

PROBABILISTIC MODELS TO UNDERSTAND AND ANALYZE STUDENT PERFORMANCE IN POST GRADUATE ENTRANCE EXAMINATIONS - A CASE STUDY

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ABSTRACT

Competitive examinations occur at all the levels of education in the current scenario-more important at the Graduate and Post Graduate levels. The intense level of competition at this stage makes it difficult for both the candidate to answer the papers and the person to set the paper. While the standard of the questions have to be maintained throughout the examination paper it also has to be seen that there is a right balance between the severity of the questions and the strength of the candidates to answer. This balance is difficult to achieve. This paper discusses some probabilistic and statistical techniques to analyze the results of competitive exams at the post graduate level-and thereby evolve a predictive model for the future use in setting up the question papers. Data Mining softwares like Rapid Miner, Weka and R and statistical packages like SPSS can be employed suitably in order to do this kind of an analysis.

KEYWORDS: Data Mining, Probability, Rasch Model, Statistical Methods

INTRODUCTION

The effectiveness of competitive examinations is a matter of investigation. Whether the exams are rightly measuring the aptitude of the candidates or not, if not to what extent they are measuring it-what will be the impact of such an examination once the selected candidate goes to the Post Graduate level and thereafter? What will be the performance of such a student in the employment scenario-these are all pertinent questions to be asked at the entrance examination level itself. This calls for an extensive analysis of the results and the factors on which the score of the students depend. Several methods can be used for such an analysis and this paper describes some of such methods and models – with particular reference to probabilistic and statistical approaches. The particular examination that has been made a study of is the Karnataka PG CET examination.

LITERATURE REVIEW

Studies regarding comparisons of the exam patterns has been done in Bandale and Adewale^[1]. They discuss the validity of three types of mathematics examinations. While studying the examination pattern itself is a significant part of this study, the examinee part also has to be studied. The model that has been taken up in this study is the Rasch model-this caters for studying and integrating both the facets – examinee part and examiner part-this model is a widely accepted model for analysis in health studies, education and psychology^[2] Basically, the model could be used to develop the questionnaire in a manner that befits the students' ability to answer.

Competitive examinations contain several types of questions – multiple choices, descriptive, analytical-and so on. Different student can have different ability to answer such questions and also at different speeds. The main dependent factor in this scenario is the score of the student. It may depend on a variety of factors such as his ability to answer-the marks in the previous degree marks is a sure indicator of this factor and we have considered this factor strongly in our analysis. Other independent factors are the severity /degree of difficulty of questions, the type of questions and so on.

Before the probabilistic model can be seen, it has to be considered what data mining can do for the study. In the current study, a comparison has been done in the first level as to what are the marks scored in each year of the PG CET examinations for MCA- starting from 2011. This is a weak dependency as the marks and previous exam scores over an year does not speak anything much of significance. Nevertheless it is an useful comparison to be made because it gives an hindsight as to what sort of patterns are present in the scores. For this the software Rapid Miner has been employed and a sample screen shot is shown below.

