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Development of Academic Community Recommendation System Using Content-Based Filtering at UIN Malang Informatics Engineering Study Program

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Keywords

Academic Community; Content-Based Filtering; Recommendation System; System Usability Scale.

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Abstract

The mismatch between the number and quality of Information and Communication Technology (ICT) talents and industry needs in Indonesia creates significant challenges, especially for Informatics Engineering students who often experience difficulties in determining the appropriate professional field. This research aims to develop a content-based filtering-based academic community recommendation system to help students choose communities that are relevant to their interests, skills and experience. The system uses TF-IDF and cosine similarity methods to match student profiles with community descriptions. Data was collected from 48 students and 10 academic communities in the Informatics Engineering Study Program of UIN Malang, and processed through preprocessing stages before modeling. Evaluation results using the System Usability Scale (SUS) resulted in a score of 76, which is categorized in the "good" level, However, users indicated the need for improved guidance in navigating the system. This system is expected to be an innovative solution to increase student participation in appropriate academic communities, as well as support the development of their potential and readiness for the world of work

1. Introduction

The Technology, Information and Communication (ICT) industry in Indonesia faces significant challenges in meeting the growing demand for labor. According to projections by the Ministry of Manpower, labor demand in the ICT sector is expected to reach 1.74 million by 2024, up from 1.49 million in 2023 and 1.23 million in 2022. However, a report from the HR R&D Agency of the Ministry of Communication and Information Technology (Kemenkominfo) in 2022 showed that there were only about 430,000 ICT graduates in Indonesia. The mismatch between the growing industry needs and the limited availability of manpower is a serious challenge in facing the digitalization era that requires qualified ICT expertise [1].

In addition to quantity challenges, Informatics Engineering (IT) students often have difficulty in determining the professional field they want to pursue. The diverse informatics industry makes students tend to be confused in choosing a field of specialization, so that it can affect their academic performance [2], [3]. Facing this situation, the formation of Academic Communities in universities is very important. These communities can be a place for students to explore their interests, share knowledge, and develop specialized skills [4].

UIN Malang Informatics Engineering Study Program has provided various academic and non-academic communities that aim to support the development of student talents. There are 12 communities, including 10 academic communities namely MOCAP (Android), WEBBOENDER (Web), UINUX (Interface Design), MAMUD (Multimedia), ETH0 (Network), UINBUNTU (Operating System), FUN JAVA (Java Programming), GDSC (Google), DSE (Data Science), and ONTAKI (Robotics), and 2 non-academic communities namely ALFATAA (Sholawat) and ISC (Sports). However, there are still many students who have difficulty in choosing a community that suits their interests and abilities, resulting in less than optimal participation [5].

To overcome this, a recommendation system is needed that can help students in choosing a community that suits their interests, abilities, and experiences. This recommendation system uses the content-based filtering method with the TF-IDF (Term Frequency-Inverse Document Frequency) approach and Cosine Similarity to measure the similarity between student preferences and community content [6] With this system, it is hoped that students can easily find the most suitable community, so that their potential can be optimally developed and participation in the community can increase.

2. Research Method

This research was conducted through several systematic stages to develop an academic community recommendation system for Informatics Engineering students of UIN Malang.

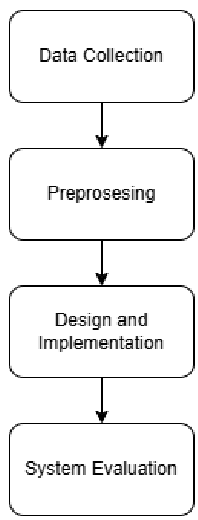

Figure 1. Research Flow

Figure 1 illustrates the research flow which includes four main stages: data collection, pre-processing, system planning and implementation, and system evaluation. The following is an explanation. At data collection stage, data is collected from two main sources: student data of Informatics Engineering UIN Malang which includes interests, skills, and experience, and data from various available academic communities. Student data is obtained through a questionnaire that answers several questions. This information is used as the basis for the recommendation matching process. The data that has been collected is then processed through a pre-processing stage to clean and prepare it. This stage includes the removal of stopwords, tokenization, and text transformation into a format that can be processed, such as the calculation of TF-IDF values. The recommendation system was designed and implemented using the content-based filtering method. At this stage, the matching logic between student profiles and community characteristics is developed using the cosine similarity technique to produce relevant recommendations. After the system was built, an evaluation was conducted to measure the effectiveness and convenience of its use. Testing is done using the System Usability Scale (SUS), which provides an overview of the level of system usability from the user's perspective.

