Faculty of Engineering & Technology – Electrical & Computer

Engineering Department

ARTIFICIAL INTELLIGENCE

- ENCS3340 -

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Section : 1

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The idea of the project :

The manufacturing plant has several machines that are used to complete a sequence of operations for each job. Each operation involves a group of machines, and each machine has a specific processing time. The goal of this project is to solve a scheduling problem to determine the optimal sequence and timing for each product in order to minimize the overall production time or maximize throughput, while considering the machine capacities and job dependencies.

This will be achieved by using a genetic algorithm to optimize the job shop scheduling in the manufacturing plant setting. The genetic algorithm is an optimization technique inspired by the process of natural selection. It will evolve a population of potential scheduling solutions, applying genetic operators like crossover and mutation, to iteratively improve the solutions and converge towards the optimal schedule.

Problem formulation :

- Population :

  The population in this project well be the jobs

- Chromosome :

  The Chromosome in this function the sequence for each job

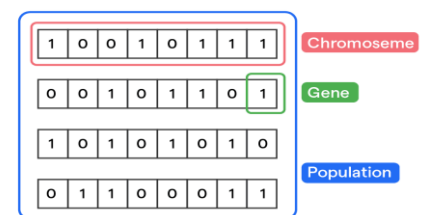 or the machines and the time for each machine for each job

Figure 1 - Genetic algorithm

the generation_initall_population ( ) function in the code , it have 2 list one for population and one for chromosome , first make for loop to but the operations in the chromosome list and use the job name to clarify the operations for each chromosome , then take operation for each chromosome randomly , finally add the chromosome to the population list and return the population.

- Fitness function

  The fitness function in this project well be based the total time for each job to end

The fitness function have three variable (EndOfTimeMachine , EndOfTimeJob , TotalTime), first it take the operation and the time of the operation , then it calculate the start time by get the max between EndOfTimeMachine and EndOfTimeJob , that mean when the machine is available and when the previous operation of the same job is finish, calculate the finish time (start time + time of machine) , and calculate the total time by get the max between total time and the finish time , finally return 1/ total time .

Cross over : Crossover is a genetic operator used to vary the programming of a chromosome or chromosomes from one generation to the next. Crossover is sexual reproduction. Two strings are picked from the mating pool at random to crossover in order to produce superior offspring. The method chosen depends on the Encoding Method.

In the code it compere the random generation with the cross over , if random generation > cross over return the tow parent if not , cut part from the 2 parents , first cut part from parent 1 and put it with the part from parent 2 that does not have the same part the cut from parent 1 , and then take part from part 2 from parent 1 , but only if those genes are not already in the child list , then the cross over well create 2 new child .

Mutation : may be defined as a small random tweak in the chromosome, to get a new solution. It is used to maintain and introduce diversity in the genetic population and is usually applied with a low probability .

In the code first it check if the probability of random generation chromosome is less than mutation probability , then it select 2 random unique indices from the rang of chromosome , then swap these 2 indices from the chromosome , then return the new chromosome .
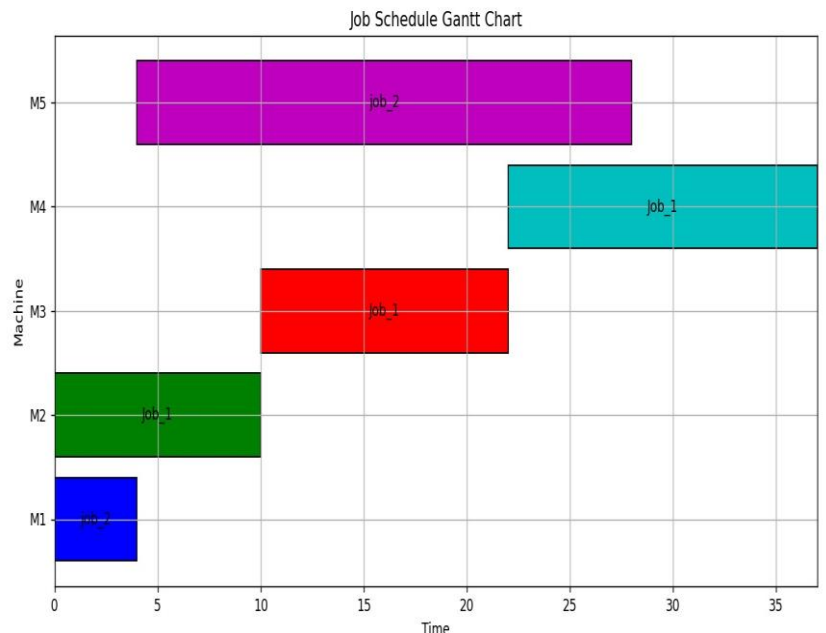
Test cases :

