Literature Review:
Using Psychometric Data and Matric Marks to Recommend Suitability
for a Degree

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1   Introduction

Deciding on a degree to study towards is often a difficult one and career indecisiveness is common as there are numerous career domains to consider [Robbins et al., 2004; Gaudron, 2011].Contrary to popular misconception, meeting the admission requirements does not necessarily mean the student is suitable, ready and well equipped for the degree at hand [Wilson-Strydom, 2015].

Through this research we aim to identify features that can predict a students suitability for a degree based on their high school results and psychometric evaluation outcomes. This writing explores previous work done in related educational research (Section 3.1) and psychological research (Section 3.2). Mathematical methodologies useful for making predictions and inferences are also introduced and described based on applications in related work and how they will be fundamental for the basis of this research.

Through the review of related work it has been shown that there are other features that can be used to help determine the students suitability and readiness for a degree path. These range from Character[1] [Robbins et al., 2004], academic ability [Lemmens et al., 2010] and social aspects that can be identify through biographical data [Ajoodha and Jadhav, 2017].

An in depth of analysis of the research work in the field of analysing and predicting university student performance is explored in the chapters to follow, including work in the psychological field of psychometric evaluations. Firstly we look at the background (Section 2) of this research by mentioning the work that our research will be building up on. This gives the the contextual overview of the research. We then explore features that have been established to be contributing measures of readiness (Section 3)and we discuss how these could be used to influence our predictions when making suggestions to students on their most suitable degree choice. We then give the methodologies that were adopted in the related works (Section 4) and overviews of the results obtained from adopting these approaches.

This literature review is a conventional analysis of the identified appropriate related work for our research in assisting students by providing recommendations on their suitability for a degree to study towards at university.

2   Background

In this section we aim to discuss the background of educational and psychological research related to our research topic. We will be taking a look at work done previously and discussing how they relate to our instance of research. The work to be discussed forms the basis

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[1]How personality affects individuals learning ability in different degrees

of our research as they give us contextual understanding of the problem and a perspective on how our research will contribute to it's field.

A student's entry characteristics affects their success (persistence) or withdrawal from a particular degree [campbell1984predicting, Lemmans2011, Rithesh2017].Universities have different admission requirements for each particular degree they offer, these are often based on high school performance on subjects most correlated to the degree course work. Matric results and admission point scores (APS) are what universities use to accept students into programs. Approximately 30% students drop out of university in their first year, and about 55% of all students never graduate [Wilson-Strydom, 2015]. With such figures it is evident that these admission requirements alone are not sufficient determine student suitability [Wilson-Strydom, 2015]. Through our research, we aim to identify correlations between non cognitive evaluations in addition to the existing entrance requirements to better predict a students suitability for a degree.

Psychometric evaluations are considerably difficult to make inferences on because they are often presented as qualitative data[Hammond, 2006]. Hammond [2006]Provides extensive outlooks on the history of psychometrics and how to ensure they provide the most insight to a given question that needs to be answered. which in our case is what psychometric results can tel us about a students suitability for a particular degree. The relationship between university outcomes and psychological and social factors is also explored extensively by Robbins et al. [2004].

Thus evidence of the feasibly of or research question is given good backing by the background work done previously by researches in the respective related fields.

3   Measures of Student Readiness and Degree Suitability

In this section We intend to examine factors that can be characterized to be affecting student readiness. The Readiness Theory states that [Conley, 2007] Robbins et al. [2004] makes a compelling argument that overemphasis is placed on test preparation and test performance, in his instance, in the United States, the Scholastic Assessment Test (SAT) is used extensively. This is equivalent to the National Benchmark Test (NBT) in South Africa. Other formal assessments used as admission requirements are High School results.The argument raised is that the focus should be shifted from test performance alone to psycho-social[2] evaluations.

