Therapy scheduling system using genetic algorithm for Batam autism service centre

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Abstract. Autism is a neurological disorder that causes the sufferer difficult to communicate. Autism Service Centre was established to provide better education for Autism in the order they can adapt to an environment around them, even in formal or informal education. Autism Service Centre has a variety of daily activities, one of them is providing therapy to students. The therapy consists of speech, occupational, and physiotherapy. In carrying out the therapy, Batam Autism Service Centre found difficulties when processing student data and determining therapy schedules. Therefore, a therapy scheduling system is made using genetic algorithms for utilizing this algorithm to create dynamic schedule. Initiate from creating chromosome until mutation to get the new chromosome. These chromosomes will be experienced the same process until obtain the best chromosome on the next generation. This method can display the schedule by using data of therapeutic, therapist, room, time, and student appropriately to be solution in determining therapy schedules.

1. Introduction

The condition of neurodevelopment when an individual faces challenges involving social and age-appropriate play but fails to develop relationships with peers that are at the appropriate level of development is a depiction of Autism Spectrum Disorder (ASD) [1]. Autism is a neurological disorder that makes hard for the sufferer to communicate using spoken language with other people. In other condition, they also have brain disorder so that their brain is not functioning well. Autism patients in Indonesia have increased from 1:1000 to 8:1000 in all along period. This number exceeds the world average, about 6:1000. In 2012, Autistic patients in Indonesia reach 150.000 – 200.000 in person [2].

Autism Service Center in Batam existed on February 18, 2014. This Service Center aims to provide education to autistic patients so that they can communicate well and be able to adjust themselves to the surrounding environment. There are many activities they can do, but the most important activity is therapy. Three therapeutic methods used are Speech Therapy, Occupational Therapy, and Physiotherapy. Speech Therapy is a therapy of language that supports the improvement of the patient's speaking ability. Occupational Therapy intended to train a patient's muscles to be used correctly. Physical or physiology therapy aims to improve the balance of the body due to lack of strong muscles. Regarding with the methods of therapy mentioned above, the sufferer could train their senses to be carried out normally.

Batam Autism Service Center has a problem to match the schedule with the therapist due to the number of patients that always increase. Besides, the patients do therapy according to their needs that caused the schedule different between one and another. Until now, the scheduling system still uses a

manual method. However, the method often causes a problem. Parents exchange their child therapy schedule with others according to their respective matter. It makes difficult for the therapist to be negotiated with other sufferers' parents.

Based on the existing problems, this research is conducted to help the officer determine a therapy schedule that can be controlled by the patient also cannot be changed according to their personal needs.

2. Literature review

2.1. Autism

Autism is a physical disorder of the brain that becomes the cause of a limited developmental abilities. Psychological treatment of autistic child with Individualized Education Program (IEP) and therapeutic methods resulted in success story [3]. Types of therapy performed for autistic people:

2.1.1. Behavioural therapy. This therapy provides training in positive behaviour so that sufferers can reduce unnatural actions. Also, this therapy makes patients control their emotions slowly.

2.1.2. Academic therapy. An advanced stage of therapy to teach sufferers about how to count, recognize letters, and so on.

2.1.3. Integration sensor therapy. This therapy is useful for training the muscles of sufferers because sometimes patients have muscles that are too weak and some who have muscles that are too strong. The sufferer is recommended to do this therapy to use their muscle properly.

2.1.4. Speech therapy. Speech therapy is applied to patients who have poor communication. Patients will be taught about verbal communication.

2.2. Genetic algorithm

Genetic Algorithms are algorithms that apply Darwin's theory of evolution, where many species of living things in the world can adapt, survive, and reproduce to increase the population of living things. Genetic algorithms are used to solve optimization problems by searching to find the best solution. The use of genetic algorithms in the Autistic Therapy Scheduling System to determine the best genes to produce a therapeutic schedule [4]. Research on optimal scheduling of batch multi-production processes using genetic algorithms to maximize revenue was carried out by Wu et al [5]. Whereas Loukil, Taĭcir & Fortemps also utilize genetic algorithms in scheduling multipurpose production for flexible production workshops [6].

The method of solving problems using the Genetic Algorithm consists of several stages as shown at Figure 1. Generating Initial Population is the process of selecting individuals randomly or through certain procedures. The population states several solutions that are sought randomly. Data Selection is the process to get a good parent. In this case, the individual who has the highest fitness value will be chosen as the parent. The selected parent (individual) will be used in the next process, which is the cross-over and mutation process. Cross-Over is a process involving 2 parents (individuals) to produce new derivative. Cross-over can be carried out directly on everyone with a probability of cross-over that has been determined. Mutation is the process of exchanging genes with their inverse values, for example, genes 0 to 1. Mutations are also carried out by providing inversion values or shifting gene values in selected genes.

