Elective subject recommendation using machine learning

Project submitted to the

SRM University – AP, Andhra Pradesh

for the partial fulfillment of the requirements to award the degree of

Bachelor of Technology/Master of Technology In

Computer Science and Engineering

School of Engineering and Sciences

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[December, 2022]

Certificate

Date: 13/9/2022

This is to certify that the work present in this Project entitled **"Elective subject recommendation using machine learning"** has been carried out by Munagala Rasagna under my/our supervision. The work is genuine, original, and suitable for submission to the SRM University – AP for the award of Bachelor of Technology/Master of Technology in School of Engineering and Sciences.

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Acknowledgements

We would like to convey our sincere gratitude to the one who helped us to complete this report. " Dr. Tapas K Mishra ", our supervisor, deserves special thanks for his help, steering the team toward the goal and pushing us to keep moving forward and support us throughout the process and the writing of this report. We also appreciate the time you took to proofread and rectify our numerous mistakes.We have learnt various things from the weekly meetings that will be useful in the future process of our research project. We will try to apply all the skills which we have learnt and improve the project.We are really happy for the opportunity. We would like to thank SRM AP for providing us an opportunity to do a Research project.

Yours Truly,

Name: Juturu Saisree, Munagala Rasagna, K.L.Amrutha and N.Harichandana

Place: SRM-AP

Date: 13/12/2022

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ABSTRACT:

In General, a student in academic life has to choose elective courses. These courses are required to have the overall exposure of a particular academic qualification. However, the university recommends some guidelines towards the selection of the elective subject. To keep up with the latest trends, many organizations are continuously updating their curriculum, which creates a challenging situation for students and their counselors. Recently, some recommendation systems have been proposed using machine learning techniques. The existing techniques take help from different collections of parameters such as, student registration records, other contextual characteristics, pre-qualification. The system not only helps the students but also facilitates their counselors. This recommended course helps the student for a better experience in university life to reach their career goal. In this study some existing models that include fuzzy based approach, collaborative filtering method and content-based filtering method are presented and descriptive analysis has been prepared.

Keywords: Recommendation system, Fuzzy logic, Elective courses, Machine learning and artificial intelligence

INTRODUCTION

A course selection plays an important role in the student academic life and career path. Course chosen must be useful and must meet the requirements of the student's career growth and the university standards. Many students face a dilemma during the selection of a course due to lack of knowledge and guidance and due to the lack of self-awareness the students don't know their potential skills to select a course based upon their skill and the interest. To overcome this issue and to provide a solution to it as the selection of course is important in the student's academic life the course recommendation system is recommended as it is useful for the student to choose the right course and to know about their strengths to get their desired results in the academic life.[1]

A course is nothing but a group of lessons which we taught at tertiary level and it is similar to subjects which we taught at primary and secondary level. Each and every student must fill some credits for some of the Courses which contain both compulsory one and elective courses. However, some students may face difficulties in choosing an open elective based on their interests and skills[3]. Even though the percentage of elective courses is lower than that of required courses, they play a significant part in calculating each student's academic accomplishment index[4]. In order to succeed academically, it is crucial for all students to select proper electives.

The recommender system was required due to the rise in internet usage. It provides accurate information on both users and products. Course recommendation system (CRS) gives course suggestions about elective courses, they handle the process according to courses taken by others. Student grades vary according to course content, students can take the suggestions about the course from those who have already taken. Using collaborative filtering student grades were predicted. All the courses were checked using current data. The Recommendation system is related to subjective preferences and personalized data. The research on this neural network-based recommender system was done to apply deep learning to computer vision and natural language processing. There is a type of RS-Content-based filtering which uses the information to users which they are interested in doing. The assumption is that the similar choices are helpful in the future as well[5].

Existing Literacy Models

Section 2.1: Using fuzzy logic approach -

Fuzzy logic is a part of AI, it has truth values variables between 0 and 1. In this model, it consists of four basic blocks such as fuzzification, defuzzification, knowledge base and inference engine. The process from taking input from the user to output. user-defined fuzzification of input variables is involved, an inference engine consisting of rule evaluation and aggregation and defuzzification.

