Int. J. Nonlinear Anal. Appl. 12 (2021) No. 2, 2263-2267
ISSN: 2008-6822 (electronic)
http://dx.doi.org/10.22075/ijnaa.2021.5373

Suggested methods for prediction using semiparametric regression function

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(Communicated by Madjid Eshaghi Gordji)

Abstract

Ferritin is a key organizer of protected deregulation, particularly below risky hyperferritinemia, by straight immune-suppressive and pro-inflammatory things. We conclude that there is a significant association between levels of ferritin and the harshness of COVID-19. In this paper, we introduce a semi-parametric method for prediction by making a combination of NN and regression models. So, two methodologies are adopted, Neural Network (NN) and regression model in designing the model; the data was collected from a nursing home hospital for period 11/7/2021- 23/7/2021, the sample size is 100 covid positive patients with 12 females & 38 males out of 50, while 26 female & 24 male are non-COVID out of 50. The input variables of the NN model are identified as the ferritin and a gender variable. The higher results precision is attained by the multilayer perceptron (MLP) networks when we applied the explanatory variables as the inputs with one hidden layer, which covers 3 neurons, as the planned many hidden layers are with one output of the fitting NN model which is used in stages of training and validation beside the actual data. We used a portion of the actual data to verify the behavior of the developed models, we find out that only one observation is a false predictive value. This means that the estimation model has significant parameters to forecast the type of Covid cases (Covid or no Covid).

Keywords: Semi-parametric method, Neural Network models (NN), regression, Ferritin level, COVID 19, multilayer perceptron (MLP).

1. Introduction

Ferritin is a key mediator of immune deregulation, especially under extreme hyperferritinemia, via direct immune-suppressive and pro-inflammatory effects. Many individuals with diabetes exhibit

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Received: March 2021 *Accepted:* July 2021

elevated serum ferritin levels 3-5, and it is known that they face a higher probability to experience serious complications from COVID-19. On this basis, we briefly reviewed the evidence supporting the hypothesis that ferritin levels might be a crucial factor influencing the severity of COVID-19. [7] Linlin Cheng et al, studies demonstrate ferritin in COVID-19 was collected from PubMed, EMBASE, CNKI, Sino Med, and WANFANG. A meta-analysis was performed to compare the ferritin level between different patient groups: non-survivors versus survivors; more severe versus less severe; with comorbidity versus without comorbidity; ICU versus non-ICU; with mechanical ventilation versus without mechanical ventilation, and concluded that Ferritin was associated with poor prognosis and could predict the worsening of COVID-19 patients. [2] In this paper, we introduced a semiparametric method for prediction by making a combination of NN and regression models. So, two methodologies are adopted, Neural Network (NN) and regression model in designing the model; the data was collected from nursing home hospital for period 11/7/2021- 23/7/2021, we have 100 people. COVID positive 12 females & 38 males out of 50, while 26 females & 24 males were non-COVID out of 50. We used MATLAB to evaluate the NN result & MINITAB Student Release version 14 to evaluate the Regression model. The input variables of the NN model are identified as the ferritin and a gender variable. The higher results precision was attained by the multilayer perceptron (MLP) networks when we applied the explanatory variables as the inputs with one hidden layer, which covers 3 neurons, as planned many hidden layers are with one output of the fitting NN model which is used in stages of training and validation beside the actual data. We used a portion of the actual data to verify the behavior of the developed models, we deduced that only one observation is a false predictive value. This means that the estimation model has significant parameters to forecast the type of Covid cases (Covid or no Covid).

2. Models Review

Nonlinear models are used to express the problem which is not standard structures in linear models, moreover, controlled to recover the predictable part to explain the performance procedure somewhat than to present certain molds which are hard to grip or/to enhance certain stochastic mechanisms. The neural network was used in fitting and predicting the incidence tendency of hemorrhagic fever with renal syndrome (HFRS) in the mainland of China and the results showed a better effect in fitting and predicting than using the traditional ARIMA model. Neural network models seemed to have strong application value in the prevention and control of HFRS [1]. The whole of nonlinear statistical demonstrating methods is large and can categorize into a parametric method which resources that the number of the connection parameters are known and the construction of the purpose to estimate is firm; nonparametric models do not oblige the function to any exact procedure; and semiparametric models as a mixture of parametric and nonparametric parts [2]. The NN model has to be stated by counting the number of parameters - earlier it was estimated, so it can categorize as parametric models [4]. Then the NN models can be mentioned as the parametric model in the arithmetical logic. It is established by the contrast of estimating linear functions neural networks to traditional linear methods are the achieve of linear neural function little effective since the unnecessary extra exertion, but results [7] showed that NN models are the finest in the situation of a nonlinear in statistics patron. The model design using Regression and a neural model in this equation:

$$x_t = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p + \theta_1 F(x_1, x_2, \ldots, x_p) \tag{2.1}$$

Where F is a function of the nonlinear part means a multilayer perceptron (MLP) by the input vector x_p and weight (parameter) vector θ_1.

