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Forecasting Covid-19 New Cases in Hungary

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***Abstract* - In this study, the ANN approach was applied to analyze COVID-19 new cases in Hungary. The employed data covers the period 1 January 2020 – 25 March 2021 and the out-of-sample period ranges over the period 26 March – 31 July 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is quite stable. The results of the study indicate that daily COVID-19 cases in Hungary are likely to remain very high over the out-of-sample period. Amongst other suggested policy directions, there is need for the government of Hungary to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The SARS-CoV2 virus emerged in Wuhan, China in December 2019 and virus was observed to be highly contagious with high morbidity and mortality (Garbalenya et al, 2020; Chan et al, 2020; WHO, 2020). This new virus caused great alarm in many parts of the globe as the first wave swept across borders killing thousands of people. The virus is transmitted through inhalation or exposure to contaminated droplets on surfaces (Haren & Levi, 2020). The symptoms of the viral disease are fever, dry cough, shortness of breath, sore throat and chest pains. Hungary reported its first cases of COVID-19 on the 4th of March 2020 (Khanday et al, 2020). The government responded to the pandemic by imposing lockdown, social distancing, wearing face masks, hygiene practices, isolation and treatment of cases and contact tracing. In this paper we apply the artificial neural network approach to predict daily COVID-19 cases in Hungary. The technique has been found to produce reliable forecasts when analyzing huge data sets (Maradze et al, 2021; Nyoni & Nyoni, 2021).

II. LITERATURE REVIEW

Pinter et al (2020) applied a hybrid machine learning approach to predict the COVID-19, and we exemplify its potential using data from Hungary The hybrid machine learning methods of adaptive network-based fuzzy inference system (ANFIS) and multi-layered perceptron-imperialist competitive algorithm (MLP-ICA) are proposed to predict time series of infected individuals and mortality rate. The models predicted that by late May 2020, the outbreak and the total morality would drop substantially. A study done by Hamadneh et al (2020) used artificial neural networks (ANNs) to predict the number of cases of COVID-19 in Brazil and Mexico. A Prey predator algorithm (PPA), as a type of met heuristic algorithm, was used to train the models. The simulation results of the ANN models show very well predicted values. A comparative analysis of machine learning and soft computing models to predict the COVID-19 outbreak as an alternative to SIR and SEIR models was carried out by Ardabili et al (2020). Among a wide range of machine learning models investigated, two models showed promising results (i.e., multi-layered perceptron, MLP, and adaptive network-based fuzzy inference system, ANFIS). The study concluded that real novelty in outbreak prediction can be realized through integrating machine learning and SEIR models. Shorten et al (2020)evaluated the current state of Deep Learning and conclude with key limitations of Deep learning for COVID-19. The literature review found out many examples of Deep Learning systems to fight COVID-19.

III. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modeling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting new COVID-19 cases Hungary.

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Data Issues

This study is based on daily new cases of COVID-19 in Hungary for the period 1 January 2020 – 25 March 2021. The out-of-sample forecast covers the period 26 March 2021 – 31 July 2021. All the data employed in this research paper was gathered from the Johns Hopkins University (USA).

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	H
Observations	438 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.080725
MSE	249237.943842
MAE	322.369371

