International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 6, pp 248-254, June-2021

https://doi.org/10.47001/IRJIET/2021.506045

Forecasting Covid-19 New Cases in Finland

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***Abstract* - In this study, the ANN approach was applied to analyze COVID-19 new cases in Finland. 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 COVID-19 cases are likely to surge over the out-of-sample period. Amongst other suggested policy directions, there is need for the government of Finland to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Finland has an estimated population size of about 5.5 million people (Tiirinki et al, 2020). The country reported the first case of COVID-19 on the 29th January 2020. The Finish government responded to the pandemic by implementing measures such as lockdowns, social distancing, wearing masks, hygiene practices, isolation and treatment of cases, contact tracing and health education (Omaolo, 2020; Jormanainen et al, 2020).In addition the government increased ICU and general ward bed capacity to cope with the increasing demand (STM, 2020; Finish government, 2020; Ministry of social affairs and health, 2020). There was scaling down of non-urgent medical services, however some of the non-urgent cases were attended to if it was seen fit to do so (Ministry of social affairs and health, 2020). Furthermore, the government ordered closure of non-essential businesses which meant that there would be a decline in tax incomes due to increase in unemployment levels (Statistics Finland, 2020).In this study we applied the multilayer neural network to predict daily COVID-19 cases in Finland. Several studies have proven the predictive accuracy of the this technique (Maradze et al, 2021; Nyoni et al, 2021; Zhao et al, 2020), hence we have chosen to utilize it in this paper. We expect the results of this piece of work to reveal the evolution of the epidemic in Finland and this will guide decision makers and help in the allocation of resources for the prevention and control of COVID-19.

II. LITERATURE REVIEW

Tiirinki et al (2020) analyzed the COVID-19 health system response and economic consequences. The study was based on available documents and reports of different ministries and social, health and economic authorities collected online. This was complemented by other relevant pandemic data from Finland. The study revealed thatCOVID-19 pandemic has accelerated the development of digital health services and telemedicine in Finnish healthcare system. Yue et al (2020) analyzed the national and global infection status of the Coronavirus Disease that emerged in 2019 (COVID-19), then used the trend comparison method to predict the inflection point and Key Point of the COVID-19 virus by comparison with the severe acute respiratory syndrome (SARS) graphs, followed by using the Autoregressive Integrated Moving Average model, Autoregressive Moving Average model, Seasonal Autoregressive Integrated Moving-Average with Exogenous Regressors, and Holt Winter's Exponential Smoothing to predict infections, deaths, and GDP in China. Finally, it discusses and assesses the impact of these results. This study concluded that even if the risks and impacts of the epidemic are significant, China's economy will continue to maintain steady development. Stang et al (2020)estimated excess mortality in Germany during the first wave of COVID-19.They analyzed age-specific numbers of deaths per week from 2016 to week 26 in 2020.The authors used weekly mean numbers of deaths of 2016–2019 to estimate expected weekly numbers for 2020 and then estimated standardized mortality ratios (SMR) and 95% confidence intervals. The study results revealed that excess mortality existed for two months.

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

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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 Finland.

Data Issues

This study is based on daily new cases of COVID-19 in Finland 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	F
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	0.123204
MSE	3529.776339
MAE	38.653287

