DATA MINING FOR STUDENTS' EMPLOYABILITY PREDICTION

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Abstract: This study has been undertaken to predict the student employability. Assessing student employability provides a method of integrating student abilities and employer business requirements, which is becoming an increasingly important concern for academic institutions. Improving student evaluation techniques for employability can help students to have a better understanding of business organizations and find the right one for them. The data for the training classification models is gathered through a survey in which students are asked to fill out a questionnaire in which they may indicate their abilities and academic achievement. This information may be used to determine their competency in a variety of skill categories, including soft skills, problem-solving skills and technical abilities and so on. The goal of this research is to use data mining to predict student employability by considering different factors such as skills that the students have gained during their diploma level and time duration with respect to the knowledge they have captured when they expect the placement at the end of graduation. Further during this research most specific skills with relevant to each job category also was identified. In this research for the prediction of the student employability different data mining models such as such as KNN, Naive Bayer's, and Decision Tree were evaluated and out of that best model also was identified for this institute's student's employability prediction. So, in this research classification and association techniques were used and evaluated.

Index Terms - **Employability, Data mining, Techniques, Skills, Classification, Association**

1. INTRODUCTION

Mostly in education sector uses prediction-based analysis to predict student placement as a employability which has become one of the crucial area in the present world. Vast number of students take admission on government institutes with the hope of acquiring their dream job. So, it would be great if students and the institute lecturers can get an idea about placement crucial factors beforehand. Many businesses nowadays place a greater premium on practical and provable abilities rather than academic subjects studied or grades obtained in institutions.

This predictive analysis will be done using the Higher National Diploma in Business Finance (HNDBF) students who are studying at a higher education institute of government. This business finance course provides students with a solid business and finance foundation. Specific knowledge in a range of subjects, as well as technical skills in finance, management, and business strategy, will be provided to students. The program allows students to build analytical, logical, critical, problem-solving, and soft skills in the process. The main objective of this business finance course is to produce the middle level professionals in business finance. Those middle level finance professional play and important role in the business organization.

These students will be able to get the higher national diploma at the end of two institutional academic periods and half year industry training. So, the diplomates finally have to compete with the graduates who passed out from state universities as well as the private universities and professional organizations.

Therefore, it is very important to identify important skills, determine the time duration to get an expected job with their knowledge and skills after completion of the diploma.

Students want to enroll in an institution that has a strong academic record and a high rate of employability among its graduates. Predicting academic achievement as well as employability can assist management in identifying students who are at risk of poor educational performance and low employability. The prediction process entails the use of various data mining methods to forecast dependent variables based on independent variables.

Candidate selection in accounting and finance can have a significant impact on a company's operational performance and strategic direction, as both applied and interpersonal skills of an accountant and/or finance management are critical.
In this learning and teaching environment, it's also critical to analyze how students feel about graduation skills and what they believe are the most significant skills that will make them valuable to employers. So, it is very import to predict what kind of skills they need to develop to get the desired job and as well as the time duration.

The lack of identifying skills in diplomates in business finance in higher education institutions is a major problem. Therefore, it is important to identify the skills in employability of business finance students and determining pattern and identify future trend. No research was found regarding the employability of higher national diplomates in Sri Lanka or the foreign countries.

Mostly in education sector uses prediction-based analysis to predict student placement as employability which has become one of the crucial fields in the present world. It is important for institute lecturers and students to get an idea about placement in future. So, we decided to introduce a method to predict the employability by using model formation in data mining. Ultimately it can be used to predict the student employability.

II. METHODOLOGY

Data mining techniques are effective for a wide range of activities and clustering, classification, association rule mining and regression are a few of them. In any case, each of these approaches is essential. In career development, data mining techniques are used to look for meaningful interactions such as patterns, associations, and changes in variables in datasets. So among these techniques, classification will be used to build employability prediction model in this research. Classification use to assign new data to the relevant classes based on previous categorized data and help to do predictions for the future. Naive Bayes, k-Nearest Neighbors & Decision Tree will be used as classification algorithms with relevant to this research. Further Association technique will be used to identify the specific skills relevant to different job categories.

For conducting this research, business finance students of a government higher education institute were considered and those students were the already passed out students from academic years 2014 to 2017. To the research a survey questionnaire was created in Google Form and it was shared among these passed out students. So this survey questionnaire was distributed online and collected the feedbacks to an online Google Sheet for data analysis purpose. This questionnaire was mainly divided into three sub sections such as background factors, work situation and rating of work-related skills and competences. By using online questionnaires all the employability related attributes were collected. Then those attributes were highly used for the data mining analysis. These values went through multiple stages of pre-processing prior to mining and used as inputs to Rapid Miner.

