

Supporting students' learning-pathway choices by providing rule-based recommendation system

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Abstract—Educational Data mining has been proved as a practical solution in handling educational obstacles. Selecting undesirable learning pathway is a real precarious problem. The complication of such problem backs to its nature, as it is discovered after graduation or in the middle way of the learning pathway which makes the correction is almost impossible and it is too late to take corrective actions. Selecting undesirable learning pathway influences even the whole community by either low quality of graduates or graduates working in unsuitable career. This paper is introduced a rule-based recommendation system for students' learning pathway at University of Tabuk, at Kingdom of Saudi Arabia. As a research methodology: first, decision tree has been selected as a data mining algorithm. Second, required data has been collected from University of Tabuk, Faculty of Computers and Information Technology. Third, decision tree has been developed based on the questionnaire's data. Last, induction rules have deduced from the tree paths to provide a recommendation advices. The proposed recommendation has been validated using test samples which are part of collected questionnaires. From the rules there are seven interesting findings have been presented. Expected result is enhancing the overall learning process at University of Tabuk by providing suitable learning pathways.

Keywords—About four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

In the current era, applications of computer science have been applied in different parts of our daily life [1]. Day after day, computing applications have been involved in improving our life. Education is one of the necessities of life. It has become the use of technology in education a reality. Nowadays, development in education is not grateful only for technology. Computing becomes a key player in the education.

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The usage of computing in education makes our dreams touches the ground. To explain this sentence, for instance, how the students can be classified based on future academic performance? One more instance like how to predict students' performance. Computing can be used for providing successful solutions for these impossible and insurmountable questions. Thus it is common to use Information Technology solutions to handle challenges in education and it becomes a common strategy in different ways. In this context, data mining applications have been introduced intensively for solving many obstacles in education. From there, education data mining has been born as a new science concern with predicting students' academic performance, model student behaviour, and classification of students types [2][3]. Certainly, the students' achievement depends on desirable learning-pathway [4]. Learning pathway is defined as the chosen route taken by a learner, which allows him to build knowledge progressively, i.e., in learning pathways, the control of choice moves away from the tutor to the learner [5]. Learning pathway aids learners to access information and courses by which they can construct personalized transitions between the information to be accessed and their own cognitive structures [6]. In other words, learning pathway is collection of courses that student should pass it to get the approval certificate.

Usually, students discover their real preferred study field after spending time in their studying. Mismatching between current and preferred learning pathway could be a source for many academic difficulties, such as weak performance, high percentage of absence. Moreover, in the daily life, there are many students who drop their level of education in spite of the promising beginnings. As well, many graduates do not have a desire to work in their field of study. Both of these two problems are a consequence of unsuitable learning pathway.

This paper introduces a rule-based recommendation system that could be used to assist student at Tabuk University, Faculty of computers and Information Technology to select the most suitable academic program. These rules have been generated from decision tree, which is developed based on questionnaire data.

This paper is organized as follow: section two defines the

problem. Related works are presented and analyzed in section 3. Details descriptions of developing of the proposed recommendation have been presented in section 4. Section 5 contains result discussion and future work.

II. PROBLEM DEFINITION

As a fact, good students have chosen a suitable learning pathway carefully, and exploit this right decision to get the full benefits from his educational journey [7]. On the other hand, those are did the wrong decision of their learning pathway, i.e., unsuitable learning pathway they were never enjoyed their educational journey. Hence, they have a little chance to success in their education or their career later in case they choose a career that is related to their educational learning pathway.

From general observations, students choose their field of study without any scientific method. The students choose their field of study for different kind of social reasons such as friends' advices, society's perception, or career expected. No one of these reasons can guarantee that this learning pathway would be suitable for the student.

Currently, choosing the educational pathway is not based on scientific standard model, which may lead to the wrong choice. Some students may discover very late that they have chosen the wrong or not suitable educational pathway. In such case, it is impossible to fix this mistake. This problem (selecting unsuitable learning pathway) effect even the whole country as the higher education get the lion share of national income in Saudi Arabia and expecting in return exact number of employees per specific jobs but due to incorrect selection of learning pathway many graduates choose to work in a different fields from their studying.

As a summary, selecting unsuitable learning pathway or studying in a field that is not really matching with the personal desire might cause at least one of the following problems:

- Low academic performance;
- High ratio of class absence;
- Evade graduates from working in their fields;
- Graduate unqualified employees.

Hence, these problems reflect the importance of finding a guidance to assist students for selecting the best learning pathway that match with their personnel desire.

III. RELATED WORKS

Recommendation system is widely used in social networks and in E-learning systems. In social networks, is used for recommending new friends and E-learning systems are used for recommending new books, courses and learning objects. The successful of recommendation system in these two domains attract researchers to use the same concept in education data mining [8].

