Drone grocery delivery

A PDP problem

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Drones / UAV’s

- Two kinds:
  - Lightweight drone (based on DJI matrice 100)
    - Payload: +- 3.5 kg
    - Battery life: 40 min
    - Charging time: 78 min
    - Speed: 17 - 22 m/s
    - Range: 5 km
  - Heavyweight drone (based on Freefly Alta 8)
    - Payload: 9 kg
    - Battery life: 25 min
    - Charging time: 105 min
    - Speed: 11 - 22 m/s
    - Range: 3-4 km

- Speed scales linearly with load

The task at hand

1. Customer orders groceries (requests)
2. Order is composed at the specified supermarket (+- 5 min)
3. Parcel is done:
    a. Pickup window
        i. Depending on the kinds of purchased goods
    b. Drone flies to destination
        i. Taking into account the battery life and load capacity
    c. Drone drops parcel at the customer's house
        i. Depending on the timeframe specified by the customer

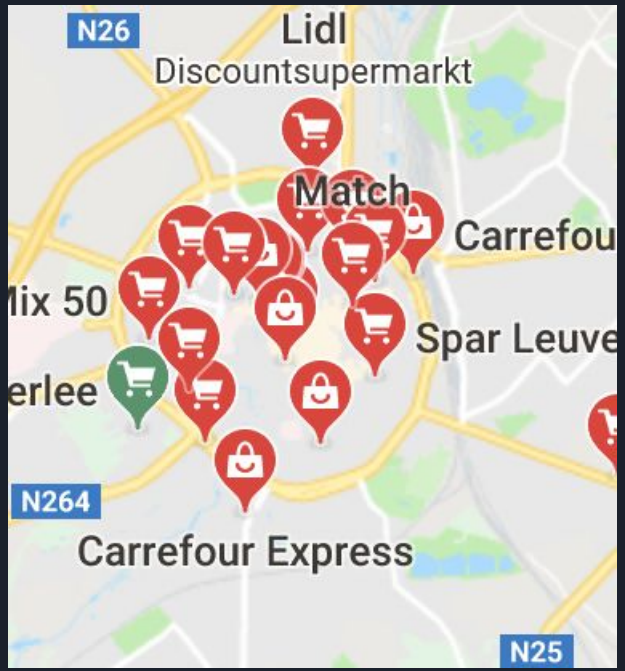
Possible expansions

Depending on the project progress:

- Prioritized parcels
- Combining parcels
- Dealing with drone crashes

Scale

- Leuven city
  - Different stores
  - A charging station
- Bird's eye view
- Number of drones:
  - Standard 30 drones
    - 20 lightweight
    - 10 heavyweight



Routing for charging point

- Information about central charging point
  - Coordination
  - Occupation
- Charging point
  - Several chargers for each kind of drone
  - 5 chargers light weight
  - 5 chargers heavy weight

Delegate MAS and BDI

- Each drone has 2 types of ants
- Feasibility ants
  - ≈ charging ants
    - responsible for sending information to the charging point
- Intention ants
  - ≈ pickup ants
    - responsible for communicating with parcels
  - Parcel analyzes incoming intention ants
    - wait a couple of ticks
    - decide which ant/drone to use depending on current pdp window
      - intention ant returns with decision (pickup or discard)

Dynamism

- Depending on load
  - Increase # drones
  - Decrease # drones
- Request arrivals
  - Poisson?
  - Uniform randomly distributed?
  - Fixed rate?

Research objectives

1. Study if a drone PDP method is a suitable solution for grocery delivery.

2. Study the effect of increasing/decreasing the amount of drones on the performance.

3. Investigate the performance of drone types.

Research questions for objective 1

1. What is the percentage of orders delivered on time during normal circumstances?
   - H_0: Less than 80% of the orders are delivered in time during normal circumstances.
   - H_1: At least 80% of the orders are delivered in time during normal circumstances.

2. What is the average delivery time of an order during normal circumstances?
   - H_0: The average time of delivery is 2 minutes or more.
   - H_1:The average time of delivery is less than 2 minutes.

3. How high is the average occupation at the charging station?
   - H_0: The average occupation of the charging station is at most 95%.
   - H_1: The average occupation of the charging station is greater than 95%.

4. If a parcel is delivered too late, what is the average time the parcel is overdue?
   - H_0: The average latency is larger than 1 minute.
   - H_1: The average latency is smaller than 1 minute.

Research questions for objective 2

1. How different is the average delivery time when using an increased amount of drones?
   - H_0: When using 10 additional drones, the average delivery time will increase.
   - H_1: When using 10 additional drones, the average delivery time will decrease.

2. What is the effect of more drones on the coordination at the charging station?
   - H_0: When using 10 additional drones, the occupation of the charging station remains the same or lower.
   - H_1: When using 10 additional drones, the occupation of the charging station increases.

3. What is the occupation of each drone individually when a large amount of drones is used?
   - H_0: When using 100 drones, the occupation of each drone will be at least 50% or higher.
   - H_1: When using 100 drones, the occupation of each drone will be at lower than 50%.

Research questions for objective 3

1. Does the lightweight drone provide a lower average delivery time?
   - H_0: The heavyweight drone provides a lower average delivery time compared to the lightweight model.
   - H_1: The lightweight drone provides a lower average delivery time compared to the heavyweight model.

2. What kind of drone has the highest amount of packages that are too late?
   - H_0: The lightweight drone delivers the highest percentage of packages too late.
   - H_1: The heavyweight drone delivers the highest percentage of packages too late.

3. What kind of drone reduces the stress on the charging station the most?
   - H_0: The heavyweight drone puts less stress on the charging station compared to the lightweight model.
   - H_1: The lightweight drone puts less stress on the charging station compared to the heavyweight model.