As the main output of this process, the students feedback sheet was obtained which was collected using an online Google sheets and further the job categories also could be able to receive and time durations to get the particular job with regards to the skills that the students have acquired. Moreover, types of skills need to develop to get a particular job also can be identified.

Data Collection and Pre- processing of data have been done by Rapid Miner Studio software. Collected data is used to data mining process to build a classification model. These models were created by using rapid miner software. Then compare the accuracy by applying several classification techniques and evaluate the model. After that, based on evaluated classification model, prediction was done for the students' employability. Further job specific employability skills were identified by using association mining techniques used in Rapid Miner software.

III. ANALYSIS AND DESIGN

3.1 Data Collection

Data collection has done using a survey questionnaire using the Google Forms. Some of the most important features are job category, time duration to get a job after graduation, professional courses followed, level of importance for the selected skills and to what extend these skills were developed within the institute. These are some of the important attributed assessed within the questionnaire. In this research fifteen skills were selected to get the feedback for the employability prediction.

Then the prepared questionnaire was distributed among student batches from 2014 to 2017 and collected the students' feedbacks to the Google sheet. There are 202 student feedbacks were collected for the employability prediction using data mining techniques.

3.2 Data Pre-Processing

In the data mining process data cleaning and preparing is an important step. In most instances, data in the real world is incomplete, noisy, and inconsistent. It's possible that the data in data sources is missing attribute values, data of interest, and so forth. There are occasions when data contains errors or outliers. In this research when distributing an online survey questionnaire most of the important questions marked as required. And when there are optional questions that did not mentioned required those questions were having missing values. So students have completed the questionnaire with less missing values. In this stage all the missing values were cleaned and prepared the data set for the classification.

3.4 Classification Models

Rapid Miner Studio is the software used for Data mining. Naive Bayes, K-NN and Decision Tree were the classification techniques used in this research study. Then model accuracy was identified individually. The data set collected using the Google Form was split in to two categories such as training which is 70% and testing set which is 30%. Using training dataset classifications models were created and then using the testing dataset, already created models were tested and identified the best model. By using the model, relevant and optimized features have been selected and used for the prediction of the student employability.

In this research study there were two aspects/ modules were considered for the classification techniques. These were the main prediction modules analyzed. Those predictions implemented under classifications methods in this study were given below.
- Predict the job category according to the skills use and their level of importance.

- Determine time period to get a job after graduation with relevant to the skills available

In Rapid Miner when creating the classification model split validation has been used. Using split validation relevant classification models were created by allocating the 70% from the dataset.

3.5 Association Analysis

The association techniques were also used to find the relation between job categories and the types of skills need to have when students search a placement after gratuation. Therefore in the association analysis mainly, the most associated skills with respect to the job title/ position.was implemented using the Rapid Miner.

IV. RESULT AND DISCUSSION

4.1 Evaluation of Classification Techniques

The data set was collected by using the survey questionnaire in Google Form and it was trained using different classification techniques namely Decision Tree, Naïve Bayes and k-NN by using the data mining software names as Rapid Miner tool. The main purpose of this classification was to create and identify the best model with the highest accuracy for the prediction of student employability. Accuracy of the prediction was mainly depended on the model.

In this evaluation stage the aspects/ modules implemented were evaluated with their accuracy and selected the best accuracy model for the future prediction of known data. The main classification modules implemented and evaluated in this research study were given below.
1. Predict the job category according to the skills use and their level of importance.
2. Determine time period to get a job after graduation with relevant to the skills available.

For this evaluation, the below-mentioned classifiers were used. For classification, split-validation techniques were used with 70% for the model training and 30% for the testing dataset was allocated.
Following are the classification models evaluated according to the first module in the classification which is the predicting the job category according to the skills use and their level of importance. KNN, Naïve Bayes and Decision tree algorithms were tested to identify the best model for this prediction.

accuracy: 67.82%

	true Mana...	true Whol...	true Banki...	true Accou...	true Marke...	true Auditing	true Custo...	true Public...	class prec...
pred. Man...	1	0	1	0	0	0	0	0	50.00%
pred. Who...	0	0	0	0	0	0	0	0	0.00%
pred. Ban...	0	0	17	6	3	4	0	0	56.67%
pred. Acco...	5	2	6	96	4	23	1	2	69.06%
pred. Mark...	0	0	0	0	1	0	0	0	100.00%
pred. Audit...	1	0	3	4	0	22	0	0	73.33%
pred. Cust...	0	0	0	0	0	0	0	0	0.00%
pred. Publ...	0	0	0	0	0	0	0	0	0.00%
class recall	14.29%	0.00%	62.96%	90.57%	12.50%	44.90%	0.00%	0.00%	