Predicting the future academic performance is the main concern of educational data mining [9] [10]. Predicting academic future performance is based mainly on classification

or clustering of students regardless the used technique aiming [11]. Then the final aim is to provide guidance or advices for lecturer or student for enhancing the academic performance. Looking for this final aim, we can easy consider that "developing recommendation" is the final aim of educational data mining. Although social networks are the main target for recommendation's developers, recently education and specially enhancing student performance grab the attention of recommendation's developers. There is huge works of educational data mining with different perspectives that have been published. However, this rich literature, here, in this section, we have focused only on works that discuss literally recommendation systems.

Romero et al. [12] developed a recommendation system to guide student in selection of links within an adaptable educational hypermedia system. Wang et al. [13] proposed a ranking-based recommendation system to help students to get the useful learning resources in suitable ordering. Chen et al. [14] proposed Library recommendation system to propose suitable books based on borrowing record of the library. Khribi et al. [15] developed web-based recommendation for matching between learning objects and learner to minimize the effort of finding suitable learning objects.

Wong and Looi [16] proposed a recommendation for e-learning paths by stochastically computing previous learners' performances. García et al. [17] suggest rule-based recommendation to support E-learning teachers classify their students and provide suitable learning objects respectively. Alsalama [18] proposed a hybrid framework recommendation system which matches between users and items. Alsalama's model is proposed to be general and useful in different places. However, it did not validate or test in education field.

Vialadir et al. [19] develop a recommendation system to support student in selected their courses based on data from previous students. Nagy et al. [20] proposed a recommendation system that could be used to provide pieces of consultations to a first year university student to pursue a certain education track. Lin et al. [21] proposed personalized learning paths in creativity e-learning system. This model is applied only in E-learning environment. Shaw et al [22]. Vialadir et al. [19] and Nagy et al. [20] developed their recommendation based on previous students' results which may not be fair enough to provide clear or complete picture as the results itself depend on many reasons. Shaw et al. [22] suggested personalized learning platform called Guided Learning Pathways (GLP). GLP is an environment in which learner can get learning materials and topics suited for him. It has been developed for developing countries that may not have access to traditional learning opportunities. GLP did not evaluate with traditional learning.

In the above, two groups of previous works have been discussed. First class was targeted E-learning system and second class was targeting class system. Table 1 summarizes the discussion of related works.

Table 1: Summary of Educational recommendation system

Work	Technique	Environment
Romero et al. [12]	Clustering and Sequential Pattern Mining Algorithm	E-learning
Wang et al. [13]	Transition Probability	Portal
Khribi et al. [15]	Association Rules	E-learning
Wong and Looi [16]	Ant Colony Optimization	E-learning
García et al. [17]	Production Rules	E-learning
Alsalama [18]	Association Rules	E-learning
Vialadir et al. [19]	Decision Trees	Class Room
Nagy et al. [20]	k-Means Clustering	Class Room
Lin et al. [21]	Clustering	E-learning
Shaw et al. (2014)	Content maps	Non formal Class Room

As our work is classroom based then its features should be compared with the previous classroom works. Vialadir et al. [19] and Nagy et al. [20] developed their recommendation in classroom environment based on academic results. Our recommendation is different as it is developed based on different factors such as demographic, academic and social students' information. We claim that including of all these factors will strengthens the chance of success of the recommendation system. While our recommendation is proposed for formal classroom education, the work of Shaw et al. [22] proposed their recommendation for untraditional classroom or what it called non-formal education.

IV. DEVELOPING A RULE-BASED RECOMMENDATION MODEL

In this section, detailed description of developing the proposed rule-based recommendation has been presented. First, variables that might be useful in predicting suitable learning pathway have been defined from the literature. Table 2 shows these variables. These variables have been collected from Bhardwaj and Pal [23], Kotsiantis et al. [24], Abu Tair, M.M. and El-Halees [25], Ramaswami and Bhaskaran [26], Pal [27], Yadav and Pal [28]. The appendix shows the variables that have been used to construct the questionnaire as a mean of data collection.

Data have been collected using questionnaire from Faculty of Computers and Information Technology at Tabuk University. We have targeted students from Computer science and Information Technology departments. The target group is about 900 students. Successful collected questionnaire are 450 papers, which is considered more than satisfied as a sample size. Table 2 shows the questionnaire variables which are issued based on four perspectives: basic information, personal information, academic information, and learning pathway information. Although there are some works deal with learning pathway recommendations, as the best of our knowledge, our proposed recommendation is the first learning pathway recommendation that consider these four perspectives together.