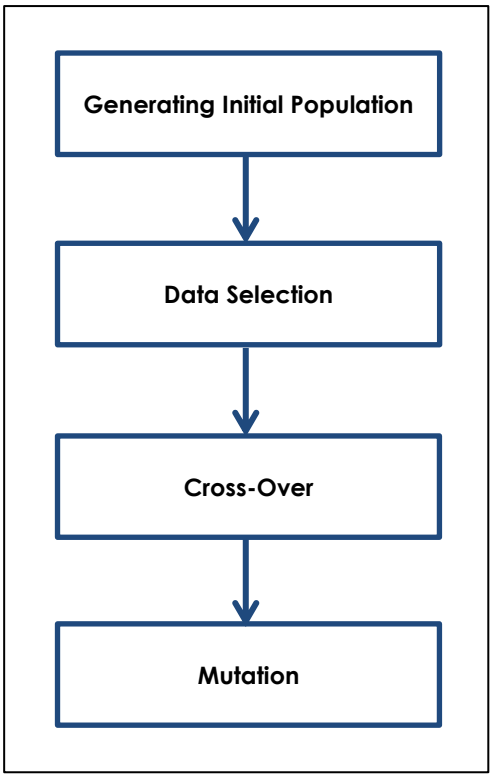


Figure 1. Genetic algorithm stages.

3. Analysis and design

This chapter will explain the genetic algorithm, general description of the system, user characteristics, main features of the software, functional requirements, non-functional requirements, diagram design including use case diagrams, sequence diagrams, entity-relationship diagrams, and interface design.

3.1. Genetic algorithm

Genetic Algorithms in the Autism Therapy Scheduling System Batam Autism Service Centre can be denoted using the following pseudocode language:

Input : Therapist, Therapy, Students, Space, Time
Process :
Awaken the initial population, individual P
Loop for individual P
Decode the individual P
Evaluate the individual P
End
Loop until the condition stops
Select two individuals as parent1 and parent2
	//if needed cross-over
	If Cross-over then
	Offspring = cross-over (parent1, parent2)
	End
	//if need mutation
	If Mutation then
	Offspring = mutation (Offspring)
	End
	If offspring then
	Population = Replacement (population, offspring)
	End
	End

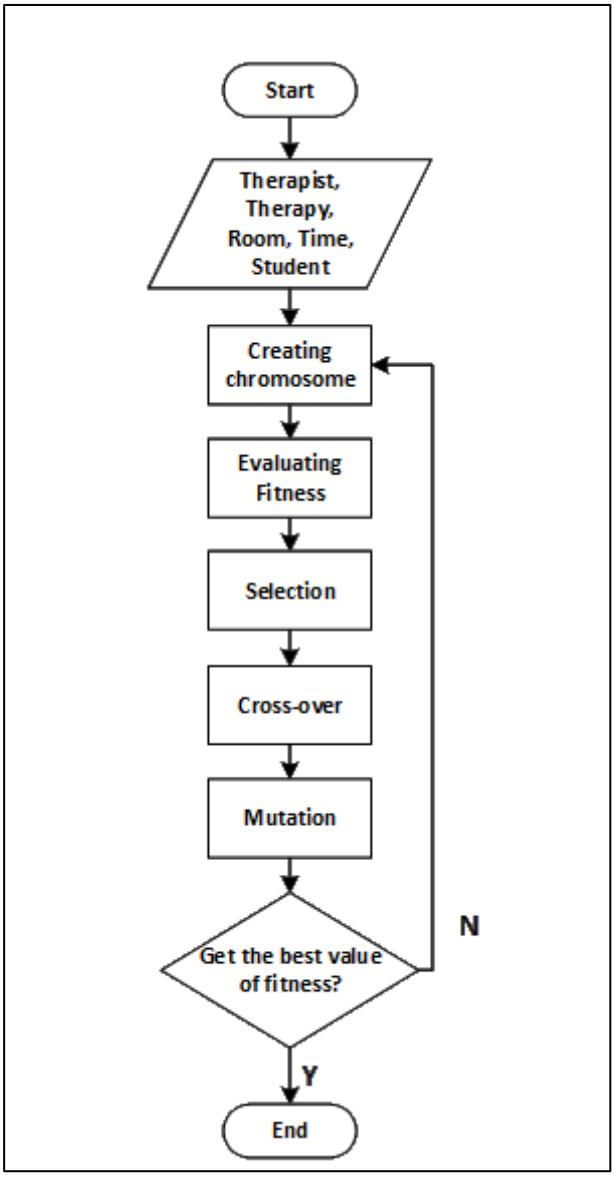


Figure 2. Flowchart for Genetic Algorithm.

