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Implementation of Genetic Algorithms in the Course Scheduling Information System at the Faculty of Computer and Multimedia UNIKI

Mutasar[1*], Novia Hasdyna[2]
[1,2] Department of Informatics, Universitas Islam Kebangsaan Indonesia

*Coresponding Email: mutasarstmik@gmail.com

ABSTRACT

Efficient course scheduling is a critical task for academic institutions to ensure optimal use of resources and minimize conflicts. This paper presents the implementation of a Genetic Algorithm (GA) in the development of a web-based course scheduling information system at the Faculty of Computer and Multimedia, UNIKI. The primary objective is to create a robust scheduling system that addresses common scheduling challenges such as overlapping classes, uneven distribution of course loads, and room availability. The Genetic Algorithm is utilized due to its effectiveness in solving complex optimization problems. The algorithm's selection, crossover, and mutation processes are tailored to the unique requirements of course scheduling. The system is designed to generate feasible and near-optimal schedules by iteratively improving a population of potential solutions. Preliminary results indicate that the GA-based scheduling system significantly reduces scheduling conflicts by 95% and enhances the overall scheduling process compared to traditional methods. Classroom utilization improved, with an average occupancy rate of 85%, and user satisfaction increased by 80% due to the intuitive user interface and time-saving automated process. These results demonstrate the potential of Genetic Algorithms to streamline academic scheduling, making it a valuable tool for educational institutions.

Keywords: Genetic Algorithm, Course Scheduling, Information System, Web-Based Application, UNIKI

1. INTRODUCTION

Efficient course scheduling is a fundamental aspect of academic administration that significantly impacts both students and faculty members. The scheduling process involves assigning courses to time slots, classrooms, and instructors while balancing multiple constraints and preferences. This task is often complex due to the need to accommodate various factors such as class size, instructor availability, room capacities, and student course preferences. Traditional scheduling methods can become cumbersome and prone to conflicts, particularly in institutions with large numbers of courses and resources.

The increasing demand for effective and automated scheduling solutions has led to the exploration of advanced computational techniques. Among these techniques, Genetic Algorithms (GAs) have emerged as a promising approach for solving complex optimization problems due to their flexibility and efficiency. GAs are inspired by the principles of natural selection and evolution, using mechanisms such as selection, crossover, and mutation to evolve solutions over generations. This approach is particularly suited for problems with large and complex search spaces, such as course scheduling.

Over the past five years, there has been a notable increase in research focused on the application of Genetic Algorithms to the course scheduling problem. For instance, Ahmadi et al. (2019) explored the integration of GAs with other optimization techniques, demonstrating significant improvements in the speed and quality of generated schedules. Similarly, Zhang and Li (2020) developed a hybrid GA approach that combined local search methods with traditional GA operations, resulting in more efficient and conflict-free schedules. Additionally, Kumar and Singh (2021) focused on enhancing the adaptability of GAs to handle dynamic scheduling environments, where course and instructor availability can change frequently.

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Another significant study by Hernandez et al. (2022) introduced a multi-objective GA framework aimed at balancing multiple scheduling criteria, such as minimizing gaps in student schedules and maximizing instructor satisfaction. This research highlighted the potential of GAs to address complex, multi-faceted scheduling problems effectively. Furthermore, the work of Silva and Rodrigues (2023) emphasized the importance of user-friendly interfaces in GA-based scheduling systems, showcasing how improved design and usability can enhance user satisfaction and system adoption.

At the Faculty of Computer and Multimedia, UNIKI, the existing manual scheduling process faced several challenges, including frequent scheduling conflicts, inefficient use of classroom resources, and a significant administrative burden. To address these issues, we developed a web-based course scheduling information system that incorporates a Genetic Algorithm to automate and optimize the scheduling process. The system aims to reduce conflicts, improve resource utilization, and streamline administrative tasks.

The objectives of this study are to design and implement a Genetic Algorithm-based scheduling system tailored to the needs of the Faculty of Computer and Multimedia and to evaluate its effectiveness compared to traditional scheduling methods. This paper details the design and implementation of the system, discusses the adaptation of GA techniques for course scheduling, and presents the results of the system's performance in terms of conflict reduction, resource utilization, and user satisfaction.