The data collection method used in this research is to conduct a survey using Google Forms targeting students of the Informatics Engineering study program at UIN Malang. This survey aims to collect information about students' interests, skills, and experience. The survey questions are shown in table 1.

Table 1. Survey Questions

Question/Criteria	Reference
What are your interests and passions in IT?	[7]
Mention any previous specialized knowledge in the field of information technology that you have learned.	[8]
Which would you rather work with a large team or a small team?	[9]
What programming language/technology would you like to learn from the Academic Community?	Academic Community
What motivated you to join the academic community at TI UIN?	[9]
Communities followed Community Rating	-

In table 1 there are 5 criteria questions that will be asked to students, each question is taken from several relevant studies. For the first question, research [7] makes a recommendation system for elective courses for appropriate students, in this case the criteria taken by students are the interests or passions possessed by the students themselves so that later they will be in accordance with the courses that will be recommended using the content-based filtering method.

The second question is taken from research [8] which examines the E-Learning Course recommendation system where in the research there are some data or criteria needed by users to be able to produce good recommendations, one of which is Knowledge Area, namely previous knowledge owned by users. Furthermore, the third question is taken from research [9]. In that research, the researcher wants to show that the highest motivation of Informatics Engineering students in learning lies in teamwork, therefore the author refers that the influence of teamwork can be a criterion factor in choosing the academic community, especially in Informatics Engineering. The fourth question is taken directly from the knowledge of the academic community at IT UIN Malang. In this case, each academic community has different technologies or programming languages to learn, so the author includes this as a criterion that affects the suitability of academic community recommendations for students. The last question is taken from the same research as the third question because student motivation greatly affects student learning achievement. The author wants to get maximum results from the recommendation of academicians who are in accordance with this. An overview of the recommendation system used in this study is as follows

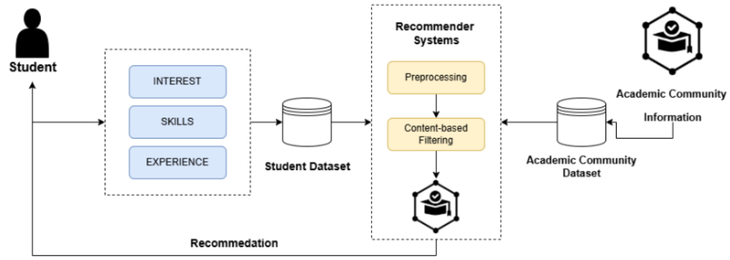

Figure 2. System Desain

This academic community recommendation system is designed as a dynamic system that begins with the input process of student data (including interests, expertise, and experience) and community profile data. Both data sets are then processed through preprocessing stages (such as stopwords, stemming, and lowercasing) and content-based filtering to calculate content similarity. The end result is a list of community recommendations generated in real-time based on the current data in the database, where the dynamic architecture allows the addition of new student or community data at any time to ensure recommendations are always relevant.

Furthermore, after the data is collected, the next stage is data processing. The existing data will be processed using TF-IDF weighting which will then be calculated using the cosine similarity algorithm. The flow of data processing will be visualized in Figure 3.

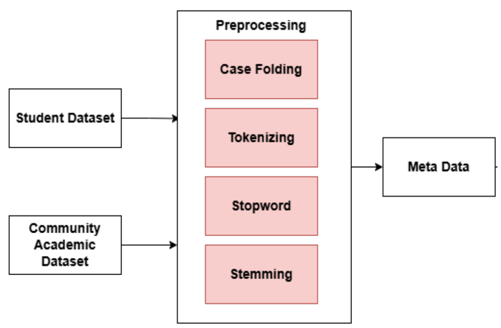

Figure 3. The Flow of Preprocessing data

Figure 3 shows the flow of processing student data and community data. Figure 2 shows that the data is processed through the preprocessing stage which has several stages such as case folding, tokenizing, stopwords, and stemming. After the data is completed at the preprocessing stage, the data will be combined into meta data and then calculated the weight using tfidf.

