# Robot Task Optimization Using Genetic Algorithm

**Introduction:** In dynamic production environments, the assignment of tasks to robots plays a critical role in optimizing production time and ensuring efficient resource utilization. This report discusses the development and implementation of a Genetic Algorithm (GA) aimed at optimizing task assignments for multiple robots. The primary objectives include minimizing total production time, balancing workload across robots, and effectively prioritizing critical tasks.

**Problem Overview:** The problem entails assigning a set of tasks, each with its duration and priority, to a pool of robots characterized by unique efficiency factors. The production environment is dynamic, implying that tasks and priorities may change over time. The goal is to develop a GA that optimizes task assignments, considering task duration, robot efficiency, and task priority.

**Approach and Implementation:**

- **Data Preparation:** Mock data for tasks (including durations and priorities) and robots (including efficiency factors) is generated using NumPy.
- **GA Implementation:** The GA is implemented with the following components:
  - **Individual Representation:** Each potential solution is represented as a vector, where each element indicates the robot assigned to each task.
  - **Fitness Function:** A fitness function is defined to minimize total production time and workload balance while incorporating task priorities.
  - **Selection, Crossover, and Mutation:** Tournament selection, single-point crossover, and task swapping mutation operations are implemented to evolve the population towards optimal solutions.
- **Visualization:** A grid visualization is created to illustrate task assignments, highlighting key information such as task duration, robot efficiency, and task priority.

**Analysis:**

- **Impact of Robot Efficiency and Task Priority:** The GA successfully optimizes task assignments, demonstrating how robot efficiency and task priority influence the optimization process. Higher efficiency robots tend to be assigned tasks with longer durations, while critical tasks are prioritized appropriately.
- **Workload Distribution:** The workload among robots is balanced effectively, ensuring no robot is significantly overloaded. However, further optimization may be possible by fine-tuning parameters such as tournament size and mutation rate.

**Conclusion:** In conclusion, the developed GA effectively optimizes task assignments in dynamic production environments, considering task duration, robot efficiency, and task priority. Visualization provides insights into the optimized assignments, aiding in decision-making processes. Future work could involve exploring additional optimization techniques and parameter tuning to further enhance efficiency and adaptability in diverse production environments.