Faculty of engineering and technology

Electrical and Computer Engineering
Department

Artificial Intelligence - **ENCS3340**

Project - 1

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Section: 1

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Problem Formulation:

Job Definition

Each job is defined as a sequence of operations, where each operation specifies a machine and the required processing time. The sequence of operations for a given job must be performed in the specified order. For example:

- **Job 1**: M1[10] -> M2[5] -> M4[12]
- **Job 2**: M2[7] -> M3[15] -> M1[8]

Machine Constraints

Each machine can process only one job at any moment. The goal is to schedule the jobs on available machines to optimize the overall production time.

Objective

The primary objective is to minimize the overall production time, also known as the fitness, which is the total time required to complete all jobs.

Genetic Algorithm:

Chromosome Representation

A chromosome represents a potential solution to the scheduling problem. Each chromosome consists of a sequence of job operations, ensuring the order of operations within each job is maintained.

```
'Operation', ['job_id', 'machine_id', 'duration']
```

Population Initialization

The initial population is generated by creating multiple random sequences of job operations. Each sequence represents a different potential schedule.

Fitness Function

The fitness function evaluates the quality of each chromosome by calculating the makespan(time period for done with the job). It considers the end times of operations on all machines and determines the maximum end time, which represents the total production time.

Crossover Mechanism

Crossover combines parts of two parent chromosomes to produce offspring. A random cut point is chosen, and the segments from two parents are exchanged to create two new offspring while ensuring valid job sequences are maintained.

Mutation Mechanism

Mutation introduces variations by randomly swapping two operations within a chromosome. This helps explore the solution space and prevents premature convergence to suboptimal solutions.

Implementation Details:

Code Structure

The project is implemented in Python using the following key components:

- **Job and Operation Classes**: Define the structure of jobs and their operations.
- **Genetic Algorithm Functions**: Include initialization, fitness calculation, crossover, mutation, and the main algorithm loop.
- **Input Handling**: Methods for reading jobs from a file or manually entering jobs.
- **Visualization**: Function to generate a Gantt chart for visualizing the schedule.

Input Handling

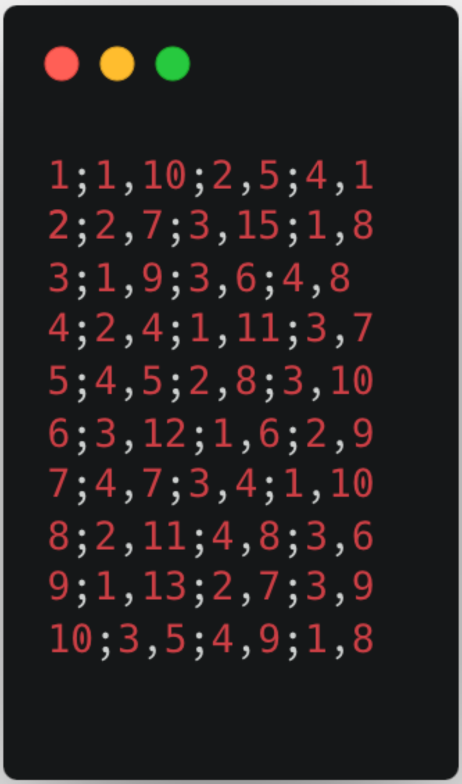
The system can read job information from a file or accept manual input. Each job's operations are specified in terms of machine ID and duration.

Visualization

The plot_schedule function generates a Gantt chart to visualize the schedule, showing the start and end times of operations on each machine.

Test Cases:

Test Case 1:



```
1;1,10;2,5;4,1
2;2,7;3,15;1,8
3;1,9;3,6;4,8
4;2,4;1,11;3,7
5;4,5;2,8;3,10
6;3,12;1,6;2,9
7;4,7;3,4;1,10
8;2,11;4,8;3,6
9;1,13;2,7;3,9
10;3,5;4,9;1,8
```

