PREDICTION OF DAILY NEW COVID-19 CASES IN COLOMBIA USING ARTIFICIAL NEURAL NETWORKS

*Dr. Smartson. P. NYONI[1], Thabani NYONI[2], Tatenda. A. CHIHOHO[3]

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Department of Economics, University of Zimbabwe, Harare, Zimbabwe
[3]Department of Economics, University of Zimbabwe, Harare, Zimbabwe
**Corresponding Author*

ABSTRACT

National projections of new COVID-19 infections can be used to plan for effective healthcare responses. The ANN model is applied in this study to forecast daily new corona virus infections using time series data from 6 March 2020 to 31 October 2020 and the out of sample period covers the period November 2020 to April 2021.The residuals and the model evaluation statistics of the applied model indicate that the model is stable and suitable for forecasting daily new COVID-19 cases in Colombia. The results of the study indicate that the projected number of daily new corona virus cases will generally be at an equilibrium point (flattening of the curve) at around 11400 cases per day. The government of Colombia must tighten lockdown restriction early in cities reporting large numbers of daily new COVID-19 infections and should continue to enforce wearing of face masks, physical (social) distancing, hand sanitization and continuous health education among communities.

Keywords: - *ANN, COVID-19, Forecasting*

INTRODUCTION

Colombia is a South American country with an estimated total population by 2020 of 50,372,424 inhabitants according to the National Administrative Department of Statistics (DANE).77% of the population live in urban areas and 68.2%Colombians are between 15 and 64 years of age (Laura et.al, 2020). The first case of COVID-19 was confirmed on 6 March 2020 in Bogota, the Capital of the country. This disease is highly contagious and has led to high morbidity and mortality in most countries in the world including Colombia. Many countries are struggling to contain the disease despite implementation of recommended WHO guidelines (Rodriguez & Urdinola, 2020). In order to reduce the impact of Covid-19 outbreak in Bogota, a local lock down was introduced on 15 March ,2020 followed by a National lockdown on 18 March 2020.On this same day (18th of March,2020) the President of Colombia Ivan Duque declared a state of Emergency and the following measures were immediately taken 1) mandatory isolation of elderly people above 70yrs 2) national quarantine 24 March to 12 April, 2020 (Ghosh & Martcheva, 2020). Since then the government has been following WHO guidelines in order to prevent and control the disease. Due to shortage of anti-COVID-19 therapies decision makers in the government of Colombia require timely and accurate information or data to estimate the incidence of the disease and the availability of hospital resources to contain the outbreak

(Iragorri et al, 2020). In this study we seek to model and forecast the daily new COVID-19 infections in order to assist in policy making and in the national response to the fatal disease.

LITERATURE REVIEW

Table 1: Literature Review

Author(s)	Study period	Method	Major Findings
Brown et.al (2020)	March 2020-August 2020	Global Covid-19 Assessment of Mortality (GCAM)	The peak covid-19 mortality is around August 12 and an expected total of Covid deaths of 24000-31000 or 48-92% over the total throughout August 21.
Castro.C. A (2020)	March 2020	SIR model	Covid-19spreads rapidly infecting many people in a short time with huge peaks of active infections which poses a huge threat to health systems in the world.
Iragorri et.al (2020)	March 16 to May 17 ,2020	CORE (Covid-19 Resource estimates) model.	Model predicted depletion of hospital and ICU beds by September 20,2020 if all restrictions were to be lifted and the infection growth rate to increase to 10%.
Velasquez et.al (2020)	5June -13July 2020	Logistic regression	The predicted final size of Covid-19 epidemic will be around 495000 cases and the daily peak will be 29 July,2020.

METHOD

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily new Covid19 cases. The study particularly applies the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function.

Data Issues

This study is based on daily new Covid-19 (referred to as N series in this study) for all age groups in Colombia. The data covers the period 6March 2020 to 31 October 2020 while the out-of-sample forecast covers the period November 2020 to April 2021. All the data employed in this paper was gathered from the COVID-19 data repository prepared by the CSSE at JH University.

