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CHAPTER 10

Daily confirmed cases and deaths prediction of novel coronavirus in Asian continent Polynomial Neural Network

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10.1 Introduction

In the realm of 2020, where WHO has announced COVID-19 to be Pandemic (Anderson, Heesterbeek, Klinkenberg, & Hollingsworth, 2020), where there is confusion all over the place, individuals are isolated, the occasions square is unfilled, as are the other swarmed places, where one can discover anyone wearing a cover, and with dread in their eyes—we are truly surviving the pages of history books of things to come days.

Coronavirus has spread around the world and affecting large numbers of individuals. The WHO has announced COVID-19 as a pandemic affecting all 223 nations (World Health Organization). In excess of 2,435,145 (19 February 2021) individuals over the world have lost their lives, and a huge number of individuals have been affected (World Health Organization). Nations across the world are articulating health crises and making sense of how to attempt to guarantee the inhabitants’ safety (Xu et al., 2020).

Daily confirmed case and death are frequently increased day by day in Asian continent.

The 2019—2020 coronavirus pandemic started in Asia in Wuhan, Hubei, China, and spread generally through the mainland.

At March 22, 2020, one instance of COVID-19 had been accounted for in each nation in Asia aside from Tajikistan, Turkmenistan, and North Korea. The most noteworthy quantities of detailed cases in Asia at that time were in China and Iran.

A few Southeast Asian nations encountered a huge increase in cases following a Tabligh Akbar occasion from February 27 to March 1 at a mosque in Kuala Lumpur, where numerous individuals were infected (World Health Organization). The occasion had around 16,000 participants, including around 1500 from outside Malaysia.
Attendees shared nourishment, sat near one another, and clasped hands at the occasion. The organizers of the occasion didn’t discuss COVID-19 precautionary measures, yet most participants washed their hands during the occasion. Malaysian specialists were censured for permitting the occasion to go ahead (World Health Organization).

Fig. 10.1 represents daily cases and daily confirmed deaths in the Asian continent. From the figure, it is clear that daily confirmed cases and daily confirmed deaths are increasing but the fluctuation is very small. So the objective of the present investigation is to predict the daily confirmed cases. The second objective of this study is to predict the daily confirmed deaths of the Asian continent. Another target of the current examination is to anticipate the daily confirmed deaths with regard to day by day affirmed cases.

10.2 Data collection

The WHO (World Health Organization) and Governments have collected the data of the Asian continent. Table 10.1 shows the day by day information of confirmed cases and deaths from December 31, 2019 to April 16, 2020. Matrix 10.1 represents the scatter matrix of the given data. Also Table 10.2 represents statistics of the given data.

10.3 Polynomial Neural Network

In 1997 the Artificial Neural Network (ANN) was developed by Bourquin and Agatonovic-Kustrin and Beresford (Lee & Mun, 2014; Michalena & Hills, 2013). It is generally applied for anticipating methane (Behera, Meher, & Park, 2015),
Table 10.1 Per day information of confirmed cases and confirmed deaths from December 31, 2019 to April 16, 2020.

| Date          | Daily confirmed cases | Daily confirmed deaths |
|---------------|-----------------------|------------------------|
| 31 December 19 | 27                    | 0                      |
| 01 January 20  | 0                     | 0                      |
| 02 January 20  | 0                     | 0                      |
| 03 January 20  | 17                    | 0                      |
| 04 January 20  | 0                     | 0                      |
| 05 January 20  | 15                    | 0                      |
| 06 January 20  | 0                     | 0                      |
| 07 January 20  | 0                     | 0                      |
| 08 January 20  | 0                     | 0                      |
| 09 January 20  | 0                     | 0                      |
| 10 January 20  | 0                     | 0                      |
| 11 January 20  | 0                     | 1                      |
| 12 January 20  | 0                     | 0                      |
| 13 January 20  | 1                     | 0                      |
| 14 January 20  | 0                     | 0                      |
| 15 January 20  | 1                     | 1                      |
| 16 January 20  | 0                     | 0                      |
| 17 January 20  | 5                     | 0                      |
| 18 January 20  | 17                    | 0                      |
| 19 January 20  | 136                   | 1                      |
| 20 January 20  | 20                    | 0                      |
| 21 January 20  | 152                   | 3                      |
| 22 January 20  | 142                   | 11                     |
| 23 January 20  | 97                    | 0                      |
| 24 January 20  | 266                   | 9                      |
| 25 January 20  | 448                   | 15                     |
| 26 January 20  | 669                   | 15                     |
| 27 January 20  | 794                   | 25                     |
| 28 January 20  | 1765                  | 25                     |
| 29 January 20  | 1475                  | 26                     |
| 30 January 20  | 1752                  | 38                     |
| 31 January 20  | 1994                  | 43                     |
| 01 February 20 | 2110                  | 46                     |
| 02 February 20 | 2604                  | 46                     |
| 03 February 20 | 2814                  | 57                     |
| 04 February 20 | 3240                  | 65                     |
| 05 February 20 | 3895                  | 66                     |
| 06 February 20 | 3739                  | 72                     |
| 07 February 20 | 3172                  | 73                     |
| 08 February 20 | 3433                  | 86                     |
| 09 February 20 | 2618                  | 89                     |
| 10 February 20 | 2981                  | 97                     |

