Using Machine Learning to Improve Numerical Weather Prediction

Casey, Conor (School: Pobalscoil Inbhear Sceine)

Weather forecasting is traditionally done by physical models, which are unstable to perturbations. Even the best simulators can be inaccurate due to insufficient knowledge of the underlying physics and parameters. An alternative is to use neural networks (NNs) to train simulators directly from observational data, as this does not suffer from the same limitations. My project hypothesizes that it is possible to train a NN on an atmospheric reanalysis dataset from the past 40 years, and ultimately that a machine learning model will improve weather prediction compared to physical models. A factor which led to the development of a machine learning model was the decrease in computational resources required to generate a forecast. Once the model has trained, a performance increase of 100 times is expected in comparison to a physical model of a similar resolution. Benchmarks have demonstrated that the model can be regarded as useful, as it outperforms persistence and climatological forecasts. The root mean squared error was chosen as the primary error metric because it mirrors the loss used for most machine learning applications. The performance is equivalent to physical models of a similar spatial resolution; however, it fails to beat well established operational models at this time. The model's spatial awareness, as measured by the anomaly correlation coefficient, can be regarded as quite poor. My results demonstrate that neural networks can be utilised to improve the computational efficiency of numerical weather prediction and could allow for larger ensemble sizes in the future. This would provide greater certainty in the forecast produced, as well as, requiring less computational resources to generate a forecast of equal accuracy.

Awards Won:

Second Award of $2,000