Case Folding is the process of equalizing the case in a document. Not all text documents are consistent in the use of capital letters. Therefore, case folding is needed in converting the entire text in the document into a standardized form in this case lowercase letters [10]. Tokenizing is the process of breaking a document into sets of words. Tokenizing can be done by removing punctuation marks and separating them per-space. This stage also removes certain characters such as punctuation marks [11] . Stopword removal is a process in text pre-processing that aims to remove common words that are considered to have no important meaning in the analysis, such as "and," "or," "which," "with," and the like. These words, called stopwords, usually do not contribute significantly to the understanding of the context or meaning of the document in text processing [12]. By removing stopwords, the system can focus more on words that are truly relevant and distinguish between documents, thus improving efficiency and accuracy in calculations such as TF-IDF and in matching algorithms such as content-based filtering. Stemming is a process contained in the IR (Information retrieval) system that transforms the words contained in a document to its root words using certain rules [13]. After the preprocessing stage is carried out, all data will be merged into a meta data which will be processed next to be weighted using tf-idf.

Content-based filtering is one of the techniques used in recommendation systems to provide personalized recommendations. This technique works by analyzing the content or characteristics of existing items and matching them with users' preferences or past behavior [14]. This method emphasizes items can refer to a variety of products or services, such as movies, books, music, or even healthcare. The content-based filtering method involves identifying and extracting important features or attributes from each item. These features could be genre, author, actor, keywords, or other relevant parameters depending on the type of item being analyzed [15].

TF-IDF (Term Frequency-Inverse Document Frequency) is a statistical method used to assess how important a word is in a document relative to the entire corpus. The TF (Term Frequency) value shows how often a word appears in a document, while IDF (Inverse Document Frequency) measures how rarely the word appears in all documents. The more often a word appears in one document but rarely appears in other documents, the higher the TF-IDF value. This method is effective in extracting key words that can represent the content of documents more accurately, so it is widely used in information retrieval systems and text-based recommendation systems [16]. TF_IDF calculation can be shown in the following equation (1).

$$W = TF \times (IDF + 1) \tag{1}$$

Description:
TF : Number of occurrences of a word or term in a document
IDF : Inverse document frequency
D : Number of all documents
W : weight of each document

Cosine Similarity is a method of measuring the similarity between two vectors in vector space by calculating the cosine value of the angle between them. In the context of text processing, each document or entity (such as student profiles and communities) is represented as a vector based on the TF-IDF values of its words. The cosine similarity value ranges from 0 to 1, where a value of 1 indicates that the two vectors have the same direction (meaning they are very similar), and a value of 0 indicates that they have nothing in common. This method is effectively used in content-based recommendation systems because it is able to measure the closeness between user preferences and item descriptions mathematically and accurately, despite different text lengths [17]. After weighting with TF-IDF, similarity is performed on each document using the cosine similarity method [18]. The cosine similarity formula is shown in the equation below.

$$Cosine\ Similarity(A, B) = \frac{A.B}{\|A\|.\|B\|} \tag{2}$$

Description:
A : Vector A or document A
B : Vector B or document B
||A|| : Absolute value of A
||B|| : Absolute value of B

At system usability scale testing stage, a test plan for the recommendation system will be carried out. The test method used in the research is the System Usability Scale (SUS). System Usability Scale (SUS) is a questionnaire used to measure the usability of computer systems from a subjective user perspective. SUS consists of ten statements, each of which has a five-point scale that ranges from Strongly Disagree to Strongly Agree. There are five positive statements and five negative statements, which alternate. The System Usability Scale (SUS) has 10 question items that have a scale of 1-5, The statements are shown in table 2.

Table 2. List Of Questions SUS

No	English Statement	Indonesian Statement
1	I think that I would like to use this product frequently.	Saya berpikir akan menggunakan sistem ini lagi.
2	I found the product unnecessarily complex.	Saya merasa sistem ini rumit untuk digunakan.
3	I thought the product was easy to use.	Saya merasa sistem ini mudah untuk digunakan.
4	I think that I would need the support of a technical person to be able to use this product.	Saya membutuhkan bantuan dari orang lain atau teknisi dalam menggunakan sistem ini
5	I found the various functions in the product were well integrated.	Saya merasa fitur-fitur sistem ini berjalan dengan semestinya.
6	I thought there was too much inconsistency in this product.	Saya merasa ada banyak hal yang tidak konsisten (tidak serasi) pada sistem ini.
7	I imagine that most people would learn to use this product very quickly.	Saya merasa orang lain akan memahami cara menggunakan sistem ini dengan cepat.
8	I found the product very awkward to use.	Saya merasa sistem ini membingungkan.
9	I felt very confident using the product.	Saya merasa tidak ada hambatan dalam menggunakan sistem ini.
10	I needed to learn a lot of things before I could get going with this product.	Saya perlu membiasakan diri terlebih dahulu sebelum menggunakan sistem ini.