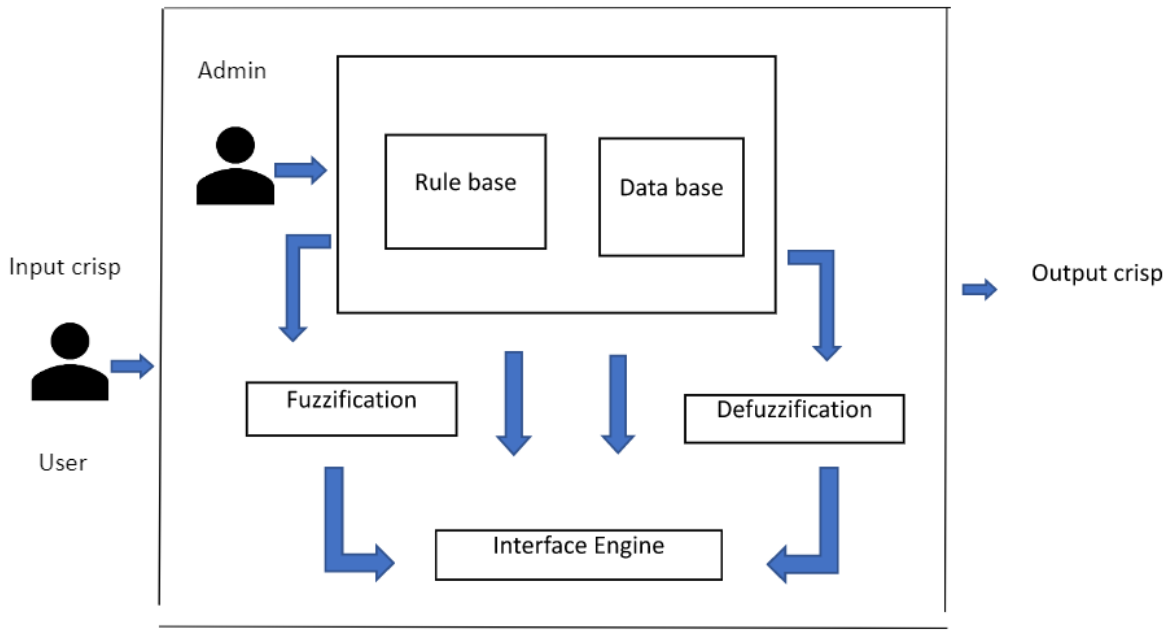


Figure-1: Fuzzy logic process architecture

The first phase of fuzzy logic is fuzzification, here we take clear inputs from the student. It is divided into two parts based on the interest and skill (table 1 and table 2) The data answered by the students in Table 1 and Table 2 will be transformed into a linguistic variable. The data is classified into three parts such as weak, medium and good based upon the ranges between the 0 to 10 with overlapping graphs. To avoid the problems

like the user linguistic variable overlapping the higher fuzzy value(medium) is chosen by the interface.

The fuzzy rules are constructed in the step Rule of evaluation. If a given fuzzy rule has multiple predecessors, a fuzzy operator such as AND and OR operators must be used. Here the result of the evaluation should be expressed in the form of the single variable so this is done. The result will be used for the following membership function. We use fuzzy OR operation to evaluate the disjunction of the antecedents. The Fuzzy OR operator is easily adaptable. Two OR methods are built into the MATLAB fuzzy logic toolbox [2]: max and the probabilistic OR method (probor).

The Probor is calculated as:

μAUB (X) = cross section [μA(X), μB (X)]= μA (X) + μB (X) – μA (X) x μB (X) -------- ----- (1)

Fuzzy inference also supports two AND methods: min and product, prod.

The product is calculated as:

μAUB (X) = prodr [μA(X), μB (X)]= μA (X) x μB (X) ----------(2)

Different operators give different results, many proposed different OR and AND fuzzy operators. The result of evaluating the antecedent is applied to the appropriate function of the consequence. The third step is Aggregation, in which we process the output we got from all the fields. In this case we have four aggregated rule outputs named as programming skill, computer skill, problem solving skill, and data analyst skill.

In the fourth step is defuzzification which is the last step in the fuzzy logic system. In the defuzzification process the input for it is the unification of the output yield from all of the rules output fuzzy set and output is a single number. But we can also use the centroid technique.

The centroid technique helps us to cut the aggregate set into two equal masses.

$$COG = \frac{\int_a^b \mu_A(X)\, x\, dx}{\int_a^b \mu_A(X)\, x\, dx} \quad \text{---------- (3)}$$

The Four fuzzy outputs are shown. The tested set of numbers of inputs and the obtained result matched the formula. From the output values, we calculate whether the skill is medium, high or low.