- Test (1) :

```
welcome, please enter the number of jobs: 2
sorry for annoying, please enter the number of machines:4
please enter the JobName of job 1: Job_1
please enter the number of operations for job 1: 3
please enter the machine number for operation 1 of job 1: 1
please enter the Time for operation 1 of job 1: 5
please enter the machine number for operation 2 of job 1: 2
please enter the Time for operation 2 of job 1: 6
please enter the machine number for operation 3 of job 1: 4
please enter the Time for operation 3 of job 1: 10
please enter the JobName of job 2: Job_2
please enter the number of operations for job 2: 3
please enter the machine number for operation 1 of job 2: 2
please enter the Time for operation 1 of job 2: 7
please enter the machine number for operation 2 of job 2: 3
please enter the Time for operation 2 of job 2: 15
please enter the machine number for operation 3 of job 2: 1
please enter the Time for operation 3 of job 2: 8
```
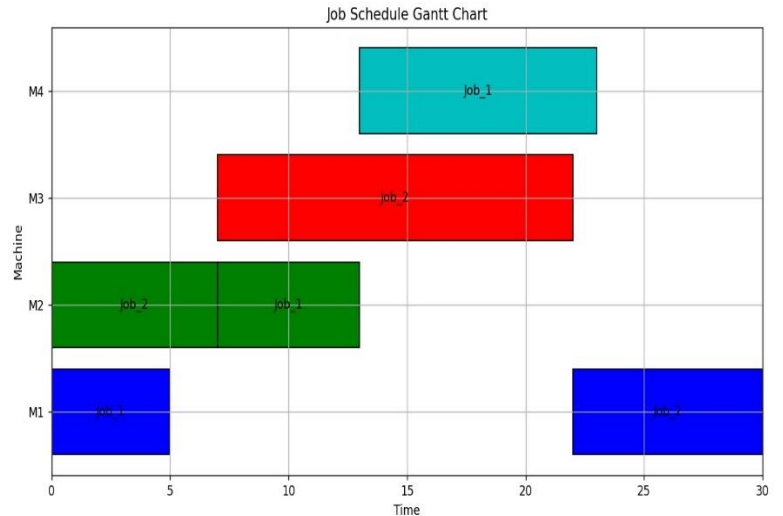

- Test (2) :

```
welcome, please enter the number of jobs: 2
sorry for annoying, please enter the number of machines:5
please enter the JobName of job 1: Job_1
please enter the number of operations for job 1: 3
please enter the machine number for operation 1 of job 1: 2
please enter the Time for operation 1 of job 1: 10
please enter the machine number for operation 2 of job 1: 3
please enter the Time for operation 2 of job 1: 12
please enter the machine number for operation 3 of job 1: 4
please enter the Time for operation 3 of job 1: 15
please enter the JobName of job 2: job_2
please enter the number of operations for job 2: 2
please enter the machine number for operation 1 of job 2: 1
please enter the Time for operation 1 of job 2: 4
please enter the machine number for operation 2 of job 2: 5
please enter the Time for operation 2 of job 2: 24
```

```
welcome, please enter the number of jobs: 3
sorry for annoying, please enter the number of machines:6
please enter the JobName of job 1: Job_1
please enter the number of operations for job 1: 4
please enter the machine number for operation 1 of job 1: 1
please enter the Time for operation 1 of job 1: 10
please enter the machine number for operation 2 of job 1: 2
please enter the Time for operation 2 of job 1: 2
please enter the machine number for operation 3 of job 1: 4
please enter the Time for operation 3 of job 1: 3
please enter the machine number for operation 4 of job 1: 3
please enter the Time for operation 4 of job 1: 10
please enter the JobName of job 2: job_2
please enter the number of operations for job 2: 3
please enter the machine number for operation 1 of job 2: 2
please enter the Time for operation 1 of job 2: 12
please enter the machine number for operation 2 of job 2: 1
please enter the Time for operation 2 of job 2: 11
please enter the machine number for operation 3 of job 2: 6
please enter the Time for operation 3 of job 2: 6
please enter the JobName of job 3: job3
please enter the number of operations for job 3: 2
please enter the machine number for operation 1 of job 3: 5
please enter the Time for operation 1 of job 3: 1
please enter the machine number for operation 2 of job 3: 6
please enter the Time for operation 2 of job 3: 2
```


Job Schedule Gantt Chart