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Khatib and Imam Scheduling System Using Genetic Algorithm

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Abstract. Masjid has a function to do various activities, both worship activities to God and social activities to fellow human beings. In Masjid there is an instance that has the responsibility of determining the schedule of khatib, imam, and plans for various other activities. It is known as the masjid prosperity council or DKM. The DKM should be able to provide information to the pilgrims quickly. But in reality, people still have difficulty getting schedules and information about activities that will take place at the masjid. The length of scheduling that is done manually causes the discovery of activity schedule clashes, activities that are not in accordance with priorities, loss of previous plans, and khatib or imam who are unable to attend. To overcome this problem one approach is needed that can help the masjid prosperity council more easily manage schedules. In this study, Genetic Algorithm are used to solve this problem because of its good ability to be used in scheduling activities. After testing, the system built is able to provide solutions to problems in scheduling clashes of khatib and imam in the masjid.

1. Introduction
Masjid are places of worship for Muslims. A masjid is a place or space that is used by Muslims in conducting individual worship activities or together. Besides that, the masjid also functions as a center for fostering the ummah which refers to the principle of Islamic teachings about integration between mahdho worship and social worship (ijtimaiyah). Masjid prosperity council or Dewan Kemakmuran Masjid (DKM) has the responsibility of determining the schedule of muezzins, khatibs, imams, muballighs, and plans for various other activities. The DKM should be able to provide information to the pilgrims quickly. But in reality, the community is still challenging to get information on schedule information, as well as information about activities that will take place in the masjid.

Not just between DKM and the congregation, but the lack of information also occurs between masjids. In determining the schedule of khatibs and imams. For example, based on the results of interviews that have been done, the time needed to make the Friday sermon schedule takes one month to compile a four-month plan. The duration of the program is due to having to consider several criteria, namely: age, the ability of khatib or imam, and address of khatib or imam [1]. Besides having to consider some of these criteria, another problem that is often faced by DKM is that there are still frequent clashes of schedules, schedules that are not by rules, loss of previous plans, and khatibs or imams who are unable to attend. To overcome this problem; one approach is needed that can make DKM easier in arranging schedules and providing information to the pilgrims. Manually scheduling often causes...
clashes when activities take place, which are caused by the difficulty of matching the schedule of activities with the program of khatibs and imams, as well as the problem of the pilgrims to access information about the plan of the khatib's operations and prayers.

The following are some of the previous researches related to this research. Research on automatic scheduling system for Friday sermon muballigh [2] that uses constraint satisfaction problem (CSP) method and most constraint variable (MCV) by using 50 muballighs data and 50 masjids data. The schedule preparation accuracy was 95.59% and the user acceptance level was quite high, namely 92%. Research on the implementation of constructive satisfaction in the priority scheduling method for scheduling the Friday sermon on IKMI Pekanbaru [3] uses an algorithm that applies the least constraint variable (LCV) principle, which is the principle that prioritizes variables that have fewer constraints to be compiled. Research on optimization of hospital personnel scheduling that implement a combination of Genetic Algorithms (GA) and Tabu Search to produce six optimal schedule patterns require some iterations of 1396 and a time of 35 minutes 14 seconds [3]. Research uses the implications of GA for customer service scheduling [4] for the best parameters that produce the most optimal fitness value with population size of 110, generation 110, and crossover rate and mutation rate of 0.7: 0.3. By using these parameters, customer service scheduling has optimal results even though there are still violations that occur with a shorter computational time compared to the manual. Research on course scheduling at Department of Information System ITS [5] is made using GA as a tool to solve problems that exist schedules. Programming is made according to some limitations in the department, such as the availability of lecturers, students taking courses, and the availability of time and classrooms.

2. Material & Method
The materials and methods used in this study are sample information from several masjids in Medan and then processed using GA.

2.1. General architecture
The general architecture of the design to be built can be seen in Figure 1.

![General Architecture](image)

**Figure 1.** General Architecture

2.2. Input
A process of entering data patterns that will be processed by the application program. The data entered is in the form of the name of the masjid or the name of the imam and khatib.
2.3. Processing
After the user enters select a masjid or select ustadz, then the application system will request (get/post) to the server. Then the web server will process requests from Android and will query the database. The genetic algorithm process is as follows:

2.3.1. Initialize the initial population
Generating the first community is the process of producing random numbers of individuals or specific procedures. Within each, there is a component of the gene that makes up an individual entity. These genes are placed in a schedule array scheme box. The gene component is a representation of the date, masjid id, activity id, and ustadz id. An example of a schedule table can be seen in Table 1.