Section 2.2: Using content –based Filtering and weighted Cosine Similarity – To evaluate system performance, we use an accurate level in terms of objectivity. whereas relevancy, novelty, serendipity, are utilized in terms of subjectively. The oddity assessment is to check whether the framework gives another elective course where the client doesn't foresee. The Serendipity evaluation is to check whether it gives an unexpected but interesting elective course. This strategy chiefly relies upon the individual/client credits to give yield suggestion.To fabricate a framework with text information this is the best technique. Here the informational collection utilized in this exploration is "subject information". i.e course name and course schedule. The parameters which were used in this entire course is course code, course name, and the value that has been obtained.

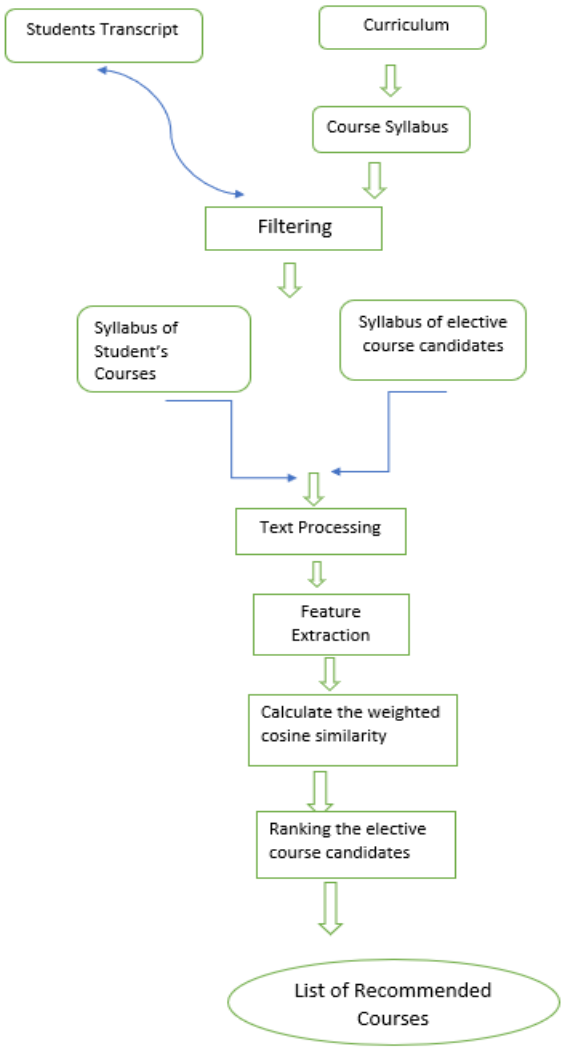


Figure-2: Architecture of Elective Courses Recommendation System

The suggested course is acquired by computing weighted cosine between the educational plan profile and the understudy's profile.

Text Preprocessing which is a cleaning process before texts and documents which we use for further processing. It is a part of "Natural Language Processing". A text document contains multiple characters. Case folding is the process to change the letters in the document to lowercase.

Punctuation removal is the process to delete any type of characters other than letters.

Tokenization is a type of text division. To split the text into word, phrase, and meaningful parts.

Stop enlightening words which are trivial that can be taken out on the grounds that they contain no helpful data.

Lemmatization is a process to make the best of the text mining process.

TF – IDF method is used to find the result of text processing.

TF – Term Frequency

IDF – Inverse Document Frequency

$$tf(w_i, d_j) = f(w_i, d_j) \quad \text{----------(4)}$$

tf(wi, dj) is determined as frequency of word wi in the syllabus document dj.

s= number of documents.

tdj = collection of terms in syllabus in document j.

j=1,2,3,4……., s.

n= total number of terms uniquely from s .

idf is a reduction of the term dominance.

$$idf(w_i) = log\left(\frac{s}{s(w_i)}\right) \quad \text{---------- (5)}$$

Weighting Cosine Similarity:

Students courses are k,qk,

The syllabus of elective course candidates are j,pj

WSim(qk,pj)=weighted cosine similarity between the students course and candidates elective course.

