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Drone Delivery

Metaheuristics for Optimization Problems

Artificial Intelligence

Integrated Masters in Informatics and Computer Engineering

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Specification

Given a fleet of drones, all with a determined finite capacity, a list of customer orders and availability of the individual products in warehouses, schedule the drone operations so that the orders are completed as soon as possible.

All drones start from the same warehouse and will pick up items from that warehouse that will be delivered to customers or other warehouses.

Not all orders have to be fulfilled.

The problem can be interpreted as a **Vehicle Routing Problem (VRP)**.

Related Work

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- Google HashCode problem statement:
  https://storage.googleapis.com/coding-competitions.appspot.com/HC/2016/hashcode2016_qualification_task.pdf
- Kaggle competition:
  https://www.kaggle.com/c/hashcode-drone-delivery/code?competitionId=22040
- Articles about the CVRPPAD:
  https://link.springer.com/content/pdf/10.1007/s10479-017-2722-x.pdf
  https://www.sciencedirect.com/science/article/pii/S0957417420307429
- Toth, P., Vigo, D., (2002). The Vehicle Routing Problem. SIAM

Problem Formulation

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Evaluation function: For an order completed in turn *t* and a simulation taking *T* turns in total, the score for the order is calculated as $(T - t) / T \times 100$, rounded up to the next integer. The score of a simulation is the sum of the score of all orders. An unfulfilled order has score 0.

Rigid constraints:

- Drones cannot carry more than their capacity;
- Each drone's operations cannot exceed the maximum number of turns;
- Drones can only load products in Warehouses;
- Drones cannot load more products than are available at a Warehouse;
- Drones can only deliver or unload products that they are carrying.

Problem Formulation

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Solution representation:

Drone	1	1	5	6	5
Quantity	8	-8	3	2	-2
Product	1	1	2	2	2
Node	W1	O1	W1	W2	O2

...

Neighborhood/mutation and crossover functions:

Mutations:

- Change the drone that performs an operation;
- Swap two genes;
- Split a gene into two;
- Change the node of a gene;
- Inactivate/activate a gene.

Crossover:

- Swap segments from two parent chromosomes.

Work Already Done

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Programming language: **Python**

IDE: **IntelliJ/VSCode**

Data structures:

- Python classes for the various problem entities
- Lists for storing the problem domain and the solution (list of drone commands)
- Graph that represents the map

File structure: specified in the HashCode problem statement.

Implemented:

- File parsing