Table 1. Example of Masjid Activities Schedule

| Date     | Masjid Name     | Activity     | Ustadz Name          |
|----------|-----------------|--------------|----------------------|
| 2018-01-01 | Agung Medan     | Sholat Subuh | Ust. Abu Illias Al – Atrys |
| 2018-01-01 | Agung Medan     | Sholat Dzuhur | Ust. Abu Aliyah      |
| 2018-01-01 | Agung Medan     | Sholat Ashar  | Budi Purnomo        |
| 2018-01-01 | Agung Medan     | Sholat Maghrib| Firdaus              |
| 2018-01-01 | Agung Medan     | Sholat Isya  | H. Haidan Siregar   |
| 2018-01-01 | Al-Jihad Medan  | Sholat Subuh | Ust. Abdul Latif Khan|
| 2018-01-01 | Al-Jihad Medan  | Sholat Dzuhur | Ust. Krido Wardoyo |
| 2018-01-01 | Al-Jihad Medan  | Sholat Ashar  | Zainuddin           |
| 2018-01-01 | Al-Jihad Medan  | Sholat Maghrib| Jenal Alawi         |
| 2018-01-01 | Al-Jihad Medan  | Sholat Isya  | Ahmad Sofyan        |
| 2018-01-01 | Raya Al Mashun  | Sholat Subuh | Ust. H. Salman Alfarisi, Lc, MA |
| 2018-01-01 | Raya Al Mashun  | Sholat Dzuhur | Ust. Fajar Hasan Mursyid, Lc, MA |
| 2018-01-01 | Raya Al Mashun  | Sholat Ashar  | Budi Utomo          |
| 2018-01-01 | Raya Al Mashun  | Sholat Maghrib| Ayub Sulaiman       |
| 2018-01-01 | Raya Al Mashun  | Sholat Isya  | Agus Susanto        |
| 2018-01-01 | Dakwah USU      | Sholat Dzuhur | Arifin              |
| 2018-01-01 | Dakwah USU      | Sholat Subuh | Ust. Firozah Ramli, Lc, MA |
| 2018-01-01 | Dakwah USU      | Sholat Ashar  | Ust. Dr. Ali Musri Semjan Putra, MA |
| 2018-01-01 | Dakwah USU      | Sholat Maghrib| Adi Darma           |
| 2018-01-01 | Dakwah USU      | Sholat Isya  | H. Syaruddin        |
| 2018-01-01 | Al Falah Medan  | Sholat Subuh | Ust. Ali Nur        |
| 2018-01-01 | Al Falah Medan  | Sholat Dzuhur | Ust. Nuruddin Bukhori|
| 2018-01-01 | Al Falah Medan  | Sholat Ashar  | M. Fakhrozi         |
| 2018-01-01 | Al Falah Medan  | Sholat Maghrib| M. Anta Yuda        |
| 2018-01-01 | Al Falah Medan  | Sholat Isya  | Yenti Sari          |
| 2018-01-01 | Baiturrrahman Unimed | Sholat Subuh       | Ust. Razali Taat, S.Pdi   |
| 2018-01-01 | Baiturrrahman Unimed | Sholat Dzuhur        | Ust. Abdul Fattah     |
| 2018-01-01 | Baiturrrahman Unimed | Sholat Ashar        | Lili Sadeki          |
| 2018-01-01 | Baiturrrahman Unimed | Sholat Maghrib       | Mulyono              |
| 2018-01-01 | Baiturrrahman Unimed | Sholat Isya          | Ridwan               |

Table 1 is an example of a schedule table consisting of component genes. then get activities per pattern that is daily, weekly, annual activities. Activity patterns can be seen in Table 2.

Table 2. Activity Patterns

| Activity Identity | Activity     | Activity Pattern |
|-------------------|--------------|------------------|
| 1                 | Sholat Subuh | Daily            |
| 2                 | Sholat Dzuhur| Daily            |
| 3                 | Sholat Ashar | Daily            |
| 4                 | Sholat Maghrib| Daily         |
| 5                 | Sholat Isya | Daily            |
| 6                 | Sholat Jumat (immam)| Weekly |
| 7                 | Sholat Jumat (khutib)| Weekly |
| 8                 | Sholat Idul Fitri| Yearly          |
| 9                 | Sholat Idul Adha| Yearly          |
Next, take the list of religious teachers based on the masjid. Ustadz lists based on masjids can be seen in Table 3.

Table 3. Example of Ustadz and Masjid Identity

| Ustadz Identity | Masjid Identity | Ustadz Identity | Masjid Identity | Ustadz Identity | Masjid Identity |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 1               | 1               | 3               | 3               | 26              | 5               |
| 8               | 1               | 5               | 3               | 27              | 5               |
| 9               | 1               | 20              | 3               | 28              | 5               |
| 14              | 1               | 21              | 3               | 2               | 6               |
| 15              | 1               | 22              | 3               | 12              | 6               |
| 16              | 1               | 6               | 4               | 29              | 14              |
| 32              | 1               | 7               | 4               | 30              | 6               |
| 4               | 2               | 23              | 4               | 31              | 6               |
| 13              | 2               | 24              | 4               |                 |                 |
| 17              | 2               | 25              | 4               |                 |                 |
| 18              | 2               | 10              | 5               |                 |                 |
| 19              | 2               | 11              | 5               |                 |                 |

Table 3 is a table of ustazd lists based on the masjid where he served which was represented based on ustazd id and masjid id. Ustadz who are not priority can only help in the masjid that has been determined, while the religious teacher can be assigned to the six masjids. After all, the population is generated randomly. Examples of population initialization in this system can be seen in Table 4.