Positioning of suggested elective courses depends on the connection of the course with understudy ability.Cor(pj)=average likeness between the elective course and understudy course.

m = no.of students course .

$$WSim(q_k, p_j) = Sim(q_k, p_j) \times \frac{Score(q_k)}{4} \quad \text{---------- (6)}$$

The higher the correlation value it means the smaller rank.

Section 2.3: prediction of student grades using collaborative filtering in a course recommender system

In the evaluation, there are some limitations to be considered-whether a student had retaken a course, if he/she re takes the course then updated grade is considered. In order to get the accurate result, more than one approach is considered. There are some correlation-based similarities & distance-based similarities -

1) Pearson correlation coefficient

2) Median-Based Robust correlation coefficient

3) Manhattan and Euclidean distance similarities

All the above mentioned similarity equations are below:

Table1:

Type	Abbr.	Formula
correlation-based	*PCC*	$\frac{\sum_{i=1}^{n}(x_i-\bar{x})\,(y_i-\bar{y})}{\{\sum_{i=1}^{n}(x_i-\bar{x})^2\sum_{i=1}^{n}(y_i-\bar{y})^2\}^{1/2}}$ (1)
	MRC	$\frac{\sum_{i=1}^{n}(x_i-\bar{x})\,(y_i-\bar{y})}{\{\sum_{i=1}^{n}(x_i-\bar{x})^2\sum_{i=1}^{n}(y_i-\bar{y})^2\}^{1/2}}$ (2)
distance-based	*MAN*	$1/\left(\left(\sum_{i=1}^{n}\lvert x_i-y_i\rvert\right)+1\right)$ (3)
	EUC	$1/\left(\left(\sqrt{\sum_{i=1}^{n}(x_i-y_i)^2}\right)+1\right)$ (4)

Here, x and y represents two different student grade vectors

$\bar{x}$ and ~ x represents the correlation mean and median of x.

After evaluating using the above equations the most similar students are obtained, to obtain the final predictions this formula is used:

$$p_{x,i}=\bar{x}+\frac{\sum_{u=1}^{n}\left((x_i-\bar{x})\times w_{x,u}\right)}{\sum_{u=1}^{n}w_{x,u}} \quad \text{----------(7)}$$

If a student obtains BB-grade and above considered as students 's success

The evaluation was concluded based on diversity of metrics rather than simple accuracy. There is a metric name coverage which provides statistics about the grades that can be predicted. There are some other metrics below:

Table 2:

Metric	Formula	
Sensitivity	$\frac{TP}{TP + FN}$	(6)
Specificity	$\frac{TN}{FP + TN}$	(7)
Precision	$\frac{TP}{TP + FP}$	(8)
F1-Measure	$\frac{2 \times TP}{2 \times TP + FP + FN}$	(9)
MAE	$\frac{1}{n}\sum_{i=1}^{n} \lvert p_i - x_i \rvert$	(10)
RMSE	$\sqrt{\frac{1}{n}\sum_{i=1}^{n} (p_i - x_i)^2}$	(11)

Where TP (True positive), TN (True Negative), FP (False Positive), and FN (False Negative) represents the primitive confusion matrix elements,

x represents student grade vector

pi represents the predicted value for the course i.

The above metrics have their own part in giving accuracy result:

sensitivity metric: It is the measure of true positives of each available category

specificity metric: It is the measure of true negatives of each available category

precision metric: This is the measure of correct positive predictions

F1-measure metric:This is the combination of precision and sensitivity & this can also be defined as the harmonic mean of precision and sensitivity.

Mean absolute error (MAE) metric: This measures the average magnitude of the errors in predictions compared to the actual values.

Root mean squared error (RMSE) metric: The square root of the summation-based squared means of all errors.

