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Shipping optimization for an online store using Google OR-Tools

Specifications

V.1.0.0

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N° revision	Date	Description
0.1.0	3 October 2023	Initial prototype
0.2.0	10 October 2023	First corrections and added the planning
1.0.0	13 October 2023	Final version

Contents

1 Context

Enterprise-XY is a online supermarket that does deliveries of groceries and other goods directly to the homes of customers. Currently they have warehouses where they prepare the packages for delivery and then send them to third party delivery services (like Post) for the ”last mile”. Enterprise-XY wants to expand into doing some of the deliveries themselves for the customers that live close to warehouses provided it is cheaper than having to send these packages through third parties.

For direct delivery of packages (not through third parties) they have a certain number of vans that can carry a certain number of packages. Orders also have a time window in which the order needs to be delivered. To organize the delivery of these packages at the correct location and time in an efficient manner, Enterprise-XY needs an application that is able to plan the route for delivery of packages.

In an earlier semester project an application that generates a distance and travel time matrix between ZIP codes in Switzerland has been implemented. During that project a naive implementation of a program that can plan the deliveries has also been created.

The idea of this project is to use the Google OR tools library to make a fast and efficient application, building on the work that was made during the earlier project. The OR tools is made for constraint programming and has a dedicated module for VRP (Vehicle routing problem). Enterprise-XY has provided access to some order data and a description and the constraints of the problem.

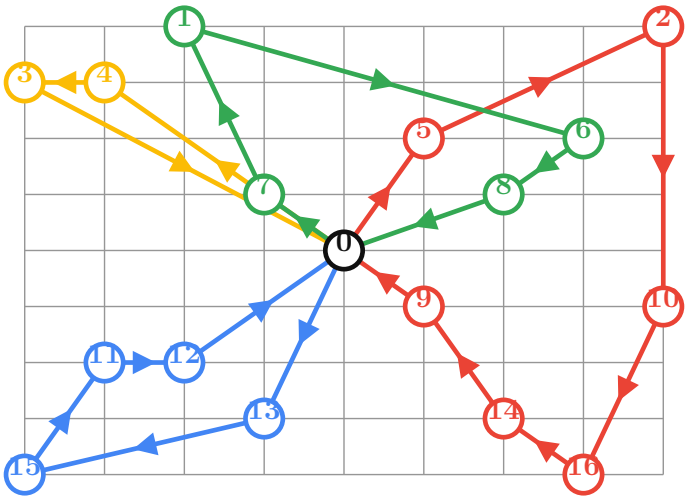

Figure 1: Example of the VRP

2 Goals

The primary goals of this project are the following:

- The main objective is to realize a solver/planner based on OR-Tools: a program where our problem model is fully expressed using OR-Tools constructs, which is able to import the problem instance from the available data files (orders, distance matrix etc.), and somehow output the solution with its associated cost.
- Test out the algorithm on test data and evaluate to what extent the program is able to find high-quality solutions in reasonable time, and compare it to the naive algorithm implemented during the previous project.
- Design a possible approach, identifying the needed components for a expanded model with real addresses. Right now the model that is used for the project is simplified, it doesn't use the full addresses of the customers but only the ZIP code.

If the planned tasks are completed faster than expected, the following secondary goals could be implemented:

- Include a visual representation of the solutions on a map to help the van drivers to see where they have to go. It can also help us to see if a solution makes intuitive sense and maybe allows us to visualize the solution strategy used.
- Implement the components (or some of them) needed to make the application be able to plan routes with full addresses

3 Tasks

To achieve the above-mentioned goals the following tasks need to be carried out:

- Explore the code base of the previous project
- Precisely describe the model (constraints, variables, parameters and cost function) of the problem and the structure of the data files provided
- Implement a first version of the planner without considering the capacity or time window constraints
- Implement the automated tests with randomly generated data, and test cases
- Implement the capacity and time window constraints
- Evaluate the planner by testing different Google OR-Tools solution strategies and compare them to the naive algorithm of the previous project
- Design a possible approach to the extended problem model
- Make a technical documentation for the project containing:
  - An analysis that describes the problem model and the approach of the algorithm developed during the previous project
  - A design for the application structure and behaviour and the test cases
  - A chapter that describe the implementation of the application
  - A user manual of how to use the application

4 Planning

See next page.

