Understanding Defect Prediction Models with Halstead & McCabe Metrics

Shrenuj Gandhi
Computer Science
North Carolina State University
sgandhi4@ncsu.edu

Neng Jiang
Computer Science
North Carolina State University
njiang@ncsu.edu

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I. INTRODUCTION

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II. BASELINE STUDY

In the paper ”Data Mining Static Code Attributes to Learn Defect Predictors”, authors Tim Menzies, Jeremy Greenwald and Art Frank demonstrate that *naive Bayes* data miner with a *log filtering* preprocessor on the numeric data outperforms rule-based and decision-based learning methods.

III. METHODOLOGY

As part of this project, we perform 4 experiments in order to understand the behavior of defect prediction models.

A. Experiment 1 - Reproducing Baseline Results

B. Experiment 2 - Performing SMOTE

C. Experiment 3 - Tuning Feature Selection

D. Experiment 4 - Comparing Learners

Each dataset goes through the following procedure

E. Data Cleaning

Any string column is ignored. Only numeric columns are processed. The idea is to keep it simple. String columns will

F. Pre-processing

The numeric data varies a lot. The following figure shows the min and max values of all the columns in the dataset -. Due to high variance, we are applying a filtering layer. We applying log filtering and then normalize the data.

G. Processing Method

The dataset is broken into testing and training sets. We are using 10×10 cross evaluation i.e. 10 times we train on 90% of data and test on the remaining 10%. Then SMOTE is applied to training set (keeping the size constant). Figure x shows the defect percentage in the 7 datasets. Clearly there is a minority of the defective class. Due to this we apply the Synthetic Minority Over-Sampling Technique (SMOTE). (source - http://machinelearningmastery.com/tactics-to-combat-imbalanced-classes-in-your-machine-learning-dataset/) This is done by replacement (resulting in inflated training set), or by SMOTE and then reconstructing original bin size by random selection// How SMOTING works - It works by creating synthetic samples from the minor class instead of creating copies. The algorithm selects two or more similar instances (using a distance measure) and perturbing an instance one attribute at a time by a random amount within the difference to the neighboring instances.(source -http://www.jair.org/papers/paper953.html)

OR examine results of SMOTE and try re-sampling i.e. duplicating data Side-effect of SMOTE-ing You will have more and different data, but the non-linear relationships between the attributes may not be preserved.

The training and testing datasets are fed to the learners after SMOTE. For evaluating the effect of SMOTE with the baseline result, we have used Naive Bayes classifier. Naive Bayes uses Bayes Theorem to model the conditional relationship of each attribute to the class variable.

Prior works(mention references) have also used different learning methods. To get a good grasp of the performance of different learners, we have also used, in this experiment, Support Vector Machine (SVM), Random Forest, Classification and Regression Trees(CART), and Logistic Regression(LR).

SVM method uses points in a transformed problem space that best separate classes into two groups. Classification for multiple classes is supported by a one-vs-all method. SVM also supports regression by modeling the function with a minimum amount of allowable error[MLM]. Random Forest is an extension of Bootstrap Aggregation or bagging that in addition to building trees based on multiple samples of your training data, it also constrains the features that can be used to build the trees, forcing trees to be different. CART are constructed from a dataset by making splits that best separate the data for the classes or predictions being made. Logistic regression fits a logistic model to data and makes predictions about the probability of an event (between 0 and 1). Different learners (source-http://machinelearningmastery.com/get-your-hands-dirty-with-scikit-learn-now/)

Decision Trees perform well on imbalanced datasets.The splitting rules that look at the class variable used in the creation of the trees, can force both classes to be addressed.try a few popular decision tree algorithms like C4.5, C5.0, CART, and Random Forest.

The above logic is wrapped around a feature selection process. This spits out the top K attributes (based on info gain). This process is tuned to select top k attributes that provide the most recall value. (provide reason do doing this)

H. Reporting Results

sdfsdf

IV. RESULTS

V. PROCEDURE FOR PAPER SUBMISSION

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B. Units

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$$\alpha + \beta = \chi \tag{1}$$

Note that the equation is centered using a center tab stop. Be sure that the symbols in your equation have been defined before or immediately following the equation. Use (1), not Eq. (1) or equation (1), except at the beginning of a sentence: Equation (1) is . . .

D. Some Common Mistakes

- The word data is plural, not singular.
- The subscript for the permeability of vacuum ?0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter o.
- In American English, commas, semi-/colons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
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Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced. Styles named Heading 1, Heading 2, Heading 3, and Heading 4 are prescribed.

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TABLE I
AN EXAMPLE OF A TABLE

One	Two
Three	Four

We suggest that you use a text box to insert a graphic (which is ideally a 300 dpi TIFF or EPS file, with all fonts embedded) because, in an document, this method is somewhat more stable than directly inserting a picture.

Fig. 1. Inductance of oscillation winding on amorphous magnetic core versus DC bias magnetic field

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity Magnetization, or Magnetization, M, not just M. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write Magnetization (A/m) or Magnetization A[m(1)], not just A/m. Do not label axes with a ratio of quantities and units. For example, write Temperature (K), not Temperature/K.

VIII. CONCLUSIONS

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

APPENDIX

Appendixes should appear before the acknowledgment.

ACKNOWLEDGMENT

The preferred spelling of the word acknowledgment in America is without an e after the g. Avoid the stilted expression, One of us (R. B. G.) thanks . . . Instead, try R. B. G. thanks. Put sponsor acknowledgments in the unnumbered footnote on the first page.

References are important to the reader; therefore, each citation must be complete and correct. If at all possible, references should be commonly available publications.

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