In Figure 2, it starts with entering therapist data, therapy, room, time, and students. Then the data will be made into chromosomes, then the fitness value will be calculated. After that, the chromosomes will be selected based on fitness values. If the fitness value has not reached 1 then proceed with the crossover process. Then the mutation process, if there are genes that are the same or clash return to the fitness evaluation process, if not then the process is complete.

3.2. Description of the system

Batam Autism Service Center is a government program to facilitate children with special needs. One of the activities is a therapy which trains students' brain to develop well and be able to adapt to the surrounding environment. In the therapeutic activities carried out scheduling using this system. There are two users involved, namely officers as administrators who can manage student data, create therapy schedules automatically, and manage therapist data.

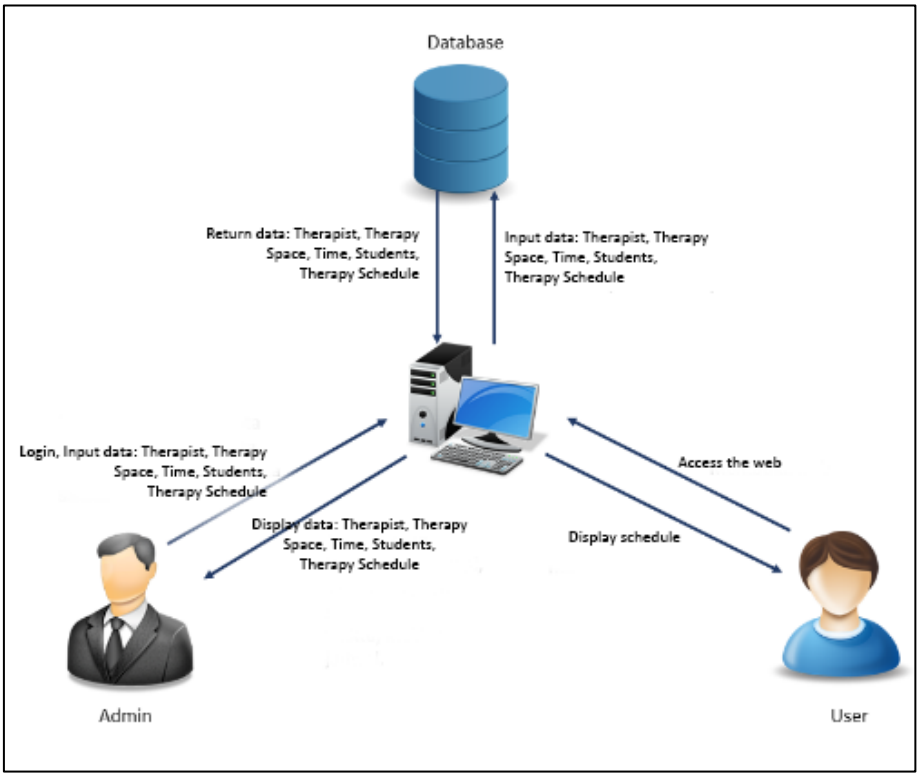


Figure 3. Description of the system.

In Figure 3, the patient registers with the admin, then the admin enters the patient's data. Patients can open the system to see the therapeutic schedule. While the admin can log in to the system to manage patient data therapist data, therapeutic data, room data, and time data. The admin can also manage the therapeutic schedule if the therapist is unable to attend, or the patient is absent. Note: Patient is called with Student.

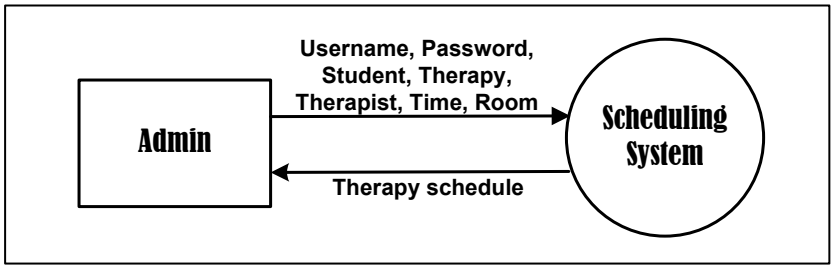


Figure 4. DFD level 0.

Figure 4 shows the zero level of data flow diagram which the admin send many data after login in order to get the schedule of therapy.

