

Forecasting Covid-19 New Cases in Kyrgyzstan

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

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The COVID-19 pandemic is regarded as the greatest health crisis in recent times (Lucero-Prisno et al, 2020). The disease is caused by the novel coronavirus, SARS-COV2 which was first identified by scientists in Wuhan, China in late December 2019 (Wang et al, Tang et al, 2020; CDC, 2020; Lucero-Prisno et al, 2020). Kyrgyzstan is a land locked country in central Asia. The country reported its first case of COVID-19 on the 18th of March 2020 (OCHA, 2020). The government promptly responded to the pandemic by imposing a national lockdown, temporary ban on public gatherings, closure of borders to foreigners and barred export of medicines and medical equipment and other essential goods (COVID health system response monitor, 2020). Kyrgyzstan being a developing country with a 22.4 % of the population living below the poverty datum line, was severely hit by the pandemic (UNDP, 2020). The country witnessed an increase in the vulnerability of its citizens especially the elderly, disabled and migrant workers (Dzushupov et al, 2021). The purpose of this study is to predict daily COVID-19 cases in Kyrgyzstan using artificial neural networks (ANNs). ANNs are gaining prominence in public health surveillance have been proven to be a useful technique for detecting disease outbreaks and helping in the assessment of the impact of mitigation measures (Maradze et al, 2021; Nyoni et al, 2020; Zhao et al, 2020).

II. LITERATURE REVIEW

Wieczorek et al (2020) developed a model which can work as a part of an online system as a real-time predictor to help in estimation of COVID-19 spread. The prediction model was developed using Artificial Neural Networks (ANN) to estimate the future situation by the use of geo-location and numerical data from past 2 weeks. The results of the model were confirmed by comparing them with real data and, during the research the model was correctly predicting the trend and very closely matching the numbers of new cases. Khanday (2020) forecasted the spread of COVID-19 in Hungary. Different methods effective for short-term forecasting are applied to the dataset, and predictions are made for the next 20 days. Auto regression and other exponential smoothing methods are applied to the dataset. SIR model was used and predicted 64% of the population could be infected by the virus considering the whole population is susceptible to be infectious. Auto regression, and exponential smoothing methods indicated there would be more than a 60% increase in the cases in the coming 20 days. The doubling of the number of total cases is found to around 16 days using an effective reproduction number. In another study Car et al (2020) modeled the Spread of COVID-19 Infection Using a Multilayer Perceptron using publicly available dataset, containing information on infected, recovered, and deceased patients in 406 locations over 51 days (22nd January 2020 to 12th March 2020) in Croatia. The results of the study indicated that best models achieved consists of 4 hidden layers with 4 neurons in each of those layers, and use a ReLU activation function, with R2 scores of 0.98599 for confirmed, 0.99429 for deceased, and 0.97941 for recovered patient models. When cross-validation is performed, these scores drop to 0.94 for confirmed, 0.781 for recovered, and 0.986 for deceased patient models, showing high robustness of the deceased patient model, good robustness for confirmed, and low robustness for recovered patient model.

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 Kyrgyzstan.

Data Issues

This study is based on daily new cases of COVID-19 in Kyrgyzstan 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 | K |
|------------------------------|---------------------------------|
| 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 | 0.085465 |
| MSE | 298402.786399 |
| MAE | 181.724651 |