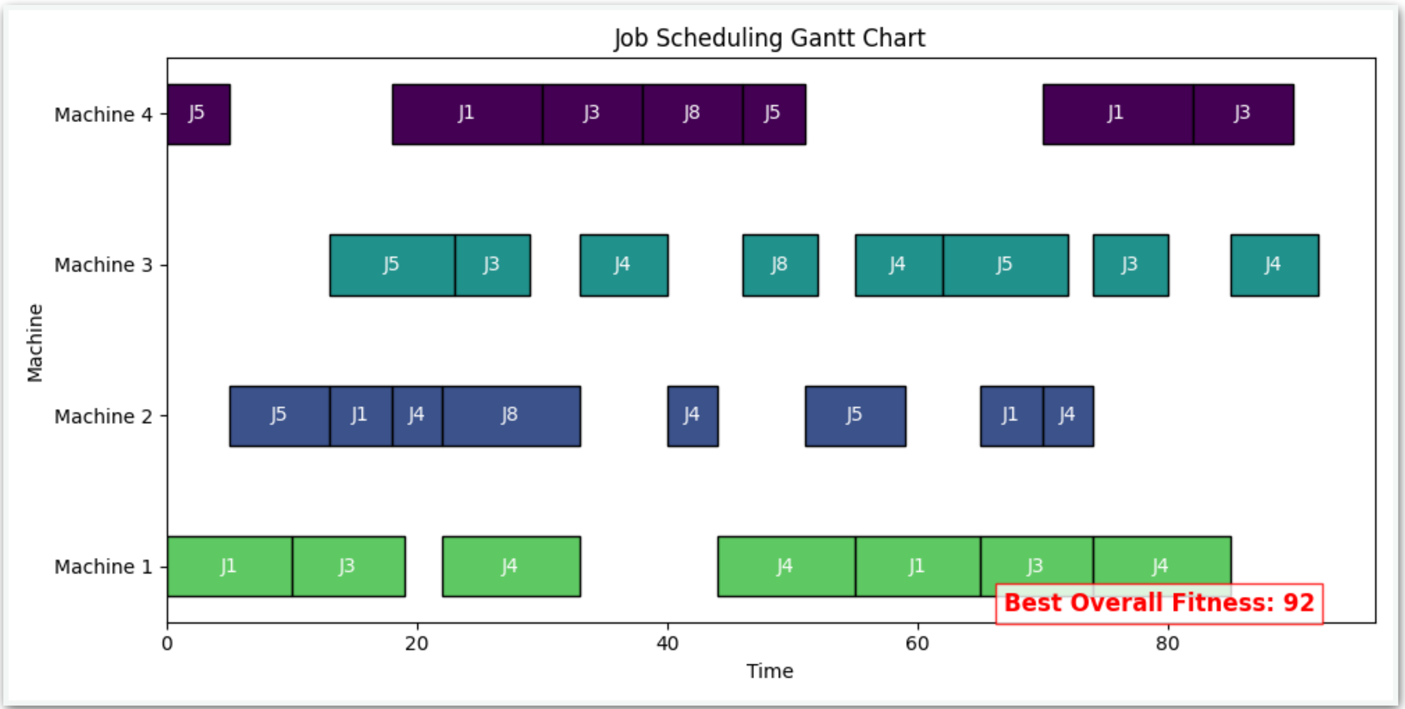
*Each line represents a job, and within each job, there are multiple operations.

for example the first line :

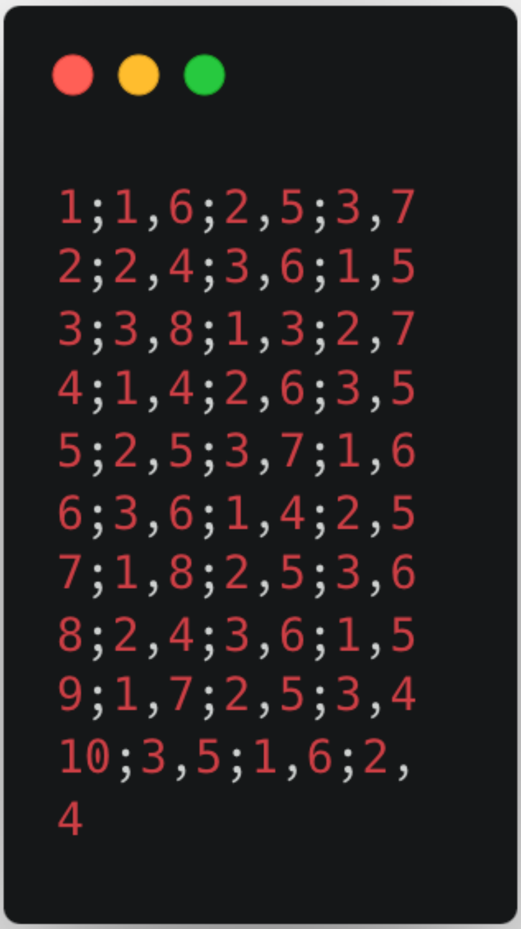
Job 1: 1;1,10;2,5;4,12

- **Job ID**: 1
- **Operations**:
- Operation 1: Machine 1, Duration 10
- Operation 2: Machine 2, Duration 5
- Operation 3: Machine 4, Duration 12