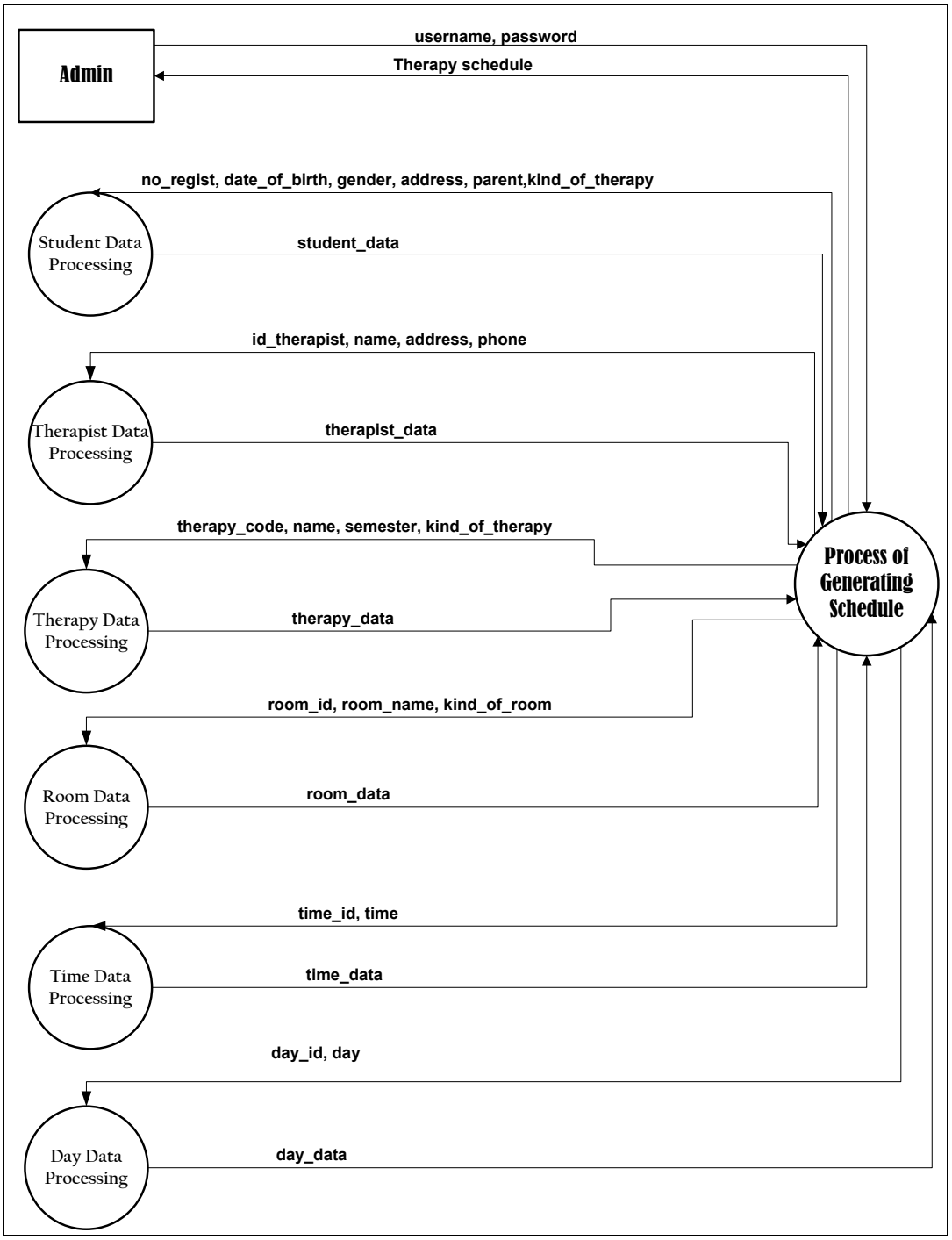


Figure 5. DFD Level 1.

Figure 5 has a number of data processing including process 1.1, processing student data where the admin adds the name of the student, address, gender, date of birth, telephone number, name of the guardian and therapy then the data will be stored into a database so that it can be generated by the system to produce a therapeutic schedule. Process 1.2 is the process of therapeutic data where the admin input the therapy data, semester, and type of therapy then the data will be stored into a database so that it can

be generated by the system to produce a therapeutic schedule. Process 1.3 is the process of therapist data where the admin enter the therapist's name, address, and telephone number then the data will be stored into a database so that it can be generated by the system to produce a therapeutic schedule. Process 1.4 is the process of room data where the admin input the name of the room and the type of room, then the data will be stored into a database so that it can be generated by the system to produce a therapeutic schedule. Process 1.5 is the data processing where the admin input hours and then the data will be stored into a database so that it can be generated to get the therapeutic schedule. Process 1.6 is day data process where the admin inserts the day data. Next, the data will be stored in a database so that it can be generated by the system to produce a therapeutic schedule.