V. VALIDATION

The proposed recommendation has been validated by testing the extracted rules using questionnaire papers that have been saved a way and kept as testing samples. The collected

questionnaire papers have been divided in two groups, developing group and test group with ratio of 70%, and 30% respectively. The results show that the accuracy of the proposed recommendation is satisfied.

VI. RESULTS DISCUSSION

A. Statistical Analysis

Although our target is developing rule-based recommendation system by using of educational data mining decision tree, still there are some interesting fact that have been generated by direct analysis of the conducted questionnaire. In this subsection, some important statistical analyses have been provided.

Figure 1 shows the ratio of students that are willing to change their current learning pathway. The highest value goes to female. Regarding males' selection the ratios are almost equal and slight wining for those willing to keep their current learning pathway. The fact that could be extracted from Figure 1 proves the problem and shows the importance of establish –learning pathway recommendation system as 69% of the female students and 47% of male students wishing to change their current learning pathway. With considering the fact of the number of female students is far greater from the number of male students the criticality of the problem becomes very obvious.

Figure 2 shows the selection factors of current learning pathway by gender. In which, family recommendation get the highest value in female students' selection and personnel desired get the highest value in male students' selection. Reading the meaning of figures 1 and 2 inspired this fact: choosing learning pathway based on family recommendation usually ending with dissatisfaction for learning pathway.

Figure 3 demonstrates the ratio of students that are found problems during selection of learning pathway. Here again the highest values goes to female students. Also there are many male students were found problems in selection of learning pathway. This is an important indicator and it could lead to dissatisfaction for learning pathway.

Figure 4 shows the source of problems in selection of learning pathway. Reading the above figure we could easy conclude that ambiguity or absences of guidance are the sources of problems in selection of learning pathway. Figure 5 shows reasons of selection of current learning pathway where the highest value in both gender goes to better job opportunities. Figure 5 presents another source for the problem of the dissatisfaction for learning pathway. Choosing learning pathway based on better jobs opportunities neglects students' skills, talents, and personnel desired.

Table 2 shows the output results and respective recommendation. These results and recommendation it is only mentioned and should be used by Tabuk University, Faculty of Computers and Information Technology, KSA.