Residual Analysis for the Applied Model

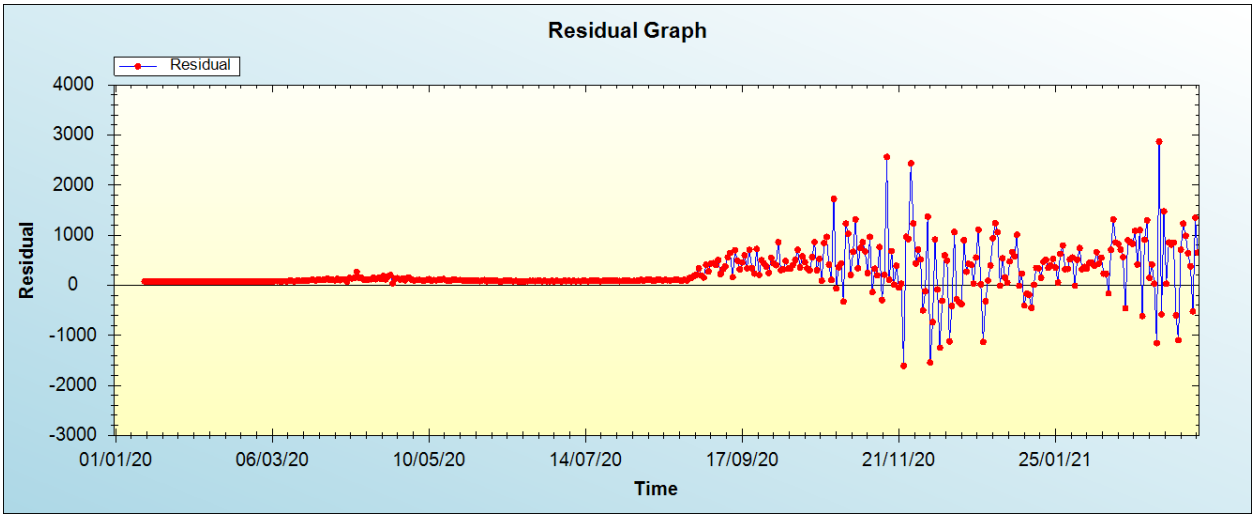

Figure 1: Residual analysis

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In-sample Forecast for H

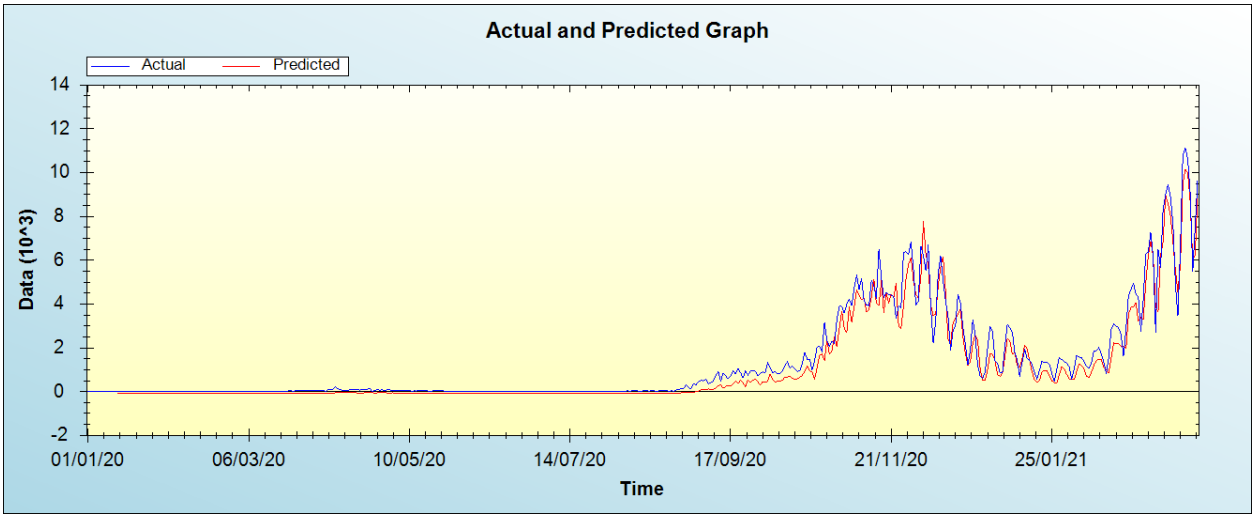

Figure 2: In-sample forecast for the H series

Out-of-Sample Forecast for H: Actual and Forecasted Graph

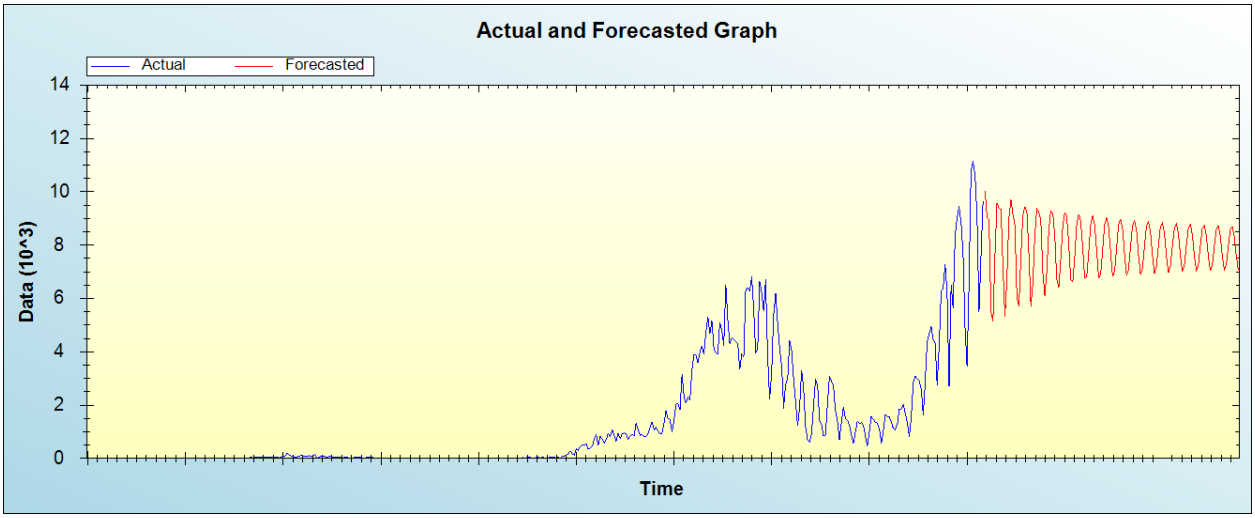

Figure 3: Out-of-sample forecast for H: actual and forecasted graph

Out-of-Sample Forecast for H: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	10030.4476
27/03/21	9058.0581
28/03/21	8929.1960
29/03/21	5511.2569
30/03/21	5158.4767
31/03/21	7619.2786
01/04/21	9574.6128
02/04/21	9379.2191
03/04/21	9349.1595
04/04/21	7147.1988
05/04/21	5313.9552
06/04/21	6726.1159
07/04/21	8997.0601
08/04/21	9708.2211
09/04/21	9146.7045