Figure 4.1 Accuracy of predicting the job category- using KNN algorithm

accuracy: 65.35%

	true Mana...	true Whol...	true Banki...	true Accou...	true Marke...	true Auditing	true Custo...	true Public...	class prec...
pred. Man...	4	0	2	7	0	1	0	0	28.57%
pred. Who...	0	2	0	0	0	1	0	0	66.67%
pred. Ban...	1	0	12	6	1	1	0	0	57.14%
pred. Acco...	2	0	11	78	1	15	0	0	72.90%
pred. Mark...	0	0	2	7	6	3	0	0	33.33%
pred. Audit...	0	0	0	6	0	27	0	0	81.82%
pred. Cust...	0	0	0	0	0	0	1	0	100.00%
pred. Publ...	0	0	0	2	0	1	0	2	40.00%
class recall	57.14%	100.00%	44.44%	73.58%	75.00%	55.10%	100.00%	100.00%	

Figure 4.2 Accuracy of predicting the job category- using Naïve Bayes algorithm

accuracy: 70.79%

	true Mana...	true Whol...	true Banki...	true Accou...	true Marke...	true Auditing	true Custo...	true Public...	class prec...
pred. Man...	5	0	2	2	0	0	0	0	55.56%
pred. Who...	0	0	0	0	0	0	0	0	0.00%
pred. Ban...	0	1	13	4	0	4	0	1	56.52%
pred. Acco...	2	1	10	95	3	19	1	1	71.97%
pred. Mark...	0	0	0	0	5	1	0	0	83.33%
pred. Audit...	0	0	2	5	0	25	0	0	78.12%
pred. Cust...	0	0	0	0	0	0	0	0	0.00%
pred. Publ...	0	0	0	0	0	0	0	0	0.00%
class recall	71.43%	0.00%	48.15%	89.62%	62.50%	51.02%	0.00%	0.00%	

Figure 4.3 Accuracy of predicting the job category- using Decision Tree algorithm

The following summary table is relevant to the classification module 01 which is regarding to the prediction the job category according to the skills use and their level of importance.

Table 4.1 Accuracy of prediction the job category according to the skills

Classification Model	Accuracy
KNN	67.82%
Naïve Bayes	65.35%
Decision Tree	70.79%

According to the algorithms evaluated for the prediction of the job category according to the skills use and their level of importance, the best algorithm identified with the highest accuracy was the Decision Tree.

Following are the classification models evaluated according to the second module in the classification which is the determining of the time period to get a job after graduation with relevant to the skills available. KNN, Naïve Bayes and Decision tree algorithms were tested to identify the best model for this prediction.

accuracy: 78.71%

	true less than 06...	true 01 year to 1...	true 06 months t...	true 1.5 years to ...	true More than 2 ...	class precision
pred. less than 0...	142	6	23	3	2	80.68%
pred. 01 year to 1...	0	3	1	0	0	75.00%
pred. 06 months ...	8	0	14	0	0	63.64%
pred. 1.5 years to...	0	0	0	0	0	0.00%
pred. More than ...	0	0	0	0	0	0.00%
class recall	94.67%	33.33%	36.84%	0.00%	0.00%	

Figure 4.4 Accuracy of determining the time period to get a job – using KNN algorithm

accuracy: 67.33%

	true less than 06...	true 01 year to 1...	true 06 months t...	true 1.5 years to ...	true More than 2 ...	class precision
pred. less than 0...	106	1	14	1	0	86.89%
pred. 01 year to 1...	5	7	0	0	0	58.33%
pred. 06 months ...	17	0	19	0	0	52.78%
pred. 1.5 years to...	7	0	2	2	0	18.18%
pred. More than ...	15	1	3	0	2	9.52%
class recall	70.67%	77.78%	50.00%	66.67%	100.00%	

Figure 4.5 Accuracy of determining the time period to get a job – using Naïve Bayes algorithm

accuracy: 82.67%

	true less than 06...	true 01 year to 1...	true 06 months t...	true 1.5 years to ...	true More than 2 ...	class precision
pred. less than 0...	141	4	16	3	2	84.94%
pred. 01 year to 1...	1	4	0	0	0	80.00%
pred. 06 months ...	8	1	22	0	0	70.97%
pred. 1.5 years to...	0	0	0	0	0	0.00%
pred. More than ...	0	0	0	0	0	0.00%
class recall	94.00%	44.44%	57.89%	0.00%	0.00%	

Figure 4.6 Accuracy of determining the time period to get a job – using Decision Tree algorithm

The following summary table is relevant to the classification module 02 which is regarding to the determining the time period to get a job after graduation with relevant to the skills available.