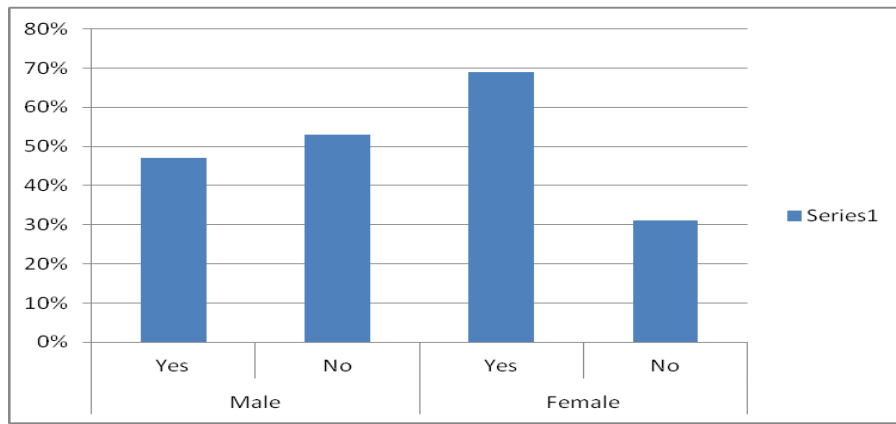


Fig. 1 Students that are wishing to change their current learning pathway

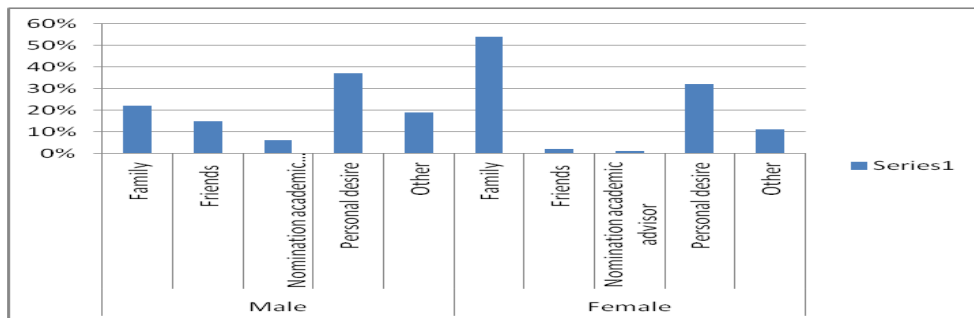


Fig. 2 Selection factors of current learning pathway by gender

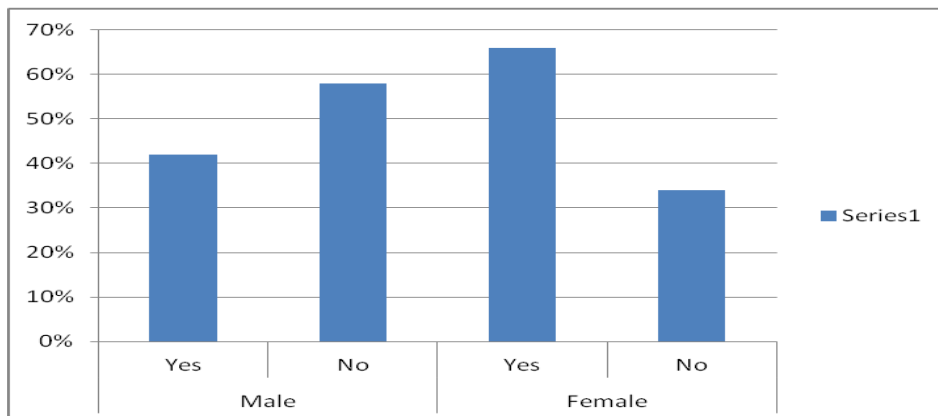


Fig. 3 Students found problem during selection of learning pathway

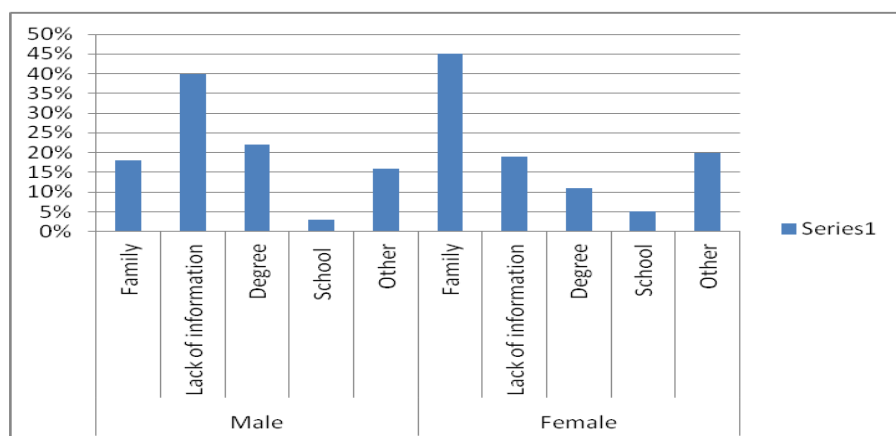


Fig. 4 Source of problems in selection of learning pathway.

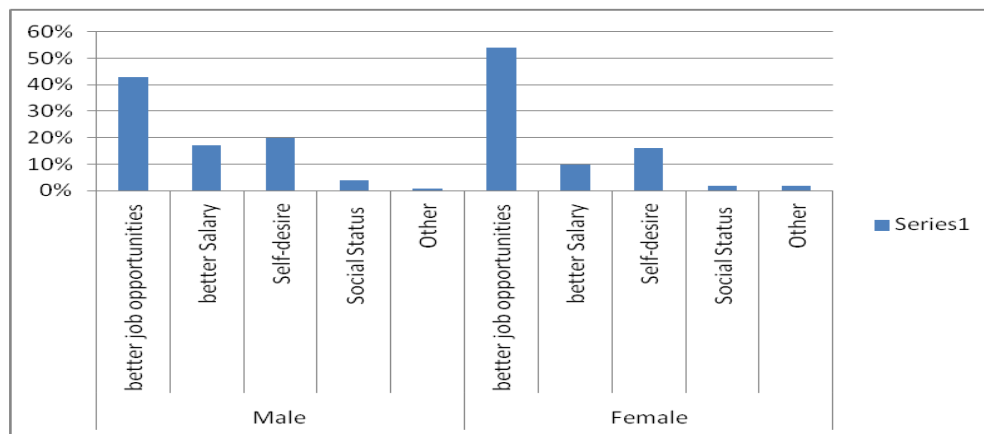


Fig. 5 Reasons for selection of current learning pathway

Table 2: The output results and respective recommendation

Result	Recommendation
70% of the females have dissatisfaction with the current learning pathway.	Provide more explanation about the available courses; Activate mentoring academy in first stages; Issue a channel of information exchange between the students and graduates.
47% of the males have dissatisfaction with the current learning pathway.	
54% of the females selected their learning pathway based on family recommendation.	
37% of the males selected their learning pathway based on personal desired.	
66% of the females found problems during selection of learning pathway.	
58% of the males not found problems during selection of learning pathway.	
60% of the females mentioned that the family is the source problem in selection of learning pathway.	
40% of the males mentioned that the lack of information is the source problem in selection of learning pathway.	

