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Application of Genetic Algorithm with Roulette Wheel Selection Method for International Certification Scheduling Optimization at ITCC ITPLN

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Abstract

Information Technology Certification Center (ITCC) is a division within the PLN Institute of Technology, authorized to conduct international training and certification. During the scheduling process, it was identified that the current schedule creation was not optimal. Therefore, an optimization algorithm was required to address the scheduling issues. The chosen algorithm was the genetic algorithm with roulette wheel selection, applied to a prototype, followed by black-box testing of the prototype and ANOVA for the algorithm's. The findings of the research suggest that the genetic algorithm with roulette wheel selection can generate an optimal schedule for international certification activities while adhering to established rules.

Keywords: ITCC, Scheduling, Optimization, Genetic Algorithm, Blackbox, ANOVA

Abstract

Information Technology Certification Center (ITCC) merupakan unit bidang kerja yang dimiliki oleh Institut Teknologi PLN yang memiliki hak otorisasi untuk menyelenggarakan pelatihan dan sertifikasi internasional. Dalam proses penjadwalan yang dilakukan, ditemukan bahwa pembuatan jadwal tersebut belum optimal. Oleh sebab itu, dibutuhkan algoritma optimasi yang dapat menyelesaikan masalah yang dihadapi. Algoritma yang dipilih adalah algoritma genetika dengan metode seleksi roulette wheel dan diterapkan pada prototipe yang dibuat, lalu dilakukan pengujian blackbox pada prototipe dan ANOVA pada algoritma. Kesimpulan yang didapatkan oleh peneltian yang dilakukan dengan menerapkan algoritma genetika dengan metode seleksi roulette wheel adalah algoritma tersebut dapat membuat hasil jadwal kegiatan sertifikasi internasional optimal dengan mematuhi peraturan yang telah ditetapkan.

Kata-kata kunci: *ITCC, Penjadwalan, Optimasi, Algoritma Genetika, Blackbox, ANOVA*

1. Introduction

The Information Technology Certification Center or known as ITCC is one of the work units owned by the PLN Institute of Technology and has been established since 2016. With the authorization rights of Certiport Inc as Certiport Authorized Testing Center (CATC) and MikroTik – SIA Mikrotīkls, ITCC has the authority to organize international training and certification **[1].** In the process of making a schedule for international certification activities, it was found that the schedule was not optimal in terms of time efficiency and the creation process, where the amount of time needed to make a schedule based on existing data was 4-6 hours. The committee also compared the time of willingness and the time of international certification, so that the manufacturing process is prone to *human error*. To solve the optimization problem, researchers will apply genetic algorithms to the scheduling system at ITCC to produce a scheduling system that can produce an optimal schedule of training activities and international certification exams. By conducting this research, the researcher will help the international certification activity committee to make the schedule of international certification activities more optimal. The result of this research is the formation of a web-based prototype that applies genetic algorithms by using genetic algorithms to create an optimal schedule of international certification activities.

2. Method

2.1 Data Collection

In the data collection includes primary data and secondary data. Primary data is data that is recorded and obtained directly from the research object through interviews or interviews to obtain data that will be used to support the research process. Secondary data is taken directly from previous research from books, journals, and the internet regarding the methods used by researchers.

2.2 Genetic Algorithm Methods

Genetic algorithm (GA) is an optimization algorithm inspired by natural selection, where GA is a population-based search algorithm that uses the concept *of* survival of the fittest **[2].** Genetic algorithms have a method of finding the optimal solution to a problem and finding a good solution by crossing other solutions to create a new solution **[3].** Genetic algorithm process is presented on **Figure 1**.

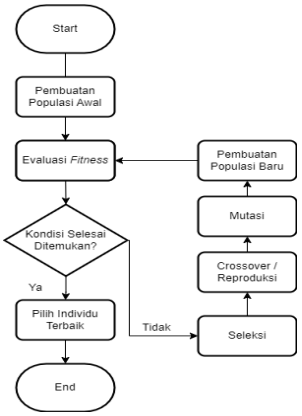

Figure 1. Genetic Algorithm Process

1. Create an initial population (initialization)
2. Perform a fitness evaluation in that initial population
3. Check if the initial population meets the criteria to complete the algorithm
4. Otherwise;
    a. Enter the initial population into the operator of selection, reproduction, mutation.
    b. Create an up-to-date population with results from operators.
    c. Repeat steps 2 and 3.
5. If so, choose the best individuals in the population.

