Paper: Harnessing Deep Learning in Ecology: An Example Predicting Bark Beetle Outbreaks

My Abstract:

Predictive ecology is critical in addressing some of the most pertinent concerns of the 21st century such as climate change and biodiversity loss. Policy makers and ecosystem managers rely on predictions to respond to these concerns. Recent advances in data availability and computing power have made predictions more conceivable. However, methodologies that can leverage these developments are not yet commonly used in ecology. Deep learning is a machine learning method that is capable of using large amounts of nonlinear data for prediction and forecasting that is still underused in ecology. In this study we present an example of how a convolutional deep neural network (CNN) may be used for the purpose of predictive ecology. We apply this method to the context of bark beetle outbreaks in the Bavarian Forest National Park, Germany. Aerial surveys were combined with qualitative and timeseries data to create a CNN prediction model. The CNN model outperformed other commonly used model architectures in predicting disturbance probability for individual years with an accuracy of 0.996, precision of 0.652 and recall of 0.392. Furthermore, it was capable of predicting disturbance dynamics over time with a Gleichlaufigkeit of 0.750 which outperformed the statistical model. All code and data required for reproducing the example presented here are available online https://github.com/werner-rammer/BBPredNet.

Their Abstract:

Addressing current global challenges such as biodiversity loss, global change, and increasing demands for ecosystem services requires improved ecological prediction. Recent increases in data availability, process understanding, and computing power are fostering quantitative approaches in ecology. However, flexible methodological frameworks are needed to utilize these developments towards improved ecological prediction. Deep learning is a rapidly evolving branch of machine learning yet has received only little attention in ecology to date. It refers to the training of deep neural networks (DNNs), i.e. artificial neural networks consisting of many layers and a large number of neurons. We here provide a reproducible example (including code and data) of designing, training, and applying DNNs for ecological prediction. Using bark beetle outbreaks in conifer dominated forests as an example, we show that DNNs are well able to predict both short term infestation risk at the local scale and long-term outbreak dynamics at the landscape level. We furthermore highlight that DNNs have better overall performance than more conventional approaches to predicting bark beetle outbreak dynamics. We conclude that DNNs have high potential to form the backbone of a comprehensive disturbance forecasting system. More broadly, we argue for an increased utilization of the predictive power of DNNs for a wide range of ecological problems.

Comparison:

- Their abstract seems to focus more on the fact that they were interested in showcasing deep learning in predictive ecology and my abstract focuses more on the model itself.
- They do not state their summarizing statistics for the model's performance in their abstract and only states that it outperforms other methods. I think those specific statistics are important on a first view.
- They also include more of a conclusion in their abstract where I ended with only the results.

- Our abstracts seem to overlap quite a lot especially with sculpting the context of the study.
- They never mention what deep neural network architecture or style they use. I think it is important to mention that it is a convolutional neural network and not just a normal feed forward network.
- Considering that the paper was published in Frontiers in Plant Science their abstract is probably better suited to the audience where mine is more aimed at someone interested in the model. Their abstract seems to be aimed at someone more generally interested in new techniques in ecology.