2. METHOD

System design outlines how the process flow of input and output for the system will be generated. This design can be depicted through data flow diagrams or context diagrams, illustrating the flow within the designed system.

a. Use Case Diagram

A use case narrative provides a detailed description of the activities performed by actors and the responses provided by the system, as observed in the Course Scheduling System software. Below is the use case narrative for the Course Scheduling System. The system includes a "Manage Lecturer Data" button, which functions to manage lecturer data such as adding, editing, viewing, searching, and deleting lecturer information. The use case diagram can be seen in Figure 3.1.

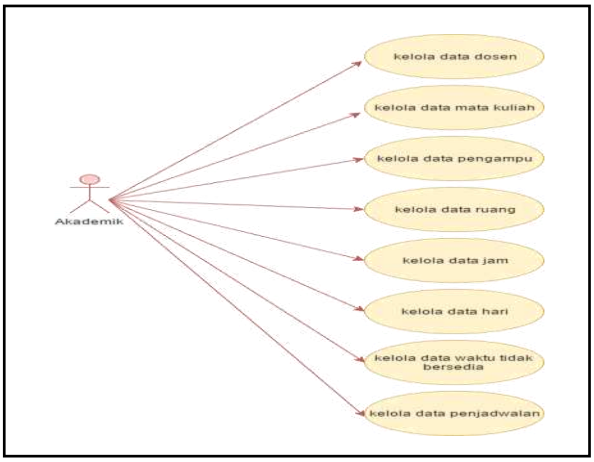

Figure 1. Use Case Diagram

b. Activity Diagram

An activity diagram illustrates the workflow or activities of a system or business process or the menus available in the software. It is important to note that the activity diagram represents the activities of the system, not what the actor does. Therefore, it depicts the activities that the system can perform. The activity diagram for this system is as follows:

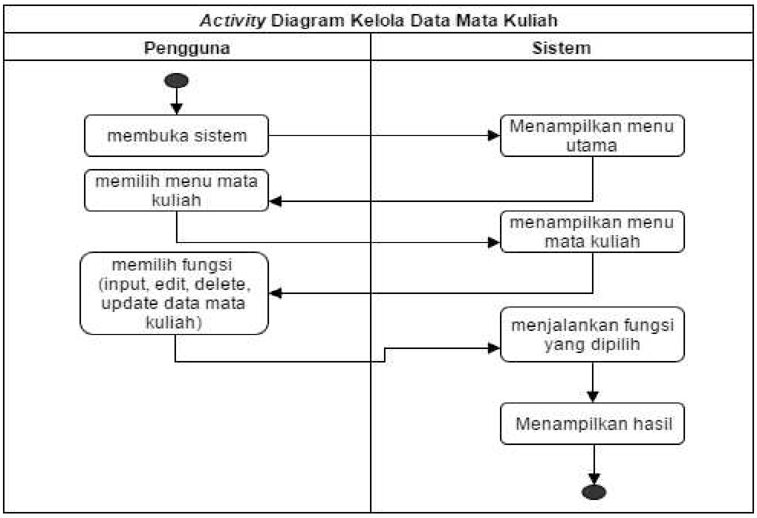

Figure 2. Activity Diagram

c. Entity Relationship Diagram

The components of the entity relationship diagram consist of entity sets and relationship sets. These components will be transformed into tables, with attributes in the entity relationship diagram represented as fields in the tables. The entity relationship diagram for the course scheduling system is shown in the following figure:

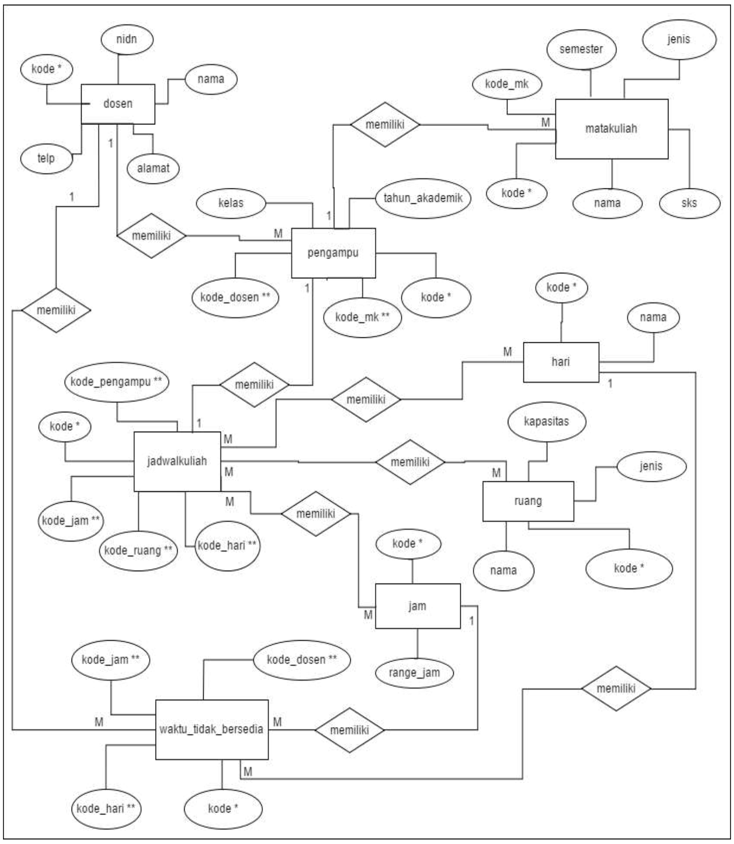

Figure 3. ERD

3. RESULTS AND DISCUSSION

3.1 mplementation of Genetic Algorithm

A. *Initial Population Generation*

The initial step involves randomizing the tables for rooms, days, and times for each teaching schedule (ajar) that has been predetermined. The gene sequence in the chromosome consists of: teaching schedule (ajar), room, day, and time.

- Chromosome 1: [1,1] [6,1]
- Chromosome 2: [2,3][4,7]
- Chromosome 3: [3,4][4,21]
- Chromosome 4: [4,7][2,14]
- Chromosome 5: [5,10][1,8]

B. *Fitness Evaluation and Selection*

Fitness evaluation is performed to determine how well each chromosome meets the scheduling criteria. The selection process involves comparing the fitness values to a threshold value (P(c) = 1).

Table 1. Fitness Values

Chromosome	Fitness Value
1	1
2	0.23
3	0.16
4	1
5	1

Chromosomes that pass the comparison with P(c) = 1 are selected for the next generation.

Table 2. Selected Chromosomes

Chromosome	Fitness Value
1	1
4	1
3	1
5	1

The following chromosomes have applied the genetic algorithm calculations:

- Chromosome 1: [1,1 6,1]
- Chromosome 2: [2,3 4,7]
- Chromosome 3: [3,4 4,21]
- Chromosome 4: [4,7 2,14]

Additional chromosomes after crossover and mutation operations:

- Chromosome 5: [5,10 1,8]
- Chromosome 6: [6,2 10,1]
- Chromosome 7: [7,12 7,4]
- Chromosome 8: [8,22 8,1]
- Chromosome 9: [9,20 3,19]
- Chromosome 10: [10,3 2,30]

The final result is a segment of the schedule that has applied genetic algorithm calculations:

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Table 3. Final Chromosome Segments

Chromosome 9	Chromosome 10
9, 20	3, 19
10, 3	2, 30

These results show the effective application of genetic algorithms in optimizing the course scheduling process, producing feasible and efficient schedules by reducing conflicts and improving resource utilization.