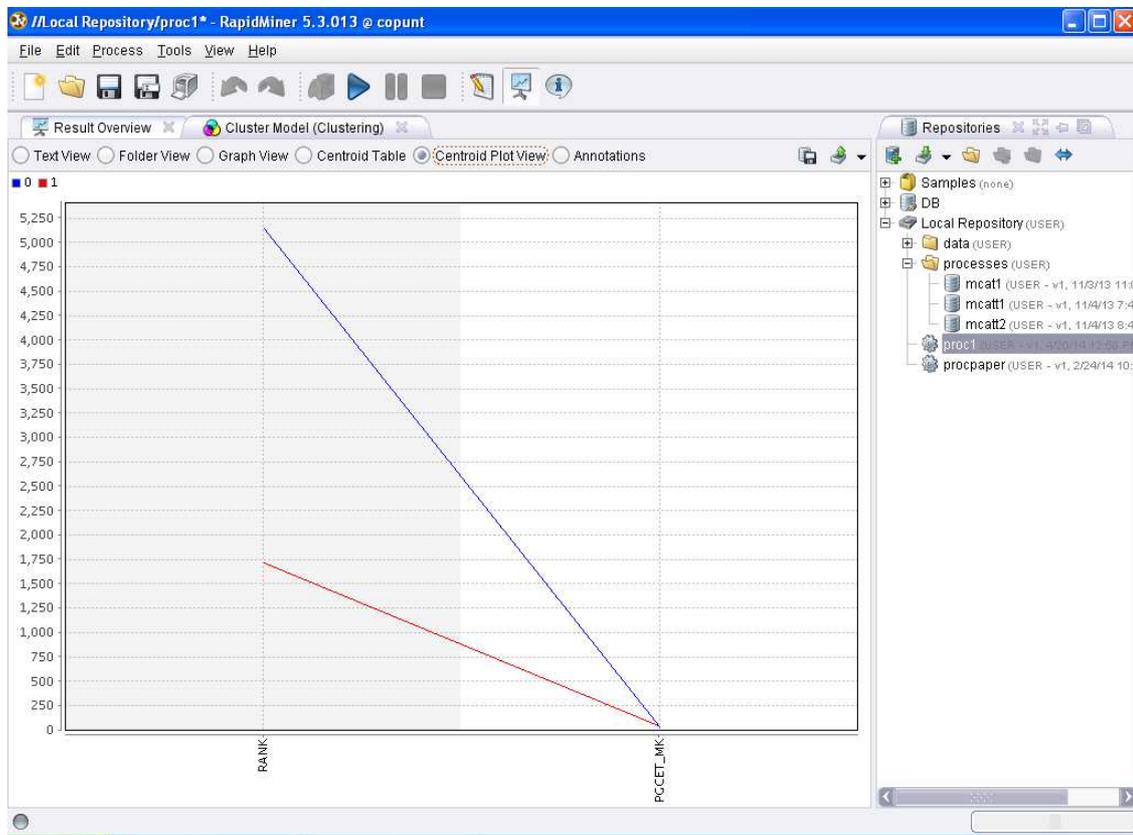


Figure 1

Once we get an idea of this gross distribution we goto examine the correlation between the degree marks and the scores in the entrance examination. This factor is a very strong independent parameter because the degree marks scored by the student is going to be a strong indicator of his aptitude. Again the following screenshot shows the dependency between the degree marks and the ranks. This screen has been generated by using SPSS software.