The prediction step is comparatively executed by parameterizing different neighborhoods

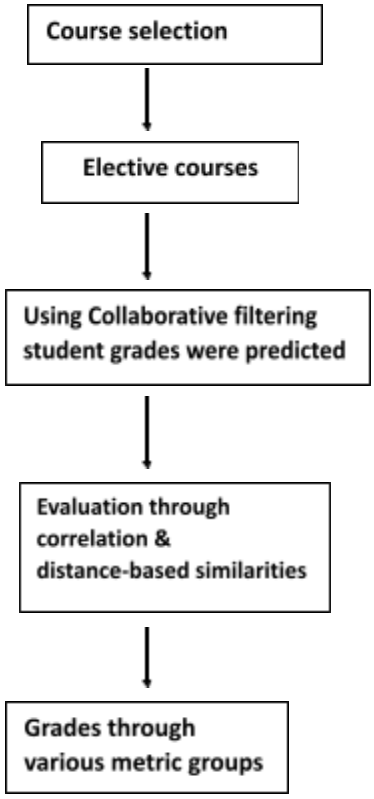


Figure 3:The overall view

Data Set

Section 3.1:

Based upon the data entered in table 1 and table 2, the system calculates and classify the type of interest into three categories such as weak, moderate and good as the rage represented in the table3 and table 4.as from the tables 3 and 4 we can observe that the range between 0 to 10 are categorized into three parts named as weak, moderate and good. In the graph the overlay acts as the gray area.

The overlapping graph will workout the result of the point of interaction, where fluffy derivation needs to conclude the covering chart will really be figured as a result.

No.	Course Code	Course Name	Skills
1	CSC138	Structured programming	Programming (S1)
2	CSC248	Fundamental of data structure	
3	QMT200	Probability and statistic	Problem solving (S2)
4	MAT233	Calculus II	
5	CSC204	Approach of operating system	Computer (S3)
6	ITT300	Introduction of data communication & networking	
7	IT232	Introduction to database	Data analysis (S4)
8	IT332	Information System	

Table 1. Input for Skill Part

No.	Questionnaire	Interest
1	Do you eager to learn more about programming language (e.g. Java, C, C++, PHP and ASP)?	Programming (I1)
2	You have just been given a complex task to code. Do you have interest to solve the task?	
3	When you face unexpected problem, do you like to handle it and look at different ways to solve it?	Critical thinking (I2)
4	Do you have ever image to create a creative solutions in information technology?	
5	Do you have an interest to translating client requirement into highly specified project brief?	Organizing information
6	Do you think that working in group can help you to organize the client requirement information easily?	(I3)
7	Do you have an interest work about routing and switching?	Practical work (I4)
8	Do you have an interest and courage to perform the practicality study about network courses?	
9	Do you have an interest to handle and process large amount of unstructured data to develop intelligent systems applications?	Data processing (I5)
10	Do you have an interest to manage and process large amount of data using various intelligent techniques?	
11	Do you like to learn about how computer hardware and software operates?	Networking (I6)
12	Do you like to learn and have better knowledge about computer networking?	

Table 2. Input for Interest Part

No.	Input / Courses	Skills	Linguistic variable	Range
1	CSC138	Programming (S1)	{Weak, Medium, Good}	{0 - 3.5, 3.2 - 6.5, 6.2 – 10}
2	CSC248			
3	QMT200	Problem Solving (S2)	{Weak, Medium, Good}	{0 - 3.5, 3.2 - 6.5, 6.2 – 10}
4	MAT233			
5	CSC204	Computer (S3)	{Weak, Medium, Good}	{0 - 3.5, 3.2 - 6.5, 6.2 – 10}
6	ITT300			
7	ITS232	Data Analysis (S4)	{Weak, Medium, Good}	{0 - 3.5, 3.2 - 6.5, 6.2 – 10}
8	ITS332			

Table 3. Linguistic Variable for Skill

No.	Input / Questions	Interest	Linguistic variable	Range
1	Q1	Programming (I1)	{Weak, Medium, Good}	{0 – 3.5, 3.2 – 6.5, 6.2 – 10}
2	Q2			
3	Q3	Problem Solving (I2)	{Weak, Medium, Good}	{0 – 3.5, 3.2 – 6.5, 6.2 – 10}
4	Q4			
5	Q5	Organizing Information (I3)	{Weak, Medium, Good}	{0 – 3.5, 3.2 – 6.5, 6.2 – 10}
6	Q6			
7	Q7	Practical work (I4)	{Weak, Medium, Good}	{0 – 3.5, 3.2 – 6.5, 6.2 – 10}
8	Q8			
9	Q9	Data Processing (I5)	{Weak, Medium, Good}	{0 – 3.5, 3.2 – 6.5, 6.2 – 10}
10	Q10			
11	Q11	Networking (I6)	{Weak, Medium, Good}	{0 – 3.5, 3.2 – 6.5, 6.2 – 10}
12	Q12			

