Grey prediction model of dengue fever infectious diseases in Guangzhou

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Abstract: Application of grey system theory to predict the number of dengue fever in Guangzhou population, first to predict the net number of sick, and to predict the total population, but the results show that due to the presence of error, with grey prediction model, prediction of dengue fever infectious disease is flawed.

1. Establishment of grey prediction model for patients with dengue fever

According to the "Guangdong Yearbook" [3] dengue statistics data (data shown in Table 1), the grey optimization GM (1,1) model was used to establish a grey prediction model for the total number of dengue fever patients in Guangzhou.

2. The dengue fever model with time delay

2.1 Establishment of grey prediction model

The 2010-2014 5-year net increase case sequence was modeled and the initial sequence was obtained.

Let $S_1(t)$, $I_1(t)$, $R_1(t)$, $S_2(t)$, $I_2(t)$ represents the number of susceptible people, patient, remove people, no-viruses-carrying mosquitoes, viruses-carrying mosquitoes at time t. In reference[2], Tewa et.al study the following dengue fever model:

$$X^{(0)} = \{x^{(0)}(1), x^{(0)}(2), x^{(0)}(3), x^{(0)}(4)\} = (63,-29,106,1175) \qquad (1)$$

Its 1-AGO sequence is:

$$X^{(1)} = \{x^{(1)}(1), x^{(1)}(2), x^{(1)}(3), x^{(1)}(4)\} = (63,34,140,1315) \qquad (2)$$

The sequence of the nearest mean of $X^{(1)}$ is:

$$Z^{(1)} = \{Z^{(1)}(1), Z^{(1)}(2), Z^{(1)}(3), Z^{(1)}(4)\} = (63,48.5,87,727.5)$$

Make:

$$B = \begin{pmatrix} -48.5 & 1 \\ -87 & 1 \\ 727.5 & 1 \\ -19599 & 1 \end{pmatrix}, \quad Y = \begin{pmatrix} -29 \\ 106 \\ 1175 \\ 36568 \end{pmatrix}$$

$$a = (B^{\mathrm{T}}B)^{-1}B^{\mathrm{T}}Y = \begin{pmatrix} u \\ a \end{pmatrix}^{\mathrm{T}} = \begin{pmatrix} -0.8718 \\ -120.4061 \end{pmatrix}$$

The GM(1,1) time response of $X^{(1)}$ obtained by (4) is

$$X^{(1)}(k) = 62.9928e^{0.8718k} + 0.0072$$

The resulting analog sequence is

$$X^{(1)}(k+1) = (63,150.6363,360.1932,861.287,2059.5)$$

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Make: $X^{(0)}(k+1) = X^{(1)}(k+1) - X^{(1)}(k)$

Table 1. 2009-2014 Guangzhou Dengue Fever Infectious Disease Data

Year	**Virus Type**	**Breteau Index BI**	**Mosquito index**	**Cumulative incidence**	**Dengue case (local)**	**Dengue Case (input)**	**Net increase case**
2009	III	3.27 ± 1.66	7.07 ± 5.97	0.08/100,000	3	15	
2010	I II III IV	3.19 ± 1.79	8.37 ± 8.63	1.57/100,000	59	22	63
2011	I	2.81 ± 1.45	0.58 ± 0.50	0.4/100,000	33	18	-29
2012	III，IV	4.53 ± 2.95	10.09 ± 8.90	1.235/100,000	136	21	106
2013	III	4.99 ± 2.83	15.67 ± 13.8	10.45/100,000	1249	83	1175
2014	I II III IV	1.190 ± 0.002	1.59 ± 2.56	290.83/100,000	37340	560	36568

The simulated sequence of $X^{(0)}$ is

$$X^{(0)} = (63,,8.6363,209.5569,501.0947,1198.2)$$

2.2 Model inspection

Using MATLAB math software [4], the data in Table 1 is analyzed and calculated, and the residuals are calculated for the actual data (81, 51, 157, 1332) (-6.6363, -158.5569, -344.0947, 138.8), and the relative error is (8.1930, 310.8959, 219.1686, 100.4505), from which the average relative error is calculated as

$$\overline{\Delta} = \frac{1}{4}\sum_{k=1}^{4}\Delta k = 1.59677\%$$

3. Conclusion

The gray GM (1,1) model established in this paper predicts the future cases of dengue infectious diseases in Guangzhou and empirically analyzes the data through the data. It is known that the cases of dengue infectious diseases in Guangzhou have shown an upward trend during 2010-2014, through MATLAB mathematics. The software analysis calculated the average relative error value to be 1.59677%.

References

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