EXPLORATION OF DEEP LEARNING TECHNIQUES TO DETECT AND TRACK TROPICAL CYCLONES

Ashwin Samudre[1], Linus Magnusson[2], Pedro Maciel[2]

Tropical Cyclones are the complex events characterized by strong winds surrounding a low pressure area. These are among the most harmful events on the Earth and accurate prediction of them is essential to make reliable warnings. A necessary tool in the process is the track of the cyclone and its intensity, which can be extracted from the forecasts. Tropical cyclones are manually detected from observations (mainly satellite images), by the World Meteorological Organization (WMO) regional specialized meteorological centers (RSMCs) and tropical cyclone warning centers (TCWCs), and the estimated positions and intensities are broadcasted and put into the IBTrACS ("Best-Track") database [1]. Cyclone intensity classification is usually performed using Dvorak technique [2], which mainly focuses on statistical relationships between different environmental parameters and the intensity of the cyclone. The Advanced Dvorak Technique (ADT) [3] is an automated and improved method based on Dvorak technique. Numerical weather forecast models iteratively predict a range of variables in a 4-dimensional volume including the 3 spatial dimensions and time. These models have the capability to use the 3-dimensional output to simulate satellite images. It opens up the possibility to use the analytical techniques on the model output to classify the cyclones. Currently, the applied tracking algorithms mentioned above are based on the surface pressure, circulation further up in the atmosphere and the temperature in the core of the cyclone. These algorithms are configured from human experience. A challenge is to find tropical cyclone features in this vast amount of data and to extract the tracks of the cyclone features. Using data-oriented techniques can be highly useful in this scenario.

Deep learning methods [4] have shown remarkable efficacy in pattern recognition tasks across diverse fields. In a recent attempt at classification of tropical cyclone intensities using convolutional neural networks (CNN) [5], authors created a dataset of the fixed size tropical cyclone images from the satellite imaging data and provided as input to the CNN for classification. Our work aims to perform an object recognition and classification task in an integrated manner (also called as object detection). We make use of the full resolution satellite imaging data instead of the fixed-size tropical cyclone images and thus treating the problem as an object detection task. A variety of state of the art object detection algorithms can be utilized for this task, with our current focus on algorithms such as YOLOv3 [6], Faster R-CNN [7]. We plan to compare the performance and select the best algorithm for our case. Later we plan to integrate the temporal context (using memory based neural network variants) for end-to-end tracking of cyclones. The developed algorithm will be crucial for the real time analysis and classification of the tropical cyclones in order to take the necessary measures ahead of time based on forecasting data.

Corresponding author: A Samudre, ashwin.samudre@embl.de
[1]EMBL Heidelberg, Germany [2]ECMWF, Shinfield Park, RG2 9AX, Reading, UK

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