Table 4. Linguistic variable for interest

No	Rules
RULE 1	IF CSC138 is A+ AND CSC248 is C+ THEN programming skill is medium
RULE 2	IF CSC204 is A+ AND ITT300 is A THEN computer skill is good
RULE 3	IF CSC204 is B+ AND ITT300 is B- THEN computer skill is medium
RULE 4	IF MAT233 is B+ AND QMT is C THEN problem solving skill is weak
RULE 5	IF ITS232 is A AND ITS332 is A THEN data analyst skill is good

Table 5. Linguistic variable for interest

Section-3-2:

	A	B	C	D	E	F	G
1	No	Kode MK	Nama MK	Silabus	clean_silabus_all		
2	1	MFF1011	Basic Phys	Measurement and	measurement magnitude physic kinematics dyn		
3	2	MII1003	Elementar	Systems of linear	system linear equation solution gaussjordan elir		
4	3	MII1201	Programm	Programming 1 co	programming course provides student knowledg		
5	4	MII1203	Logic for C	This lecture discus	lecture discus basic concept logic topic provide		
6	5	MII1205	Introductic	This course provid	course provides introduction computer science		
7	6	MII1211	Programm	Programming II Cc	programming ii course continuation course prog		
8	7	MII1213	Discrete M	In this course, son	course basic concept discrete mathematics requ		
9	8	MII1811	Digital Syst	This lecture prese	lecture present discussion logical circuit used bu		
10	9	MII2201	Analysis of	In the course of A	course algorithm complexity analysis student in		
11	10	MII2203	Probability	This lecture provic	lecture provides theoretical applicative foundat		
12	11	MII2205	Language a	In this course, the	course basic idea computer science theory intrc		
13	12	MII2207	Computer	This course provid	course provides introduction computer graphic		
14	13	MII2211	Advanced	Algorithm Advanc	algorithm advanced algorithm course continuat		
15	14	MII2213	Numerical	In this course, vari	course various method numerical solution vario		
16	15	MII2411	Artificial Ir	The main objectiv	main objective target lecture make student reta		
17	16	MII2501	Database	Database is a colle	database collection data form information purp		
18	17	MII2601	Microproc	This course focuse	course focus principle practice modern embedd		
19	18	MII2602	Computer	Course Computer	course computer network basic course field digi		
20	19	MII2603	Organizati	Organizational stu	organizational study computer architecture stuc		
21	20	MII2611	Operating	This course is the	course introduction course operating system o		
22	21	MII3003	Research I	This course provid	course provides introduction conceptual practic		
23	22	MII3007	Philosophy	Computer Science	computer science philosophy course basically a		
24	23	MII3411	Machine L	This course provid	course provides introduction concept technique		
25	24	MII3501	Software E	The software is a l	software business product requires engineering		
26	25	MII3601	Cryptograp	Cryptography pro	cryptography provides introduction basic princi		

Figure 1: Cleansed Pieces of Cleared Course Data Results

The informational index utilized in this exploration is subject information. for example, course name, and the schedule of the 2016 educational plan for the UGM Software engineering program. Course information and Schedule are put away hardcoded into tables. The put away information is then preprocessed to deliver a lean schedule. The consequences of the pre-handling prospectus are then put away in another section that is a perfect schedule.

Before the computing part begins the framework will acknowledge the contribution to the type of a record document. In that it contains course code, course name, and esteem. After that the framework acknowledges the text handling will change from letter scale to number scale esteem 4. After the framework gets the client esteem record information, After that TF-IDF computation begins, then will work out the cosine comparability between the schedule of courses that client has taken and the prospectus of elective course that client has not taken. Then the framework gives 2 sorts of outcome: one is without a weighted worth and another is with weighted esteem.

The exploratory outcome shows that the weighted proposal framework beats than without loads, as far as both emotionally, impartially.

Section 3.3:

In the data set they collected 10 years of student data from Eskişehir Osmangazi University Computer Engineering Department. To analyze the exact outcome they proposed a recommender framework using student and course information with collaborative filtering and content-based filtering models. The collaborative filtering algorithms use grades as rating values6]. By using all the metric group formulas we analyze the result.