(Continued)
Table 10.1 (Continued)

| Date            | Daily confirmed cases | Daily confirmed deaths |
|-----------------|-----------------------|------------------------|
| 11 February 20  | 2495                  | 108                    |
| 12 February 20  | 2031                  | 97                     |
| 13 February 20  | 15149                 | 255                    |
| 14 February 20  | 4166                  | 13                     |
| 15 February 20  | 2558                  | 143                    |
| 16 February 20  | 2028                  | 142                    |
| 17 February 20  | 2066                  | 106                    |
| 18 February 20  | 1896                  | 98                     |
| 19 February 20  | 1776                  | 139                    |
| 20 February 20  | 453                   | 114                    |
| 21 February 20  | 979                   | 119                    |
| 22 February 20  | 1048                  | 112                    |
| 23 February 20  | 945                   | 102                    |
| 24 February 20  | 413                   | 155                    |
| 25 February 20  | 675                   | 75                     |
| 26 February 20  | 756                   | 58                     |
| 27 February 20  | 986                   | 36                     |
| 28 February 20  | 920                   | 52                     |
| 29 February 20  | 1525                  | 58                     |
| 01 March 20     | 1405                  | 48                     |
| 02 March 20     | 1328                  | 59                     |
| 03 March 20     | 1273                  | 50                     |
| 04 March 20     | 1514                  | 52                     |
| 05 March 20     | 1253                  | 49                     |
| 06 March 20     | 1357                  | 54                     |
| 07 March 20     | 1962                  | 47                     |
| 08 March 20     | 1625                  | 54                     |
| 09 March 20     | 1165                  | 78                     |
| 10 March 20     | 912                   | 65                     |
| 11 March 20     | 1345                  | 86                     |
| 12 March 20     | 1633                  | 88                     |
| 13 March 20     | 1373                  | 88                     |
| 14 March 20     | 1821                  | 116                    |
| 15 March 20     | 1807                  | 111                    |
| 16 March 20     | 1943                  | 135                    |
| 17 March 20     | 1823                  | 150                    |
| 18 March 20     | 1945                  | 162                    |
| 19 March 20     | 2108                  | 167                    |
| 20 March 20     | 2403                  | 187                    |
| 21 March 20     | 2540                  | 177                    |
| 22 March 20     | 2979                  | 174                    |
| 23 March 20     | 2736                  | 187                    |
| 24 March 20     | 3208                  | 172                    |

(Continued)
metropolitan air quality (Nagendra & Khare, 2005), Nox emission in a tangentially fired boiler (Ilamathi, Selladurai, Balamurugan, & Sathyanathan, 2013), and dependability examination in hydropower plant (Majumder, Majumder, Saha, Sarkar, & Nath, 2019). The principal favorable position of the ANN is that it has the capacity to adapt rapidly which is especially suitable for nondirect displays. Large dimensionality and the choice of training methodology are disadvantages of ANN. As in this current examination target capacities are nonlinear, a model of ANN is appropriate for use in the investigation. Polynomial Neural Network (PNN) is a form of ANN which is unique in relation to the system followed in the later methods. The main difference between the PNN and ANN lies in the way the topology of the network is identified and the manner in which the weightage of connections between the input and hidden and hidden and output layers was estimated. Both of these boundaries are significant in expanding the precision of the neural organization models.