Table 4.2 Accuracy of determining the time period to get a job

Classification Model	Accuracy
KNN	78.71%
Naïve Bayes	67.33%
Decision Tree	82.67%

According to the algorithms evaluated for the time period to get a job after graduation with relevant to the skills available, the best algorithm identified with the highest accuracy was the Decision Tree. So, that the Decision Tree has produced the best results in predicting the student employability for this dataset. Other classification techniques as shown in the above tables, did not perform significantly well in this research.

4.2 Evaluation of Association Techniques

The data set collected using the survey questionnaire was implemented using association rules and conducted the evaluation. In this evaluation the most associated skills with respect to the job title/ position were identified. According to the survey questionnaire there were eight (08) job categories identified and data were collected from the past out student from the year 2014 to 2017.

13. If you are/have been employed, What are/were your main job duties related to? (Please tick the appropriate sector(s) from the list below). *

○ Marketing, business services and public relations

○ Banking and finance

○ Wholesale and retail trade

○ Public administration

○ Management and supervision

○ Customer service

○ Accounting

○ Auditing

Figure 4.7 Job categories mentioned in the survey questionnaire

For the association analysis the above-mentioned job categories and the most important job skills were used and evaluated. After applying the association algorithm with respect to each job category the most associated skills could be identified. The higher the support value of the skill that means which has the highest association for the job category. The most associated one skill or two skills or three skills or four skills could be identified according to the support value.

4.2.1 Following are the associated skills with respect to the job category, accountancy.

Following figure 4.8 is related to the most associated one skill type with respect to the accountancy job category. This the skill level with highest support value.

Size	Support ↓	Item 1
1	0.717	Financial skill
1	0.632	Communication skills
1	0.604	Technical Skills
1	0.547	Team work
1	0.547	Time management

Figure 4.8 The most associated one skill type for accountancy job category

4.2.2 Following are the associated skills with respect to the job category, auditing.

Size	Support ↓	Item 1
1	0.653	Communication ski...
1	0.633	Time management
1	0.571	Financial skill
1	0.551	Team work
1	0.510	Problem solving
1	0.510	Technical Skills

Figure 4.8 The most associated one skill type for auditing job category

4.2.3 Following are the associated skills with respect to the job category, banking and finance.

Size	Support ↓	Item 1
1	0.704	Financial skill
1	0.667	Time managem...
1	0.630	Communication...
1	0.556	Team work

Figure 4.109 The most associated one skill type for Banking and finance job category

4.2.4 Following are the associated skills with respect to the job category, customer service.

Size	Support	Item 1
1	1.000	Adaptability
1	1.000	Communication...
1	1.000	Critical thinking
1	1.000	Problem solving
1	1.000	Technical Skills

Figure 4.11 The most associated one skill type for customer service job category

4.2.5 Following are the associated skills with respect to the job category, management and supervision.

Size	Support ↓	Item 1
1	0.857	Team work
1	0.714	Communication...
1	0.571	Problem solving

Figure 4.12 The most associated one skill type for, management and supervision job category

4.2.6 Following are the associated skills with respect to the job category, marketing business services and public relations.

Size	Support ↓	Item 1
1	0.750	Creativity
1	0.625	Communication...
1	0.625	Team work

Figure 4.13 The most associated one skill type for marketing business services and public relations job category.

4.2.7 Following are the associated skills with respect to the job category, administration.

1	0.500	Communication...
1	0.500	Communication...
1	0.500	Creativity
1	0.500	Financial skill
1	0.500	Interpersonal S...
1	0.500	Problem solving

Figure 4.14 The most associated one skill type for administration job category

4.2.8 Following are the associated skills with respect to the job category, whole sale and retail trade.

1	0.500	Interpersonal S...
1	0.500	Planning & orga...
1	0.500	Planning and or...
1	0.500	Problem solving
1	0.500	Team work
1	0.500	Technical Skills

Figure 4.15 The most associated one skill type for whole sale and retail trade job category

V. CONCLUSION

In this research, the best model for the student employability prediction was identified by the evaluation of classification models. Further the most associated skills for each and every job category also evaluated and identified. The accuracy of the tool was very high because it has considered the fifteen most important academic skills and student professional skills also.

According to the results decision tree algorithm was the best algorithm to predict the student employability in this research study. Further the most perceived skills for any job was communication skill and followed by team work skill, financial skill, technical skill and time management skill. This was identified by considering the highest support of each job category.

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