UNIVERSITI PUTRA MALAYSIA

BERILMU BERBAKTI

FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

GROUP PROJECT

OPTIMAL SCHEDULING OF DRONE DELIVERIES IN A SMART CITY

COURSE NAME : **DESIGN AND ANALYSIS OF ALGORITHM**
CODE : **CSC4202**
GROUP : **6**
LECTURER NAME : **DR. NUR ARZILAWATI BINTI MD YUNUS**

GROUP MEMBERS :

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Project Proposal Refinement (week 11, submission date: 7 June 2023)

<table>
<tr><td>Group Name</td><td>PowerPuffBoys</td></tr>
<tr><td>Members</td><td>
<table>
<tr><th>Name</th><th>Role</th></tr>
<tr><td>MUHAMMAD ZAHIN BIN MAHAT</td><td>Leader</td></tr>
<tr><td>MUHAMMAD NURI BIN MOHD ALI</td><td>Software Developer</td></tr>
<tr><td>MUHAMMAD FARHAN</td><td>Project Designer</td></tr>
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<tr><td>Problem statement</td><td>In the smart city of Shenzhen, a drone delivery service has been implemented to streamline package deliveries. The city is divided into different sectors, and each sector has a set of delivery points that drones must visit. Each drone has a limited battery life that can support a maximum number of delivery points before it needs to return to the base for recharging. Additionally, each package has a specific delivery time window during which it must be delivered. The challenge is to schedule the drones so that all packages are delivered within their respective time windows while minimizing the total distance traveled by the drones.</td></tr>
<tr><td>Objectives</td><td>· Minimize the total distance traveled by the drones.

· Ensure all packages are delivered within their specified time windows.

· Optimize the utilization of available drones to reduce the need for additional resources.

· Develop a scalable solution that can handle increasing delivery demands as the city grows.</td></tr>
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Expected output	· An optimized set of delivery routes for drones. · A minimized total travel distance for all drones. · Verification that all packages are delivered within their respective time windows. · A Java program implementing the solution. · Analysis of the solution's efficiency and scalability.
Problem scenario description	In Shenzhen, the implementation of a drone delivery service requires efficient scheduling and routing to ensure timely deliveries. Each sector of the city contains multiple delivery points, and drones must operate within battery life constraints. Each package has a delivery time window that must be respected. The complexity of the problem arises from the need to optimize routes to minimize travel distance while adhering to these constraints.
Why it is important	· Reducing the total distance traveled by drones lowers energy consumption and extends battery life, which is crucial for sustainability and cost-effectiveness. · Timely deliveries within specified time windows increase customer satisfaction and trust in the service. · Optimal drone scheduling and routing reduce the need for additional drones, lowering operational costs. · An efficient system can handle increased delivery demands as the city expands, ensuring long-term success.
Problem specification	· The city is modeled as a graph where nodes represent delivery points and edges represent paths with distances. · Each delivery point has a specific time window for delivery. · Drones have a maximum number of delivery points they can visit before needing to return for recharging. · The goal is to minimize the total distance traveled while ensuring all deliveries are made within their time windows.

Potential solutions	· Sorting · Divide and Conquer · Dynamic Programming (DP) · Greedy Algorithms · Graph Algorithms
Sketch (framework, flow, interface)	**Framework** · Use DP to manage overlapping subproblems and graph algorithms for shortest path calculation. · Nodes represent delivery points; edges represent distances between points. · Define a state where u is the current node and mask is a bitmask of visited nodes. **Flow** ● Initialize DP table with high values (INF). ● Set the starting point (base) with dp[base][1 << base] = 0. ● Iterate over all subsets of delivery points, updating the DP table for minimal distances. ● Extract the optimal route and calculate the minimum distance to visit all points and return to the base.

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<td>Methodology</td>
<td>Steps :

1. Problem Definition and Requirements Gathering
2. System Design and Algorithm Development
3. Implementation
4. Simulation and Testing
5. Evaluation and Optimization
6. Documentation

<table>
<tr><td>Milestone</td><td>Time</td></tr>
<tr><td><eg: scenario refinement></td><td>wk10</td></tr>
<tr><td><eg: find example solutions and suitable algorithm. Discuss in group why that solution and the example problems relate to the problem in the project></td><td>wk11</td></tr>
<tr><td><eg: edit the coding of the chosen problem and complete the coding. Debug></td><td>wk12</td></tr>
<tr><td><eg: conduct analysis of correctness and time complexity ></td><td>wk13</td></tr>
<tr><td><prepare online portfolio and presentation></td><td>wk14</td></tr>
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Project Progress (Week 10 – Week 14)

Milestone 1	Scenario Refinement
Date (week)	week 10
Description/ sketch	**Test Scenarios:** Create various scenarios to simulate different delivery demands, battery levels, and environmental conditions. **Simulation:** Develop simulations to understand potential real-world challenges and refine the problem definition accordingly.

Milestone 2	Find Example Solutions and Suitable Algorithms
Date (Wk)	week 11
Description/ sketch	**Solution Exploration:** Identify example solutions and suitable algorithms, such as dynamic programming. **Group Discussion:** Discuss in teams why the chosen solutions and example problems relate to the project's objectives and constraints. **Decision Making:** Select the most appropriate algorithms based on group consensus and alignment with project goals.

Milestone 3	Edit and Complete Coding, Debug
Date (Wk)	week 12
Description/ sketch	**Coding Completion:** Finalize the coding of the chosen solution, ensuring all necessary functionalities are implemented. **Debugging:** Systematically debug the code to eliminate errors and ensure smooth operation.

Milestone 4	Conduct Analysis of Correctness and Time Complexity
Date (Wk)	week 13
Description/ sketch	**Correctness Analysis:** Verify that the implemented algorithms produce accurate and reliable results. **Time Complexity:** Evaluate the time complexity of the algorithms to ensure they meet the performance requirements for real-time operation.

Milestone 5	Prepare Online Portfolio and Presentation
Date (Wk)	week 14
Description/ sketch	**Documentation:** Prepare comprehensive documentation of the project, including objectives, methodologies, algorithms, and results. **Portfolio Creation:** Develop an online portfolio showcasing the project's progress, simulations and results. **Presentation:** Create a presentation to communicate the project's findings.