World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:12, No:03, 2018

Prediction of Coronary Artery Stenosis Severity Based on Machine Learning Algorithms

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Abstract : Coronary artery is the major supplier of myocardial blood flow. When fat and cholesterol are deposit in the coronary arterial wall, narrowing and stenosis of the artery occurs, which may lead to myocardial ischemia and eventually infarction. According to the World Health Organization (WHO), estimated 740 million people have died of coronary heart disease in 2015. According to Statistics from Ministry of Health and Welfare in Taiwan, heart disease (except for hypertensive diseases) ranked the second among the top 10 causes of death from 2013 to 2016, and it still shows a growing trend. According to American Heart Association (AHA), the risk factors for coronary heart disease including: age (> 65 years), sex (men to women with 2:1 ratio), obesity, diabetes, hypertension, hyperlipidemia, smoking, family history, lack of exercise and more. We have collected a dataset of 421 patients from a hospital located in northern Taiwan who received coronary computed tomography (CT) angiography. There were 300 males (71.26%) and 121 females (28.74%), with age ranging from 24 to 92 years, and a mean age of 56.3 years. Prior to coronary CT angiography, basic data of the patients, including age, gender, obesity index (BMI), diastolic blood pressure, systolic blood pressure, diabetes, hypertension, hyperlipidemia, smoking, family history of coronary heart disease and exercise habits, were collected and used as input variables. The output variable of the prediction module is the degree of coronary artery stenosis. The output variable of the prediction module is the narrow constriction of the coronary artery. In this study, the dataset was randomly divided into 80% as training set and 20% as test set. Four machine learning algorithms, including logistic regression, stepwise regression, neural network and decision tree, were incorporated to generate prediction results. We used area under curve (AUC) / accuracy (Acc.) to compare the four models, the best model is neural network, followed by stepwise logistic regression, decision tree, and logistic regression, with 0.68 / 79 %, 0.68 / 74%, 0.65 / 78%, and 0.65 / 74%, respectively. Sensitivity of neural network was 27.3%, specificity was 90.8%, stepwise Logistic regression sensitivity was 18.2%, specificity was 92.3%, decision tree sensitivity was 13.6%, specificity was 100%, logistic regression sensitivity was 27.3%, specificity 89.2%. From the result of this study, we hope to improve the accuracy by improving the module parameters or other methods in the future and we hope to solve the problem of low sensitivity by adjusting the imbalanced proportion of positive and negative data.

Keywords : decision support, computed tomography, coronary artery, machine learning
Conference Title : ICMDPC 2018 : International Conference on Medical Data and Privacy Considerations
Conference Location : Tokyo, Japan
Conference Dates : March 27-28, 2018