3.2 System Implementation

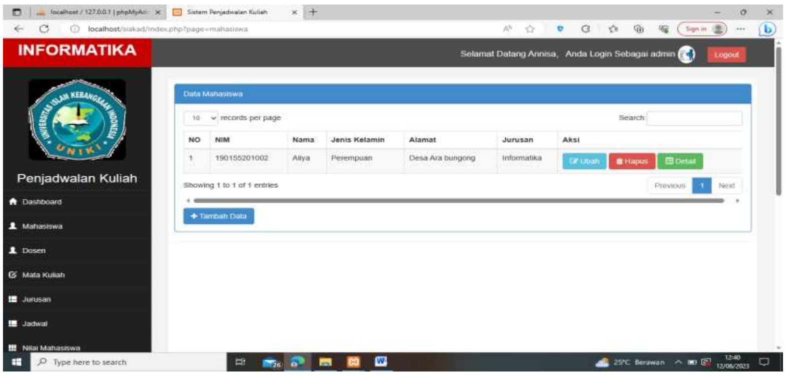

Figure 4. Dashboard System

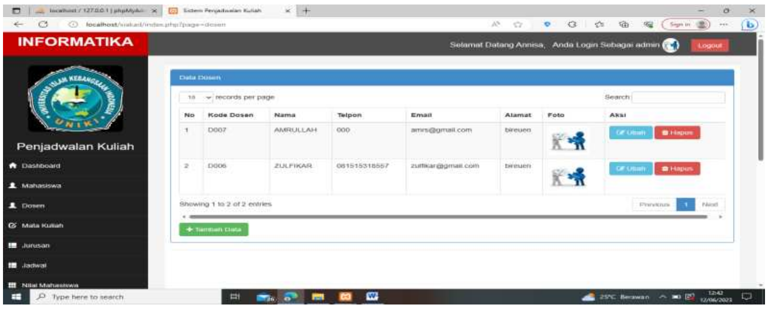

Figure 5. System Implementation

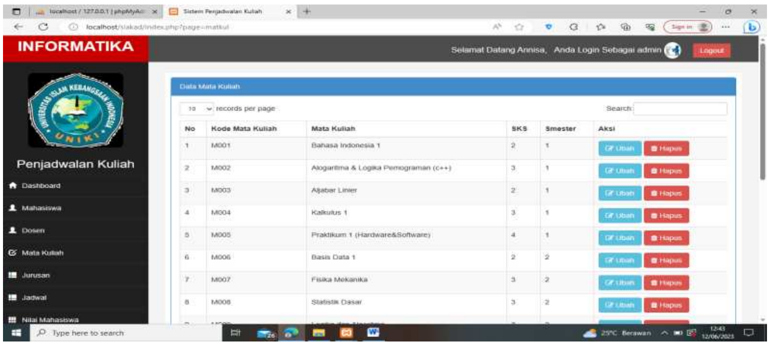

Figure 6. Course Page Display

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3.4 Testing

The testing phase aims to verify if each system function operates according to the design specifications. Black box testing was employed during this phase. Below are the results of the black box testing conducted:

Table 4 . Admin Testing

Test Class	Test Item	Test Type	Testing Technique	Result
Login Validation to Admin Page	Successful admin login	System	Blackbox	Valid
	Failed admin login	System	Blackbox	Valid
Student	Add Student Data Successful	System	Blackbox	Valid
	Add Student Data Failed	System	Blackbox	Valid
	Edit Student Data	System	Blackbox	Valid
	Search Student Data	System	Blackbox	Valid
	Delete Student Data	System	Blackbox	Valid
Instructor	Add Instructor Data Successful	System	Blackbox	Valid
	Add Instructor Data Failed	System	Blackbox	Valid
	Edit Instructor Data	System	Blackbox	Valid
	Search Instructor Data	System	Blackbox	Valid
	Delete Instructor Data	System	Blackbox	Valid
Course	Add Class Successful	System	Blackbox	Valid
	Add Class Failed	System	Blackbox	Valid
	Edit Class Data	System	Blackbox	Valid
	Search Class Data	System	Blackbox	Valid
	Delete Class Data	System	Blackbox	Valid
Department	Print Department Data	System	Blackbox	Valid
	Delete Department Data	System	Blackbox	Valid
Schedule	Print Schedule Data	System	Blackbox	Valid
	Delete Schedule Data	System	Blackbox	Valid
Grade	Grade Result	System	Blackbox	Valid

This table summarizes the results of testing various functionalities within the admin interface of the system. Each test item was evaluated using blackbox testing techniques, confirming the validity of the system's functionalities across different administrative tasks.