B. The Output Rules

Decision tree has been obtained by mining the questionnaire data. Figure 6 shows the obtained decision tree. In this obtained decision tree, there are two ends: “Yes” and “No”. The word “Yes” means wishing to change the current learning pathway. In other words, means there is a dissatisfaction of the current learning pathway. The word “No” means there is satisfaction of the current learning pathway. Production rules have been extracted from paths or directions in the obtained decision tree to get full benefits from it. Figure 7 presents the direct translation of the obtained decision tree. The output of the proposed recommendation has been declared in Figure 8. There are twelve production rules that result in “Yes” or “No”.

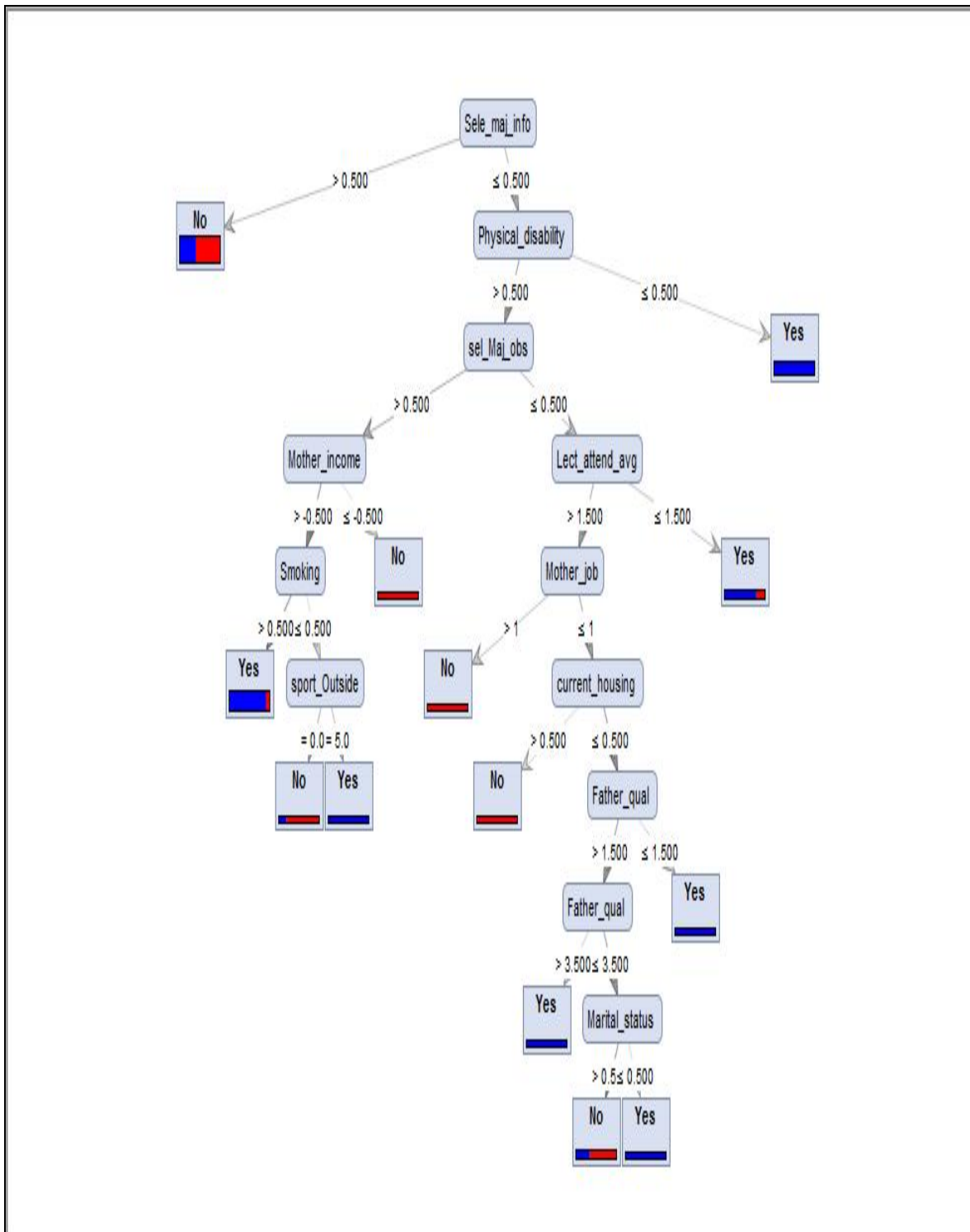


Fig. 6 The obtained decision tree

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□ Sele_maj_info > 0.500
  | change_major > 0.500
  | | Home_Teach_asst > 4.500: No {Yes=0, No=3}
  | | Home_Teach_asst ≤ 4.500: Yes {Yes=29, No=14}
  | change_major ≤ 0.500
  | | mid_terms_avg > 1.500
  | | | High_sch_loc > 0.500: No {Yes=0, No=2}
  | | | High_sch_loc ≤ 0.500
  | | | | Youn_bro_no > 2: Yes {Yes=9, No=1}
  | | | | Youn_bro_no ≤ 2: No {Yes=1, No=2}
  | | | mid_terms_avg ≤ 1.500: No {Yes=6, No=42}
Sele_maj_info ≤ 0.500
  | Physical_disability > 0.500
  | | change_major > 0.500
  | | | Home_Teach_asst > 4.500: No {Yes=1, No=2}
  | | | Home_Teach_asst ≤ 4.500
  | | | | Pri_sch > 0.500
  | | | | | sport_Outside = 0.0: No {Yes=0, No=2}
  | | | | | sport_Outside = 5.0: Yes {Yes=4, No=0}
  | | | | Pri_sch ≤ 0.500: Yes {Yes=62, No=3}
  | | change_major ≤ 0.500
  | | | High_sch > 0.500
  | | | | Mother_qual > 1: No {Yes=0, No=12}
  | | | | Mother_qual ≤ 1
  | | | | | BMI > 1.500: No {Yes=0, No=2}
  | | | | | BMI ≤ 1.500: Yes {Yes=2, No=0}
  | | | High_sch ≤ 0.500
  | | | | Lab_attend_avg. > 1.500
  | | | | | uni_ent_ratio > 0.500: No {Yes=0, No=4}
  | | | | | uni_ent_ratio ≤ 0.500
  | | | | | | Mother_qual > 4.500: No {Yes=0, No=2}
  | | | | | | Mother_qual ≤ 4.500
  | | | | | | | Tut_attend_avg > 1.500
  | | | | | | | | BMI > 1.500: Yes {Yes=5, No=0}
  | | | | | | | | BMI ≤ 1.500
  | | | | | | | | | act_sport > 0.500: No {Yes=0,
No=2}
  | | | | | | | | | | act_sport ≤ 0.500: Yes {Yes=8,
No=1}
  | | | | | | | | | | | Tut_attend_avg ≤ 1.500: No {Yes=1,
No=4}
  | | | | | | | | | | | | Lab_attend_avg. ≤ 1.500
  | | | | | | | | | | | | | Father_income > 0: Yes {Yes=8, No=0}
  | | | | | | | | | | | | | Father_income ≤ 0: No {Yes=1, No=1}
  | Physical_disability ≤ 0.500: Yes {Yes=35, No=0}

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Fig. 7 Direct Translation of the obtained decision tree

In the following, each rule has been explained in detailed:

Rule1: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is no any problem occurred during facing the selection of current learning pathway, and there is no smoking habit then recommendation is to change your current learning pathway.

Rule 2: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is no any problem occurred during facing

the selection of current learning pathway, and there is smoking habit, and the preferable sport is football then recommendation is do not change the current learning pathway.

Rule 3: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is no any problem occurred during facing the selection of current learning pathway, and there is smoking habit, and the preferable sport is Martial Arts then recommendation is to change the current learning pathway.

R1: ((Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs > 0.5) and (Mother_income > -0.5) and (Smoking > 0.5)) → Yes

R2: (Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs > 0.5) and (Mother_income > -0.5) and (Smoking ≤ 0.5) and (sport_Outside)) = 0.0 → No

R3: (Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs > 0.5) and (Mother_income > -0.5) and (Smoking ≤ 0.5) and (sport_Outside)) = 5.0 → Yes

R4: ((Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs > 0.5) and (Mother_income ≤ -0.5)) → No

R5: (Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs ≤ 0.5) and (Lect_attend_avg > 1.5) and (Mother_job > 1)) → No

R6: (Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs ≤ 0.5) and (Lect_attend_avg > 1.5) and (Mother_job ≤ 1) and (current_housing > 0.500)) → No

R7: (Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs ≤ 0.5) and (Lect_attend_avg > 1.5) and (Mother_job ≤ 1) and (current_housing current_housing ≤ 0.500) and (Father_qual > 3.500) → Yes

R8: (Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs ≤ 0.5) and (Lect_attend_avg > 1.5) and (Mother_job ≤ 1) and (current_housing current_housing ≤ 0.500) and (Father_qual ≤ 3.5) and (Marital_status > 0.5)) → No

R9: (Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs ≤ 0.5) and (Lect_attend_avg > 1.5) and (Mother_job ≤ 1) and (current_housing current_housing ≤ 0.500) and (Father_qual ≤ 3.5) and (Marital_status ≤ 0.5)) → Yes

R10: (Sele_maj_info ≤ 0.5) and (Physical_disability > 0.5) and (sel_Maj_obs ≤ 0.5) and (Lect_attend_avg ≤ 1.5)) → Yes

R11: (Sele_maj_info ≤ 0.5) and (Physical_disability ≤ 0.5)) → Yes

R12: (Sele_maj_info > 0.5) → No

Figure 8: Explanation of extracted rules

Rule 4: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is no any problem occurred during facing the selection of current learning pathway, and the mother does not has monthly income, then recommendation is do not change the current learning pathway.