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[2]relating to the interrelation of social factors and individual thought and behaviour(Oxford University Press, 2019)

3.1 High School Results

A correlation exits between student performance in high school and their university outcome. [Lemmens et al., 2011] outlines useful findings that show that a students home background influences their readiness for university. Theses characteristics affect student failure or withdrawal from a degree.

The resources available to students at high school level along with the teaching quality influence the readiness of the student at university level. [Campbell and McCabe, 1984] for example the exposure of the student to computing facilities at high school level influences their initial technical abilities and confidence when engaging with these technologies.

A strong relationship between high school math results and university performance in computer science is identified by Campbell and McCabe [1984]. This can be attributed to the fact that computer science is based on problem solving ability which is well measured by mathematical ability. At some universities insist all prospective students undertake assessment in the NBT, this is to assess and measure the students arability apply academic literacy, quantitative literacy and mathematics to the demands of tertiary material. This test does not test students on any curriculum-related material. However not all universities utilize this assessment criteria, it is most commonly used for evaluating Health Science prospective students.

3.2 Psychometric evaluations

Psychometric assessments are used to evaluate an individuals mental capabilities and behavioural style, these traits measure ones suitability for a role based on required personality characteristics and aptitude[3][of Psychometric Coaching, 2019]

The use of psychometric results is not at all mandatory, only some high schools offer the opportunity of students to be evaluated, as a results many students only discover later on in their careers that what they are doing does not align well with their character traits, this is particularly common for students the choose career fields because of the prospective financial gain more than anything else. This can be attributed to a lack of education and family pressure having come from disadvantaged backgrounds.

Psychometric tests give non cognitive evaluations such as personality, motivation and interests [Hammond, 2006; Robbins et al., 2004] The confidence and belief that a student has on their ability (self-efficacy) are primary indicators of an individuals behaviour towards tasks in the face of challenging circumstances [Gaudron, 2011]. Watson et al. [2001]

Robbins et al. [2004] posed the question of whether psycho-social and study skills could be used as factors that can predict a college student's outcome. once again academic self-efficacy, academic-related skills and achievement motivation emerged as the most correla-

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[3]cognitive abilities

tive factors to student performance and retention. From Bayes textbook for further reading: qualitative (order-of-magnitude) probabilities (known as kappa rankings; Darwiche and Goldszmidt 1994)

3.3 Variations by Degree Field

Using feature engineering from machine learning to find characteristics associated with each respective degree will make our prediction model perform better [Mitchell et al., 1990]. Campbell and McCabe [1984] notes that there were different entrance requirements for the separate divisions of the university. indicating further that universities establish their own entrance requirements.

4 Methods and Results

In this section we discuss the methodologies applied in the works of the indexed literature. We explore how data was collected, prepared and consequently used to make inferences and probabilistic findings. The mathematical foundations of most of the researchers' work is also introduced and thoughts of how the same approaches can be applied and extended to our research are also examined based on the results in the papers.

4.1 Data Collection

The data required was collected directly from the respective university institutes. [Ajoodha and Jadhav, 2017] obtained biographical data and mathematical science results from the Academic Information Systems Unit (AISU) of the University of the Witwatersrand. [Lemmens et al., 2011] similarly obtained student results in economic science at the University of Pretoria. In addition an Academic Readiness Questionnaire was used to collect student's own retrospective outlook on their university readiness. This self report measure was then aligned with consequent student marks, Campbell and McCabe [1984] Collected data of sophomore(first year) University in the United States for computer science students.

One of biggest issue in educational data mining is ensuring that no individual students private details will be disclosed to any third party. Thus ethics clearance is required. Similar procedures will be required with our research and particularly more since psychological data is considered to be more sensitive and personal [Hammond, 2006]. In all of the above mentioned research, individual student identification is protected in line with the principles of ethical research mentioned in Josselson [2007]

4.2   Data Analysis

Measures of central tendency were commonly used to analyse quantitative data of particular group characteristics, the mean was used to summarise most data [Ajoodha and Jadhav, 2017; Lemmens et al., 2011; Campbell and McCabe, 1984]. Additional measures of spread such as variance, as well as quartiles we also used.

