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

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ABSTRACT

In this research article, the ANN approach was applied to analyze daily new COVID-19 cases in Italy. The employed data covers the period 31 January 2020 to 31 October 2020 and the out-of-sample period ranges over the period November 2020 to 30 April 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting daily new COVID-19 cases in Italy. The results of the study indicate that the projected number of daily new COVID-19 cases will be constant at around 33000 cases per day from November 1, 2020 to 30 April, 2021. Therefore the Italian government must enforce WHO guidelines on prevention and control of COVID-19 in order save lives. However, an effective vaccine if availed early to the majority of people in Italy will lead to a drop in daily new corona virus infections.

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

INTRODUCTION

COVID-19 is rapidly spreading across the whole world and millions of people have suffered from the effects the pandemic. The novel virus was first reported in China ,Wuhan City in the Hubei Province in late December 2019(Wang et al, 2020; Wang et al, 2020; Read et al, 2020; Wang, 2020; Tang et al, 2020; CDC, 2020). The causative agent of the viral disease is the new severe acute respiratory syndrome virus 2(SARS-CoV-2) (Huang et al, 2020; Li et al, 2020; Leang et al, 2020; Kurcheski et al, 2020). Since the beginning of the epidemic in Italy, many people have died from the deadly virus. In 5 weeks the number of COVID-19 deaths in Italy increased from 21 to 3200 by 20 March, 2020 and then trebled to over 9000 deaths by 28 March 2020(Porcheddu et al, 2020; Sanita et al, 2020). The overall fatality rate of people were COVID-19 positive in the Italian population by 17 March 2020 was 7,2% (Bucher, 2020). In 2019 about 23% of the Italian population was aged 65 years and above hence older age distribution contributed in part to the higher case fatality as compared to other countries (China CDC, 2020). Italy though facing a deadly epidemic quickly responded on the 24th of February, 2020 by implementing mitigatory measures which included zoning, quarantining of areas, imposing restrictions on movement of people, temporary closure of schools, shops, and non-essential industrial activities (Sebastiani et al, 2020).Other measures incorporated include wearing face masks, regular washing of hands with soapy water and use of hand sanitizers. In this paper we applied the artificial neural network model to forecast the number of daily newCOVID-19 cases

in Italy from November 1, 2020 to 30 April 2021.The results of this study will help the Italian government to review its COVID-19 mitigatory measures and allow evidenced based approaches to be implemented in order to effectively control the epidemic.

LITERATURE REVIEW

Table 1: Literature Review

Author(s)/year	Study period	Method	Major findings
Martelloni &Martelloni (2020).	24February 2020-5May 2020.	Logistic, Gompertz, Modified SEIR model	I(end)=247471, D(end)=35235 close to10 July 2020. I(end)243766, D(end)34682 close to 20 June 2020.
Distante etal (2020).	1February to 30April 2020.	SEIR model	The epidemic peak is likely to be around end of March 2020. Total confirmed cases in all Italy regions could reach 160,000 cases by 30 April 2020 and stabilize at a plateau.
Gatto etal (2020).	21February 2020-25March 2020.	Modified SEIR model.	The imposed restrictions reduced COVID-19 transmission by 45%.
Ciutolini etal (2020).	15February 2020-29 March 2020	Gaussian process model, Monte Carlo.	The day of a substantial reduction in new COVID-19 would be between 17April 2020 to 27April 2020.
Wangping etal (2020)	22January 2020 - 2April 2020	eSIR model, Markov chain, Monte Carlo.	The mean of basic reproductive number for COVID-19 was 4134 in Italy. Projected total confirmed cases of COVID-19 of

			182,051 cases.
Sebastiani etal (2020).	1March ,2020 to 31March 2020.	Modified SIR model, Markov Chain, Monte Carlo.	The cumulative incidence (CI) growth rate of COVID-19 cases would substantially slow by Mid -May 2020.
Giuliani etal (2020).	20February 2020- 18March 2020.	Spatio-temporal analysis. Multivariate time series mixed effects generalized linear model.	Strict measures implemented in some provinces efficiently break contagions and limit the spread to nearby areas.

METHOD

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID-19 infections. This research 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 cases (referred to as W series in this study) for all age groups in Italy. The data covers the period 31 January 2020 to 31October 2020 while the out-of-sample forecast covers the period November2020 to April 2021. All the data employed in this research paper was gathered from Johns Hopkins University (USA).

