IONONet: A deep learning model for ionospheric nowcast

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The usage of deep learning algorithms is increasing at a very fast pace. The versatility and power of the deep learning algorithms have allow them to enter in a great variety of fields. The most generally known fields are autonomous vehicles; bid data handling and image and speech recognition. Moreover, it has also entered the space applications related with Earth Observation, Spacecraft operations and telemetry anomaly detection among others. Thanks to this wide adoption of the deep learning models, there have been an increasing number of open source tools that have been put on user hands. Some examples would be the so-called: TensorFlow, Keras, PyTorch, Caffe, and Theano; and the list can be easily found in the web. This shows the widespread of these models and the easy access that any community has in order to develop deep learning-based applications.

In the Ionospheric field, there were some attempts to use neural networks for computing/retrieving ionospheric parameters with scattered data. Most works were related with the computation of the M3000 and FoF2 data, with pretty good success. Thus, since there is a large availability of vTEC data in the public domain, spanning more than 20 years; and the computational resources available to train such massive amount of data (more than 500 billion points) have reach mainstream (by using GPU cards). The application of deep learning algorithm to vTEC data was a must do in the ionospheric community to verify the usefulness of such models. A first attempt to do this was reported in RD.1, where a deep learning algorithm based on TensorFlow was developed on the Solar Minimum (from 2005 to 2009) and then used to predict the data on the following Solar Minimum (2016 and 2017). This model was called IONONet and it used the Galileo Signal-in-Space Az parameters as a proxy of the Solar Flux to perform nowcasting. It demonstrated that the position accuracy was at the level of the NeQuick G for the tested years. Therefore, in this work and extension of the IONONet will be presented doubling the amount of data and catching the Solar Maximum (from 2000 to 2009). This will pose a challenge to identify the best deep learning architecture and the possible strategies to develop the IONONet. The test will be done by means of worldwide position error covering the most part of the last Solar Cycle where there is Galileo Signal (2013 to 2018).

RD.1. R. Orus Perez, Using TensorFlow-based Neural Network to estimate GNSS single frequency ionospheric delay (IONONet), Advances in Space Research, https://doi.org/10.1016/j.asr.2018.11.011