Most importantly the data records had to be labelled according to indicate whether the students qualified for their respective degree or not.The most widespread performance measure is aggregating the student marks for respective student groupings [Robbins et al., 2004]

Selecting the combination of variables that will give the same amount of information by using the least number of variables. The data used was classified categorically discriminant analysis was used to evaluate the accuracy of the classification.[Campbell and McCabe, 1984]. In order to predict the performance of a student in a particular field, probabilistic inferences need to be made. the basis of this approach is well defined in the textbook [Koller et al., 2009] which describes how Bayesian network can be used to structure the relationship of random variables. This is done to calculate conditional probabilities used to make predictions as described in the section below

4.3   Making Predictions-Machine Learning

Our research problem is distinguished as a supervised learning problem in machine learning terms.This means classification predictions are made based on previously observed labelled data[Mitchell et al., 1990]. The section below describes prediction models that were used and how they they will be useful for our respective research model.

4.3.1   Bayesian Analysis

Bayesian analysis maintains probabilistic distribution over any random variables having levels of uncertainty [Berger, 2013]. In our research the uncertainty will be the Matric and psychometric results and their effect on students university performance. The Bayes rule can be interpreted as: $P(Y|X) = P(Y)\frac{P(X|Y)}{P(X)}$ where $P(Y|X)$ represents the desired posterior probability. $P(X|Y)$ represents the prior probability.$P(X)$ and $P(Y)$ are the features observed and target class respectively [Koller et al., 2009]. When incorporating more features to this standard rule, this can be described as a chain rule of conditional probabilities [Koller et al., 2009].

This a method that allows for knowledge to be encoded in a way that can be navigated by a computer. In this model, nodes represent random variables. Edges represent the direction of dependence of the variables[Koller et al., 2009]. This methods was applied by

[Ajoodha and Jadhav, 2017] particularly by having biographical profiles mapped against the explicitly calculated Bayesian probability indicating their probability of failing. The results indicated at-risk biographical profiles with a Bayesian estimate that was larger than 0.7 for failing to complete the requirements of their respective degrees [Ajoodha and Jadhav, 2017].

Local probability models represent nature of dependence of each variable on its parents. This is particularly useful when examining the influence variables have on each other. for example, the Admittance Point Score of a student is directly dependent on the high school results of the student.

5   Conclusion

From this review of related work, we have established that there are numerous characteristics that can be used as predictors of how a student will perform at university. Multidimensional readiness characteristics include the students own attitude towards learning, curiosity and confidence to learn [Wilson-Strydom, 2015]. These non cognitive characteristics are a few of the ones that can be evaluated through student self retrospection in the form of questionnaires in psychometric tests [Robbins et al., 2004].

Student readiness for university can be closely linked to the question of whether the student is suitable for a degree program. Readiness theory is describe by Conley [2007] as the level of preparation a student needs in order to enroll and succeed in a degree program. Through the research We found that certain university requirements are common across different faculties such as willingness to learn [Lemmens et al., 2011], however in order to make better predictions across different degrees, a level of feature engineering is required to refine the list of characteristics associated with each degree in our classification list [campbell1984predicting, lemmens2010students].

Psychometric test are an important psychological evaluation tools that measure behavioural style [Hammond, 2006]. In addition to academic performance in high school, there are personal individual characteristics that can be used to predict student performance at university[Rithesh2017, campbell1984predicting, Lemmans2011, Rithesh2017

Statistical relationships between student characteristics (random variables) and student performance(target variable) are used as principled models for making predictions [Lemmens et al., 2010]. Bayesian networks reduce over-fitting to data and make the established prediction models as general as possible[Koller et al., 2009]. With all that the above gathered from the review of related work, we can say that predicting student suitability for a degree and using matric results and psychometric evaluations is a feasible and necessary research.

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