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 2: Descriptive statistics

| Mean	Median	Minimum	Maximum
2471.7	888.00	0.00000	31756.
Std. Dev.	C.V.	Skewness	Ex. Kurtosis
4672.2	1.8903	3.8719	16.861
5% Perc.	95% Perc.	IQ range	Missing obs.
0.00000	10882.	2397.0	0

ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN ITALY

Table 3: ANN model summary

Variable	W
Observations	263 (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	0.029934
MSE	278898.577374
MAE	354.471850

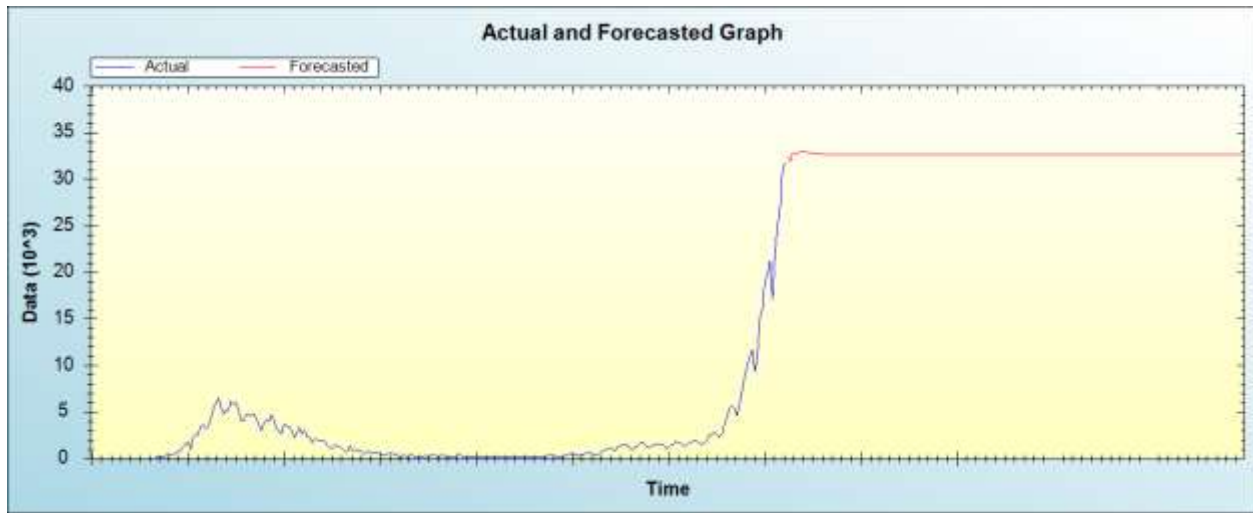*Residual Analysis for the ANN model*

Figure 1: Residual analysis
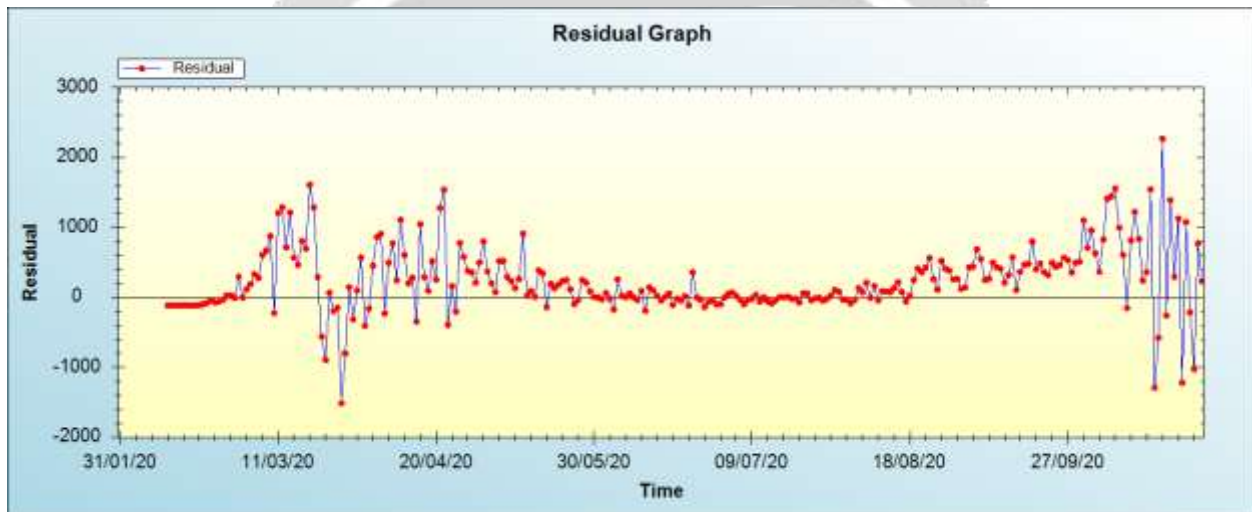
In-sample Forecast for W