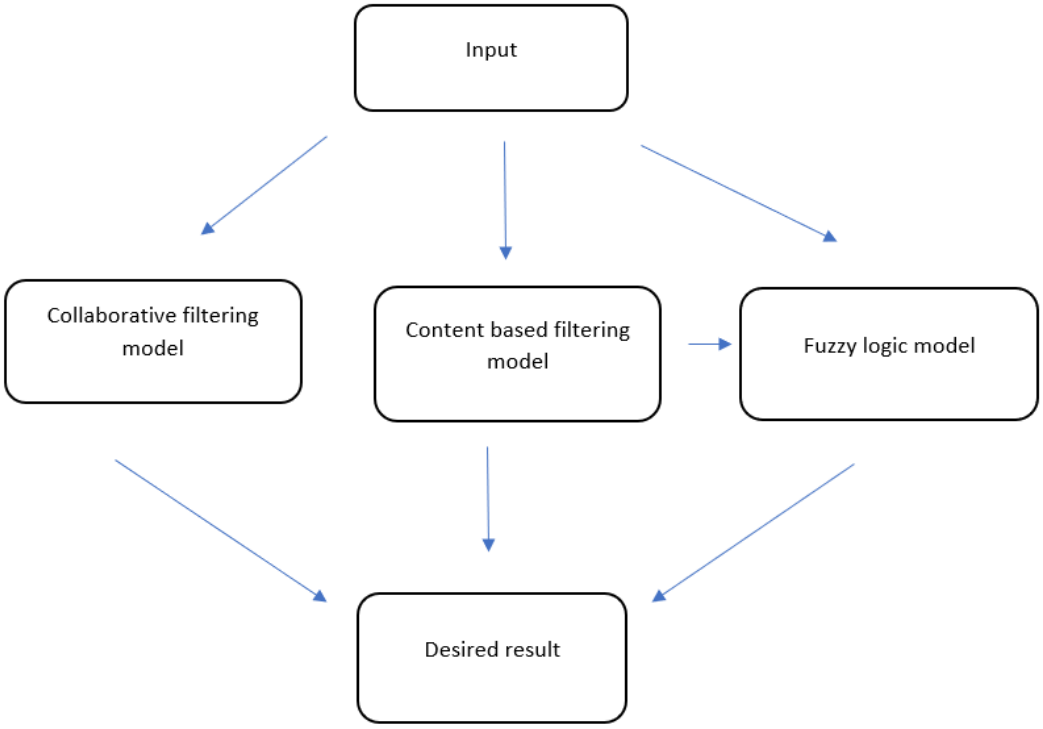
Future work:

To help the students to overcome this issue and help the students in their academics and for their career growth we are going to propose a model to help the students who are facing the dilemma.This proposed model is a combination of the three working models we have discussed in the above report, By using the content based and collaborative filtering approach we will take input from the dataset,By using the content based filtering model we will get to know about the history of the courses pass percentage and the course difficulty level .Based upon the two results student can obtain a conclusion to choose which course.

Data set of Future work:

	A	B	C	D	E	F	G	H	I	J	K	
1	Timestamp	Emai	Select Branch	Select Year	Select your dream job	In which semester you ca	Are you aware of the folk	Have you taken any subj	What leads you to select	Are you passed out stude	Did you get placement	Do yc
2	11/29/2022 1	prath	CSE	3rd year	Higher studies	semester 5	others	Yes	Flow of any friends	No		
3	11/29/2022 1	saipri	CSE	3rd year	Software	semester 5	NPTEL, Course era	No				
4	11/29/2022 1	sudh	ECE	2 nd year	Higher studies	semester 6	others	No				
5	11/29/2022 1	gopic	CSE	3rd year	Software	semester 5	NPTEL, Course era	Yes	My own interest	No		
6	11/29/2022 1	swatl	CSE	3rd year	Higher studies	semester 5	NPTEL	Yes	Seniors advice	No		
7	11/29/2022 1	haricl	CSE	3rd year	Software	semester 3	NPTEL	Yes	My own interest	No		
8	11/29/2022 1	mani	CSE	3rd year	Higher studies	semester 5	NPTEL, Course era	Yes	My own interest	No		
9	11/29/2022 1	saisr	CSE	3rd year	Software	semester 4	NPTEL, Course era	Yes	My own interest	No		
10	11/29/2022 1	eswa	CSE	3rd year	Software	semester 4	NPTEL, Course era	Yes	My own interest	No		
11	11/29/2022 1	laksh	CSE	4 th year	Software	semester 4	NPTEL, Course era, Edu	Yes	Seniors advice, My own	No		
12	11/29/2022 1	babyl	CSE	3rd year	Software	semester 4	NPTEL, Course era	Yes	Seniors advice	No		
13	11/29/2022 1	srikar	CSE	3rd year	Software	semester 5	NPTEL	Yes	Seniors advice, My own	No		
14	11/29/2022 1	sriya	ECE	4 th year	Software	semester 4	NPTEL	No				
15	11/29/2022 1	bhara	CSE	3rd year	Software	semester 5	NPTEL	Yes	My own interest	No		
16	11/29/2022 1	harsh	CSE	3rd year	Software	semester 5	NPTEL	Yes	My own interest	No		
17	11/29/2022 1	bhavi	CSE	3rd year	Higher studies	semester 3	NPTEL, Course era	Yes	My own interest	No		
18	11/29/2022 1	pram	CSE	3rd year	Software	semester 3	NPTEL, Course era	Yes	My own interest, Faculty	No		
19	11/29/2022 1	manil	CSE	3rd year	Software	semester 4	NPTEL, Course era, Edu	Yes	Faculty suggestion	No		
20	11/29/2022 1	aliviy	CSE	2 nd year	Software	semester 3	NPTEL, Course era, Edu	No				
21	11/29/2022 1	sivak	CSE	3rd year	Self sustainable/Enterpre	semester 5	NPTEL, Course era	Yes	Faculty suggestion, Flow	No		
22	11/29/2022 1	omka	CSE	3rd year	Software	semester 5	NPTEL, Course era	Yes	My own interest	No		
23	11/29/2022 1	urmil	CSE	2 nd year	Software	semester 3	others	No				
24	11/29/2022 1	sown	CSE	3rd year	Software	semester 5	NPTEL, Course era	No				
25	11/29/2022 1	vinod	CSE	3rd year	Software	semester 5	NPTEL, Course era, Edu	Yes	Seniors advice, My own	No		
26	11/29/2022 1	vivek	CSE	3rd year	Higher studies	semester 5	NPTEL, Course era	No				

Future work model:



Conclusion

Selecting the proper course when enrolling activity for the continuation of studies is the primary key for a student to attain future success. Course recommendation is a system that can help students to identify their potential, ability, skills to get the best suggestion of course. Furthermore,designing a course recommendation system which only recommends technical lessons can help guide students to the right field of expertise on the subject.

The usage of user-based collaborative filtering approach in grade prediction was calculated according to the various metric groups. providing an integrating algorithm into a student automation system can give accurate results and a course

recommendation system only recommends technical courses which helps the students to guide the right area of mastery.

References

[1] N. Sawarkar, M. M. Raghuwanshi, and K. R. Singh, “Intelligent Recommendation System for Higher Education,” Int. J. Futur. Revolut. Comput. Sci. Commun. Eng., vol. 4, no. 4, pp. 311-320, 2018.

[2] [2] I. The MathWorks, “Fuzzy Logic Toolbox,” 2019. [Online]. Available: https://au.mathworks.com/products/fuzzylogic.html

[3] Samrit, N.B. and Thomas, A, "A Recommendation System for Prediction of Elective Subjects," International Journal for Research in Applied Science & Engineering Technology (IJRASET), vol. 5, no. 4, pp.36-43, 2017.

[4] M. S. Sulaiman, A. A. Tamizi, M. R. Shamsudin, and A. Azmi, “Course recommendation system using fuzzy logic approach,” Indones. J. Electr. Eng. Comput. Sci., vol. 17, no. 1, pp. 365–371, 2019, doi: 10.11591/ijeecs.v17.i1.pp365-371.

[5] Jawatankuasa Unit Kualiti, “Quality Documents,” 2019.

[6] The Prediction of Student Grades Using Collaborative Filtering in a Course Recommender System Merve Ceyhan, Savas Okyay, Yusuf Kartal, Nihat Adar Department of Computer Engineering, Eskisehir Osmangazi University, Eskisehir, Turkey

[7] A. Arik, S. Okyay, and N. Adar, "Hybrid Course Recommendation System Design for a Real-Time Student Automation Application," European Journal of Science and Technology, no. 26, pp. 85-90, July 2021, doi: 10.31590/ejosat.944596.