4. Implementation and results

The Autistic Therapy Scheduling System uses genetic algorithms to display schedules automatically. First of all, all the data will be input for the scheduling process. The data contain therapeutic data, therapist data, hour data, day data, student data, time data which includes the time of available and unavailable therapists. From these data, chromosomes will be used as new data in the form of schedules. The processes of forming the data into a schedule are like below:

4.1. Initializing chromosomes

In this process, chromosome will be created and repeated as much as chromosome input. Microtime used as long as we need the time web to load. Syntax can be like this:

```
function generate_crommosom() {
      $numb = 0;
      while($numb < $this->num_crommosom) {
         $cro = $this->get_rand_crommosom();
         $this->crommosom[] = $cro;
         $this->fitness[] = 0;
         $numb++;
      }
```

4.2. Selection

In selection, gen will be chosen randomly but with one rule: the greater the value of fitness, then the greater the chance to be chosen. The syntax is displayed below:

```
function selection(){
      $this->console.="<h5>Seleksi generasi ke-$this->generation</h5>";
      $this->get_rand();
      $new_cro = array();
      foreach ($this->rand as $key => $val) {
         $k = $this->choose_selection($val);
         $new_cro[$key] = $this->crommosom[$k];
         $this->fitness[$key] = $this->fitness[$k];
         $this->console.="K[$key] = K[$k] \n";
      }
      $this->crommosom = $new_cro;
   }
```

4.3. Calculating the value of fitness

This stage is calculating the probability of every fitness. However, fitness value should be found first, The formula is fitness_value div total_fitness. The syntax is:

```
function calculate_all_fitness() {
      foreach($this->crommosom as $key => $val) {
         $this->calculate_fitness($key);
      }
   }
```

4.4. Cross-over

In this process, the value of crossover from two parent will be calculated. Before this stage, chromosome will be determined to become parent as much as crossover rate. The syntax could be like this:

```
if(!$this->success) {
            $this->get_com_pro();
            $this->selection();
            $this->show_crommosom();
            $this->show_fitness();
                  }
         if(!$this->success) {
            $this->crossover();
            $this->show_crommosom();
            $this->show_fitness();
         }
                  if(!$this->success) {
            $this->mutation();
            $this->show_crommosom();
            $this->show_fitness();
         }
```

