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| Data Science with R II (JEM220) – Charles University Prague, FSV |
| Comparing performances of logistic regression, decision trees, and neural networks for classifying heart disease patients |
| by Anchana Khemphila & Veera Boonjing |

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| Analysis and improvements by Erik Nemcik & Paul Mainka  17.5.2020 |

Overview

In their study Anchana Khemphila and Veera Boonjing compare the performance of logistic regression, decision trees and artificial neural networks in classification problems. For this purpose, the authors employ a data set on the development of heart disease among individuals.

In order to evaluate the performance of the three different methods, the authors use measurements of area under the curve (AUC), sensitivity, specificity, accuracy and the error rate. Since artificial neural networks have the lowest error rate and the highest accuracy in their estimations, they conclude that artificial neural networks is the most suitable of the three classification techniques assessed for this data set.

# Data

The data set used by Boonjing and Khemphila includes 303 individuals, 13 explanatory variables and the dependent variable whether the patient has developed heart disease or not. The data set is quite balanced with 165 patients having developed a heart disease which corresponds to approximately 54% of all the patients. Of the 13 explanatory variables, 8 are factors and 5 are continuous variables.

Description of the eight factor variables:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Name | Meaning | Different Levels | Frequency of occurrence |
| 1 | Sex | Patient gender | Female | 96 (32%) |
| Male | 207 (68%) |
| 2 | Chest Pain Type |  | Angina | 143 (47%) |
| Abnormal | 50 (17%) |
| Nonanginal pain | 87 (29%) |
| Asymptotic | 23 (8%) |
| 3 | Fasting Blood Sugar | Is fasting blood sugar less than 120? | True | 45 (15%) |
| False | 258 (85%) |
| 4 | Resting ECG | The electrocardiogram (ECG) measures the heart’s electrical activity, and a resting ECG is administered when the patient is at rest. | Normal | 147 (49%) |
| Abnormal | 152 (50%) |
| Left ventricular hypertrophy | 4 (1%) |
| 5 | Induced Angina | Does the patient experience angina as a result of exercise? | True | 99 (33%) |
| False | 204 (67%) |
| 6 | Slope | Slope of the peak exercise ST segment. | Up | 21 (7%) |
| Flat | 140 (46%) |
| Down | 142 (47%) |
| 7 | Number Coloured Vessels | Number of major vessels coloured by fluoroscopy. | 0 | 175 (58%) |
| 1 | 65 (21%) |
| 2 | 38 (13%) |
| 3 | 20 (7%) |
| 4 | 5 (2%) |
| 8 | Thal | Thalassemias, blood disorders characterized by decreased hemoglobin production | Normal |  |
| Fixed defect |  |
| Reversable defect |  |

Description of the 5 continuous variables:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Name | Meaning | Min | Median | Mean | Max |
| 9 | Age | Age in years | 29 | 55 | 54.37 | 77 |
| 10 | Blood Pressure | Resting blood pressure upon hospital admission | 94 | 130 | 131.6 | 200 |
| 11 | Cholesterol | Serum cholesterol | 126 | 240 | 246.3 | 564 |
| 12 | Maximum Heart Rate | Maximum heart rate achieved. | 71 | 153 | 149.6 | 202 |
| 13 | Ole Peak | ST depression induced by exercise relative to rest. | 0 | 0.80 | 1.04 | 6.20 |

# Theory/Model

The authors take a data mining approach, implying that they do not make assumptions regarding the mode of influence of the various explanatory variables on the dependent variable. Instead, they let the data speak for itself. The aim of the paper is to determine which of the three presented techniques provides the best estimations when applied to new data. The three approaches used are Logistic regression, Artificial neural networks and Classification and Regression Trees. For this purpose the authors of the study draw a random sample of 60% of the data set to train the models and then test their predictive power on the remaining 40%. By knowing the true data of the test data set, they can then evaluate the accuracy of the prediction of the different models.

# Results

Improvements to the Study

We have a number of criticisms of the quality of the study and suggestions for improvement to improve the validity of the results.

First of all, we would like to criticize the form of the paper. The readability is partly limited, for instance due to missing spaces and spelling mistakes.

More important, however, are technical comments, especially that Boonjing and Khemphila do not perform cross-validation. Our main contribution to improve the validity of the study is to utilize cross validation for the different methods (Logistic regression and neural networks) or to employ more sophisticated methods based on the same idea (bagged trees or random forest for decision trees). Without cross validation, the overall performance of the estimation methods rely heavily on the random sample drawn. As we show in our study, the values of the quality measures area under the curve (AUC), sensitivity, specificity, accuracy and the error rate vary strongly with different splitting into training and test data set. A reliable statement about which data mining technique gives the best scores can therefore only be made by averaging the performance over many variations.

# References

A. Khemphila and V. Boonjing, "Comparing performances of logistic regression, decision trees, and neural networks for classifying heart disease patients," 2010 International Conference on Computer Information Systems and Industrial Management Applications (CISIM), Krackow, 2010, pp. 193-198, doi: 10.1109/CISIM.2010.5643666