3. Data Analysis

The correlation coefficient was used to figure out the relationship between the level of ferritin in the blood and the case of covid-19 infection and no infections. The result demonstrated that Pearson correlation of two variables (with and without covid) = -0.052 at P-Value = 0.721. This means a significant difference between the two cases of ferritin level. It is clear from this fig the cases with

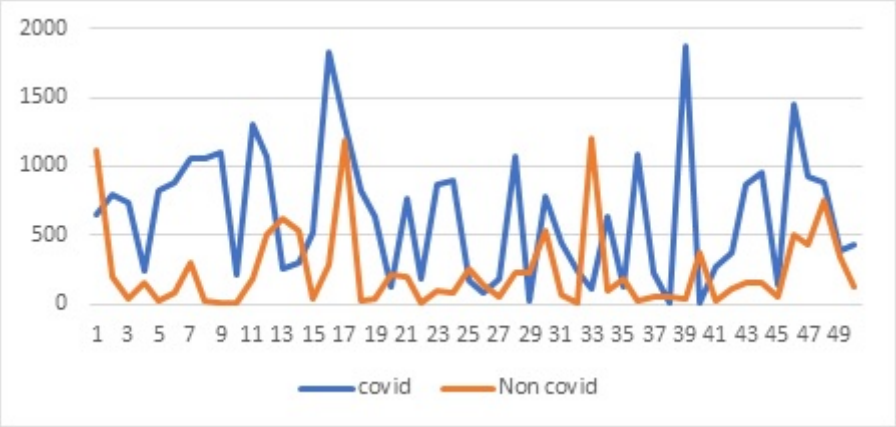

Figure 1: The comparison between ferritin level in cases (covid positive) and control (non-covid)

covid have high level than the cases with non-covid. Therefore, the construction prediction model must include this impact factor. Another important factor that impacting on the output is gender (male and female). It is clear that the significant influence of this variable, when computed the frequencies of the female numbers in the infection cases, is =12 out of 50, while in cases no infection is =26 out of 50. Two variables are dependent on building the prediction models.

4. Model building of Covid Prediction

Based on data analysis; two methodologies (NN and regression model) are adopted to build the semi-model prediction. By using the combination methodologies in this estimation equation:

$$p_{t+1} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \cdots + \hat{\beta}_p x_p + \hat{\theta}_1 \hat{F}(x_1, x_2, \ldots, x_p) \tag{4.1}$$

Then using the multiple regression model whereP_{t+1} is the prediction value and $\hat{F}(x_1, x_2, \ldots, x_p)$ is the result of the NN prediction model.
The input variables of the NN model are identified as the ferritin and a gender variable. The higher results precision was attained by the multilayer perceptron (MLP) networks when we applied the explanatory variables as the inputs with one hidden layer, which covers 3 neurons, as planned many hidden layers are with one output of the fitting NN model which is used in stages of training and validation beside the actual data.

A series of correlations were found between the ferritin and gender when estimating the parameters of the above equation. Therefore, it was used formally to get optimal Covid prediction:

$$p_{t+1} = \begin{cases} 0.000415 * \text{ferritin} + 0.547 \;\; \text{NNoutput} & \text{Male} \\ 0.000563 * \text{ferrtin} & \text{Female} \end{cases} \tag{4.2}$$

The Table below represent the DW statistics and F-statistics for the two estimating models

From Table 1, we see that the Durbin Watson Statistics is (DW) equal to 1.40726 for males and 1.20855 for females. It indicates there is a positive autocorrelation between residuals. In this section, we used a portion of the actual data to verify the behavior of the developed models.

Table 1: The statistical attributes of prediction models.

t-test	*constant*	*ferritin*	*NN output*	*DF*	*DW*	*F*	*P*	*MS*	R^2
Model (male)	*NA*	*0.0002*	*0.2*	*6*	*1.4072*	*54.02*	*0.000*	*9.8*	*0.9116*
Model (Female)	*NA*	*0.00056*	*0.0001782*	*1*	*1.2085*	*9.99*	*0.003*	*2.5*	*0.5058*

5. Results discussion

It is clear from Table 2 that just one observation is a false predictive value. This means the estimation model has significant parameters to forecast the type of Covid cases (Covid or non-Covid).

Table 2: Expected values of the Covid cases of Female gender.

Ferritin level	*Actual (Case of Covid)*	*Prediction (Case of Covid)*	*Accurate*
385.03	*1*	*0*	*False*
151.64	*0*	*0*	*True*
505.8	*0*	*0*	*True*
754.84	*0*	*0*	*True*

Table 3: Expected values of the Covid cases of male gender..

NN-output	*Ferritin level*	*case of Covid*	*Prediction*	*Accurate*
1	*1453.3*	*1*	*1*	*True*
1	*920.41*	*1*	*1*	*True*
1	*878.787*	*1*	*1*	*True*
1	*427.14*	*1*	*1*	*True*
0	*53.4*	*0*	*0*	*True*
1	*430.38*	*0*	*1*	*False*
0	*128.69*	*0*	*0*	*True*

The results in the above Table represent the optimal prediction which is dependent on two variables NN-output and Ferritin level.

6. Conclusion

(i) This suggested model shows the association between the serum ferritin level and clinical features of COVID-19 patients with the disease.
(ii) We recommended the ferritin test in an emergency to detect COVID -19 patients.
(iii) Future clinical educations should be done to additional clarify the predictive and pathogenic parts in COVID-19.

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