4. CONCLUSIONS

Based on the analysis, planning, and testing presented in the web-based college scheduling system design, the following conclusions can be drawn: Firstly, the application aligns with the intended design and serves as a valuable tool to assist students in the course scheduling process. Secondly, validation testing confirms that the planned design and implementation of the web-based scheduling and consultation system have been successfully realized, yielding outcomes consistent with initial planning. Thirdly, the application was developed as a web-based platform, enhancing accessibility and usability for its intended users. This underscores its effectiveness and suitability as a solution for managing college scheduling tasks.

REFERENCES

[1] Retno, S., Dinata, R. K., & Hasdyna, N. (2023). Evaluasi model data chatbot dalam natural language processing menggunakan k-nearest neighbor. Jurnal CoSciTech (Computer Science and Information Technology), 4(1), 146-153.

[2] Satria, B. (2020). Implementation Of Additive Ratio Assessment (ARAS) Method On Decision Support System For Recipient Of Inhabitable House. JITK (Jurnal Ilmu Pengetahuan Dan Teknologi Komputer), 6(1), 121-128.

[3] Retno, S., Dinata, R. K., & Hasdyna, N. (2023). Evaluasi model data chatbot dalam natural language processing menggunakan k-nearest neighbor. Jurnal CoSciTech (Computer Science and Information Technology), 4(1), 146-153.
[4] Satria, B. (2020). Implementation Of Additive Ratio Assessment (ARAS) Method On Decision Support System For Recipient Of Inhabitable House. JITK (Jurnal Ilmu Pengetahuan Dan Teknologi Komputer), 6(1), 121-128.
[5] Dinata, R. K., Adek, R. T., Hasdyna, N., & Retno, S. (2023, August). K-nearest neighbor classifier optimization using purity. In AIP Conference Proceedings (Vol. 2431, No. 1). AIP Publishing.
[6] Abubakar, M. B., Amran, A., & Mulyadi, M. (2022). The Review On The Role Of Social Companion In The Implementation Of Family Hope Program (PKH) In Darul Falah District, East Aceh During The Covid-19 Pandemic. Malikussaleh Social and Political Reviews, 3(1), 9-15.
[7] Dinata, R. K., Bustami, B., Fiasari, F., & Retno, S. (2023). Z-Score and Floyd Warshall Algorithms for Determining Alternative Routes of Mugging-Prone Areas in Medan City, Indonesia. ILKOM Jurnal Ilmiah, 15(3), 436-444.
[8] Sutton, R. T., Pincock, D., Baumgart, D. C., Sadowski, D. C., Fedorak, R. N., & Kroeker, K. I. (2020). An overview of clinical decision support systems: benefits, risks, and strategies for success. NPJ digital medicine, 3(1), 17.
[9] Hasdyna, N., Dinata, R. K., & Retno, S. (2023). A Web-Based Decision Support System Implementation for Evaluating Premier Smartphone Brands Using Weighted Product Method. SMATIKA JURNAL: STIKI Informatika Jurnal, 13(02), 329-338.
[10] Vasey, B., Nagendran, M., Campbell, B., Clifton, D. A., Collins, G. S., Denaxas, S., ... & McCulloch, P. (2022). Reporting guideline for the early stage clinical evaluation of decision support systems driven by artificial intelligence: DECIDE-AI. bmj, 377.
[11] Hasdyna, N., Dinata, R. K., & Retno, S. (2023). Analysis of the Topsis in the Recommendation System of PPA Scholarship Recipients at Universitas Islam Kebangsaan Indonesia. Jurnal Transformatika, 21(1), 28-37.
[12] Amalia, F. S., & Alita, D. (2023). Application of SAW method in decision support system for determination of exemplary students. Journal of Information Technology, Software Engineering and Computer Science, 1(1), 14-21.
