Journal of Physics: Conference Series 2018 vol.1141 N1

Model of the global distribution of the total electron content based on deep dense convolutional autoencoder

Khristoforov S., Bochkarev V.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2018 Institute of Physics Publishing. All rights reserved. Nowadays the prediction of ionospheric parameters is an important and acute problem in the field of ensuring stable operation of radio communication and radio navigation facilities. The network of two-frequency GPS receivers data is used for monitoring the ionospheric condition. Based on these data, a number of laboratories are building global maps of total electron content (TEC). There are strong spatial and temporal correlations in the TEC maps. As a result, in order to successfully solve the problem of TEC prediction, it is advisable to perform preliminary processing of maps data with dimensionality reduction. In this paper, the problem of constructing a low-dimensional model of global distribution of the TEC is solved. In addition, the model of global distribution of the TEC can be useful for the ionosphere dynamics investigation. In this paper, it is proposed to use dense convolutional auto encoders as a base element of the model. This architecture allows us to speed up the neural network learning process and avoid the gradient-vanishing problem in error backpropagation algorithm.

http://dx.doi.org/10.1088/1742-6596/1141/1/012067

References

[1] Pearson K 1901 On Lines and Planes of Closest Fit to Systems of Points in Space Philosophical Magazine. 2 559-572

[2] McInnes L and Healy J 2018 UMAP: Uniform Manifold Approximation and Projection for Dimension Reduction arXiv:1802.03426v1

[3] Sanjeev A, Wei H and Pravesh K 2018 An Analysis of the t-SNE Algorithm for Data Visualization arXiv:1803.01768v2

[4] Charte D, Charte F, García S, María J and Francisco H 2018 A practical tutorial on autoencoders for nonlinear feature fusion: Taxonomy, models, software and guidelines arXiv:1801.01586

[5] Bochkarev V. and Maslennikova Y. 2014 Principal component analysis of global maps of the total electronic content Geomagnetism and Aeronomy 54 216-223

[6] Hyeonwoo N, Seunghoon H and Bohyung H 2015 Learning Deconvolution Network for Semantic Segmentation arXiv:1505.04366v1

[7] van den Oord A, Dieleman S, Zen H, Simonyan K, Vinyals O, Graves A, Kalchbrenner N, Senior A and Kavukcuoglu K 2016 wavenet: a generative model for raw audio arXiv:1609.03499v2

[8] Kim Y., Jernite Y, Sontag D and Rush A. 2015 Character-Aware Neural Language Models 1508.06615

[9] Huang G., Liu Z, van der Maaten L and Weinberger K. 2018 Densely Connected Convolutional Networks arXiv:1608.06993v5

[10] Xu B., Wang N, Chen T and Li M. 2015 Empirical Evaluation of Rectified Activations in Convolutional Network arXiv:1505.00853

[11] Razvan P., Tomas M and Yoshua B. 2012 On the difficulty of training Recurrent Neural Networks arXiv:1211.5063

[12] Kingma D. and Ba J. 2015 Adam: a Method for Stochastic Optimization International Conference on Learning Representations 1-13

[13] Smith L. 2018 a disciplined approach to neural network hyper-parameters: part 1 - learning rate, batch size, momentum, and weight decay arXiv:1803.09820v2