Implementation of the fisher yates shuffle algorithm in the randomization of department recommendation examinations at PMB FKOM UNIKU

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Abstract. The new student admission test is a routine activity carried out by the Faculty of Computer Science, University of Kuningan every year. This activity is the start of the process of searching for qualified new student candidates. In the current system, there are interview sessions that aim to see the interests and talents of prospective students so that the majors chosen by these prospective students are right according to their interests and talents, but because they are still carried out face-to-face it results in less efficiency in terms of time. So we need an application that can provide recommendations for the right majors for prospective students of the Faculty of Computer Science, University of Kuningan efficiently. To avoid cheating in the new student admissions test, the application must be able to randomize the questions optimally by using the Fisher Yates Shuffle Algorithm. In this exam application, there are 300 multiple choice question banks that represent the competences of each department, namely questions with competency categories consisting of basic computer questions, logic, mathematics, programming languages, patterns, graphic design, business processes. The system will randomize using the fisher yates shuffle algorithm and display the randomized questions per category to the test takers. To see the level of effectiveness of the Fisher Yates Shuffle algorithm, 50 questions were randomized per category, displayed as many as 20 questions per examinee with a total of 30 iterations (for 30 exam participants). As a result, the position of the randomized questions is optimal and the time required for randomization is very efficient +0.01 seconds with the appearance rate of the most numbered questions being 3.17% so that the Fisher Yates Shuffle algorithm is one of the optimal algorithms for randomization.

1. Introduction

Communication networks such as the Internet are insecure networks for transmitting data, such as text, audio, video and digital images [1]. However, using the internet network can make it easier for a company to manage data efficiently because it can be accessed anywhere and anytime. One of the academic processes to enter a university is through the new student admission process [2]. The use of the internet as a learning medium has been carried out by the University of Kuningan through e-learning, but at the stage of the new student admission test it is still done manually (handwritten), in the exam there is an interview stage to see the talents and interests of prospective new students so that the major chosen appropriately so that they can support their profession in the future. For example, in
the selection of expertise programs at SMK, where it aims to make it easier for students to choose majors at higher education or lead to their profession [3].

In the system that runs at the Faculty of Computer Science, University of Kuningan, the testing system to see the interests and talents of prospective new students is carried out face to face directly through interview sessions, this is felt to be less efficient in terms of time, so the results are less than optimal. So an online exam application is needed, the results of which can provide recommendations for majors that match the interests, talents and competencies of these prospective students.

To reduce cheating in taking online exams, an algorithm is needed that can randomize the questions so that the appearance of the questions displayed to the examinees will differ from one another. One of the randomization algorithms that can randomize the questions optimally where the resulting index is not repeated in 1 iteration is the Fisher Yates Shuffle Algorithm [4]. The Fisher Yates Shuffle algorithm is used to change the order of randomly assigned inputs. The permutations generated by this algorithm appear with the same probability [5].

2. Methodology

2.1 Extreme Programming

According to Prabowo in Supriatna (2018), Extreme Programming (XP) is a software engineering process that tends to use an object-oriented approach and the goal of this method is a team formed on a small to medium scale and this method is also suitable if the team is faced with unclear requirements or changes occur very quickly [6].

![Figure 1. Extreme Programming](image)

There are four stages that must be done in the extreme programming (xp) method, namely:

a. Planning. At this stage, problem identification and system requirements analysis are carried out using data collection techniques, namely interviews and literature studies. As for the analysis of the running system using a flow map.

b. Design. At this stage, the design is carried out using the Unified Modeling Language (UML).

c. Coding. Based on the results of the design, it is applied to a web-based programming language, namely PHP and MySQL.

d. Test. After the implementation phase is complete, testing is carried out using black box testing to determine the validation between input and output and testing is carried out by randomizing the questions in several iterations to determine the level of algorithm optimality.
2.2 Fisher Yates Shuffle

The Fisher-Yates Shuffle (named after its discoverers, Ronald Fisher and Frank Yates) is used to change the order of randomly assigned entries. The permutations generated by this algorithm appear with the same probability. The basic method given for generating random permutations of numbers 1 - N goes as follows: [5]

- Write down numbers from 1 to n
- Fill in k value with random number between 0 to i + 1 round down
- Count from the low end, substitute for k and write elsewhere
- Repeat from step 2 until all numbers have been replaced
- The sequence of numbers written in step 3 is now a random permutation of the original number.
- In the new (modern) version the selected numbers are not crossed out, but their position is exchanged with the last digit of numbers that have not been selected.

![Fisher yates shuffle algorithm](image)

2.3 Unified Modeling Language (UML)

According to Rosa and Saladin (2015: 133) "UML is a standard language that is widely used in the industrial world to define requirements, make analysis and design, and describe architecture in object-oriented programming [7]. UML is a "family of graphical notations supported by a single meta-model, which helps the description and design of software systems, especially systems built using object-oriented programming (OO)" [8] So that it can be concluded that UML is a graphical notation to describe a programming-oriented architecture object.