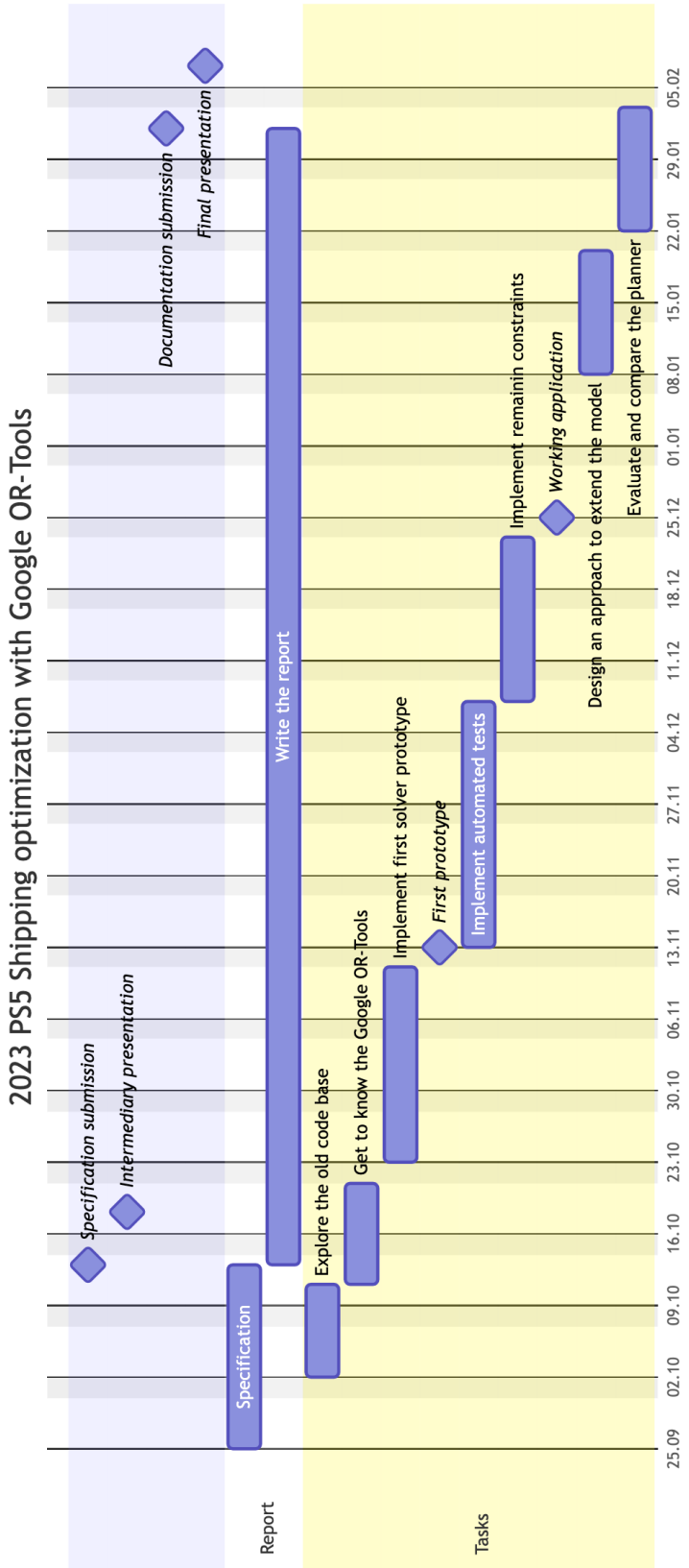

Figure 2: Gantt diagram of the planning