CV Regression

A Novel Approach for Financial Prediction to beat existing Methods like LSTMs

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Use of Novel Techniques for Financial Forecasting

INTRODUCTION

The use of Deep Learning for financial forecasting is a very popular and attractive field. Over time, there has been a lot of research on new and effective techniques for financial predictions. In this project, we look at three such techniques and compare them with traditionally proven LSTM methods to compute the future values of time series data.

MOTIVATION

The project is centered around the idea of converting **time series data to images.** The main motivation behind this approach is the better learning of deep learning models from image data rather than a single-column series. This approach should give better results provided that we have suitable ways to convert time series data into image data without any loss of information.

APPROACH USED

1. The first approach used by us was to use the GASF encoded images and train a CNN block to predict the 'close price' of the stock. But in this case, the results were not that good since CNN was not able to understand the sequential property of the time series data.

2. The next approach used by us was to build a model in which we take the GASF encoded images of the time series data, and then train an RNN using the sequence of GASF images as input and the 'close_price' as the target. In this case, we observed decent results, and thus, this gave us motivation to work on the project.

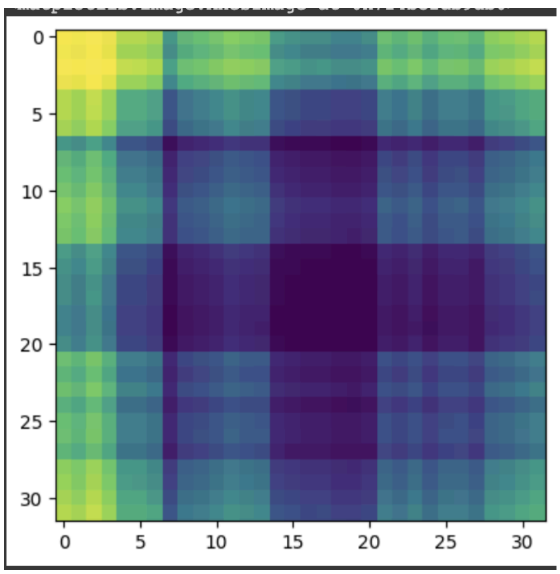
3. The next approach was to generate the images using GASF method, and run a convolutional neural network such as ResNet-50 as a feature extractor to get embeddings from the GASF encoded images. Now, after we get the feature vectors, we pass them to a LSTM model and train it to predict the future price using the sliding window method.

4. Finally, instead of using a fixed function to generate the image, we build a deep learning pipeline consisting of 3 parts: a) An image generator b) A CNN to extract embeddings and c) An LSTM to make continuous predictions. This approach should be better than previous two approaches since loss is back propagated through all the three layers, minimizing the information loss while image reconstruction .

RESULTS

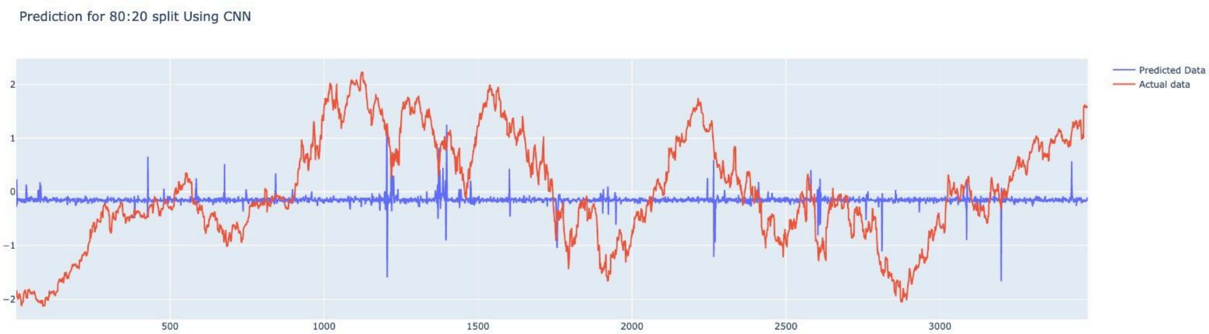
Dataset Used: 'AAPL' stock prices hourly data for last two years, obtained from the yahoo-finance library.