Result for Test Case1 :



Test Case 2:



```
1;1,6;2,5;3,7
2;2,4;3,6;1,5
3;3,8;1,3;2,7
4;1,4;2,6;3,5
5;2,5;3,7;1,6
6;3,6;1,4;2,5
7;1,8;2,5;3,6
8;2,4;3,6;1,5
9;1,7;2,5;3,4
10;3,5;1,6;2,
4
```

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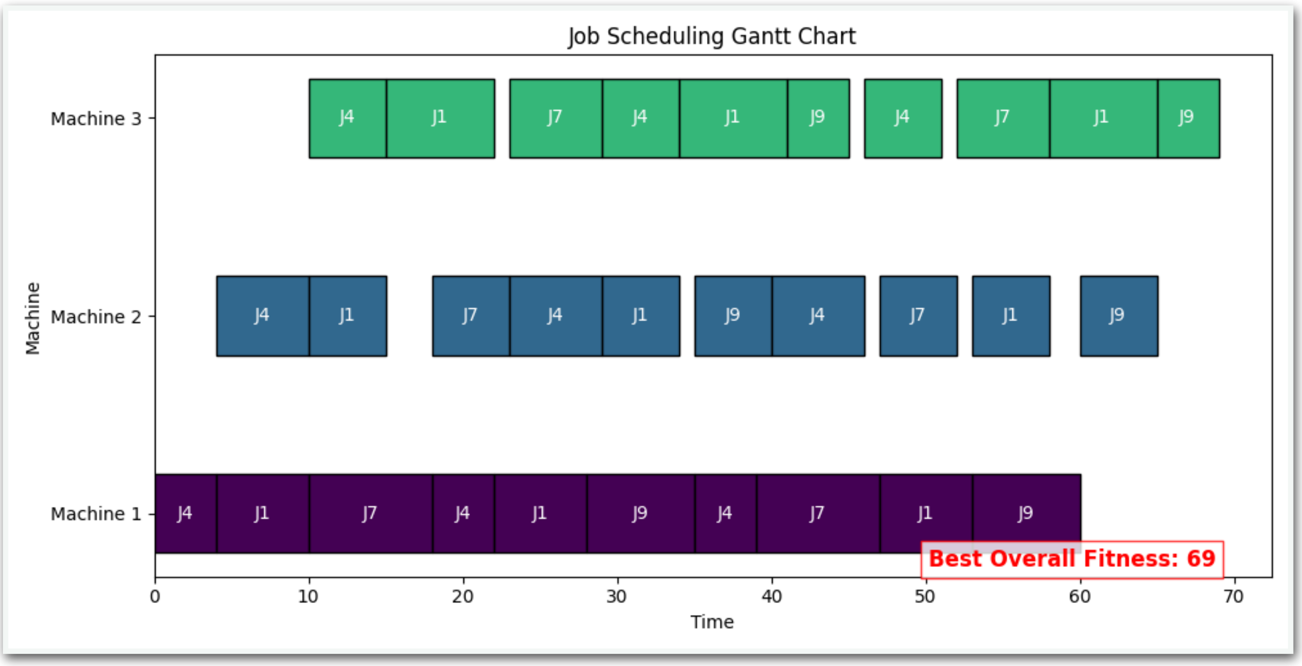
Result for Test Case1 :


Job Scheduling Gantt Chart
Machine
Machine 3
J4
J1
J7
J4
J1
J9
J4
J7
J1
J9
Machine 2
J4
J1
J7
J4
J1
J9
J4
J7
J1
J9
Machine 1
J4
J1
J7
J4
J1
J9
J4
J7
J1
J9
Best Overall Fitness: 69
Time