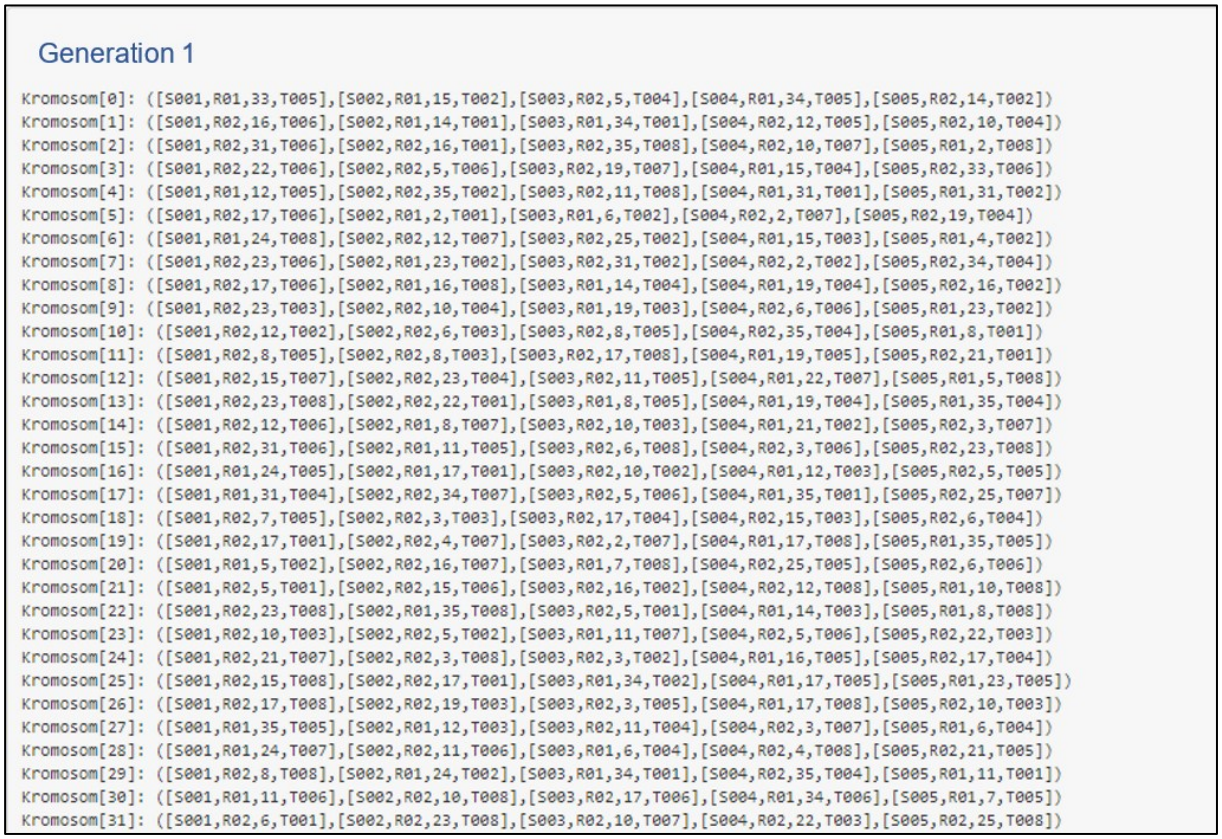
4.5. Mutation

Mutation is done according to percentage of Mutation Rate.

```
function mutation(){
      $mutation = array();
      $this->console.= "<h5>Mutasi generasi ke-$this->generation</h5>";
      $gen_per_cro = count($this->siswa);
      $total_gen = count($this->crommosom) * $gen_per_cro;
      $total_mutation = ceil($this->mutation_rate / 100 * $total_gen);
```

4.6. Result

Based on the process that already executed above, we will get the result like Figure 6 and Figure 7. The chromosome and fitness value below will be stored and used to create schedule for the sufferer.

