EAST WEST UNIVERSITY

Report on Assignment -2: Robot Task Optimization Using Genetic Algorithm

Submitted by,

Name: Farhan Tanvir

ID: 2020-1-60-132

Section: 03

Course Code: CSE 366

Spring 24

Computer Science & Engineering

Submitted to,

Dr. Md. Rifat Ahmmad Rashid

Assistant Professor, Dept. of CSE,

East West University.

Robot Task Optimization Using Genetic Algorithm

Introduction:

The Robot Assignment Problem involves allocating tasks to robots in a way that minimizes the total production time while balancing the workload across all robots. The optimization process is conducted using a Genetic Algorithm, which iteratively evolves a population of candidate solutions to find the best assignment of tasks to robots. In this report, we present a detailed analysis of how Genetic Algorithm optimization was employed to address the task assignment problem. The study explores the approach, implementation details, challenges encountered, and the insights gained from the optimization process.

Approach:

- ❖ **Problem Definition:** The task assignment problem involved allocating a set of tasks to available robots in a way that minimizes the total production time while ensuring a balanced workload among robots. Each task had a specific duration and priority, and each robot had a unique efficiency level.

- ❖ **Fitness Evaluation:** The fitness function was designed to evaluate the quality of each assignment based on the total production time and workload balance among robots. It considered task durations, priorities, and robot efficiencies to calculate the fitness of each assignment.

- ❖ **Genetic Algorithm:** The GA was chosen as the optimization technique due to its ability to efficiently explore large solution spaces and find near-optimal solutions. The GA iteratively evolves a population of potential solutions using selection, crossover, and mutation operators.

Implementation Details:

- ✓ **Data Generation:** Mock data for tasks and robots, including task durations, priorities, and robot efficiencies, was generated randomly to simulate real-world scenarios.

- ✓ **Genetic Algorithm Parameters**: Parameters such as population size, number of generations, tournament size, and mutation rate were carefully tuned to balance exploration and exploitation in the search space. These parameters significantly influenced the convergence speed and solution quality of the GA.

- ✓ **Fitness Function:** The fitness of each individual in the population was evaluated using the defined fitness function. Individuals with higher fitness values were more likely to be selected for reproduction in subsequent generations. We evaluated fitness function by sum of max total production time and workload of individuals.

- ✓ **Selection, Crossover, and Mutation:** Tournament selection, single-point crossover, and mutation operators were implemented to evolve the population across generations. These operators played crucial roles in maintaining diversity and driving the search towards promising regions of the solution space. In tournament selection a total of 50 tournaments took place and we choose the tournament size 10. From each tournament the individual with the lowest fitness decided as winner. We have excused crossover randomly and mutation based on mutation rate (20% mutation rate).

Output:

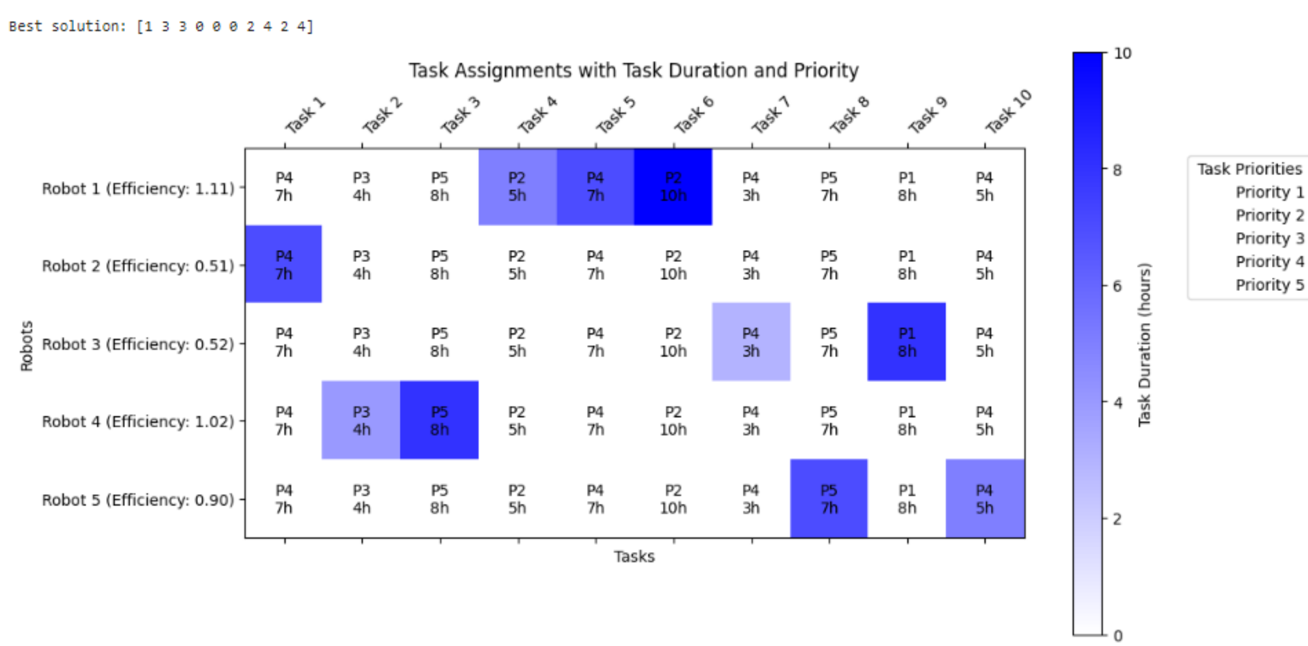

Figure: Best Solution

Comprehensive Analysis of Results

- **Effect of Robot Efficiency and Task Priority**: The optimization process revealed the significant impact of robot efficiency and task priority on the assignment quality. Higher robot efficiencies resulted in shorter production times, while task priorities influenced the distribution of workload among robots.

- **Workload Distribution:** Analysis of workload distribution highlighted the importance of balancing workload among robots to prevent bottlenecks and optimize overall production efficiency. Imbalances in workload could lead to suboptimal performance and resource underutilization.

- **Optimization Implications:** The GA facilitated the identification of task assignments that minimized production time and balanced workload effectively. The optimized assignments had implications for enhancing production efficiency, resource utilization, and overall operational performance.

Challenges

Finding optimal values for GA parameters proved challenging, as different parameter combinations had varying effects on convergence speed and solution quality. Balancing exploration and exploitation while avoiding premature convergence was a key challenge.

Conclusion:

The Genetic Algorithm proved effective in optimizing task assignments by minimizing production time and balancing workload among robots. Despite challenges in parameter tuning, the GA provided valuable insights and near-optimal solutions. The findings also underscore the importance of considering task priorities and robot efficiencies in task assignment optimization