Estimating hidden models and trends in COVID-19 Infected cases

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Abstract

The main aim of the present investigation is to estimate the hidden models and trends in COVID-19 infected cases in all the thirty seven district of from the period from 1st August,2020 to 31st December, 2020. Different statistical curve fitting tools like, Linear, Quadratic, S-Curve, Simple Exponential Smoothing, Holt's Linear Exponential, Brown's Linear Exponential Smoothing and Auto Regressive Integrated Moving Average models were employed to study the COVID-19 infected trends and it's future predictions.

I. Introduction

The COVID-19 pandemic that began in 2019 has received much attention, affecting most of the world economies and leading to countless deaths. In the absence of antiviral drugs and vaccines, the number of new COVID-19-infected cases has increased tremendously and has caused many deaths. The deployment of various methodologies to estimate the statistical models for the COVID-19 infected cases has become a very important research area.

II. Materials And Methods

The materials used and methods followed are discussed in the following Sect. 2.1 and 2.2 respectively.

2.1. Materials

The daily COVID-19 infected numbers of new cases have been collected from the Tamil Nadu government official website during period from 1st August 2020 to 31st December 2020 (the study period) for all the thirty seven districts of Tamil Nadu State, INDIA. The data sets do not contain any missing values. The hidden model and its parameters values have been estimated using the STATGRAPHICS Centurion XVI Version 16.1.12 statistical software.

2.2. Methods

Different trend fitting functions viz., Linear Trend, Quadratic Trend, Exponential Trend and S-Curve (Montgomery, et al., 2003); different smoothing methods viz., Simple Exponential Smoothing, Holt's Linear Exponential Smoothing, Brown's Linear Exponential Smoothing (Makridakis, et al., 1998) and Box_Jenkins (Box and Jenkins, 1976), Auto Regressive Integrated Moving Average (ARIMA) time series modelling were employed to identify the inter caches trends hiding in COVID-19 infected cases data sets of each and every thirty seven districts. The suitable hidden model have been identified based the Akaike Information Criterion (AIC) value. The models with the lowest value of AIC and fulfilling error diagnostic measures such as independence and auto-correlations of the residuals been checked for the best fitted trend models.

III. Results And Discussions

The hidden models exist in the different data sets have been identified and fully tested for the independence as well as auto-correlations of the residuals are presented in the Tables 1 to 5.

3.1. Quadratic Trend

The results presented in the Table – 1 reveals that the hidden Quadratic trend model is commonly identified in the districts of Perumbalur, Ramanathapuram and Sivaganga data sets.

Table 1

List of Districts with Quadratic trend

Sr. No	District	Model
1.	Perambalur	Quadratic trend = $31.56 - 0.37 t^2 + 0.0032 t^2$
2.	Ramanathapuram	Quadratic trend = $57.81 - 0.77 t + 0.0027 t^2$
3.	Sivagangai	Quadratic trend = $66.23 - 0.73 t + 0.0022 t^2$

3.2. Holt's Linear exponential smoothing

In Kancheepuram, Kanyakumari and Virudhunagar Districts the Holt's Linear exponential smoothing with different values of α and β is hidden in these three districts data sets.

Table 2

List of Districts with Holt's Linear Exp.Smoothing with different values of α and β

Sr. No	District	Model
1.	Kancheepuram	Holt's Linear Exp.Smoothing with $\alpha = 0.1772$ and $\beta = 0.0346$
2.	Kanyakumari	Holt's Linear Exp.Smoothing with $\alpha = 0.1413$ and $\beta = 0.1071$
3.	Virudhunagar	Holt's Linear Exp.Smoothing with $\alpha = 0.1775$ and $\beta = 0.0848$

3.3. Simple Exponential Smoothing

In case of Cuddalore, Dharmapuri, Dindigul, Erode, Pudukottai, Thiruvarur and Tiruppur districts the Simple Exponential Smoothing with different values of α is hidden in these districts data sets commonly.

