Research on CNN (Convolutional Neural Network)-based Forecasting Method

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Abstract. *The article deals with the problem of predicting the COVID-19 spreading in Ukraine. This task becomes more relevant each day. From all the modern models of CNN-based time series forecasting, the InceptionTime model was chosen. Its advantages are high accuracy and scalability. The research is implemented using the Python high-level programming language. The results are presented as the mean absolute error for each region. The InceptionTime model has proved its high accuracy for this task.*

Keywords: *time series, forecasting, convolutional neural networks, InceptionTime, COVID-19.*

I. Introduction

The SARS-CoV-2 pandemic affects people's lives worldwide. Many countries introduced quarantine restrictions which greatly affect all social and economic areas and the global economy in general. The COVID-19 spreading in Ukraine had many consequences: a drop in the GDP, a nearly complete halt of the retail, catering, and hospitality businesses, as well as air traffic.

In these circumstances, the predicting problem is more relevant than ever before. Forecasting financial, economical, logistical, and provisioning indicators becomes highly dependent on the COVID-19 spreading dynamics in Ukraine. Therefore, predicting the morbidity rate in Ukrainian regions with maximum precision in the short and longer-term is essential for making decisions on easing or tightening the quarantine restrictions.

So let's deal with the problem of predicting the COVID-19 spreading in Ukraine from this perspective. The input data are region-based time series of the morbidity rates: the number of confirmed cases, the number of deaths, the number of active cases, and the increase of active cases. The task is to predict the increase of confirmed cases with minimum error.

II. Problem Solution and Results

There is a wide variety of time series (TS) forecasting methods. They may be conveniently classified into static, structural, and combined [1].

Among all structural models, ANN(artificial neural network)-based models hold a special place. Neural networks' great advantage is that they are capable of training and consolidating accumulated knowledge. CNN-based models are highly accurate, so it makes sense to use them in this case.

InceptionTime has a special place among all time series categorization models. It is an ensemble of CNN models based on the Inception-v4 architecture. This model proved its high accuracy, is scalable, and can be trained on 1500 time series per hour simultaneously [2]. The ability to simultaneously process several time series is an essential advantage since the entry data, in this case, is represented by separate region-specific time series datasets. Therefore, it is appropriate to use InceptionTime to predict the COVID-19 spreading in Ukraine.

The research is implemented using the Python high-level programming language including its tsai library that is meant for modern categorization methods as well as time series regression and forecasting. The API is used to acquire the entry data from the official website of the National Security and Defense Council of Ukraine. The increase of confirmed cases is the forecasting parameter, the time frame is 56 days, and the forecasting horizon is 7 days. The forecasting accuracy is estimated by the MAE (mean absolute error).

The research result is represented by region-based MAE values (fig. 1).
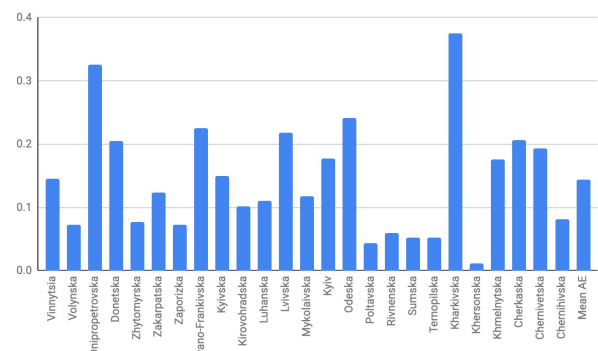

Figure 1. MAE by region.

The results received from all regions demonstrate that the InceptionTime model is very accurate. The training time was 27 minutes.

III. Conclusions

The InceptionTime model was used to predict the COVID-19 morbidity rate in Ukraine for the first time. High training speed and simultaneous work with several time series are its major advantages. The received region-based error values demonstrate the model's high accuracy with the training set.

Further research is aimed to find the most effective neural network models and to evaluate their accuracy by using various training sets.

References

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