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10/04/21	8740.5643
11/04/21	6027.9941
12/04/21	5703.5338
13/04/21	7540.3858
14/04/21	9108.7261
15/04/21	9440.8423
16/04/21	9260.9521
17/04/21	7698.7152
18/04/21	5713.6368
19/04/21	6543.3704
20/04/21	8328.3763
21/04/21	9365.9006
22/04/21	9245.6915
23/04/21	8909.0017
24/04/21	6981.6718
25/04/21	6093.2317
26/04/21	7021.2398
27/04/21	8538.9834
28/04/21	9290.9863
29/04/21	9213.8162
30/04/21	8370.4477
01/05/21	6706.3333
02/05/21	6404.3940
03/05/21	7454.3686
04/05/21	8704.0083
05/05/21	9218.9383
06/05/21	9074.5824
07/05/21	8098.8621
08/05/21	6685.4941
09/05/21	6631.3904
10/05/21	7597.7892
11/05/21	8764.7998
12/05/21	9157.4971
13/05/21	8909.7625
14/05/21	7905.9777
15/05/21	6752.4383
16/05/21	6808.9962
17/05/21	7735.3466
18/05/21	8776.3077
19/05/21	9095.5844
20/05/21	8776.1495
21/05/21	7813.1372
22/05/21	6771.0089
23/05/21	6923.0423
24/05/21	7831.8736
25/05/21	8777.4952
26/05/21	9036.8273
27/05/21	8683.8334
28/05/21	7732.8379
29/05/21	6823.6894
30/05/21	7015.6193
31/05/21	7902.2765
01/06/21	8756.8414
02/06/21	8981.9796
03/06/21	8600.4915
04/06/21	7671.5342
05/06/21	6866.1970
06/06/21	7089.4781
07/06/21	7943.5609
08/06/21	8736.0661
09/06/21	8928.6577
10/06/21	8535.0066
11/06/21	7631.0146
12/06/21	6911.0575

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13/06/21	7139.8591
14/06/21	7966.2179
15/06/21	8711.5671
16/06/21	8880.9770
17/06/21	8481.4159
18/06/21	7609.6118
19/06/21	6944.8138
20/06/21	7179.8845
21/06/21	7976.0657
22/06/21	8686.9203
23/06/21	8838.8872
24/06/21	8442.0093
25/06/21	7596.7802
26/06/21	6974.7678
27/06/21	7208.6354
28/06/21	7978.0506
29/06/21	8660.8432
30/06/21	8803.8464
01/07/21	8410.2397
02/07/21	7592.8408
03/07/21	7000.2951
04/07/21	7229.5446
05/07/21	7973.0139
06/07/21	8635.1720
07/07/21	8773.6473
08/07/21	8386.7918
09/07/21	7594.1922
10/07/21	7023.4637
11/07/21	7242.6865
12/07/21	7963.9143
13/07/21	8609.7076
14/07/21	8748.0216
15/07/21	8369.9185
16/07/21	7600.5671
17/07/21	7043.5226
18/07/21	7250.7237
19/07/21	7951.1329
20/07/21	8585.0671
21/07/21	8726.0516
22/07/21	8359.0399
23/07/21	7609.9331
24/07/21	7061.9974
25/07/21	7254.4731
26/07/21	7935.7065
27/07/21	8560.9754
28/07/21	8707.4297
29/07/21	8352.5350
30/07/21	7622.3419
31/07/21	7078.8355

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that daily COVID-19 cases in Hungary are likely to remain very high over the out-of-sample period.

V. CONCLUSION AND POLICY RECOMMENDATIONS

The control of the COVID-19 virus continues to be a challenge worldwide. Scientists are not sure of the future of the human race as more COVID-19 variants continue to emerge and concerns are being raised about the effectiveness of the currently available vaccines against these new strains. Modeling and forecasting of COVID-19 cases is critical at this point so that authorities can have an insight of the likely future trends of the SARS-COV2 virus so that governments can prepare resources to prevent and control the spread of the virus. In this study we apply the artificial neural approach to predict daily COVID-19 cases

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in Hungary. The results indicate daily COVID-19 cases in Hungary are likely to remain very high over the out-of-sample period. Therefore the government should ensure adherence to WHO guidelines and protocols to prevent and control COVID-19.

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