Residual Analysis for the Applied Model

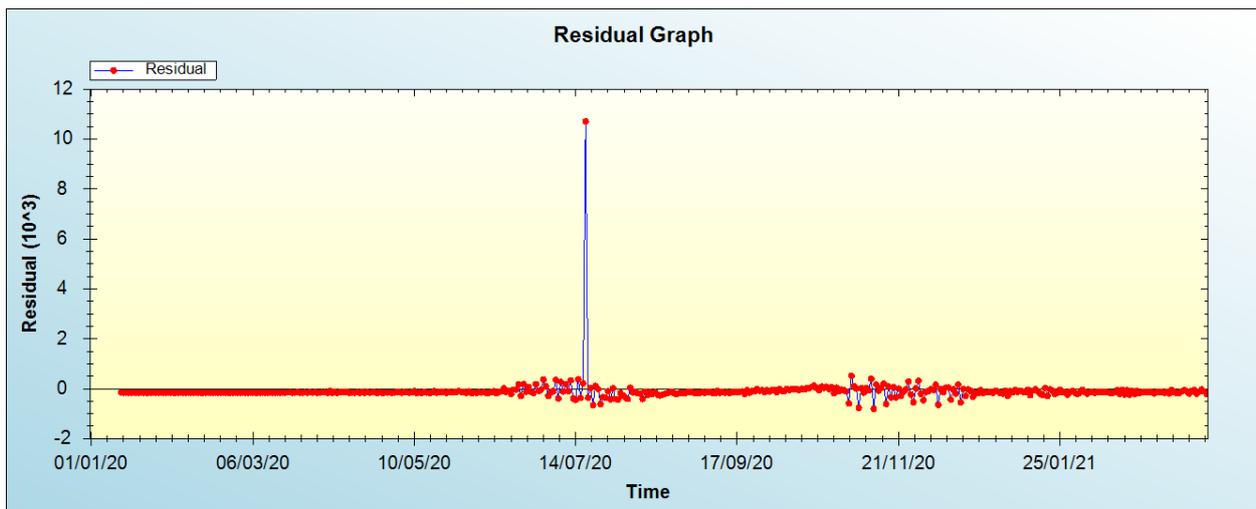


Figure 1: Residual analysis

In-sample Forecast for K

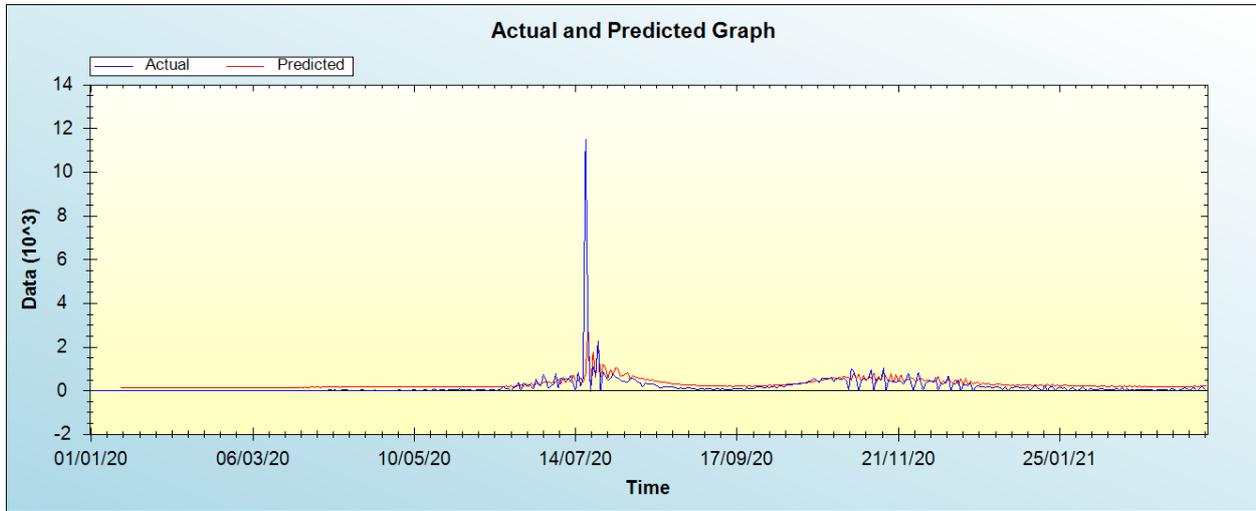


Figure 2: In-sample forecast for the K series

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

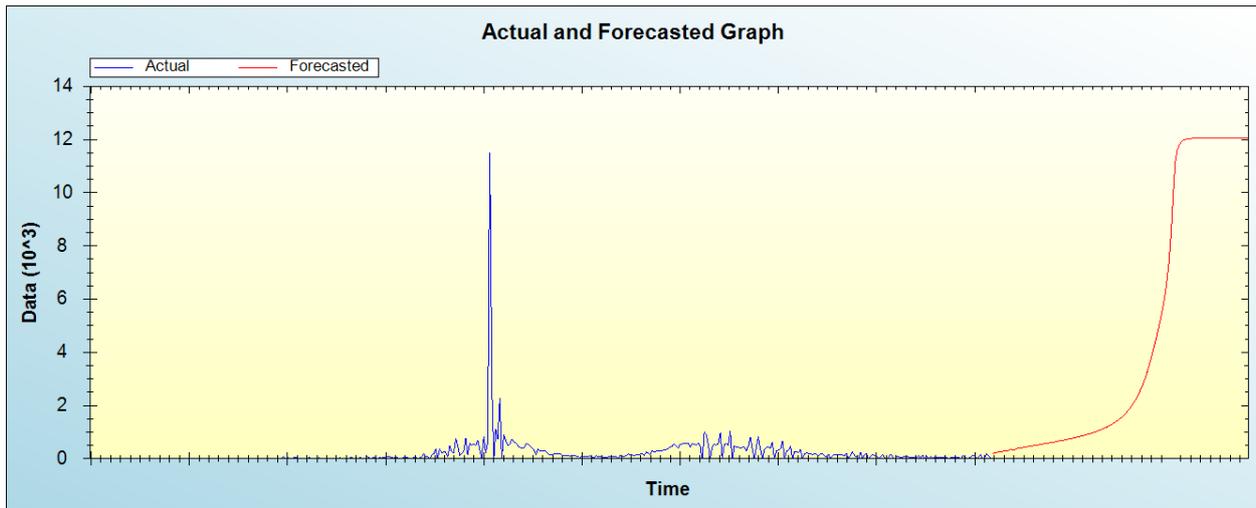


Figure 3: Out-of-sample forecast for K: actual and forecasted graph

Out-of-Sample Forecast for K: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| Day/Month/Year | Forecasts |
|----------------|-----------|
| 26/03/21 | 191.1520 |
| 27/03/21 | 241.3098 |
| 28/03/21 | 239.1578 |
| 29/03/21 | 259.9505 |
| 30/03/21 | 242.7175 |
| 31/03/21 | 285.9618 |
| 01/04/21 | 295.9904 |
| 02/04/21 | 280.1014 |
| 03/04/21 | 317.8981 |
| 04/04/21 | 349.5754 |
| 05/04/21 | 347.6537 |
| 06/04/21 | 346.2494 |
| 07/04/21 | 377.2310 |
| 08/04/21 | 399.4154 |
| 09/04/21 | 408.8306 |

| | |
|----------|-----------|
| 10/04/21 | 421.4818 |
| 11/04/21 | 431.0168 |
| 12/04/21 | 449.7973 |
| 13/04/21 | 461.7838 |
| 14/04/21 | 467.9253 |
| 15/04/21 | 486.5840 |
| 16/04/21 | 503.3246 |
| 17/04/21 | 513.2455 |
| 18/04/21 | 524.0883 |
| 19/04/21 | 538.9173 |
| 20/04/21 | 554.1855 |
| 21/04/21 | 566.7677 |
| 22/04/21 | 579.3083 |