Figure 2: In-sample forecast for the W series
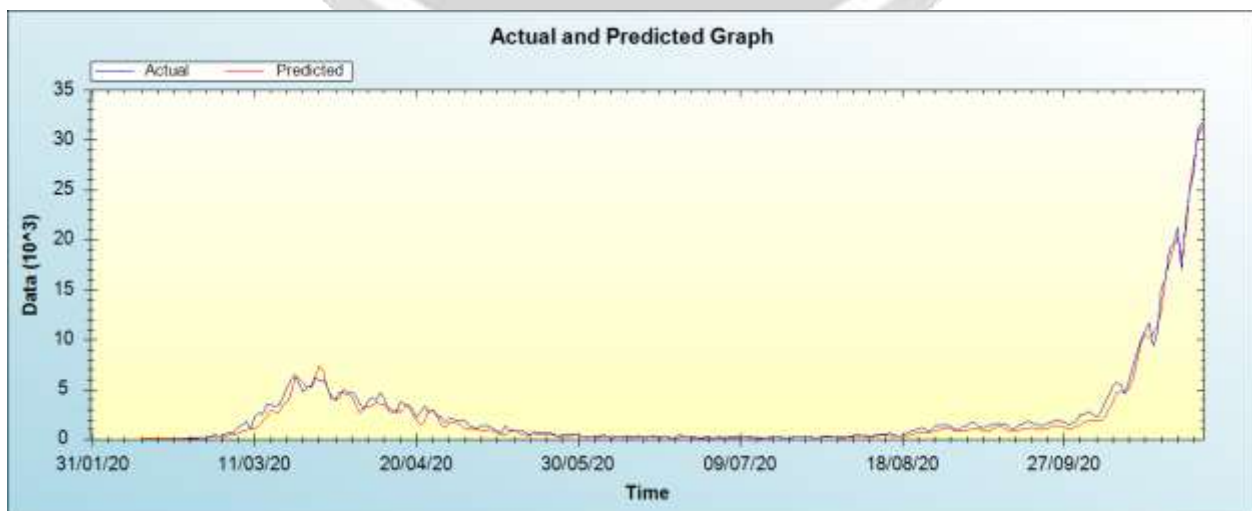
Out-of-Sample Forecast for W: Actual and Forecasted Graph

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

Out-of-Sample Forecast for W: Forecasts only

Table 4: Forecasts

Day/Month/year	Forecasted daily new COVID-19 cases
01/11/20	32409.2945
02/11/20	31869.0057
03/11/20	32861.1491
04/11/20	32699.0330
05/11/20	32777.9145
06/11/20	32995.8118
07/11/20	32955.7518
08/11/20	32941.9111
09/11/20	32876.5736
10/11/20	32837.6712
11/11/20	32733.1487
12/11/20	32729.6641
13/11/20	32734.4204

14/11/20	32720.6737
15/11/20	32713.8610
16/11/20	32714.3497
17/11/20	32709.4889
18/11/20	32703.0821
19/11/20	32705.0643
20/11/20	32705.5371
21/11/20	32706.4602
22/11/20	32708.9809
23/11/20	32710.5951
24/11/20	32710.3117
25/11/20	32710.3503
26/11/20	32710.7667
27/11/20	32710.7030
28/11/20	32710.7836
29/11/20	32711.0459
30/11/20	32711.1308
01/12/20	32711.0845
02/12/20	32711.0890
03/12/20	32711.0426
04/12/20	32710.9651
05/12/20	32710.9534
06/12/20	32710.9637
07/12/20	32710.9551
08/12/20	32710.9515
09/12/20	32710.9548

10/12/20	32710.9474
11/12/20	32710.9401
12/12/20	32710.9401
13/12/20	32710.9402
14/12/20	32710.9403
15/12/20	32710.9425
16/12/20	32710.9440
17/12/20	32710.9437
18/12/20	32710.9436
19/12/20	32710.9439
20/12/20	32710.9437
21/12/20	32710.9438
22/12/20	32710.9441
23/12/20	32710.9442
24/12/20	32710.9442
25/12/20	32710.9442
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27/12/20	32710.9441
28/12/20	32710.9441
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31/12/20	32710.9441
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30/04/21	32710.9441

Figure 1 shows that over the study period, the minimum and maximum number of daily new COD-19 cases were 0 and 31756 cases respectively. The average daily new infections were 2471 during the study period. The data is not normally distributed as shown by a positive skewness and kurtosis greater than 3(16.861). The model simulates the observed data very well. The residual graph and model evaluation criteria indicate that the model is adequate and stable. Then the out of sample forecasts in Table 4 indicate that the projected daily new COVID-19 cases will generally be constant around 33000 cases per day from November 1, 2020 until 30April 2021.

CONCLUSION & RECOMMENDATIONS

Italy is one of the European countries with a significant number of elderly people which contributed much to the deaths observed in this nation. Mitigatory measures which were put in place by the Italian authorities significantly reduced COVD-19 transmission by 45% (Gatto et al, 2020). Our study findings, however, projected that the daily new COVID-19 cases will be constant at around 33000 cases from November1, 2020 until 30April 2021.This means that the disease burden is still growing and therefore the government should strictly enforce WHO guidelines on prevention and control of COVID-19 to saves lives. An effective and safe COVID-19 vaccine is expected to act as a positive shock resulting in a drastic drop of daily new cases if availed early.

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