Odd-numbered statements are positive and even-numbered statements are negative. This aims to reduce biased responses. As stated by John Brooke [19], this aims to make respondents more focused and thorough in reading the questionnaire. The score is calculated by subtracting the weight of the statement. Positive statements minus 1 become X-1 and negative statements, namely 5 minus the weight of the statement become 5-X. The average calculation is contained in the equation.

$$\bar{x} = \frac{\sum x}{n} \tag{5}$$

Description:
$\bar{x}$: Average Score
$\sum x$: Total SUS Score
n :Number of Respondents
The results of this calculation will convert the value range to between 0-100, which is then interpreted into an adjective rating to further clarify the level of usability of the system after the survey, as shown in Figure 4.

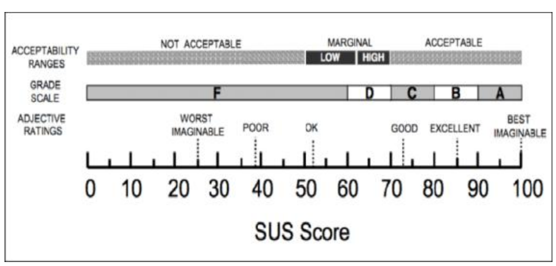

Figure 4. SUS Score

Figure 4 shows the SUS score calculated from a series of questions rated on a Likert scale and then converted into a score from 0 to 100. The interpretation of this score can be explained through three main perspectives: Acceptability Ranges, Grade Scale, and Adjective Ratings. Acceptability Ranges categorize SUS scores into several levels of user acceptability. Scores below 50 are considered “unacceptable”, scores between 50 and 70 are considered ‘marginal’, and scores above 70 are considered “acceptable”. This indicates how likely users will accept or reject the system based on its usability [20]. The Grade Scale relates SUS scores to a letter scale commonly used in educational grading systems. Scores between 0 to 39 are given a grade of "F", 40 to 52 get a grade of "D", 53 to 73 are considered "C", 74 to 85 are given a grade of 'B', and scores above 85 get an "A". This scale provides a more intuitive view of how the system performs compared to general education standards [20].

3. Result and Discussions

Data is obtained from an online survey to Informatics Engineering Students of UIN Malang through Google Form and taking from the Informatics Engineering website of UIN Malang for the academic community. The survey was distributed from February 05 to February 13, 2024. From this time frame, 48 students were obtained with their interest and passion data in the academic community, especially in Informatics Engineering UIN Malang. Community data collection is taken directly from the department website where data on 10 academic communities is obtained. Both data will be used as the main data of this research.

After the data is inputted into the database, the data must be preprocessed so that it becomes ready-to-use data by going through several stages, so that the system will process the data much better in its accuracy. In addition, this preprocessing stage will produce metadata or combinations between columns that will be further processed at a later stage.

In this research using the content-based filtering method, which in this method after doing the preprocessing stage, the data sets from different columns will be combined into one column, namely metadata. In community metadata means that there will be a combination of data on community name, description, activities, technology, and vision and mission. While in student metadata there will be a combination of passion data, previous knowledge, team, skill interests, motivation.

The next stage is the stage where this stage is a stage in the content-based filtering method, namely by using tf-idf and cosine similarity. The TF-IDF matrix is generated, each row vector (representing a single document) is normalized using L2 normalization. This step is crucial as it ensures that the length of the documents does not skew the similarity results. Normalization transforms the vectors to a unit length, allowing the Cosine Similarity calculation to focus purely on the angle (i.e., the similarity in content) between the vectors, rather than their magnitude. The following are tables 3 for the calculation results of tf-idf samples.

