A Machine Learning Workflow for Hurricane Prediction

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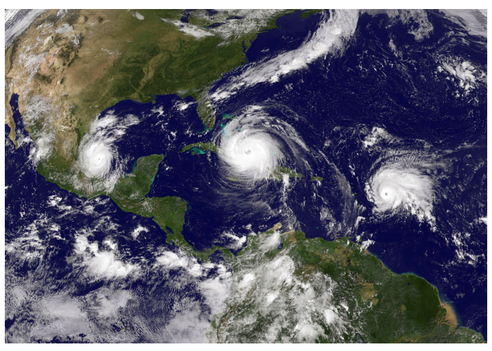
Introduction

The Atlantic hurricane season runs from June 1st to November causing massive destruction and loss of life. Meteorologists, by studying previous weather data, predict expected number of hurricanes in the season.

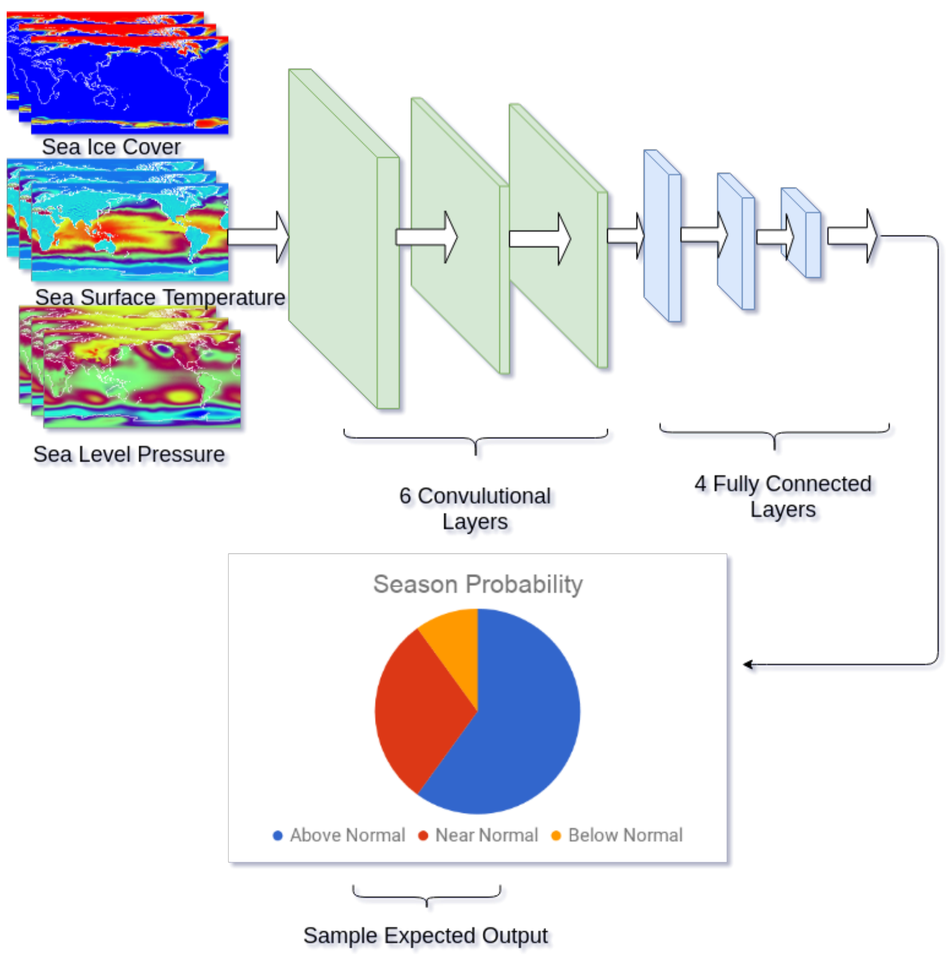
Deep neural networks(DNN) have the ability to understand complex relationships in spatio temporal data. We introduce DNN to hurricane prediction to understand the complex relationship between weather patterns and the number of hurricanes in a hurricane season.