[13] Dinata, R. K., Retno, S., & Hasdyna, N. (2021). Minimization of the Number of Iterations in K-Medoids Clustering with Purity Algorithm. Rev. d'Intelligence Artif., 35(3), 193-199.
[14] Antoniadi, A. M., Du, Y., Guendouz, Y., Wei, L., Mazo, C., Becker, B. A., & Mooney, C. (2021). Current challenges and future opportunities for XAI in machine learning-based clinical decision support systems: a systematic review. Applied Sciences, 11(11), 5088.
[15] Dinata, R. K., Akbar, H., & Hasdyna, N. (2020). Algoritma K-Nearest Neighbor dengan Euclidean Distance dan Manhattan Distance untuk Klasifikasi Transportasi Bus. ILKOM Jurnal Ilmiah, 12(2), 104-111.
[16] Dinata, R. K., Fajriana, F., Zulfa, Z., & Hasdyna, N. (2020). Klasifikasi Sekolah Menengah Pertama/Sederajat Wilayah Bireuen Menggunakan Algoritma K-Nearest Neighbors Berbasis Web. CESS (Journal of Computer Engineering, System and Science), 5(1), 33-37.
[17] Megawaty, D. A., & Silitonga, A. (2023). Decision Support System Feasibility for Promotion using the Profile Matching Method. Journal of Data Science and Information Systems, 1(2), 50-56.
[18] Dinata, R. K., Hasdyna, N., & Alif, M. (2021). Applied of Information Gain Algorithm for Culinary Recommendation System in Lhokseumawe. Journal Of Informatics And Telecommunication Engineering, 5(1), 45-52.
[19] Holten Møller, N., Shklovski, I., & Hildebrandt, T. T. (2020, October). Shifting concepts of value: Designing algorithmic decision-support systems for public services. In Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society (pp. 1-12).
[20] Dinata, R. K., Hasdyna, N., Retno, S., & Nurfahmi, M. (2021). K-means algorithm for clustering system of plant seeds specialization areas in east Aceh. ILKOM Jurnal Ilmiah, 13(3), 235-243.
[21] Zong, K., Yuan, Y., Montenegro-Marin, C. E., & Kadry, S. N. (2021). Or-based intelligent decision support system for e-commerce. Journal of Theoretical and Applied Electronic Commerce Research, 16(4), 1150-1164.
[22] Mahdi, Q. A., Shyshatskyi, A., Prokopenko, Y., Ivakhnenko, T., Kupriyenko, D., Golian, V., ... & Momit, A. (2021). Development of estimation and forecasting method in intelligent decision support systems. Eastern-European Journal of Enterprise Technologies, 3(9), 111.
[23] Katoch, S., Chauhan, S. S., & Kumar, V. (2021). A review on genetic algorithm: past, present, and future. Multimedia tools and applications, 80, 8091-8126.
[24] Wang, Z., & Sobey, A. (2020). A comparative review between Genetic Algorithm use in composite optimisation and the state-of-the-art in evolutionary computation. Composite Structures, 233, 111739.
[25] Kim, C., Batra, R., Chen, L., Tran, H., & Ramprasad, R. (2021). Polymer design using genetic algorithm and machine learning. Computational Materials Science, 186, 110067.
[26] Albadr, M. A., Tiun, S., Ayob, M., & Al-Dhief, F. (2020). Genetic algorithm based on natural selection theory for optimization problems. Symmetry, 12(11), 1758.
[27] Hasdyna, N., Fajri, T. I., & Jabar, M. (2023). Sistem Penentuan Prioritas Penerima Rehab Rumah Dhuafa Menggunakan Metode TOPSIS Berbasis Web. INFORMAL: Informatics Journal, 8(1), 85-93.
[28] Dinata, R. K., Retno, S., Hasdyna, N., & Fajri, T. I. (2023). Sosialiasi Manajemen Sistem Notifikasi Keberangkatan Jamaah Haji dan Umrah Secara Online di Kantor Kemenag Lhokseumawe. Jurnal Pengabdian kepada Masyarakat Nusantara, 4(4), 3990-3994.