Initialization in genetic algorithms is a process that involves the process of creating the initial population of a solution. This step has a major impact on the efficiency and effectiveness of genetic algorithms in the search for optimal solutions**[4].** Fitness evaluation f(x) is the process of assessing how well a solution is with the desired goal or the performance of a solution based on predetermined criteria **[5]**. Hard constraints and soft constrain can be seen in **Table 1** and **Table 2.**

Tabel 1. *Constraints*

Hard Constraints	Number of Penalties
Trainers must have an appropriate program with groups.	10
Proctor, *trainer*, assistant, and room can't were put in 2 groups at the same time.	10
Proctor and *trainer* should be placed on the groups that are in accordance with the time of willingness.	10
Proctors and *trainers* who do not fill the willingness cannot be placed in groups.	10

Table 2. Soft Constrains

Soft Constraints	*Number of Penalties*
Number of groups that the *proctor* or *trainer teaches* equivalent to or only 1 more than a *proctor* or *trainer* Other.	5
Proctor has a program that suits the group	5
Trainers are not replaced by assistants	5

$$f(xi) = fbase - (H \times PH) - (S \times PS)$$

Information:

FBASE : Initial Fitness Numbers (100)

H : the number of hard constraints violated

S : the number of hard constraints violated

PH : Personalized hard constraint (10)

PS : Nilai pinalti soft constraint (5)

f(xi) : Fitness value of the ith individual.

Selection in genetic algorithms is an important process that determines which individuals from a population can pass on their genes to the next generation **[6].** Using the roulette wheel selection, individuals will be selected based on their fitness height, where individuals with higher fitness have a greater chance of being selected.

$$P(x_i) = \frac{f(xi)}{\sum_{j=1}^{N} f(xj)}$$

Information:

xi is the ith individual

P(xi) is the probability of choosing xi

f(xi) is *the fitness* of one of the individuals

Crossover is an operator that combines genetic information from 2 *parents* to get a child. This process mimics the process of biological reproduction and is used to explore new territories of a solution **[7].** A mutation is an operator of a genetic algorithm that makes random changes to one or more genes to create a new offspring **[8].**

Tabel 3. Data User

No	User	Role	Program	Willingness
1	Abdurrasid, S.com., MMSI	Teacher	MOS: Word, MOS: Excel, MCF: Azure AI	• July 8, 2021 from 7 a.m. to 3 p.m. • July 9, 2021 from 11 a.m. to 5 p.m.
2	Sely Karmila , S.T., MMSI	Teacher	MOS: Word, MOS: PowerPoint, MikroTik: MTCNA	• July 8, 2021 from 11:30 a.m. to 6 p.m. • July 9, 2021 from 8 a.m. to 2 p.m.
3	Dine Tiara Kusuma , S.T., M.Kom.	Teacher	MOS: Excel, MOS: PowerPoint, MikroTik: MTCNA	• July 8, 2021 from 7 a.m. to 2 p.m. • July 9, 2021 from 8 a.m. to 1 p.m.
4	Yessy Asri , S.T., MMSI	Teacher	MOS: Word, MOS: PowerPoint, MCF: Azure AI	• July 8, 2021 from 11 a.m. to 5:30 p.m. • July 9, 2021 from 12:30 p.m. to 6 p.m.
5	Dewi Arianti Wulandari, S.Kom., MMSI	Teacher	MOS: Excel, MCF: Azure AI, MikroTik: MTCNA	• July 8, 2021 from 8 a.m. to 5 p.m. • July 9, 2021 from 7 a.m. to 4:30 p.m.
6	Hendra Jatnika, S.Kom., M.Kom.	*Proctor*	MOS: Word, MOS: Excel, MCF: Azure AI	• July 8, 2021 from 7 a.m. to 5 p.m.
7	M. Yoga Distra Sudirman, ST., M.TI	*Proctor*	MOS: Excel, MOS: PowerPoint, MCF: Azure AI, MikroTik: MTCNA	• July 8, 2021 from 1 p.m. to 6 p.m. • July 9, 2021 from 1 p.m. to 5 p.m.
8	Tyara Anastasia	Asisten	-	-
9	From Musika P	Asisten	-	-