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 2: Descriptive statistics

Mean	Median	Minimum	Maximum
4474.2	3863.5	0.00000	20687.
Std. Dev.	C.V.	Skewness	Ex. kurtosis
4019.9	0.89847	0.51368	-0.42684
5% Perc.	95% Perc.	IQ range	Missing obs.
18.150	11270.	7516.0	0

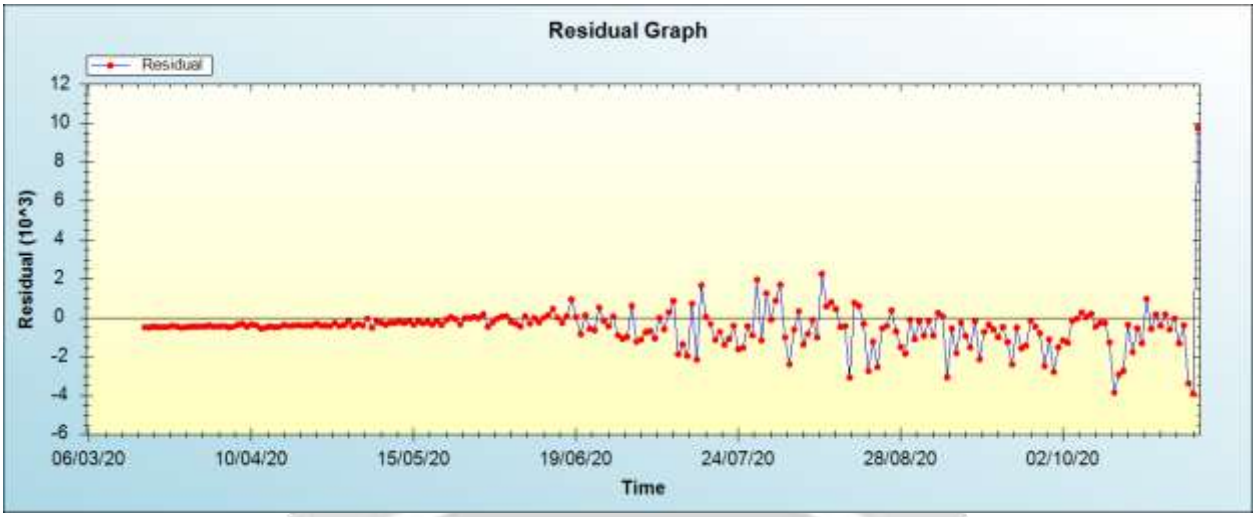
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN COLOMBIA

Table 3: ANN model summary

Variable	N
Observations	228 (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	0.105606
MSE	1473069.682418
MAE	760.015513

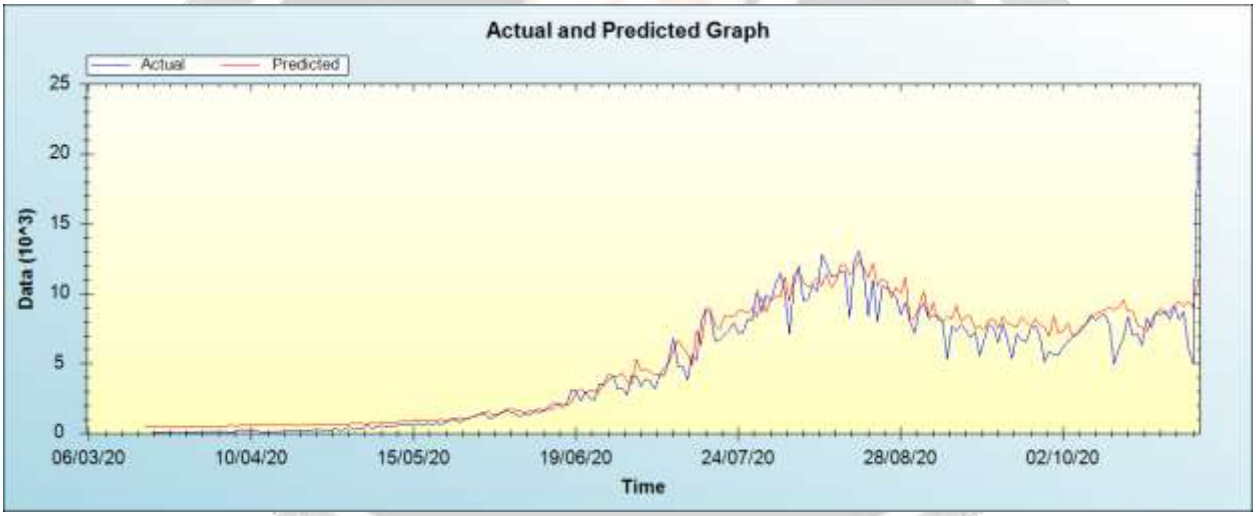
Residual Analysis for the ANN model

Figure 1: Residual analysis



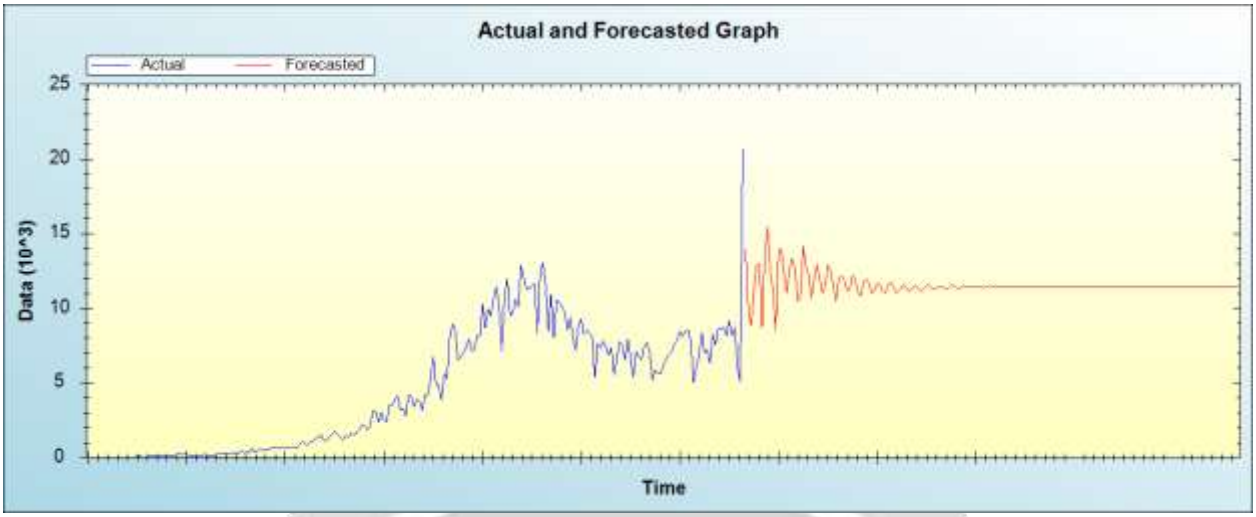
In-sample Forecast for N

Figure 2: In-sample forecast for the N series



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

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



Out-of-Sample Forecast for N: Forecasts only

Table 4: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	13914.4090
02/11/20	9874.5765
03/11/20	8824.4157
04/11/20	11293.8916
05/11/20	12939.1974
06/11/20	12999.4719
07/11/20	8655.9697
08/11/20	13655.7786
09/11/20	15494.0769
10/11/20	12414.5523
11/11/20	11326.7336
12/11/20	8518.5825
13/11/20	13903.5463
14/11/20	13946.2937
15/11/20	12194.4582

16/11/20	11051.9286
17/11/20	12619.1719
18/11/20	13319.6758
19/11/20	12695.9540
20/11/20	10474.7133
21/11/20	10697.7943
22/11/20	14178.6726
23/11/20	12872.4286
24/11/20	12296.4362
25/11/20	10645.2421
26/11/20	11929.5201
27/11/20	12936.8453
28/11/20	11995.8157
29/11/20	11017.8874
30/11/20	11542.1530
01/12/20	12891.3978
02/12/20	12545.9217
03/12/20	11446.0576
04/12/20	10470.1932
05/12/20	12040.5137
06/12/20	12175.2658
07/12/20	11925.7502
08/12/20	11190.6602
09/12/20	11292.7785
10/12/20	12235.7543
11/12/20	11862.7331

12/12/20	11085.0993
13/12/20	10810.1973
14/12/20	11710.8497
15/12/20	11972.3034
16/12/20	11696.7807
17/12/20	10979.7419
18/12/20	11224.9979
19/12/20	11650.0941
20/12/20	11562.8523
21/12/20	11168.3256
22/12/20	11010.6328
23/12/20	11570.3595
24/12/20	11738.5072
25/12/20	11419.0390
26/12/20	10985.1408
27/12/20	11170.5647
28/12/20	11493.4877
29/12/20	11543.2070
30/12/20	11245.6184
31/12/20	11177.1324
01/01/21	11446.7520
02/01/21	11543.4761
03/01/21	11350.6107
04/01/21	11109.0744
05/01/21	11264.2803
06/01/21	11518.7248

07/01/21	11535.0712
08/01/21	11315.2101
09/01/21	11255.9020
10/01/21	11398.2966
11/01/21	11499.7486
12/01/21	11388.9816
13/01/21	11274.1265
14/01/21	11375.3185
15/01/21	11526.1582
16/01/21	11516.8696
17/01/21	11359.1511
18/01/21	11317.2838
19/01/21	11428.5080
20/01/21	11514.3641
21/01/21	11448.7768
22/01/21	11379.5611
23/01/21	11423.5566
24/01/21	11510.6439
25/01/21	11492.6638
26/01/21	11395.9523
27/01/21	11380.8228
28/01/21	11463.3484
29/01/21	11520.8635
30/01/21	11471.2548
31/01/21	11413.2425
01/02/21	11432.0742

02/02/21	11487.8200
03/02/21	11477.5036
04/02/21	11424.8343
05/02/21	11418.3400
06/02/21	11470.9167
07/02/21	11499.7178
08/02/21	11458.6871
09/02/21	11415.7579
10/02/21	11429.0316
11/02/21	11469.6505
12/02/21	11467.1624
13/02/21	11434.0930
14/02/21	11426.1839
15/02/21	11455.5258
16/02/21	11467.9280
17/02/21	11440.0842
18/02/21	11414.0372
19/02/21	11426.8160
20/02/21	11455.5033
21/02/21	11453.4146
22/02/21	11428.7322
23/02/21	11419.9740
24/02/21	11437.0565
25/02/21	11445.3177
26/02/21	11429.8652
27/02/21	11415.4725

28/02/21	11425.5109
01/03/21	11442.9293
02/03/21	11439.4836
03/03/21	11421.4698
04/03/21	11415.5764
05/03/21	11428.0813
06/03/21	11435.6776
07/03/21	11427.4293
08/03/21	11418.5121
09/03/21	11424.3412
10/03/21	11434.2247
11/03/21	11431.3800
12/03/21	11420.0952
13/03/21	11417.9639
14/03/21	11427.6923
15/03/21	11433.6014
16/03/21	11428.1861
17/03/21	11421.7051
18/03/21	11424.8416
19/03/21	11431.1945
20/03/21	11430.1074
21/03/21	11423.9205
22/03/21	11423.6245
23/03/21	11430.2578
24/03/21	11433.8056
25/03/21	11429.6584

26/03/21	11425.1561
27/03/21	11427.3933
28/03/21	11432.1508
29/03/21	11432.1630
30/03/21	11428.5708
31/03/21	11428.3581
01/04/21	11432.2466
02/04/21	11434.1085
03/04/21	11431.2139
04/04/21	11428.5288
05/04/21	11430.4043
06/04/21	11433.8461
07/04/21	11433.8878
08/04/21	11431.3052
09/04/21	11430.7823
10/04/21	11432.9963
11/04/21	11434.1264
12/04/21	11432.3866
13/04/21	11430.8786
14/04/21	11432.1987
15/04/21	11434.3142
16/04/21	11434.0271
17/04/21	11432.0394
18/04/21	11431.5184
19/04/21	11432.9522
20/04/21	11433.7829

21/04/21	11432.7409
22/04/21	11431.7428
23/04/21	11432.4373
24/04/21	11433.5715
25/04/21	11433.1746
26/04/21	11431.8033
27/04/21	11431.5032
28/04/21	11432.5179.
29/04/21	11433.0832
30/04/21	11432.3426

Figure 1 shows that during the study period, the minimum and maximum number of daily new Covid-19 infections is 0 and 20687 respectively. The average daily new corona virus infections are 4474.The residual and model evaluation criteria indicate that the applied ANN model is stable, adequate and suitable for forecasting daily new corona virus cases in Colombia. Figure 3 as well as table 4 shows that daily new coronavirus cases are projected to be generally around 11400 infections per day until the end of April 2021.

CONCLUSION & RECOMMENDATIONS

Covid-19 is a highly contagious viral disease which has led to high morbidity and mortality in Colombia and the entire world (Brown et al, 2020). Strict adherence to WHO guidelines is very critical in order to control the spread of the virus. Preventive measures such as physical distancing, hand-washing with soapy water or sanitization with alcohol-based sanitizers and wearing of face mask should be continued. Results of the study indicate that COVID-19 daily new cases are projected to reach equilibrium point in the entire out of sample period with daily new infections expected to be around 11400 per day. Tightening lockdown restrictions in cities reporting high numbers of daily new cases must be promptly done to curb spread of the disease.

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