Residual Analysis for the Applied Model

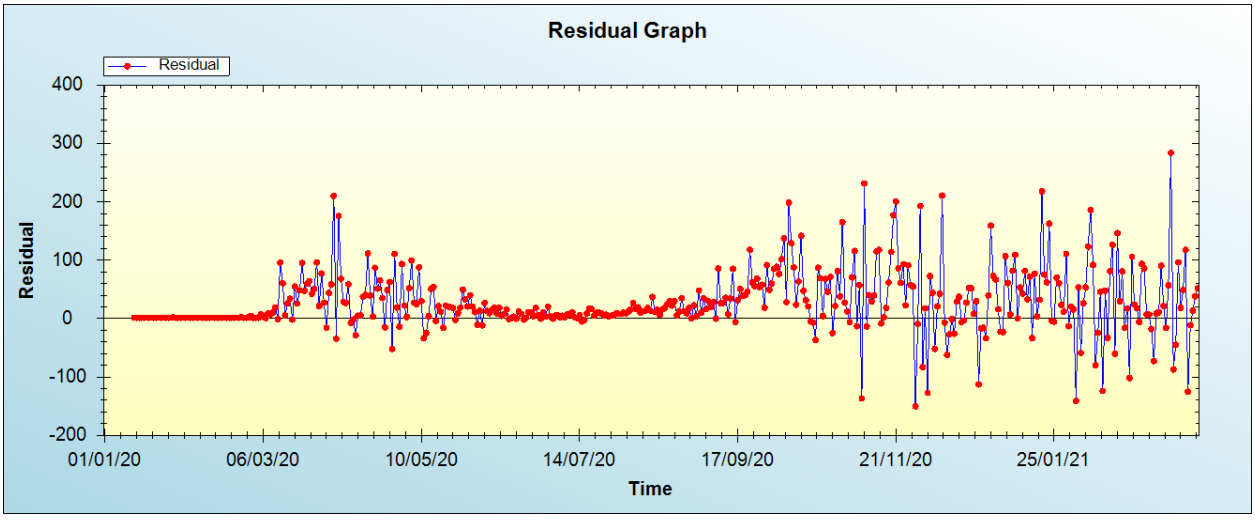

Figure 1: Residual analysis

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In-sample Forecast for F

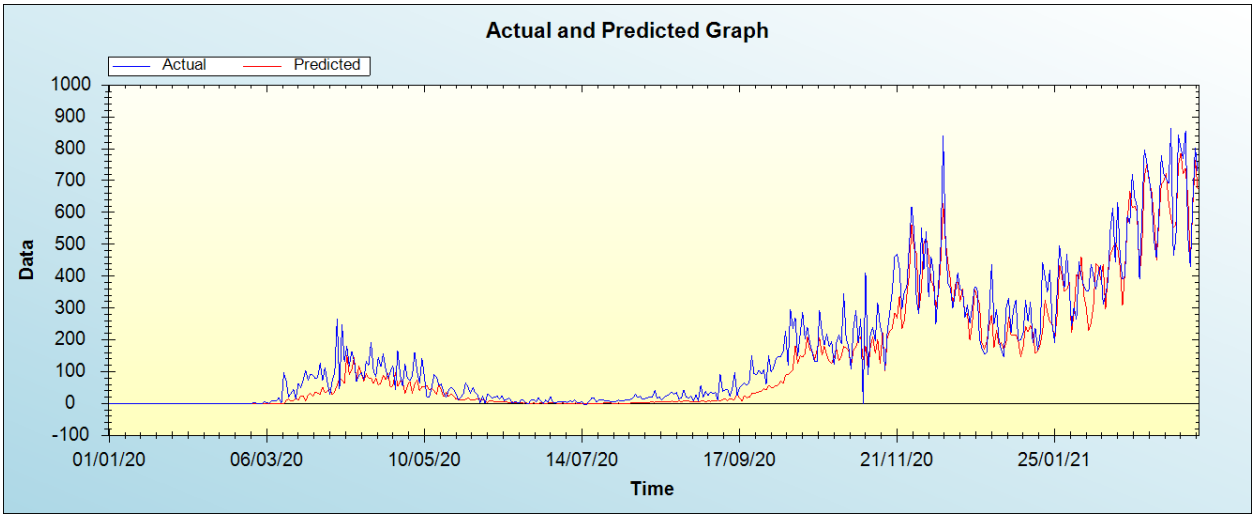

Figure 2: In-sample forecast for the F series

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

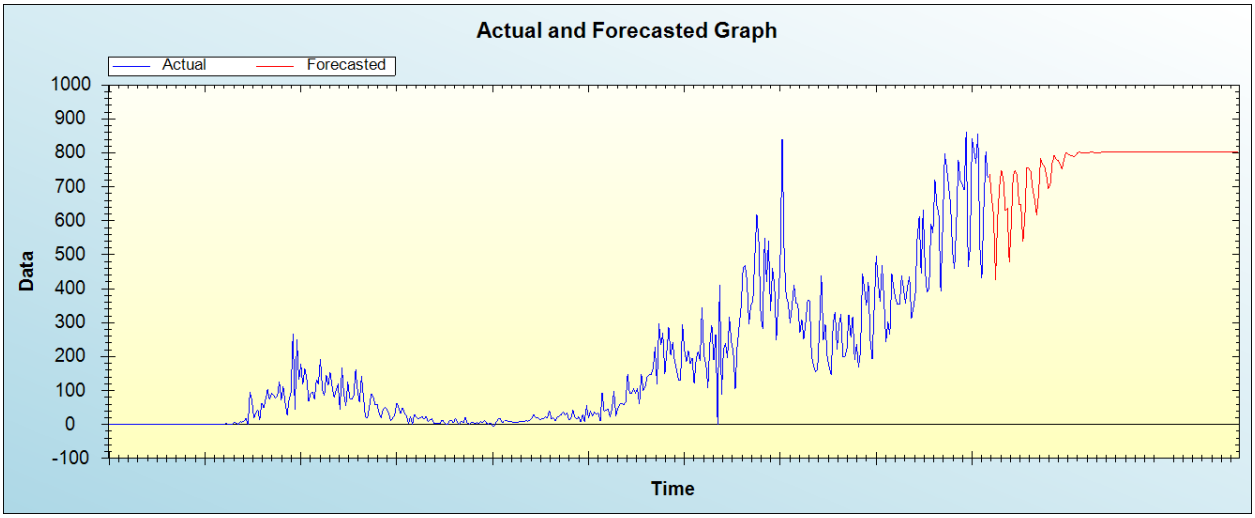

Figure 3: Out-of-sample forecast for F: actual and forecasted graph

Out-of-Sample Forecast for F: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	736.5203
27/03/21	668.1341
28/03/21	616.2907
29/03/21	426.1901
30/03/21	597.1830
31/03/21	701.5044
01/04/21	749.7256
02/04/21	720.0369
03/04/21	629.6046
04/04/21	636.9468
05/04/21	478.2953
06/04/21	586.6984
07/04/21	731.5569
08/04/21	748.5873
09/04/21	734.6028

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10/04/21	646.7366
11/04/21	647.3371
12/04/21	538.7009
13/04/21	613.5767
14/04/21	756.8003
15/04/21	754.4204
16/04/21	745.4280
17/04/21	691.4695
18/04/21	660.4980
19/04/21	616.0123
20/04/21	680.0206
21/04/21	782.9072
22/04/21	767.4452
23/04/21	760.3890
24/04/21	733.3512
25/04/21	694.4794
26/04/21	708.6809
27/04/21	770.3995
28/04/21	793.9628
29/04/21	781.3595
30/04/21	777.9068
01/05/21	767.3232
02/05/21	752.2627
03/05/21	782.0787
04/05/21	801.5465
05/05/21	796.4926
06/05/21	793.0655
07/05/21	792.3280
08/05/21	788.7892
09/05/21	792.4378
10/05/21	800.9105
11/05/21	802.4923
12/05/21	798.7930
13/05/21	799.3039
14/05/21	798.8134
15/05/21	799.0205
16/05/21	801.2323
17/05/21	802.2121
18/05/21	801.4382
19/05/21	800.9648
20/05/21	801.1000
21/05/21	801.2476
22/05/21	801.4402
23/05/21	802.0061
24/05/21	801.8244
25/05/21	801.5898
26/05/21	801.6337
27/05/21	801.6782
28/05/21	801.7388
29/05/21	801.8371
30/05/21	801.8521
31/05/21	801.7935
01/06/21	801.7452
02/06/21	801.8014
03/06/21	801.8009
04/06/21	801.8214
05/06/21	801.8379
06/06/21	801.8187
07/06/21	801.8074
08/06/21	801.8132
09/06/21	801.8202
10/06/21	801.8257
11/06/21	801.8240
12/06/21	801.8274

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13/06/21	801.8194
14/06/21	801.8206
15/06/21	801.8241
16/06/21	801.8242