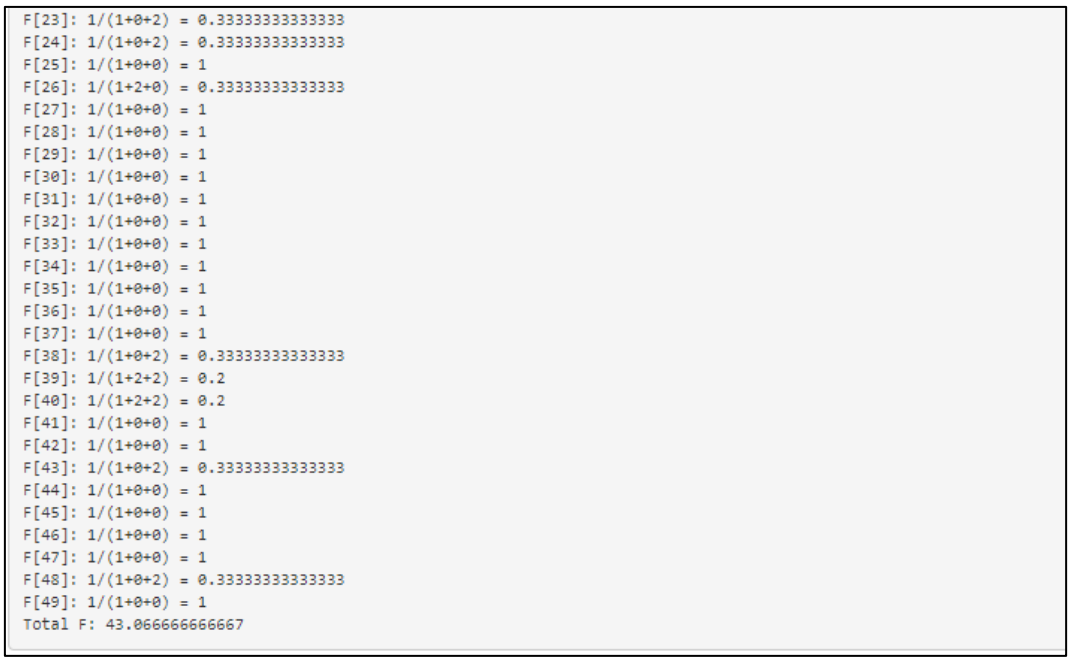


Generation 1

```
Kromosom[0]: ([S001,R01,33,T005],[S002,R01,15,T002],[S003,R02,5,T004],[S004,R01,34,T005],[S005,R02,14,T002])
Kromosom[1]: ([S001,R02,16,T006],[S002,R01,14,T001],[S003,R01,34,T001],[S004,R02,12,T005],[S005,R02,10,T004])
Kromosom[2]: ([S001,R02,31,T006],[S002,R02,16,T001],[S003,R02,35,T008],[S004,R02,10,T007],[S005,R01,2,T008])
Kromosom[3]: ([S001,R02,22,T006],[S002,R02,5,T006],[S003,R02,19,T007],[S004,R01,15,T004],[S005,R02,33,T006])
Kromosom[4]: ([S001,R01,12,T005],[S002,R02,35,T002],[S003,R02,11,T008],[S004,R01,31,T001],[S005,R01,31,T002])
Kromosom[5]: ([S001,R02,17,T006],[S002,R01,2,T001],[S003,R01,6,T002],[S004,R02,2,T007],[S005,R02,19,T004])
Kromosom[6]: ([S001,R01,24,T008],[S002,R02,12,T007],[S003,R02,25,T002],[S004,R01,15,T003],[S005,R01,4,T002])
Kromosom[7]: ([S001,R02,23,T006],[S002,R01,23,T002],[S003,R02,31,T002],[S004,R02,2,T002],[S005,R02,34,T004])
Kromosom[8]: ([S001,R02,17,T006],[S002,R01,16,T008],[S003,R01,14,T004],[S004,R01,19,T004],[S005,R02,16,T002])
Kromosom[9]: ([S001,R02,23,T003],[S002,R02,10,T004],[S003,R01,19,T003],[S004,R02,6,T006],[S005,R01,23,T002])
Kromosom[10]: ([S001,R02,12,T002],[S002,R02,6,T003],[S003,R02,8,T005],[S004,R02,35,T004],[S005,R01,8,T001])
Kromosom[11]: ([S001,R02,8,T005],[S002,R02,8,T003],[S003,R02,17,T008],[S004,R01,19,T005],[S005,R02,21,T001])
Kromosom[12]: ([S001,R02,15,T007],[S002,R02,23,T004],[S003,R02,11,T005],[S004,R01,22,T007],[S005,R01,5,T008])
Kromosom[13]: ([S001,R02,23,T008],[S002,R02,22,T001],[S003,R01,8,T005],[S004,R01,19,T004],[S005,R01,35,T004])
Kromosom[14]: ([S001,R02,12,T006],[S002,R01,8,T007],[S003,R02,10,T003],[S004,R01,21,T002],[S005,R02,3,T007])
Kromosom[15]: ([S001,R02,31,T006],[S002,R01,11,T005],[S003,R02,6,T008],[S004,R02,3,T006],[S005,R02,23,T008])
Kromosom[16]: ([S001,R01,24,T005],[S002,R01,17,T001],[S003,R02,10,T002],[S004,R01,12,T003],[S005,R02,5,T005])
Kromosom[17]: ([S001,R01,31,T004],[S002,R02,34,T007],[S003,R02,5,T006],[S004,R01,35,T001],[S005,R02,25,T007])
Kromosom[18]: ([S001,R02,7,T005],[S002,R02,3,T003],[S003,R02,17,T004],[S004,R02,15,T003],[S005,R02,6,T004])
Kromosom[19]: ([S001,R02,17,T001],[S002,R02,4,T007],[S003,R02,2,T007],[S004,R01,17,T008],[S005,R01,35,T005])
Kromosom[20]: ([S001,R01,5,T002],[S002,R02,16,T007],[S003,R01,7,T008],[S004,R02,25,T005],[S005,R02,6,T006])
Kromosom[21]: ([S001,R02,5,T001],[S002,R02,15,T006],[S003,R02,16,T002],[S004,R02,12,T008],[S005,R01,10,T008])
Kromosom[22]: ([S001,R02,23,T008],[S002,R01,35,T008],[S003,R02,5,T001],[S004,R01,14,T003],[S005,R01,8,T008])
Kromosom[23]: ([S001,R02,10,T003],[S002,R02,5,T002],[S003,R01,11,T007],[S004,R02,5,T006],[S005,R02,22,T003])
Kromosom[24]: ([S001,R02,21,T007],[S002,R02,3,T008],[S003,R02,3,T002],[S004,R01,16,T005],[S005,R02,17,T004])
Kromosom[25]: ([S001,R02,15,T008],[S002,R02,17,T001],[S003,R01,34,T002],[S004,R01,17,T005],[S005,R01,23,T005])
Kromosom[26]: ([S001,R02,17,T008],[S002,R02,19,T003],[S003,R02,3,T005],[S004,R01,17,T008],[S005,R02,10,T003])
Kromosom[27]: ([S001,R01,35,T005],[S002,R01,12,T003],[S003,R02,11,T004],[S004,R02,3,T007],[S005,R01,6,T004])
Kromosom[28]: ([S001,R01,24,T007],[S002,R02,11,T006],[S003,R01,6,T004],[S004,R02,4,T008],[S005,R02,21,T005])
Kromosom[29]: ([S001,R02,8,T008],[S002,R01,24,T002],[S003,R01,34,T001],[S004,R02,35,T004],[S005,R01,11,T001])
Kromosom[30]: ([S001,R01,11,T006],[S002,R02,10,T008],[S003,R02,17,T006],[S004,R01,34,T006],[S005,R01,7,T005])
Kromosom[31]: ([S001,R02,6,T001],[S002,R02,23,T008],[S003,R02,10,T007],[S004,R02,22,T003],[S005,R02,25,T008])
```

Figure 6. Awakening chromosome.