Table 4. Example of Population Initialization

| Date       | Masjid Identity | Activities Identity | Ustadz Identity |
|------------|-----------------|---------------------|-----------------|
| 2018-01-01 | 1               | 1                   | 1               |
| 2018-01-01 | 1               | 2                   | 8               |
| 2018-01-01 | 1               | 3                   | 9               |
| 2018-01-01 | 1               | 4                   | 14              |
| 2018-01-01 | 2               | 5                   | 4               |
| 2018-01-01 | 2               | 1                   | 13              |
| 2018-01-01 | 2               | 2                   | 17              |
| 2018-01-01 | 3               | 3                   | 3               |
| 2018-01-01 | 3               | 4                   | 5               |
| 2018-01-01 | 4               | 5                   | 6               |
| 2018-01-01 | 4               | 1                   | 7               |
| 2018-01-01 | 5               | 2                   | 10              |
| 2018-01-01 | 5               | 3                   | 11              |
| 2018-01-01 | 6               | 4                   | 4               |
| 2018-01-01 | 6               | 5                   | 12              |

2.3.2. Calculate the fitness value

After the population is raised, calculate the fitness value with the appropriate fitness function. Fitness functions can vary depending on the problem at hand. The fitness value is calculated based on the level of error in each. The calculation is done by giving the penalty for each rule used in scheduling. Rules and penalty values can be seen in Table 5.

Table 5. Rules and Penalty Values

| Rules                                                      | Penalty Value |
|------------------------------------------------------------|---------------|
| Clash schedule                                             | 1             |
| Priority schedules do not include priority ustadz           | 1             |
| Ustadz does not match the place of duty                     | 1             |
| Priority ustadz cannot be an imam in other masjids (non-priority activities) | 3             |
In Table 5, chromosome 4 has the highest fitness value, then reorder according to the highest fitness value. Chromosome sequencing with the highest fitness value can be seen in Table 6.

### Table 6. Chromosome Sequencing with the Highest Fitness Value

| Chromosome | Fitness |
|------------|---------|
| K4         | 1       |
| K3         | 0.3     |
| K5         | 0.22    |
| K1         | 0.2     |
| K2         | 0.1     |

2.3.3. **Crossover**

The crossover process is the process of combining two parent chromosomes which have been known to be the new chromosome. The crossover process used in this study is one cut-point crossover. In this manual calculation, the first step is to select two random parents to go through the crossover process. This crossover point is chosen randomly, which randomizes between religious teacher's activities.

2.3.4. **Mutation**

Mutation is the process of randomly modifying ancestral genes. In this process, the parent three is specified as the parent to make variations. The number of children is two then select parent one as parent 2.

2.3.5. **Selection**

In this study, the selection process uses the fitness-based selection method, namely the chromosome is replaced based on fitness value. The old chromosome will be compared to its fitness value with the new chromosome. Then sort by the highest fitness value. If conditions have not been fulfilled, then return to stage two. Then the process will stop when it reaches the maximum number of generations or gets the expected fitness value.

2.4. **Output**

The result is a brief description of information about the name of the masjid, the date, and the name of the imam and the name of the khatib.

### 3. Results & Discussion

In this study, the selection process uses the fitness-based selection method, namely the chromosome is replaced based on fitness value. The old chromosome will be compared to its fitness value with the new chromosome. Then sort by the highest fitness value. If conditions have not been fulfilled, then return to stage two. Then the process will stop when it reaches the maximum number of generations or gets the expected fitness value.
As seen in Figure 2 the genetic algorithm found a solution in the 3rd generation with a final fitness score of 1 and no schedule clashes were found. By changing the date range and placing the khatib to several masjids, so that the results of the GA can change, the results of the second test by replacing the date range and placing several khatibs to fill several masjids can be seen in Figure 3.

In this test, GA find a solution in the 100th generation (maximum generation) with a final fitness value of 0.2, and a different schedule is observed.

4. Conclusion
Based on analysts and the results of testing the system against the khatib and imam scheduling system using GA, it can be concluded that:

- The GA can solve the problem of scheduling the imam and the prayer;
- The algorithm shows the result of the final fitness value is between 0 and 1. If in the ultimate fitness value obtained is one then get a solution which means there is no schedule clash, whereas if the final fitness value does not get a value of 1, then it does not get a solution that clashes schedule;
- Calculation of GA in the scheduling system of the imam and the prayer is done randomly so that the results of the calculation cannot be ascertained to find a solution or find no answer.
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