The use of basic ANN tools will make the model heavier as it utilizes the different emphases to locate the ideal weighting of the associations and follows an experimentation technique or complex quest calculations for distinguishing proof of the ideal

| Date       | Daily confirmed cases | Daily confirmed deaths |
|------------|-----------------------|------------------------|
| 25 March 20| 4133                  | 159                    |
| 26 March 20| 4615                  | 193                    |
| 27 March 20| 5381                  | 241                    |
| 28 March 20| 7049                  | 203                    |
| 29 March 20| 7412                  | 226                    |
| 30 March 20| 7098                  | 200                    |
| 31 March 20| 7600                  | 219                    |
| 01 April 20| 7647                  | 229                    |
| 02 April 20| 8554                  | 284                    |
| 03 April 20| 8876                  | 295                    |
| 04 April 20| 6301                  | 150                    |
| 05 April 20| 12331                 | 444                    |
| 06 April 20| 10206                 | 328                    |
| 07 April 20| 9366                  | 279                    |
| 08 April 20| 9623                  | 316                    |
| 09 April 20| 9522                  | 288                    |
| 10 April 20| 10178                 | 351                    |
| 11 April 20| 11051                 | 329                    |
| 12 April 20| 13081                 | 386                    |
| 13 April 20| 11523                 | 388                    |
| 14 April 20| 11760                 | 342                    |
| 15 April 20| 11242                 | 389                    |
| 16 April 20| 11418                 | 340                    |
### Table 10.2 Statistics of the given data.

| Variable            | Daily confirmed cases | Daily confirmed deaths |
|---------------------|-----------------------|------------------------|
| Numeric values      | 108                   | 108                    |
| Text values         | 0                     | 0                      |
| Missing values      | 0                     | 0                      |
| Unique values       | 95                    | 76                     |
| Zero values         | 12                    | 19                     |
| Most frequent       | 0                     | 0                      |
| Min. score          | 0                     | 0                      |
| Max. score          | 15149                 | 444                    |
| Median              | 1814                  | 82                     |
| Mean value          | 3080.453704           | 111.3611111            |
| Std. deviation      | 3653.602353           | 111.1997251            |
| 2σ outliers         | 8                     | 7                      |
| 3σ outliers         | 1                     | 0                      |
| 4σ outliers         | 0                     | 0                      |

**Matrix 10.1** Scatter matrix.
number of shrouded layers. In any case, on account of PNN, the choice of concealed layers is affirmed naturally in the underlying cycles, diminishing the necessity of rehashed execution of the calculation to recognize the estimation of weighting which will yield a base mistake in the anticipated yield. Some of the time in ANN, it is important to utilize expert information for the fitting factors input determination or to perform endless tests with various blends of past factors until a magnificent outcome is reached. In PNN the information factors decision is made consequently, and the genuine information factors utilized in the diagnosis and monitoring system do not appear in the conclusive outcome.

### 10.4 Result and discussion

The PNN model was intentionally used to limit the mistakes and to boost the presentation. Also the neurogenetic models assume a more prominent part in the field of exploration and study in light of their straightforwardness. Here we have utilized the fundamental condition (1) and (2) obtained from the ANN. Using Eq. (10.1) we predict the daily confirmed cases, Eq. (10.2) predicts the daily confirmed deaths, and Eq. (10.3) predicts the daily confirmed deaths with respect to daily confirmed cases. Figs. 10.2−10.4 show the correlation between predicted and observed output of daily confirmed cases, daily confirmed deaths, as well as daily confirmed deaths with respect to daily confirmed cases, respectively. Table 10.3 shows the forecast report from April 17, 2020 to April 22, 2020 for confirmed cases and confirmed deaths. From the figure, it is clear that Table 10.4 shows the absolute Error Measurement of the developed model.

\[
Y_1 = 11472.5 + "|id, dayofweek_3"*(-1002.5) \tag{10.1}
\]

![Figure 10.2](image-url)  
**Figure 10.2** Relationship among predicted as well as observed output for model (daily confirmed cases).
\[ Y_1 = -522.837 + \text{cycle} \times 1.22284 \]  \hspace{1cm} (10.2)

\[ Y_1 = 7.84935 + \text{"Daily confirmed cases", cubert}^2 \times 0.817949 \]
\[ + \text{"Daily confirmed cases", cubert}^2 \times (-3.52075) \]  \hspace{1cm} (10.3)

**Figure 10.3** Relationship among predicted as well as observed output for model (daily confirmed deaths).

**Figure 10.4** Relationship among predicted as well as observed output for model (daily confirmed deaths with respect to daily confirmed cases).
In this study, we get three optimal networks by which real-time monitoring of the daily confirmed case, daily confirmed deaths, and finally daily confirmed death with respect to a corresponding confirmed case of COVID-19 on the Asian continent. We can use this type of prediction for the remaining continent if data are available. Also, this can be applied to each country of each continent.