Rule 5: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is a problem occurred during facing the selection of current learning pathway, and average attendance of lecturer is very good, and the mother has a job then recommendation is do not change the current learning pathway.

Rule 6: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is a problem occurred during facing the selection of current learning pathway, and average attendance of lecturer is very good, and the mother has a job, and current accommodation is single then recommendation is do not change the current learning pathway.

Rule 7: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is a problem occurred during facing the selection of current learning pathway, and average attendance of lecturer is very good, and the mother has a job, and current accommodation is with family, and the father qualification is at least university degree then recommendation is to change the current learning pathway.

Rule 8: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is a problem occurred during facing the selection of current learning pathway, and average attendance of lecturer is very good, and the mother has a job, and current accommodation is with family, and the father qualification is less than university degree, and marital status is not married then recommendation is do not change the current learning pathway.

Rule 9: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is a problem occurred during facing the selection of current learning pathway, and average attendance

of lecturer is very good, and the mother has a job, and current accommodation is with family, and the father qualification is less than university degree, and marital status is married then recommendation is to change the current learning pathway.

Rule 10: If the selection of current learning pathway is happened due to family recommendation, there is no physical disability, and there is a problem occurred during facing the selection of current learning pathway, and average attendance of lecturers is not good then recommendation is to change the current learning pathway.

Rule 11: If the selection of current learning pathway is happened due to family recommendation, there is a physical disability then recommendation is to change the current learning pathway.

Rule 12: If the selection of current learning pathway is happened due to other factors and there is no influence of the

family then recommendation is do not change the current learning pathway.

Figure 9 shows the algorithm of our proposed recommendation. This algorithm shows that the student should choose first his learning pathway then student needs to answer recommendation's questions to get the advice.

