Apply Machine Learning to Performance Trend Analysis

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Data preprocessing and data transformation had been performed. Some fields in the dataset store multiple values and these values are separated by a tab character. They need to be extracted in order to use in further analysis later. Moreover, each software product consists of several software packages and numerous test cases are executed in one software package. Test case which has a minimum value of CPU utilization is selected to represent the performance of specific software package.

Markov regime switching model is implemented for addressing the thesis' problem - we are interested to discover and estimate change points and regime shift in time series when the time instant is unknown. This model is one of the most well-known non linear time series models. It is first introduced by Hamilton [1] and is extensively implemented in economics and finance field. It takes the behavior of shifting regime in time series into account and models multiple structures that can explain this characteristic in different states at different time. The shift between state or regime comes from the switching mechanism which is assumed to follow an unobserved Markov chain. Thus, the model is able to capture more complex dynamic patterns, identify the switch in states when change-point is most likely to occur. In speech recognition, such processes are described as hidden Markov model [2].

Given the historical behavior of the observation sequence in this study, it is noticed that observed value is not completely independent of each other (i.e., performance of current software package depends on the performance from the past version of software package). Therefore, additional dependencies at observation level with the first order autoregression, AR(1), is taken into consideration when fitting the model. It is simply called Markov switching autoregressive model.

The MSwM [1] package in CRAN developed by Josep A. Sanchez-Espigares is used for performing an univariate autoregressive Markov switching model for linear and generalized model. The package implemented expectation-maximization (EM) algorithm to estimate the Markov switching model. Source code and functions used for fitting the model in this package have been studied and reviewed in detail. The purpose of this task is to get a general idea of how the package works in general and also to understand the algorithm and concept behind. Even

[1] https://cran.r-project.org/web/packages/MSwM/index.html

though most of the coding has been done for performing the Markov switching model, further implementation is still needed in order to properly deal with the problem at hand. Some modifications have been made in the function to handle errors and warnings produced when fitting the model. For instance, one minor mistake which generated warning in some cases is found in the code. This issue is now resolved.

Furthermore, in some situations when fitting linear regression, Hessian will not be invertible because the matrix is singularity. Consequently, standard error of the estimated coefficients can not be computed. This issue is solved by using generalized inverse procedure [3].

Another error that has been dealt with is when coefficients are NAs. This is mostly happened when predictor variables are categorical. Coefficients in each regime are first initialized by randomly sampling data into different subsets and performing regression in each subset. The problem arise when subset does not contain all levels of variable. As a result, model generates NA coefficient for the missing level of variable. This issue is now being taken care of by .

References

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[3] Jeff Gill and Gary King. What to do when your hessian is not invertible: Alternatives to model respecification in nonlinear estimation. *Sociological methods & research*, 33(1):54–87, 2004.