Table 3. TF-IDF Calculation Table

Term	**W**			
	Dq	**D1**	**D2**	**D3**
Data	0.134283636	0.402850909	0	0
Science	0.134283636	0.134283636	0	0
Web	0134283636	0	0.134283636	0
Mobile	0.090909091	0	0	0
Java	0.090909091	0	0	0
Multimedia	0.090909091	0	0	0
Uiux	0.090909091	0	0	0
Tim	0.090909091	0	0	0
Besar	0.090909091	0	0	0
Kegiatan	0.134283636	0	0	0.098474667
Seminar	0.090909091	0	0	0
Workshop	0.134283636	0.134283636	0	0
Php	0.134283636	0	0.134283636	0
Python	0.134283636	0.134283636	0	0
Tambah	0.090909091	0	0	0
Ilmu	0.090909091	0	0	0

The next stage after obtaining word weighting is the calculation of similarity between content or data using the Cosine Similarity algorithm. The calculation of the level of similarity is calculated based on the cosine value obtained from the comparison of multiplication between matrices. The cosine similarity results obtained from document 0 which contains metadata input from users or student preferences compared to metadata 10 The cosine similarity results for the academic community data content are shown in Table 4.

Table 4. Cosine Similarity Calculation

Dokumen	0	1	2	3	4	5
0	1.0	0.08004	0.03265	0.03303	0.06946	0.1963
1	0.08004	1.0	0.04388	0.21133	0.08361	0.12295
2	0.03265	0.04388	1.0	0.09544	0.03044	0.01823
3	0.03303	0.21133	0.09544	1.0	0.02033	0.0908
4	0.06946	0.08361	0.03044	0.02033	1.0	0.0296
5	0.1963	0.12295	0.01823	0.0908	0.0296	1.0

The recommendation system in this research is made in the form of a website using the Flask framework and database MySql. Flask is a framework that can integrate python to process data and html, css, javascript for display or visualization of the data used. The recommendation page is the main feature of the system developed in this study, which is to find recommendations for the academic community. On this page the user can directly input several criteria and data needed in order to produce good recommendations.

Figure 5. Result Recommendation Page

The system's usability was evaluated using the System Usability Scale (SUS) with 157 respondents, yielding an average score of 76. According to the adjective rating scale, a score of 76 is categorized as "Good" and falls within the "Acceptable" range. This indicates a positive overall user reception. A more detailed analysis of the SUS components provides deeper insights. The scores for odd-numbered questions (positive statements) were generally high, especially for Q3 ("I thought the product was easy to use") and Q5 ("I found the various functions in the product were well integrated"), suggesting users found the core functionality straightforward. The results of the final calculation of SUS will be displayed in Figure 6.

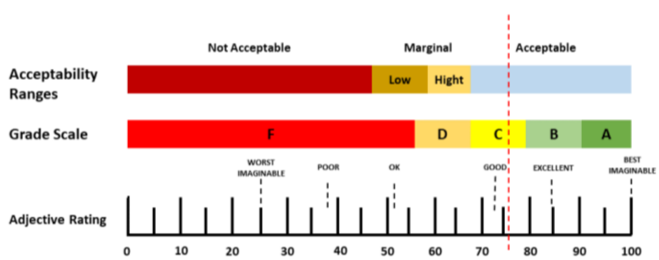

Figure 6. SUS Result

However, an analysis of the even-numbered questions (negative statements) highlights specific areas for improvement. The responses to Q4 ("I think that I would need the support of a technical person to be able to use this product") and Q8 ("I found the product very awkward to use") were notable. Although the overall score was good, these questions pointed to a subset of users who felt the system was not entirely intuitive and that they might need external help to navigate it effectively. This feedback directly correlates with the conclusion that while the system is functionally sound, clearer interaction guidelines and a more intuitive user flow are needed to enhance user independence and confidence.

4. Conclusions and Future Works

This research successfully builds an academic community recommendation system for Informatics Engineering at UIN Malang using content-based filtering method. The system effectively identifies and recommends relevant communities by aligning them based on students' interests, such as prior knowledge, team preference, and motivation. Evaluation using the System Usability Scale (SUS) resulted in a score of 76, which is categorized as "Good" and indicates that the system is generally acceptable to users. However, a more in-depth analysis of the SUS results revealed specific areas for improvement; although the core functionality was easy to use, some users felt the system was not fully intuitive and may require external guidance. This suggests that while the system has met the main objectives of the study, there is still room for refinement on the interface and overall user experience to increase clarity and user independence.This research has limitations, including a relatively small dataset size and reliance on subjective survey data. For future development, it is recommended that future research expand the dataset, explore hybrid models with collaborative filtering, and integrate implicit data such as academic records to complement survey data and improve recommendation accuracy.

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