We first convert the entire time series data into single channel images of size 32*32 and number of images 3500. This is done using Gramian Angular Fields (summation mode).



We also define our dataset into continuous regions of 80% and 20% accuracy.

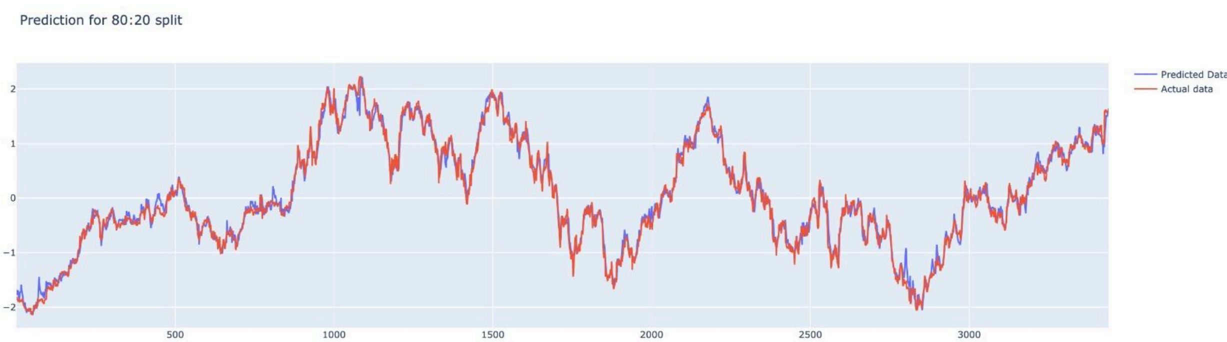
1. **Prediction Using CNN:** Now, we have 3500 images and we train a CNN on this image for stock price prediction.



We see that we get average like results with the model missing out most of the time series patterns. This re-establishes our knowledge that a simple CNN alone can't learn sequential patterns.

2. **Training an LSTM on above encoded images**

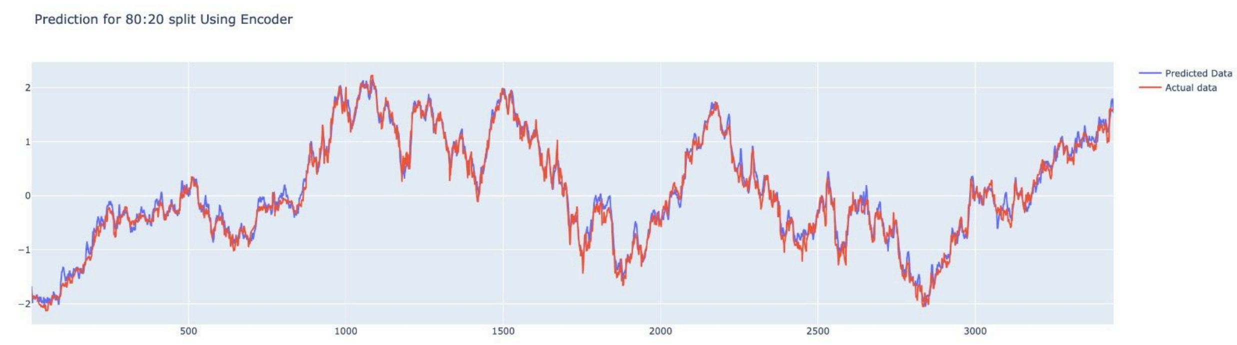
   Next, we try to use a model which is more suited for handling sequential data, i.e. LSTM! We pass a series of images to the model.



   As expected, we get excellent results on training and test data, with model learning almost all the patterns and the predicted values very close to the actual time series values. This acts as a motivation for us, to further build on this idea.