Motivation



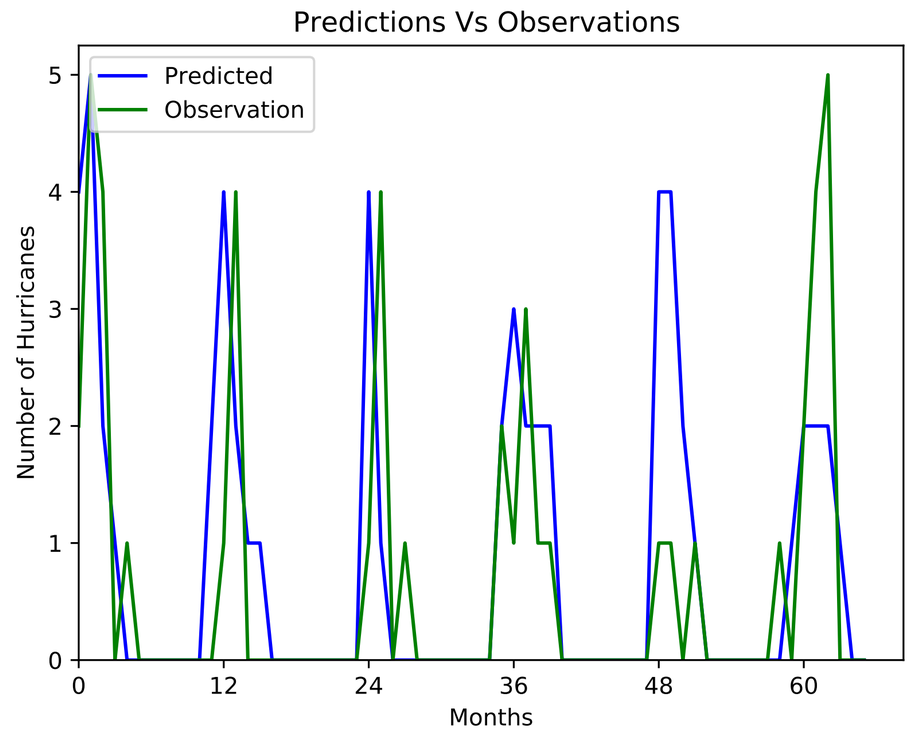
Geostationary satellites collect tens of terabytes of data everyday that is used to make predictions about future weather. With high performance computing, DNN could demystify this data and provide valuable insights and predictions.

Objective



- To predict the intensity of the hurricane season using deep learning
- Massively distribute training of the neural networks using PyCompss

Preliminary Findings



Early experiments show the following:

- It is possible to predict the nature of the hurricane season using DNN
- We obtained an accuracy of 72% in predicting number of hurricanes in a given month
- Sea surface temperature has the highest impact on the prediction of number of storms

Conclusion

- Deep learning could offer an alternative way to understand climate data and make predictions for hurricane season
- Deep learning and human expertise could significantly improve predictions and potentially save lives and property.

Future Work

- A complete end to end workflow to continously learn weather patterns that affect the hurricane season and make better predictions
- Implement distributed learning to eliminate the need to expensive computational infrastructure
- Application of approximate computing in different parts of the workflow
- Ressilience analysis of the entire workflow

References

[1] Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
Deep Learning.
The MIT Press, 2016.

[2] Yunjie Liu, Evan Racah, Joaquin Correa, Amir Khosrowshahi, David Lavers, Kenneth Kunkel, Michael Wehner, William Collins, et al.
Application of deep convolutional neural networks for detecting extreme weather in climate datasets.
arXiv preprint arXiv:1605.01156, 2016.

[3] Qin Zhang, Hui Wang, Junyu Dong, Guoqiang Zhong, and Xin Sun.
Prediction of sea surface temperature using long short-term memory.
IEEE Geoscience and Remote Sensing Letters, 14(10):1745–1749, 2017.

[4] Wei Zhang, Lei Han, Juanzhen Sun, Hanyang Guo, and Jie Dai.
Application of multi-channel 3d-cube successive convolution network for convective storm nowcasting.
arXiv preprint arXiv:1702.04517, 2017.

[5] Ming Zhao, Isaac M Held, and Gabriel A Vecchi.
Retrospective forecasts of the hurricane season using a global atmospheric model assuming persistence of sst anomalies.
Monthly Weather Review, 138(10):3858–3868, 2010.

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