17/06/21	801.8251
18/06/21	801.8249
19/06/21	801.8237
20/06/21	801.8237
21/06/21	801.8236
22/06/21	801.8251
23/06/21	801.8244
24/06/21	801.8246
25/06/21	801.8245
26/06/21	801.8241
27/06/21	801.8244
28/06/21	801.8246
29/06/21	801.8245
30/06/21	801.8246
01/07/21	801.8244
02/07/21	801.8245
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25/07/21	801.8245
26/07/21	801.8245
27/07/21	801.8245
28/07/21	801.8245
29/07/21	801.8245
30/07/21	801.8245
31/07/21	801.8245

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 Finland are likely to surge over the out-of-sample period.

V. CONCLUSION AND POLICY RECOMMENDATIONS

Artificial intelligence is an important tool in time series forecasting problems especially in predicting complex data in public health. Artificial neural network is an algorithm which has gained popularity in recent years. There are 4 basic artificial neural network frameworks namely the multilayer perceptron (MLP), generalized regression neural network (GRNN), Radial basis function (RBF) and the recurrent neural network. The MLP is the most widely used framework in time series forecasting hence its application in this study. The ANN (12, 12, 1) model was used to predict daily COVID-19 cases in Finland. The results

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of the study indicate that COVID-19 casesare likely to surge over the out-of-sample period.Therefore the government is encouraged to continuously enforce adherence to the WHO guidelines on prevention and control of COVID-19.

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International Research Journal of Innovations in Engineering and Technology (IRJIET)

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Volume 5, Issue 6, pp 248-254, June-2021

https://doi.org/10.47001/IRJIET/2021.506045

Citation of this Article:

Dr. Smartson. P. NYONI, Mr. Thabani NYONI, Mr. Tatenda. A. CHIHOHO, "Forecasting Covid-19 New Cases in Finland" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 6, pp 248-254, June 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.506045

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