- Use Case Diagram
  - Used to describe the behavior of a business process Activity Diagram
- Class Diagram
  - Describe the classes owned by the system.
- Sequence Diagram
  - Describes the life time of objects and messages sent and received between objects

3. Result and Discussion

Based on the system development method, the results are as follows:

- Planning
  - Based on the results of interviews with the secretary of the Informatics Engineering study program at the undergraduate level, it was obtained a picture of the system that was running and the problem was that the admission test for new student candidates was still carried out manually...
(using paper) and the interview sessions were still carried out face-to-face so that it was less time efficient and the results were less than optimal. Then a literature study was conducted to find studies and other literature related to research such as extreme programming system development methods, randomization algorithms, PHP and MySqli. Whereas for the system requirements are: prospective new students can take online exams and the results are in the form of department recommendations according to their interests, talents and competencies, questions must be able to reflect the interests, talents and competencies of each department in the faculty of computer science, admin is a person specially appointed to manage the question bank in the system, the head of the study program and the vice dean of the faculty of computer science can see the question bank, data of new student candidates, as well as the results of the prospective new student examinations managed by the system.

b. Design
The design of the proposed system is as follows:

Use Case:

![Use Case Diagram Proposed System](image)

**Scenario Diagram:**

| Name of Use Case | UC03 |
|------------------|------|
| Actor            | Exam Participants (New Student Candidates), Admin, Head of study program, Deputy Dean 1 of the Faculty of Computer Science |
| Result           | Displays questions randomly and generates major recommendations based on exam results |
| Pre-Condition    | The actor has logged in and is on the main page of the system |

Scenario

| Actor | System |
|-------|--------|
| 1. Examination participants choose the test to be carried out | 2. If the selected exam is a competency test, the system will randomize the questions using the Fisher Yates shuffle algorithm and display the questions one by one to the examinees, if not (the questions are tests of personality and interest) then the system will immediately display the questions sequentially. |
| 3. Examination Participant answers the question and presses the save button | 4. The system will match the answer with the answer key and store the value into |
|   |   |
|---|---|
| 5. | The system displays the next question and returns to point 3. |
| 6. | If all the questions in all categories have been done, the system will display the results of department recommendations, evaluation results from exams, descriptions of majors, competencies that must be owned, opportunities and career paths. |
| 7. | Examination Participant can see the results for consideration of the chosen department |
| 8. | Admin, Head of study program, Deputy Dean 1 of the Faculty of Computer Science select the Test Results menu |
| 9. | The system will display the test results of all participants who have taken the exam |

**c.** Coding. The results of the design are applied to a web-based programming language, namely PHP and MySqli.

**d.** Test. Testing was carried out, especially the Fisher Yates algorithm test to find out whether the questions displayed were randomized.

The Admin page can be seen in figures 4 to 7.

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**Figure 4.** Admin Login Page Display  
**Figure 5.** Question Category Data page  
**Figure 6.** Multiple Choice Question Page  
**Figure 7.** Add Multiple Choice Questions

The page for the test takers (prospective new students) can be seen in figure 8. This main page contains information about the Faculty of Computer Science, student achievements, the supporting facilities provided, and others with the aim of being a promotion for prospective new students and providing an overview of the excellence of the faculty of computer science. And contains information on how to do exams on the system.
After the exam participant has logged in, the system will display the question categories. When the examinees choose questions from the Competency category, the system will randomize the questions using the Fisher Yates Shuffle algorithm where 50 questions are randomized and 20 questions are taken to be displayed to test participants per type of exam for the competency category, then the system will save them into the database and display the randomized questions to the test takers as can be seen in Figure 11 where the examinees choose Basic Computer questions. The questions that are displayed are only 20 questions because, the exam participants have to work on other questions, namely:

a. Personality questions (accuracy, effectiveness, responsibility) in this exam are to measure the level of proficiency, thoroughness and responsibility of the test takers so that it is hoped that the results can be an evaluation for them in studying at the faculty of computer science.

b. About Interests, this exam is to see which majors are suitable based on the interests and talents of the examinees

c. Competency Questions, this exam is to see the competencies possessed by the test takers so that they can see the suitable majors based on these competencies

After the exam participant fills in the answer and presses the save button, the system will match the answer with the answer key and save the answer and score into the database. Then the system will display the next question from the randomization that has been done previously. The results of randomization carried out using the Fisher Yates Shuffle Algorithm for 30 iterations on Basic Computer Competency Category questions can be seen in Figure 13.
Figure 11. Problem 1 and 2 Results of Randomization

Figure 12. Random fisher yates shuffle results

Figure 13. Percentage results of question frequencies
Then in Figure 14 It can be seen that the percentage of questions that often appear is only 3.17%, so it can be concluded that the Fisher Yates Shuffle Algorithm is the best algorithm for case randomization of questions on recommended exam questions at the Faculty of Computer Science, University of Kuningan.

4. Conclusion
The conclusion based on this research is that the Fisher Yates Shuffle algorithm is the optimal algorithm for randomizing the questions because the percentage of the emergence of questions is small, namely 3.17% for questions that often appear so that it can improve the prevention of cheating for the examinees in doing the exam.

With this application, it makes it easier for the admin to manage exam questions, makes it easier for the head of the study program and the deputy dean of the computer science faculty to recruit prospective students who match their interests, talents and competencies based on the majors so that the resulting students will be more qualified, and make it easier for prospective new students. to understand personality, interests, talents, competencies and can be used as material for consideration or recommendations in choosing the right department.

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