| 23/04/21 | 592.7570 |
| 24/04/21 | 607.5821 |
| 25/04/21 | 621.0727 |
| 26/04/21 | 633.4840 |
| 27/04/21 | 648.7796 |
| 28/04/21 | 664.1902 |
| 29/04/21 | 678.1792 |
| 30/04/21 | 692.7217 |
| 01/05/21 | 708.2165 |
| 02/05/21 | 724.3554 |
| 03/05/21 | 740.3033 |
| 04/05/21 | 756.3886 |
| 05/05/21 | 773.4273 |
| 06/05/21 | 791.1759 |
| 07/05/21 | 809.0329 |
| 08/05/21 | 827.2393 |
| 09/05/21 | 846.6717 |
| 10/05/21 | 866.9053 |
| 11/05/21 | 887.4811 |
| 12/05/21 | 908.9367 |
| 13/05/21 | 931.5072 |
| 14/05/21 | 955.1879 |
| 15/05/21 | 979.8610 |
| 16/05/21 | 1005.6451 |
| 17/05/21 | 1032.9686 |
| 18/05/21 | 1061.8631 |
| 19/05/21 | 1092.2539 |
| 20/05/21 | 1124.4184 |
| 21/05/21 | 1158.7526 |
| 22/05/21 | 1195.3879 |
| 23/05/21 | 1234.4084 |
| 24/05/21 | 1276.2036 |
| 25/05/21 | 1321.1949 |
| 26/05/21 | 1369.7186 |
| 27/05/21 | 1422.1340 |
| 28/05/21 | 1478.9365 |
| 29/05/21 | 1540.8038 |
| 30/05/21 | 1608.3688 |
| 31/05/21 | 1682.2850 |
| 01/06/21 | 1763.4571 |
| 02/06/21 | 1852.9456 |
| 03/06/21 | 1951.8464 |
| 04/06/21 | 2061.3622 |
| 05/06/21 | 2182.9215 |
| 06/06/21 | 2318.1098 |
| 07/06/21 | 2468.5389 |
| 08/06/21 | 2635.8255 |
| 09/06/21 | 2821.5511 |
| 10/06/21 | 3027.1047 |
| 11/06/21 | 3253.3969 |
| 12/06/21 | 3500.6545 |