Table 4. Group data

No	Group	Date	Jam	Program
1	10W-MOS-1	July 8, 2021	12 p.m. - 2 p.m.	MOS: Word
2	10E-MOS-1	July 8, 2021	4 p.m. - 6 p.m.	MOS: Excel
3	10-MCF-1	July 8, 2021	10 a.m. - 1 p.m.	MCF: Azure AI
4	10P-MOS-1	July 8, 2021	2 p.m. - 3 p.m.	MOS: PowerPoint
5	10P-MOS-2	July 8, 2021	3 p.m. - 5 p.m.	MOS: PowerPoint
6	10-MIK-1	July 9, 2021	1 p.m. - 2 p.m.	MikroTik: MTCNA
7	10P-MOS-3	July 9, 2021	9 a.m. - 11 a.m.	MOS: PowerPoint
8	10E-MOS-2	July 9, 2021	11 a.m. - 1 p.m.	MOS: Excel
9	10E-MOS-3	July 9, 2021	3 p.m. - 4 p.m.	MOS: Excel
10	10-MIK-2	July 9, 2021	8 a.m. - 10 a.m.	MicroTik: MTCNA

Table 5. Room data

No	Room
1	501
2	502
3	503
4	504
5	505

2.3 Blackbox Testing

Blackbox testing is a method of software testing that focuses on the inputs and outputs of the software system without considering the internal work or structure of the software [9].

2.4 ANOVA Testing

ANOVA or *analysis of variance* is a statistical method used to analyze differences between group averages. Anova was discovered by a statistician named Ronald Fisher **[10].** Using this method, researchers will test the results obtained from genetic algorithms with differences in elite levels, *crossovers* and mutations. The tests carried out by each test are 10 (ten) tests. Here are the tiers used:

The elite number of the population uses: 1%, 2%, and 3%. Probability of crossover in population: 50%, 70% and 90%. Probability of mutation in population: 20%, 50%, and 70%

3. Results and Discussion

Here is a view of the system.

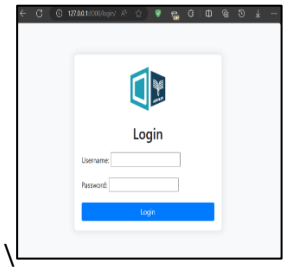

Figure 2. Login Page

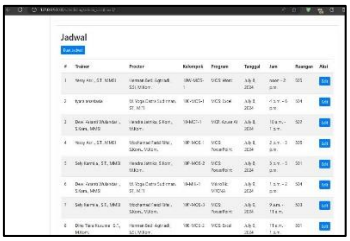

Figure 3. Schedule Results

The following is a table of the results of making a schedule of international certification activities using genetic algorithms.