### 10.5 Conclusion

In this study, we get three optimal networks by which real-time monitoring of the daily confirmed case, daily confirmed deaths, and finally daily confirmed death with respect to a corresponding confirmed case of COVID-19 on the Asian continent. We can use this type of prediction for the remaining continent if data are available. Also, this can be applied to each country of each continent.

| # | Target name                          | Confidence band | 2020-04-17 | 2020-04-18 | 2020-04-19 | 2020-04-20 | 2020-04-21 | 2020-04-22 |
|---|--------------------------------------|-----------------|------------|------------|------------|------------|------------|------------|
| 1 | Daily confirmed cases                | 776.6932041     | 11870      | 11669      | 14586      | 13319      | 13057      | 12528      |
| 2 | Daily confirmed deaths               | 57.78474646     | 385        | 340        | 438        | 408        | 382        | 444        |

| Post processed result | Model fit (daily confirmed cases) | Model fit (daily confirmed deaths) | Model fit (day by day confirmed deaths regarding day by day confirmed cases) | Predictions (day by day confirmed deaths regarding day by day confirmed cases) |
|----------------------|-----------------------------------|-----------------------------------|-------------------------------------------------------------------------|---------------------------------|
| Number of observations | 12 | 13 | 86 | 22 | 22 | 70.649 | 166.516 |
| Max. negative error | - 561 | - 58 | - 128,008 | - | 166.516 | 33.1871 |
| Max. positive error | 622 | 60 | 149,972 | 33.1871 | 149,972 | 33.1871 |
| Mean absolute error (MAE) | 336.083 | 22.9231 | 31.2448 | 31.2448 | 31.2448 | 31.2448 |
| Root mean square error (RMSE) | 388.347 | 28.8924 | 42.8467 | 42.8467 | 42.8467 | 42.8467 |
| Residual sum | -209 | 26 | -4.0923E-12 | -4.0923E-12 | -4.0923E-12 | -4.0923E-12 |
| Standard deviation residuals | 387.956 | 28.8231 | 42.8467 | 42.8467 | 42.8467 | 42.8467 |
| Coefficient of determination (R²) | 0.880977 | 0.820643 | 0.845347 | 0.845347 | 0.845347 | 0.845347 |
| Correlation | 0.951098 | 0.950426 | 0.919971 | 0.919971 | 0.919971 | 0.919971 |

| Table 10.3 | Forecast report of 6 days of confirmed cases and confirmed deaths. |
|------------|------------------------------------------------------------------|
| # | Target name                          | Confidence band | 2020-04-17 | 2020-04-18 | 2020-04-19 | 2020-04-20 | 2020-04-21 | 2020-04-22 |
|---|--------------------------------------|-----------------|------------|------------|------------|------------|------------|------------|
| 1 | Daily confirmed cases                | 776.6932041     | 11870      | 11669      | 14586      | 13319      | 13057      | 12528      |
| 2 | Daily confirmed deaths               | 57.78474646     | 385        | 340        | 438        | 408        | 382        | 444        |

| Table 10.4 | Absolutely error measure. |
|------------|---------------------------|
| Post processed result | Model fit (daily confirmed cases) | Model fit (daily confirmed deaths) | Model fit (day by day confirmed deaths regarding day by day confirmed cases) | Predictions (day by day confirmed deaths regarding day by day confirmed cases) |
| Number of observations | 12 | 13 | 86 | 22 | 22 | 70.649 | 166.516 |
| Max. negative error | - 561 | - 58 | - 128,008 | - | 166.516 | 33.1871 |
| Max. positive error | 622 | 60 | 149,972 | 33.1871 | 149,972 | 33.1871 |
| Mean absolute error (MAE) | 336.083 | 22.9231 | 31.2448 | 31.2448 | 31.2448 | 31.2448 |
| Root mean square error (RMSE) | 388.347 | 28.8924 | 42.8467 | 42.8467 | 42.8467 | 42.8467 |
| Residual sum | -209 | 26 | -4.0923E-12 | -4.0923E-12 | -4.0923E-12 | -4.0923E-12 |
| Standard deviation residuals | 387.956 | 28.8231 | 42.8467 | 42.8467 | 42.8467 | 42.8467 |
| Coefficient of determination (R²) | 0.880977 | 0.820643 | 0.845347 | 0.845347 | 0.845347 | 0.845347 |
| Correlation | 0.951098 | 0.950426 | 0.919971 | 0.919971 | 0.919971 | 0.919971 |
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