3. **Using ResNet-18 to encode images and passing embeddings to LSTM:**

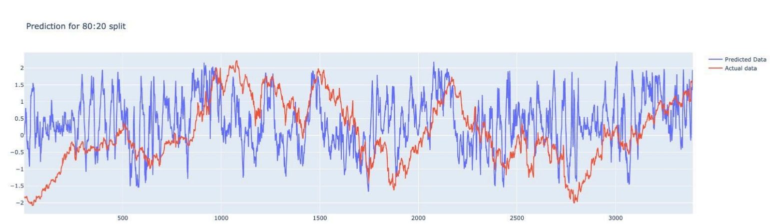
   Resnet-18 is a popular architecture known for its ability to extract features from images and being computationally cheaper. We therefore use a pre-trained Resnet-18 as an encoder to extract patterns from the Images.

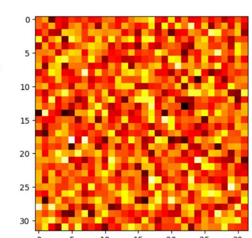


As expected, this further improves the accuracy and reduced the loss further. These results establish efficacy of GAF encoding to retain information between time series to image conversion.

4. **A deep learning pipeline for image Generation and Prediction**

Now, since we know that time series data can be effectively converted into images for predictions, instead of using a fixed function to generate images, we can actually have a deep learning model do it. This will be effective because, the generator itself will learn and update according to the performance of entire pipeline and might help us generate more time-series specific images which will improve the accuracy.



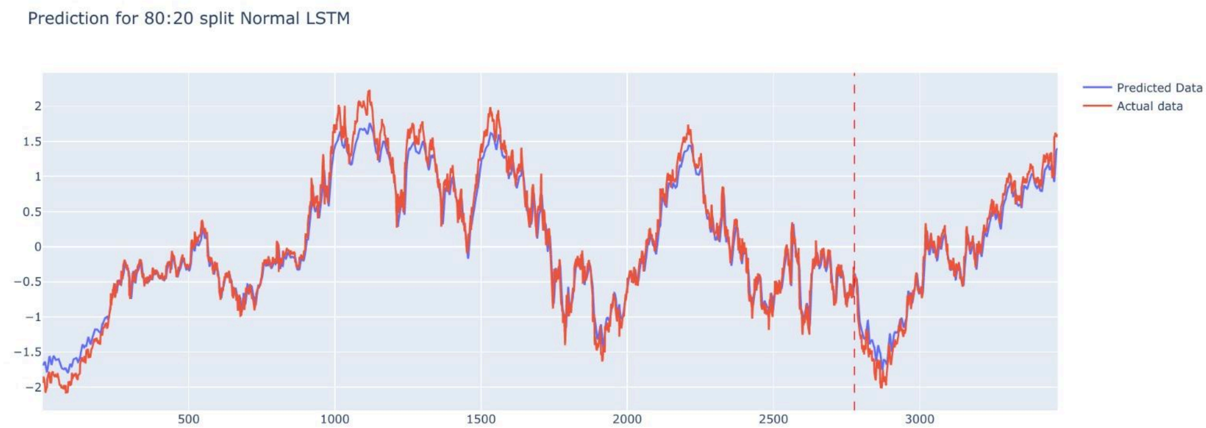


Above are time series prediction (on the left) and generated images (on the right).

Here, we see that output learns some pattern but is noisy, this might be because of poorly generated images.

COMPARISON WITH LSTM

We also trained an LSTM on the time series data and made the prediction on time series data, we compare the performance of LSTM with our approaches.



Here we see that LSTM performs poorly near the peaks and the troughs, and instead gives a very smooth version of the data. Our model however is far more accurate and almost learns even the smallest of the details. It is also worthy to note that LSTM overfits on training data and validation performance decreases as we increase the number of epochs.

CONCLUSION AND FUTURE SCOPE

We have developed approaches which are better than LSTM and can be used if far more accurate time series prediction is needed. Eg: High Frequency Trading, Medical Time Series Prediction. Future Scope of this project is to improve the performance of deep learning pipeline, as it has potential for better time-series specific image generation.

REFERENCES

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