# Job Shop Scheduling

Term Project

# Definition

- **Job Shop Scheduling:** In manufacturing or production environments, genetic algorithms can be used <u>to optimize the scheduling of jobs</u> on machines, considering constraints such as processing times, machine availability, and precedence relationships between tasks.

- Genetic algorithms can be applied to find an optimal or near-optimal schedule for more complex instances of the Job Shop Scheduling problem, considering additional factors such as machine constraints, job priorities, and setup times between operations.

# Simple Problem Example

- Three machines (M1, M2, M3)

- Four Jobs (J1, J2, J3, J4)

- Objective: **Minimize the total completion time**

- **Constraits:**
  - Each machine can process only one operation at a time.
  - The order of operations within a job must be maintained.

```
Job    Operation    Machine    Processing Time (in minutes)
---------------------------------------------------------------
J1     A            M1         3
J1     B            M2         2
J1     C            M3         5

J2     A            M2         1
J2     B            M1         4
J2     C            M3         4

J3     A            M3         2
J3     B            M1         4
J3     C            M2         6

J4     A            M1         3
J4     B            M3         2
```

# Possible Solution

**Total Completion time: 19 minutes**

| Time | M1       | M2       | M3       |
|------|----------|----------|----------|
| 0    | J1A (3)  |          |          |
| 3    | J2B (4)  | J1B (2)  |          |
| 6    | J3A (4)  | J2A (1)  | J1C (5)  |
| 10   | J4A (3)  | J3B (4)  | J2C (4)  |
| 13   | J3C (6)  | J4B (2)  |          |
| 19   | J4C (4)  |          |          |

# Why using Genetic Algorithms?

- **Combinatorial Nature:** Job Shop Scheduling involves discrete decision variables: Genetic Algorithms are well-suited for combinatorial optimization problems, allowing for the exploration of discrete solution spaces without relying on specific mathematical formulations.

- **Flexibility**: encoding for schedules can done in many ways based on problem

- **Parallelization:** The parallel nature of GAs is advantageous, as multiple candidate schedules (individuals) can be evaluated simultaneously, leading to faster convergence.

- **Adaptability to Changes:** Job Shop Scheduling problems may have dynamic elements, such as changes in job priorities or unexpected machine breakdowns. GAs can adapt to such changes over time by continuously evolving the population, making them suitable for dynamic scheduling environments.

- Etc.