| | |
|----------|------------|
| 13/06/21 | 3768.3562 |
| 14/06/21 | 4055.1655 |
| 15/06/21 | 4359.1254 |
| 16/06/21 | 4678.4321 |
| 17/06/21 | 5012.8498 |
| 18/06/21 | 5365.9225 |
| 19/06/21 | 5748.5359 |
| 20/06/21 | 6184.9769 |
| 21/06/21 | 6723.4687 |
| 22/06/21 | 7452.5830 |
| 23/06/21 | 8504.9022 |
| 24/06/21 | 9906.6461 |
| 25/06/21 | 11116.5719 |
| 26/06/21 | 11613.0777 |
| 27/06/21 | 11781.1856 |
| 28/06/21 | 11895.0463 |
| 29/06/21 | 11963.4231 |
| 30/06/21 | 11994.2170 |
| 01/07/21 | 12009.6427 |
| 02/07/21 | 12021.1325 |
| 03/07/21 | 12033.8722 |
| 04/07/21 | 12047.0188 |
| 05/07/21 | 12055.4329 |
| 06/07/21 | 12058.7615 |
| 07/07/21 | 12060.1130 |
| 08/07/21 | 12060.7034 |
| 09/07/21 | 12060.9602 |
| 10/07/21 | 12061.1041 |
| 11/07/21 | 12061.1910 |
| 12/07/21 | 12061.2568 |
| 13/07/21 | 12061.3154 |
| 14/07/21 | 12061.3571 |
| 15/07/21 | 12061.3787 |
| 16/07/21 | 12061.3898 |
| 17/07/21 | 12061.3960 |
| 18/07/21 | 12061.3986 |
| 19/07/21 | 12061.3999 |
| 20/07/21 | 12061.4006 |
| 21/07/21 | 12061.4010 |
| 22/07/21 | 12061.4013 |
| 23/07/21 | 12061.4015 |
| 24/07/21 | 12061.4016 |
| 25/07/21 | 12061.4017 |
| 26/07/21 | 12061.4017 |
| 27/07/21 | 12061.4018 |
| 28/07/21 | 12061.4018 |
| 29/07/21 | 12061.4018 |
| 30/07/21 | 12061.4018 |
| 31/07/21 | 12061.4018 |

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

V. CONCLUSION AND POLICY RECOMMENDATIONS

The COVID 19 pandemic is the biggest challenge for Kyrgyzstan and the pandemic impacted severely on the health system and the economy. Kyrgyzstan heavily depends on exports of raw materials, gold and income of migrants working abroad. The quarantine restrictions implemented by Kyrgyzstan and neighboring countries was anticipated to result in 4% drop in GDP by the end of 2020. To facilitate planning and adequate resource mobilization this piece of work forecasted daily COVID-19 cases in the country. The results indicate that daily COVID-19 cases in Kyrgyzstan are likely to surge significantly over the out-of-sample period. Therefore the government is supposed to enforce adherence to COVID-19 public health measures.

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