

Hurricanes forecast with Physics Informed Neural Networks

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Abbreviated abstract: Climate disasters have a huge impact in society in different aspects. Events like hurricanes could be destructive to families, environment and the government. Predict a hurricane disaster could not prevent it to happen, but could save thousands of lives and invested capital. This current research has as a main goal to increase an existent Machine Learning Hurricane prediction model with a deep Physics analysis.

Related publications:

– Boussioux, Léonard & Zeng, Cynthia & Guenais, Theo & Bertsimas, Dimitris. (2020). Hurricane Forecasting: A Novel Multimodal Machine Learning Framework.



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Problem, Data, Previous Works

Problem: Not certainty of current Complex Climate Systems prediction models;

Goal: Improve the Hurricast model to predict Hurricanes, adding the Physical parameters;

Data:

Statistical Data: Information of winds intensity, sea-surface pressure, atmospheric pressure, sea-surface temperature, latitude and longitude, and a reanalysis data of satellite images;

Physics Data: Coriolis Number and Radius of earth.

Strategy: Add a Physics analysis into the Hurricast model, turning into a Physics Informed Neural Networks model.



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Methods

Softwares: Python (Scipy, Numpy, Pandas, TensorFlow, Matplotlib)

Preparing the Data: Create a reanalysis of satellite images, to feed our Neural Network model; Clean and process the statistical data referred before; Load the PDE model to analyze hurricanes behavior as also the initial conditions; Create our Mathematical model.

Analyzing the Data: Create a Convolutional Neural Network model, based on the current research; Increasing the model with our Mathematical view, uniting into the loss function of the Neural Network model.

Visualizing and validating the Data: Develop an observed trajectory chart with the data and compare with the current hurricane's season.



Results and Conclusions

The project is in the beginning, as we started it last month.

The current steps:

- I. Develop the PDE model in Python;
- II. Organize, process and analyze the Data;
- III. Create the Neural Network Model;
- IV. Feed the Model with the Data;
- V. Create the visualizations;
- VI. Compare the results;
- VII. Write the article.

"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less." - Marie Curie

