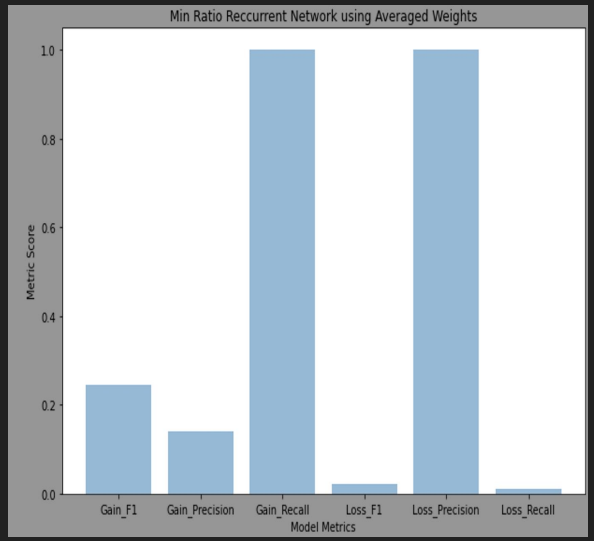


Results #2

The best weighting system for smaller ratios, loss/gain, is the sklearn weights







Results#3 Best Model

Recurrent Network GRU

	precision	recall	f1-score	support
0	0.81	1.00	0.90	2386
1	0.00	0.00	0.00	544
accuracy			0.81	2930
macro avg	0.41	0.50	0.45	2930
weighted avg	0.66	0.81	0.73	2930

Baseline (XGBOOST)

	precision	recall	f1-score	support
0	0.82	0.80	0.81	2402
1	0.18	0.20	0.18	528
accuracy			0.69	2930
macro avg	0.50	0.50	0.50	2930
weighted avg	0.70	0.69	0.70	2930

Recurrent Network LSTM

	precision	recall	f1-score	support
0	0.00	0.00	0.00	2386
1	0.19	1.00	0.31	544
accuracy			0.19	2930
macro avg	0.09	0.50	0.16	2930

Baseline (Sentiment | NON ML)

	precision	recall	f1-score	support
loss	0.10	0.00	0.00	1145
gain	0.51	0.99	0.67	1201
NotEnoughData	0.00	0.00	0.00	4
accuracy			0.51	2350
macro avg	0.20	0.33	0.22	2350
weighted avg	0.31	0.51	0.34	2350

Conclusions

- Develop & patent custom Natural Language Processing for stock news titles AND their corresponding text.
  - This will lead to higher return on investments,
  - business insights,
  - and allow your company to understand the sentiment of investors.
- To best handle the class imbalance where ratio = loss/gain:
  - Smaller Ratios (<8) : Use Sklearn generated weights
  - Larger Ratios (>8) : Use the average weight between sklearn and the general formula class/class
- Develop a sentiment analysis tool specifically for stock data. This will include labeling data for training, this should be done by human experts.

Further Work

Provided with more time, I would....

- Further develop transformer model
  - Parameter Optimization
  - Add weights
- Develop business product capable of analyzing stock sentiment to enhance company & customer return on investment
- Develop custom filtering methods capable of determining:
  - Optimal weights for class imbalance
  - Trending stocks (positive or negative)
- Develop process that collects equal gain & loss metrics so that models have higher performance

Questions?

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