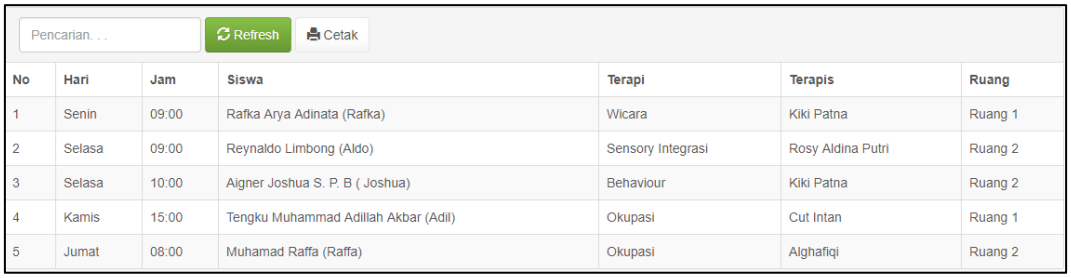
Figure 6 is the result of generating the chromosome, while Figure 7 is the result of Fitness Value.



```
F[23]: 1/(1+0+2) = 0.33333333333333
F[24]: 1/(1+0+2) = 0.33333333333333
F[25]: 1/(1+0+0) = 1
F[26]: 1/(1+2+0) = 0.33333333333333
F[27]: 1/(1+0+0) = 1
F[28]: 1/(1+0+0) = 1
F[29]: 1/(1+0+0) = 1
F[30]: 1/(1+0+0) = 1
F[31]: 1/(1+0+0) = 1
F[32]: 1/(1+0+0) = 1
F[33]: 1/(1+0+0) = 1
F[34]: 1/(1+0+0) = 1
F[35]: 1/(1+0+0) = 1
F[36]: 1/(1+0+0) = 1
F[37]: 1/(1+0+0) = 1
F[38]: 1/(1+0+2) = 0.33333333333333
F[39]: 1/(1+2+2) = 0.2
F[40]: 1/(1+2+2) = 0.2
F[41]: 1/(1+0+0) = 1
F[42]: 1/(1+0+0) = 1
F[43]: 1/(1+0+2) = 0.33333333333333
F[44]: 1/(1+0+0) = 1
F[45]: 1/(1+0+0) = 1
F[46]: 1/(1+0+0) = 1
F[47]: 1/(1+0+0) = 1
F[48]: 1/(1+0+2) = 0.33333333333333
F[49]: 1/(1+0+0) = 1
Total F: 43.066666666667
```

Figure 7. Fitness value.

Scheduling page is a scheduling menu that displays the genetic algorithm process by determining its value. On this page there is an option button that is used to change the value, then the schedule generate button is used to display the fitness value obtained from the process. This page can only be accessed by the admin.


Pencarian. . .
Refresh
Cetak

No	Hari	Jam	Siswa	Terapi	Terapis	Ruang
1	Senin	09:00	Rafka Arya Adinata (Rafka)	Wicara	Kiki Patna	Ruang 1
2	Selasa	09:00	Reynaldo Limbong (Aldo)	Sensory Integrasi	Rosy Aldina Putri	Ruang 2
3	Selasa	10:00	Aigner Joshua S. P. B (Joshua)	Behaviour	Kiki Patna	Ruang 2
4	Kamis	15:00	Tengku Muhammad Adillah Akbar (Adil)	Okupasi	Cut Intan	Ruang 1
5	Jumat	08:00	Muhamad Raffa (Raffa)	Okupasi	Alghafiqi	Ruang 2

Figure 8. Result of scheduling.

Figure 8 illustrates the results of scheduling after going through several algorithm stages where this schedule can be accessed by the admin and user.

5. Conclusions

The conclusion of this research is that the application of genetic algorithms can provide solutions to difficulties in determining a schedule that has a dynamic rhythm to the needs of autistic therapy at the autism service center. At the side of this achievement, further development is still needed in order that this schedule can be distributed directly to the parents of autistic students to improve the function of this service center in the community.

6. References

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