SoyCast: A Climate-Driven Deep Neural Network to Forecast County-Level Soybean Yields and Identify Environmentally Optimal Planting Regions

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With food insecurity becoming an increasingly important global issue, understanding the impacts of climate change on agricultural yields through yield forecasting is critical to ensure sustainable future food production. This project aimed to develop an accurate soybean yield forecasting deep neural network (DNN) model utilizing climatic data to analyze climate change's potential impacts on yields, and to identify high yield potential areas within the US based on those environmental factors. To accomplish this, over one million data points regarding yield and weather data on 36 temperature, precipitation, and snowfall factors were collected from around 2000 counties over a ~100-year range. Initially, a multivariate linear regression model utilizing backward selection was formed as a baseline, yielding an R^2 of 0.7544 on a testing set. A deep neural network was then trained on standardized data, with hyperparameters meticulously tuned for accuracy. The final deep neural network SoyCast, consisting of 6 layers and 25 epochs on a learning rate of 0.001, achieved an R^2 of 0.8002 in predicting county-level yields. This DNN was applied to project US regions with the highest climate-based yield potential, and by normalizing non-climatic inputs, areas within the Midwest and Mid-Atlantic were identified as having the optimal yield environment. Using the model, a publicly available website was built for instant yield projections, allowing for better crop preparation. Overall, the results of this study allow farmers and the government to better adapt to future climate scenarios and optimize yield to support long-term food security.

Awards Won: