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

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ABSTRACT

The most widely used Artificial neural networks (ANN) in forecasting problems are multilayer perceptrons (MLPs) which use a single hidden layer feed forward network (FFN) (Zhang & Hu, 1998; Zhang, 2003). The model has three layers which are the input, hidden, and output layers connected by acyclic links called connection weights. The nodes in different layers are known as processing elements. This machine learning algorithm is biologically inspired that is it mimics the function of the human brain. In this paper we applied the ANN (12,12,1) model and the activation function being the hyperbolic tangent function which does not have the vanishing gradient problem and has a zero centred output. The results of the study indicate that daily new corona virus cases will increase from around 3067 on November 1,2020 to around 4179 on November 23,2020,after that time daily new cases will be at a constant (equilibrium) level of around 4123 cases until April 30 ,2021.The study recommends that the Indonesian government should tighten lockdown restrictions in cities where there is rapid spread of the virus, wearing of face masks, regular handwashing with soap, continuous education of the public ,case detection and treatment ,and contact tracing.

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

INTRODUCTION

Indonesia is situated in South East Asia and has been devastated by the Novel corona virus, COVID-19. The World Health Organization (WHO) has noted that this nation is third in terms of the number of reported cases in Asia. Therefore appropriate measures must be put in place to curb the local transmissions (Effenburger et al, 2020). This virus was first reported in China, in Wuhan city at the end of December 2019. It was researched and seen that it was a genus beta corona virus ,the same as other acute and Severe Respiratory Syndrome (SARS) and the Middle East Respiratory Syndrome(MERS)(Peeri etal, 2020). By 3March 2020 754933 confirmed cases and 36 522 deaths had been reported globally (Fadly & Sari, 2020). Indonesia reported its first COVID-19 case on the 2nd of March 2020(Djalante, 2020). The novel virus has done more harm than good in the South East Asian country with estimated confirmed and mortality cases by 9May 2020 of approximately 13645 and 959 cases respectively (Pumama, 2020). COVID-19 cases were reported in all provinces with 68226 confirmed cases by 8 July 2020(Rokhmah et al, 2020). This study seeks to model and forecast the number of daily new COVID-19 cases over the out of sample period November 2020 to April 2021. The results of the study will be an eye

opener for the Indonesian government and will be used in planning, decision making and in the National response to the deadly virus.

LITERATURE REVIEW

Table 1: Literature Review

Author(s)/yr.	Study period	Method	Major findings
Sulaiman. A (2020)	2March 2020-9June 2020	SIR model	There is an acceleration of the transmission of the outbreak in Indonesia
Harini.S(2020)	2March 2020-7April 2020	Double exponential smoothing model	Covid-19 cases in India (positive, recovery, death) showed a gap in the resulting distribution patterns where the increase in the number of positive cases has not been offset by an increase in the number of those who recovered and decrease in the number of those of died. This means the public is not complying with lockdown rules.
Rayungsari et al (2020).	2March 2020 to 8June 2020	Richards Model	Daily new cases would reach peak in early June 2020 of around 600 cases and would be ended in Mid-February 2021 with a maximum amount of 65067.
Fadly &Sari (2020)	January 2010-December 2020	ARIMA	There is a discrepancy of 450-1070 funerals in March 2020 in Jarkata that could not be predicted by the ARIMA model. This

			forecast error could be an approach to the potential number of possible death impact of COVID-19 in Jarkata that could be higher than reported.
Aisami et al (2020)	2March 2020- 15 July 2020	Morgan-Mercer-Flodin (MMF) model, Modified Gompertz, Modified Richards, Modified logistics and Huang Model.	MMF model was found to be the best one considering RMSE and adjusted R squared. The MMF model forecasted that the total death toll in Indonesia will be 5315 and 6857on 15th August and 15th September 2020 respectively.
Sasmita etal (2020)	2March to 9 April 2020	SEI2RS model	Large scale social restriction, contact tracing, case detection and treatment, and wearing facemask is the most rational scenario to control COVID-19 spread in Indonesia.
Zuhairoh&Rosadi (2020)	20March 2020 to 24 June 2020	Richards Model	The maximum cumulative number of COVID-19 cases would be 10 000-12 000 cases. The epidemic peak is estimated to be from June to July 2020

METHOD

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily COVID-19 cases in Indonesia. The particulary 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 cases (referred to as J series in this study) for all age groups in Indonesia. The data covers the period 2March 2020 to 31October 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
1680.7	1297.0	0.00000	4850.0
Std. Dev.	C.V.	Skewness	Ex. Kurtosis
1456.7	0.86671	0.62124	-0.96383
5% Perc.	95% Perc.	IQ range	Missing obs.
18.000	4301.0	2511.0	0

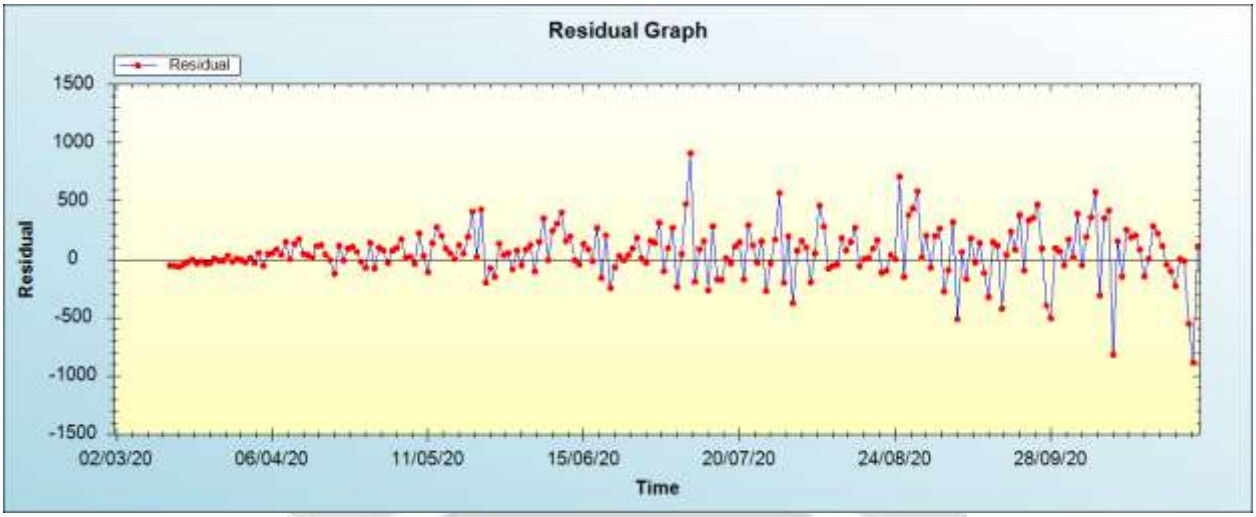
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN INDONESIA

Table 3: ANN model summary

Variable	J
Observations	232(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	0.082668
MSE	49615.612882
MAE	156.772794

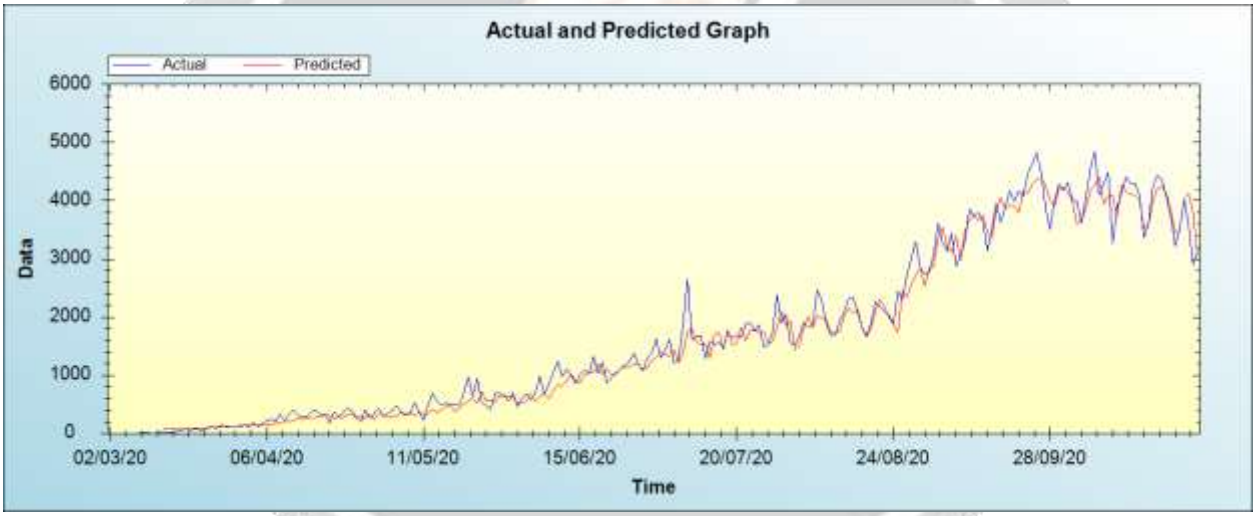
Residual Analysis for the ANN model

Figure 1: Residual analysis



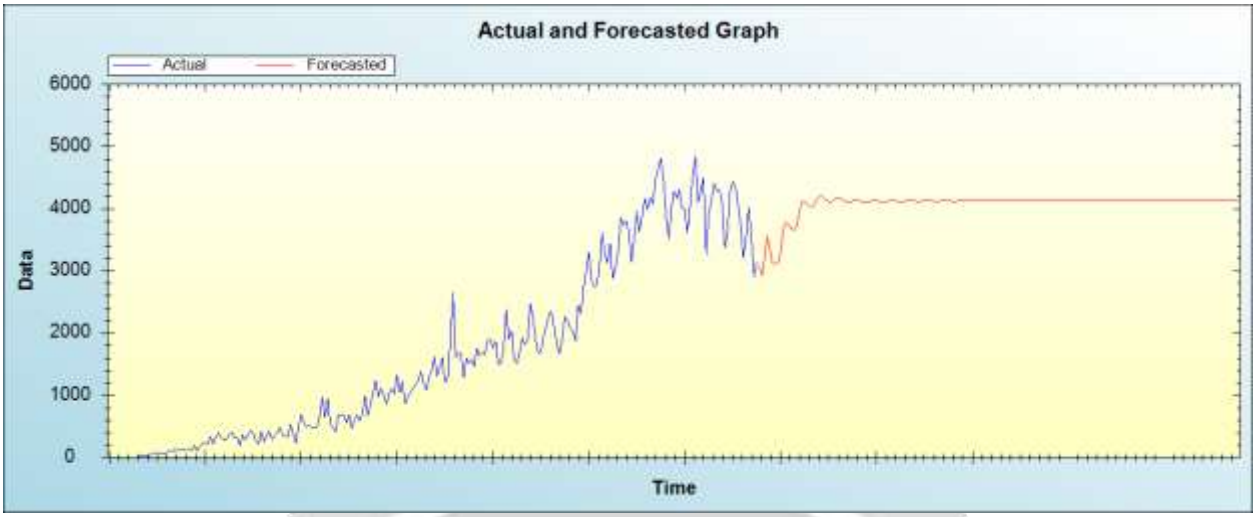
In-sample Forecast for J

Figure 2: In-sample forecast for the J series



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

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



Out-of-Sample Forecast for J: Forecasts only

Table 4: Forecasts

Day/Month/year	Forecasted
01/11/20	3067.4813
02/11/20	2922.8340
03/11/20	3250.2600
04/11/20	3562.5759
05/11/20	3350.7969
06/11/20	3114.8529
07/11/20	3113.2993
08/11/20	3137.9390
09/11/20	3287.3253
10/11/20	3689.3840
11/11/20	3779.7153
12/11/20	3737.9946
13/11/20	3675.0323
14/11/20	3654.8443
15/11/20	3723.2429

16/11/20	3935.1515
17/11/20	4112.0725
18/11/20	4109.8673
19/11/20	4075.0761
20/11/20	4030.0002
21/11/20	4023.7330
22/11/20	4087.6183
23/11/20	4179.8154
24/11/20	4216.8750
25/11/20	4189.2876
26/11/20	4145.1709
27/11/20	4110.1998
28/11/20	4110.0145
29/11/20	4144.4005
30/11/20	4178.1595
01/12/20	4179.0890
02/12/20	4151.7200
03/12/20	4119.4556
04/12/20	4100.6394
05/12/20	4106.1305
06/12/20	4128.3156
07/12/20	4143.9940
08/12/20	4139.9168
09/12/20	4122.1971
10/12/20	4104.9089
11/12/20	4099.3666

12/12/20	4108.8302
13/12/20	4124.4792
14/12/20	4132.7541
15/12/20	4128.9368
16/12/20	4118.5467
17/12/20	4110.4975
18/12/20	4110.8973
19/12/20	4119.2431
20/12/20	4128.5306
21/12/20	4131.7029
22/12/20	4127.8212
23/12/20	4121.2573
24/12/20	4117.4609
25/12/20	4119.1698
26/12/20	4124.6223
27/12/20	4129.1587
28/12/20	4129.4405
29/12/20	4125.9613
30/12/20	4121.8620
31/12/20	4120.2389
01/01/21	4121.9669
02/01/21	4125.2332
03/01/21	4127.2188
04/01/21	4126.5160
05/01/21	4123.9975
06/01/21	4121.7486

07/01/21	4121.3723
08/01/21	4122.8723
09/01/21	4124.8122
10/01/21	4125.6092
11/01/21	4124.8024
12/01/21	4123.2243
13/01/21	4122.1667
14/01/21	4122.3621
15/01/21	4123.5018
16/01/21	4124.5924
17/01/21	4124.8159
18/01/21	4124.1379
19/01/21	4123.2115
20/01/21	4122.7836
21/01/21	4123.1235
22/01/21	4123.8786
23/01/21	4124.4229
24/01/21	4124.3778
25/01/21	4123.8665
26/01/21	4123.3462
27/01/21	4123.2161
28/01/21	4123.5241
29/01/21	4123.9764
30/01/21	4124.2079
31/01/21	4124.0722
01/02/21	4123.7229

02/02/21	4123.4533
03/02/21	4123.4559
04/02/21	4123.6898
05/02/21	4123.9434
06/02/21	4124.0189
07/02/21	4123.8824
08/02/21	4123.6658
09/02/21	4123.5439
10/02/21	4123.5957
11/02/21	4123.7573
12/02/21	4123.8901
13/02/21	4123.8966
14/02/21	4123.7894
15/02/21	4123.6658
16/02/21	4123.6222
17/02/21	4123.6809
18/02/21	4123.7835
19/02/21	4123.8460
20/02/21	4123.8266
21/02/21	4123.7517
22/02/21	4123.6861
23/02/21	4123.6788
24/02/21	4123.7274
25/02/21	4123.7874
26/02/21	4123.8116
27/02/21	4123.7867

28/02/21	4123.7384
01/03/21	4123.7068
02/03/21	4123.7136
03/03/21	4123.7483
04/03/21	4123.7807
05/03/21	4123.7863
06/03/21	4123.7646
07/03/21	4123.7358
08/03/21	4123.7228
09/03/21	4123.7332
10/03/21	4123.7559
11/03/21	4123.7719
12/03/21	4123.7698
13/03/21	4123.7538
14/03/21	4123.7379
15/03/21	4123.7342
16/03/21	4123.7439
17/03/21	4123.7576
18/03/21	4123.7645
19/03/21	4123.7602
20/03/21	4123.7495
21/03/21	4123.7415
22/03/21	4123.7419
23/03/21	4123.7492
24/03/21	4123.7570
25/03/21	4123.7592

26/03/21	4123.7549
27/03/21	4123.7484
28/03/21	4123.7448
29/03/21	4123.7465
30/03/21	4123.7515
31/03/21	4123.7555
01/04/21	4123.7556
02/04/21	4123.7523
03/04/21	4123.7485
04/04/21	4123.7473
05/04/21	4123.7491
06/04/21	4123.7522
07/04/21	4123.7541
08/04/21	4123.7534
09/04/21	4123.7511
10/04/21	4123.7491
11/04/21	4123.7489
12/04/21	4123.7504
13/04/21	4123.7523
14/04/21	4123.7530
15/04/21	4123.7522
16/04/21	4123.7507
17/04/21	4123.7497
18/04/21	4123.7500
19/04/21	4123.7510
20/04/21	4123.7520

21/04/21	4123.7522
22/04/21	4123.7515
23/04/21	4123.7506
24/04/21	4123.7502
25/04/21	4123.7506
26/04/21	4123.7513
27/04/21	4123.7518
28/04/21	4123.7517
29/04/21	4123.7512
30/04/21	4123.7507

Figure 1 shows that over the study period ,the minimum and maximum number of daily new COVID-19 cases is 0 and 4850 respectively and the average daily new infections are 1680. The distribution of the data is positively skewed and platykurtic (not normally distributed). The out of sample forecasts indicate that daily new corona virus cases will increase from around 3067 cases on November 1, 2020 to 4179 cases on November 23, 2020, after that time daily new infections are expected to be at a constant (equilibrium) level of around 4123 cases until 30th of April 2021.

CONCLUSION & RECOMMENDATIONS

Indonesia, the South East Asian nation is struggling to contain the COVID-19 outbreak just like other countries in the World. Our study findings show that daily new COVID-19 cases will increase from 3067 cases on November 1,2020 to 4179 on November 23,2020, after that time daily new infections are expected to be at a constant(equilibrium) level of around 4123 cases until April 30 ,2021. Many people have suffered and died from the deadly virus. Findings from Sulaiman etal (2020) shows that the virus is rapidly spreading like veld fire in the country. The ARIMA model from a study by Fadly & Sari (2020) indicate that the forecast error from the model probably suggests that there may be more people who have died from the virus than reported. Therefore, the Indonesian Government has to be more serious in terms of tightening restrictions in urban cities where the virus is rapidly spreading uncontrollably. Sasmita etal (2020) study finding revealed that large scale social restriction, contact tracing, case detection and treatment, and wearing of face masks is the most rational scenario to control COVID-19 spread in Indonesia. Following WHO guidelines to prevent spread of COVID -19 in Health institutions and in the community is crucial at this moment. Educating communities should be done consistently and tirelessly.

REFERENCES

[1] COVID-19 Repository By the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University.

[2] Djalante (2020). Review and analysis of current responses to COVID-19 in Indonesia: Period of January to March 2020.Progress in Disaster Science. 6,1-10.

[3] Dong, E., *et al*. (2020). An Interactive Web-based Dashboard to Track COVID-19 in Real Time, *Lancet Infectious Diseases*, 20 (5): 533 – 534.

[4] Effenburger etal (2020). Association of the Covid-19 pandemic with internet values: A google trends analysis.Int.J.infect.Dis.95,192-197.

[5] Peeri et al (2020). The SARS, MERS and Novel corona vir5us (COVID-19) epidemics, the newest and biggest global health threats: What lessons have we learnt? Int.J. Epi.1-5

[6] Pumama T. B (2020). Predicting the effect of environmental humidity on COVID-19 trend in Medan, Indonesia. Research square pp1-10.

[7] Rayungsari etal (2020). Parameters estimation of generalized Richards Model for COVID-19 cases in Indonesia using generic Algorithm. Jambura Journal of Biomathemics.1,1,25-30.

[8] Rokhmah etal (2020). Increase in public interest concerning alternative medicine during the COVID-19 pandemic in Indonesia. A Google trends study. F1000 Research .9,1201,1-7.

[9] Zhang & Hu (1998). Forecasting with artificial neural networks: The state of the art. International Journal of forecasting :14,35-62.

[10] Zhang G.P (2007). A neural network ensemble method with jittered training data for time series forecasting. Information sciences .177,5329-5346.