Table 6. Results of Making a Schedule Of International Certification Activities

No.	*Coach*	*Proctor*	Group	Program	Date	Jam	Room
1	Abdurrasid, S.com., MMSI	Hendra Jatnika, S.Kom.,M.Kom.	10W-MOS-1	MOS: Word	July 8, 2021	noon - 2 p.m.	505
2	tyara anastasia	M. Yoga Distra Sudirman, ST., M.TI	10E-MOS-1	MOS: Excel	July 8, 2021	4 p.m. - 6 p.m.	501
3	Dewi Arianti Wulandari, S.Kom., MMSI	Mochamad Farid Rifai, S.Com.,M.Kom.	10-MCF-1	MCF: Azure AI	July 8, 2021	10 a.m. - 1 p.m.	501
4	Sely Karmila , S.T., MMSI	M. Yoga Distra Sudirman, ST., M.TI	10P-MOS-1	MOS: PowerPoint	July 8, 2021	2 p.m. - 3 p.m.	501
5	Yessy Asri , S.T., MMSI	Hendra Jatnika, S.Kom.,M.Kom.	10P-MOS-2	MOS: PowerPoint	July 8, 2021	3 p.m. - 5 p.m.	505
6	Dewi Arianti Wulandari, S.Kom., MMSI	Mochamad Farid Rifai, S.Com.,M.Kom.	10-MIK-1	MicroTik: MTCNA	July 9, 2021	1 p.m. - 2 p.m.	505
7	Sely Karmila , S.T., MMSI	Mochamad Farid Rifai, S.Com.,M.Kom.	10P-MOS-3	MOS: PowerPoint	July 9, 2021	9 a.m. - 11 a.m.	502
8	Dine Tiara Kusuma , S.T., M.Kom.	Herman Bedi Agtriadi , S.Si, M.Kom.	10E-MOS-2	MOS: Excel	July 9, 2021	11 a.m. - 1 p.m.	501
9	Abdurrasid, S.com., MMSI	Herman Bedi Agtriadi , S.Si, M.Kom.	10E-MOS-3	MOS: Excel	July 9, 2021	3 p.m. - 4 p.m.	502
10	Dine Tiara Kusuma , S.T., M.Kom.	Herman Bedi Agtriadi , S.Si, M.Kom.	10-MIK-2	MicroTik: MTCNA	July 9, 2021	8 a.m. - 10 a.m.	505

It can be seen in the table above that the results of the schedule made using the genetic algorithm only resulted in 1x soft *constraint* violation where there was an assistant teaching a certification group.

Table 7. Levene *Testing*

Levene's Test of Equality of Error Variances[a,b]

	Levene Statistic		df1	df2	Mr.
max_fitness	Based on Mean	1.580	26	243	.041
	Based on Median	1.002	26	243	.466
	Based on Median and with adjusted df	1.002	26	174.531	.468
	Based on trimmed mean	1.440	26	243	.083

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.[a,b]

a. Dependent variable: max_fitness

b. Design: Intercept + jumlah_elite + probabilitas_crossover + probabilitas_mutasi + jumlah_elite * probabilitas_crossover + jumlah_elite * probabilitas_mutasi + probabilitas_crossover * probabilitas_mutasi + jumlah_elite * probabilitas_crossover * probabilitas_mutasi

Tabel 8. *Tests of Between-Subjects Effects*

Source	Type III Sum of Squares	df	Mean Square	F	Mr.
Corrected Model	30804.185a	26	1184.776	1.267	.180
Intercept	471587.615	1	471587.615	504.396	<,001
jumlah_elite	1187.941	2	593.970	.635	.531
probabilitas_crossover	2976.363	2	1488.181	1.592	.206
probabilitas_mutasi	3347.763	2	1673.881	1.790	.169
jumlah_elite * probabilitas_crossover	3815.081	4	953.770	1.020	.398
jumlah_elite * probabilitas_mutasi	12274.015	4	3068.504	3.282	.012
probabilitas_crossover * probabilitas_mutasi	2040.926	4	510.231	.546	.702
jumlah_elite * probabilitas_crossover * probabilitas_mutasi	5162.096	8	645.262	.690	.700
Error	227194.200	243	934.956		
Total	729586.000	270			
Corrected Total	257998.385	269			

Based on the results *of levene's test of Equality of Error Variances*, it was found that the results of max_fitness based on *means, null hypothesis* could not be rejected, which means that there was *equal variance* in the group. Meanwhile, based on the results *of the Tests of Between-Subjects Effects*, it can be concluded that the only statistically significant interaction is the combination of the number_elite and probabilitas_mutasi, while the other individual and group variables are not significant.

4. Conclusion

Based on the results of the research and discussion obtained in the study, several conclusions can be drawn, including: (1) Genetic algorithms can create an optimal schedule of international certification activities by using existing regulations and algorithm operators, and (2) based on the results of the ANOVA test, it was found that max_fitness based on *means* had a null *hypothesis* that could not be rejected and the only statistically significant interaction was the combination between jumlah_elite and probabilitas_mutasi, while other individual and group variables were not significant.

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