Table 3

List of Districts with Simple exponential smoothing with different α values

Sr. No	District	Model
1.	Cuddalore	Simple Exponential Smoothing with $\alpha = 0.4511$
2.	Dharmapuri	Simple Exponential Smoothing with $\alpha = 0.5453$
3.	Dindigul	Simple Exponential Smoothing with $\alpha = 0.3588$
4.	Erode	Simple Exponential Smoothing with $\alpha = 0.3172$
5.	Pudukottai	Simple Exponential Smoothing with $\alpha = 0.2847$
6.	Thiruvarur	Simple Exponential Smoothing with $\alpha = 0.3517$
7.	Tiruppur	Simple Exponential Smoothing with $\alpha = 0.3328$

3.4. Brown's Linear Exponential Smoothing

In case of Namakkal and Vellore districts the Brown's linear exponential smoothing with different values of α is hidden commonly in these two districts data sets.

Table 4

List of District with Brown's linear exponential smoothing with different values of α

Sr. No	District	Model
1.	Namakkal	Brown's Linear exp.smoothing with $\alpha = 0.2062$
2.	Vellore	Brown's Linear exp.smoothing with $\alpha = .0855$

3.5. ARIMA (p,d,q) Model

In the remaining districts, the ARIMA (p,d,q) model with different values of p,d and q are hidden sets. In general in all the districts data sets shows the decreasing in COVID-19 infected new cases.

Table 5

List of Districts with ARIM(p,d,q) with different of p,d and q

Sr. No	District	Model
1.	Ariyalur	ARIMA(2,2,1)
2.	Chengalpattu	ARIMA(0,2,2)
3.	Chennai	ARIMA(1,1,1)
4.	Coimbatore	ARIMA(2,1,2)
5.	Kallakurichi	ARIMA(2,1,0)
6.	Karur	ARIMA(0,1,2)
7.	Krishnagiri	ARIMA(0,1,1)
8.	Madurai	ARIMA(0,1,2)
9.	Nagapattinam	ARIMA(2,1,1)
10.	Nilgiris	ARIMA(1,1,1)
11.	Ranipet	ARIMA(2,1,2)
12.	Salem	ARIMA(1,1,0)
13.	Tenkasi	ARIMA(0,1,1)
14.	Thanjavur	ARIMA(1,2,1)
15.	Theni	ARIMA(2,1,2)
16.	Thirupathur	ARIMA(0,1,1)
17.	Thiruvallur	ARIMA(1,1,1)
18.	Thiruvannamalai	ARIMA(0,1,1)
19.	Thoothukudi	ARIMA(2,0,0)
20.	Tirunelveli	ARIMA(2,2,2)
21.	Trichy	ARIMA(0,1,2)
22.	Villupuram	ARIMA(1,1,1)

Iv. Conclusions

Overall, in Tamil Nadu State, five different trends model viz., Quadratic trend in three districts, Holt's Linear exponential smoothing trends in three districts, Simple Exponential Smoothing trends in seven districts, Brown's Linear Exponential Smoothing in two districts and ARIMA model in twenty two districts have been estimated.

Declarations

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Figures

Figure 1

Perambalur

Figure 2

Ramanathapuram

Figure 3

Sivagangai

Figure 4

Kancheepuram

Figure 5

Kanyakumari

Figure 6

Virudhunagar

Figure 7

Cuddalore

Figure 8

Dharmapuri

Figure 9

Dindigul

Figure 10

Erode

Figure 11

Pudukottai

Figure 12

Thiruvarur

Figure 13

Tiruppur

Figure 14

Namakkal

Figure 15

Vellore

Figure 16

Ariyalur

Figure 17

Chengalpattu

Figure 18

Chennai

Figure 19

Coimbatore

Figure 20

Kallakurichi

Figure 21

Karur

Figure 22

Krishnagiri

Figure 23

Madurai

Figure 24

Nagapattinam

Figure 25

Nilagiris

Figure 26

Ranipet

Figure 27

Salem

Figure 28

Tenkasi

Figure 29

Thanjavur

Figure 30

Thenai

Figure 31

Thirupathur

Figure 32

Thiruvallur

Figure 33

Thiruvannamalai

Figure 34

Thoothukudi

Figure 35

Tirunelveli

Figure 36

Trichy

Figure 37

Villupuram