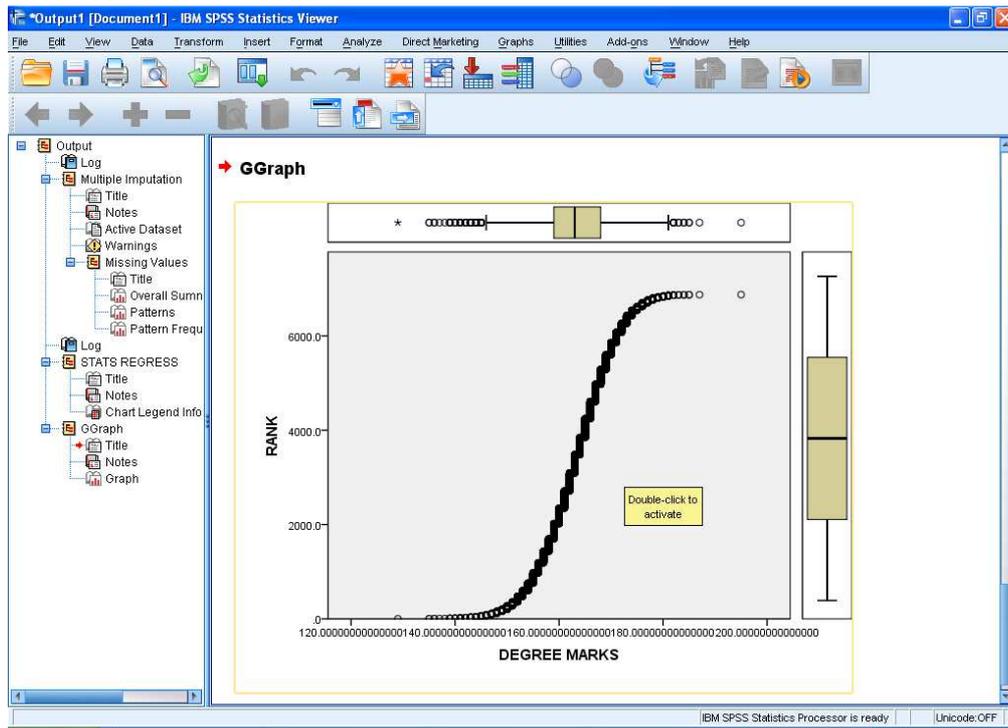


Figure 2

It can be observed very clearly that the distribution contains clusters in the graph meaning that the same set of students scoring the same marks in the entrance exam have different degree marks-otherwise the ranks would not differ.

The above analysis gives the correlation between the dependent and one independent factor namely – the degree marks. What about other independent factors like severity of questions, type of questions and so on. For this multivariate statistical analysis can be made but this paper focusses on probabilistic model to do the same

The Probabilistic Model-Analysis

This model builds on an extended Rasch model. The Rasch model basically is a psychometric model for analyzing categorical data such as students’ answers to questions. In this model the probability of a right/wrong answer is modeled as a function of person and item parameters. The item parameters may be the difficulty of the questions and the person parameters can be the maturity of the mind of which age is an indicator.

The Rasch model is a model in the sense that it gives the criteria to get what is to be got from the data- that is, the measuring criteria to get the inferences. For example, children’s education is dependent upon several criteria and if Rasch model has to be applied to it, the vast array of factors on which the education is dependent has to be considered. Thus Rasch model remains mostly as a theoretical model for such a research.

In the current study the examinations are meant to test the students’ ability across a set of examinations. This generalization requires a two facet Rasch model

$\text{Log}_e(P_{ni}/1-P_{ni}) = (B_n - D_i)$ which separates the item difficulties(D_i) and examinee performance(B_n). The examinee performance parameter can also have another measurable extension to it- the scores in the degree examination. The extended model for our case would include other parameters like the type of questions, number of questions, time given to answer. The model would then become

$$\text{Log}_e (P_{ni}/1-P_{ni}) = (B_n - D_i - T_i - H_i - P_i)$$

Where T_i - Type of questions, H_i -Number of questions– P_i -Time given to answer

This model analyzes the above facets. The data being given is B_n -previous exam performance, D_i -Difficulty level of questions and other parameters as described above.

The quantification of each facet in log-odds units (logits) locates the elements on a single common linear scale. Each facet is calibrated from the relevant observed performance scores. Although extensive analysis of all the answers for all the candidates is not a viable option it can be done effectiely if data for each of the facets is considered separately, one at a time.

To be explicit, the log odds of for an examinee performance of ability B_n , receiving a grade k rather than a grad $k-1$ on an item of difficulty D_i is modeled as

$$\text{Log}_e (P_{nik}/1-P_{nik-1}) = (B_n - D_i - T_i - H_i - P_i)$$

Where P_{nik} –probability of candidate getting grade k on an item of difficulty D_i

Where P_{nik-1} –probability of candidate getting grade $k-1$ on an item of difficulty D_i

Residual analysis and misfit statistics identify the particular gradings that are improbable, and thus put a check on the technical validity of the examinee performance levels.

The above kind of an analysis can be carried out for several years of the PG CET examination process. The output of the above analysis can be used to derive a predictive model for the future years. For example, for a certain set of students whose ability has been measured–their probable answering pattern can be generated and using that, if similar clusters of candidates are present in the future years, questions can be set accordingly to balance the candidates' ability and the severity of the questions.

CONCLUSIONS

This paper discusses a probabilistic model based on the Rasch model for understanding the students' performance in competitive examinations. Although several other probabilistic models are available to do the same, this model is a realistic one to employ in situations where in large data sets of candidates are present. Data mining techniques also help us in locating clusters of similar behavior and capacity of students. Statistical techniques also can be used to find out the correlation between the dependent and independent factors.

REFERENCES

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