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Start
Current learning pathway = empty; //start step
Students choose his learning pathway;
Current learning pathway = student's choice;
Loop: //Don't stat loop until validate the student's choice in the learning pathway
Students answer the recommendation's question;
Until end of recommendation's questions;
If the output(recommendation) = "Yes" then
Recommendation = Change (Current learning pathway);
// current major is not suitable
Else
If the output(recommendation) = "No" then
Recommendation = not(Change (Current learning pathway));
// current major is suitable
End;
```

Fig. 9 Algorithm of the proposed recommendation

Below, the obtained results have been discussed and summarized. By analysing the extracted rules, the following findings have been noticed:

1. There is a potential dissatisfaction if the learning pathway has been selected based on family recommendations;
2. There is no any influence for the mother's income in satisfaction of choosing learning pathway.
3. There is a relationship between smoking habit and dissatisfaction of learning pathway ;
4. There is a relationship between play martial arts and dissatisfaction of learning pathway;
5. Parents with high qualifications have negative influence in choosing learning pathway;
6. Attendance is a sign of learning pathway satisfaction;
7. There is a relationship between physical disability and dissatisfaction of learning pathway;

VII. FUTURE WORKS

As a future work, we are planning to extend the scope of the proposed recommendation by including all the faculties from Tabuk University and we are plan to go more deep by adding new perspectives in developing

recommendation. We will evaluate our proposed system by test it with the current graduates. On the other hand, we are planning to develop and implement a web-based software application that could be used by students before finishing the registration process, i.e., before starting their education trip.

APPENDIX

Here, in this appendix, all the variables that have been involved in this research are explained and presented. Variables are described in terms of names, description, possible values, and perspective. Four Perspectives have been deliberated in this research: basic, personal, academic and major information. The tables below shows these variables with its perspectives.

Variable	Description	Possible Values	Perspective
Gender	Gender of student	Male-Female	Basic Information
Origin	Origin place of student	Tabuk- outside Tabuk	
Current Accommodation	The current accommodation of students	With Family- Single	
Marital Status	The marital Status	Married, Single, divorced, widower	
Offspring	No of children	None, 1, 2, 3, more than 3	
Siblings	No. of sisters and brothers	None, 1, 2, 3, more than 3	
Father qualifications	Qualifications of the student's father	Illiterate, Primary School, Middle School, Secondary School, University, Master Degree, PhD Degree	
Mother qualifications	Qualifications of the student's mother	Illiterate, Primary School, Middle School, Secondary School, University, Master Degree, PhD Degree	
Father job	The job of the student's father	Service, Educational, Commercial, Military, Freelance, Retired	
Mother job	The job of the student's mother	Housewife, Service, Educational, Commercial, Retired	
Father income	The monthly income of the student's father	None,(2400-1000) (4900-2500), (-5000 9900), (-10000 14000), (-15000 25000), (more than 25000)	
Mother income	The monthly income of the student's mother	None,(2400-1000) (4900-2500), (-5000 9900), (-10000 14000), (-15000 25000), (more than 25000)	
Smoking	The student is smoking or not	Smoking, Not smoking	
BMI	Body Mass Index for student	Low Weight, Normal Weight, Overweight, Fat	
Vision State	The vision of state of student is using glasses or not	Glasses, No Glasses	

Physical disability	The student has Physical disability or not	Yes, No	
Transportation to the University	The type of transportation that the student used to go to the university	Shared Transportation, Bus, Private car	
Sports	The student practice sport or not	Yes, No	
Home Sports	Types of sports inside the home that the student practice	Chess, Corram, Table tennis, Folk games, Others	
Outside Sports	Types of sports outside the home that the student practice	Football, Basketball, Volleyball, Riding horses, Martial Arts, Others	
Entertainment using technology	Types of games and entertainment using technology	Mobile games, Internet games, PlayStation, Social networking sites, Others	
Elementary school	Type of Elementary school	Public, Private	
Intermediate School	Type of Intermediate School	Public, Private	
Secondary school	Type of Secondary school	Public, Private	
Secondary school Location	The location of the Secondary school	City, Town	Academic Information
Language in Secondary school	The teaching language used in the Secondary school	English, Arabic	
University Entry Ratio	The average ratio for the university entry ratio	80%-89%, 70%-79%, 60%-69%, 50%-59%, 40%-49%	
Home teaching assistant	Who is assist the student in home teaching	Parents, Grandparents, Only father, Only mother, No one, Others	
Current Level	The current level of student in the university	First, Second, Third, Fourth	
GPA	The current cumulative average of student	More than 4.5, 3.5-4.4, 2.5-3.4, 2-2.4, Less than 2	

GPA for previous semester	The cumulative average for the previous semester	More than 4.5, 3.5-4.4, 2.5-3.4, 2-2.4, Less than 2	
Average score of Midterm exam	The average score of Midterm exam of the student	Bad, Medium, Good	
Classwork Performance	The performance of the student in classwork	Bad, Medium, Good	
Lectures attend average	The average of the student attend for lectures	Bad, Medium, Good	
Labs attend average	The average of the student attend for Labs	Bad, Medium, Good	
Exercises attend average	The average of the student attend for Labs exercises	Bad, Medium, Good	
Classwork submission	The submit of the student of classwork to lecturer in the time	Yes, No	
Current Major	The current major of the student in the faculty	Computer Science, Information Technology, Computer Engineering	Major Information
Major Selection	The student choice of how to select his/her major	Parents nomination, Friends nomination, Academic Advisor nomination, Personal desire, Others	
Major satisfaction level	The level of satisfaction of student about the major	Excellent, Good, Medium, Not satisfied	
Major wishes	the current Major is a major which the student want	Computer Science, Information Technology, Computer Engineering, Others	
Majors availability	Majors available were enough for student when choosing major	Yes, No	
Selected major information	The student has information about the selected major before choosing it	Yes, No	
Major selection obstacles	The obstacles encounter the student in the selection of major	Yes, No	

Obstacles source	The source of obstacles that encounter the student in the selection of major	Parents, Lack of info about the major, Average, Location, Others
Change Major	The student thinking in changing of major	Yes, No
School Influence	The school influence in major selection	Yes, No
Wishing major	The major that student wishes to entry instead of the current major	Computer Science, Information Technology, Computer Engineering, Others
Wishing major advantages	The advantages that the student wishes to be in his/her major	Better job opportunities, Better salary, Self desire, Better social status, Others
Awareness of wishing major advantages	Source of the student awareness of wishing major advantages	Media, Friends, Family, Others
Current major cons	The disadvantages of the current major	Less job opportunities, Less salary, Not self-desire, Less social status, Others
Awareness of current major cons	Source of the student awareness of current major cons	Media, Friends, Family, Others
Choosing University	The cause the student choose Tabuk University	Parents Nomination, Friends Nomination, Nearness of university, Others
Awareness of university advantages	Source of the student awareness of university advantages	Media, Friends, Family, Others

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