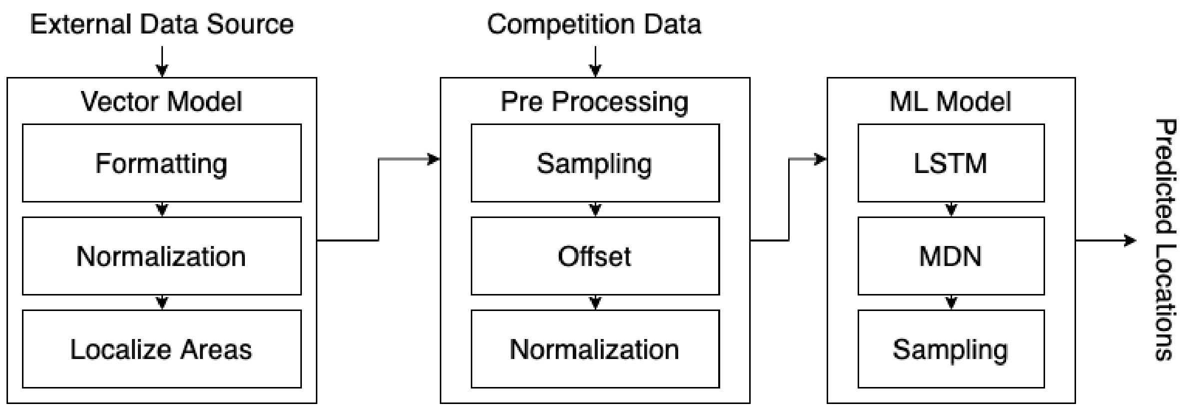
Brief Technical Approach:

For our solution, we will be using a mixture of a vector field model and a machine learning model. Our vector field model will be based on external data sets in combination with adjustments made from any calculations that we make from the spotter data. The vector field outputs a localized vector field of a set area around a given point which will be concatenated with the spotter data set which will be trained through our machine learning model.



Vector Field Model

The output of this model is a list of weighted vectors based on three parameters: x, y, t and a constant area that will be a hyperparameter. The result of the output will be concatenated with each entry to the spotter data set.
The first iteration of our prediction model will [1]use weather data from the NCEP to get localized current, wave, and wind data for our spotters. This data will be formatted, scaled, and normalized based on hyperparameters that we will be tuning to minimize the error of our model. Specifically, we plan on using the direction of wind waves in addition to wind speed to generate the vector field.

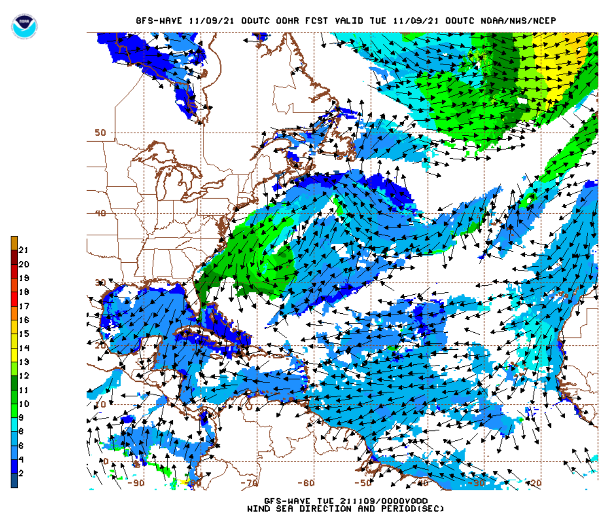


Figure 1.

[1] An example of the datasets provided by NCEP. We will take an area around a given point and produce a list of vectors that will be input to the ML model.

ML model

The ML model will consist of a mixture density network working with a recurrent neural network (RNN) to predict the trajectory of a spotter. This model will be based on a model explored in “Predicting Future Locations of Moving Objects by Recurrent Mixture Density Network " by Rui Chen, Mingjian Chen, Wanli LI, and Naikun Guo. As stated in the paper, the output of our model will be the change in location for next 1 hour (△longitude and △latitude) rather than predicting the next absolute locations. The input features consists of significantWaveHeight, peakPeriod, meanPeriod, peakDirection, peakDirectionalSpread, meanDirection, meanDirectionalSpread, the △longitude and △latitude change last 1 hour, and the around 5x5 vector field value. These features are fed into a bi-directional LSTM model which will provide its output to the Mixture Density Network (MDN) model. The MDN model finally outputs the distribution parameters of location change for next 1 hour (△longitude and △latitude) and we apply the sampling method to determine the next movement.

Overview

The two parts of our model were thought out to make the development process easier. We are able to test the base ML model without the vector field parameter to determine a general idea of trajectory predictions without inputting spatial environment data. We decided on creating a vector field model, in addition, to provide data on the surrounding environment for each point in the trajectory. Using a 5x5 local vector field, the ML model could train the prediction to keep track of the mesoscale features of the ocean and find patterns in the trajectory of spotters based on local conditions. Our error analysis will be based on the competition scoring; the distance between predictions will be summed to calculate the error in the predicted trajectory. This architecture provides a flexible interface to add environmental data to the ML model and separates it from any training data that we use for the base trajectory.