# ENGSCI 263 2019: OR Project Description
# Truck Scheduling for Foodstuffs

Foodstuffs operates the New World, Pak 'n Save and Four Square supermarket chains. Each supermarket needs to receive goods daily to ensure that their shoppers' needs can be met. The company operates a fleet of 10 trucks in order to move these goods from their central distribution warehouse in Mt Roskill to their supermarkets around Auckland.

On each day, each supermarket receives pallets of goods from Foodstuffs based on both regular orders (e.g. cereal) and Foodstuffs' proactive monitoring of inventory levels. Therefore, the number of pallets shipped to each store differs each day. For this model, we will work in units of pallets, and we will not differentiate between different product categories.

Foodstuffs' trucking division transports the goods from the central distribution warehouse to the stores. Each truck can carry up to 12 pallets of goods, and operates on a trip schedule that will have each truck deliver goods to a selection of stores, and return to the warehouse. Once at the store, a pallet takes on average 5 minutes to unload. Current Foodstuffs policy requires each scheduled trip take no more than four hours, on average, to complete; this includes both driving time and unloading time. Each truck costs $150 per hour to operate and can operate two (approximately) four-hour shifts per day. You may assume that the two shifts start at 8am or 2pm, and that each store only receives one delivery per day.

However, traffic conditions on Auckland roads are not always ideal, so the driving time required may well be longer or shorter depending on the time of day. This means some trucks may take more than four hours to complete their trip. In such cases, the extra time costs Foodstuffs $200 per hour.

On days where there are not sufficient trucks to satisfy all demand, either because of a shortage of truck time or an excess in store demand for pallets, additional trucks can be 'wet-leased' (vehicle rental that includes a driver) from Mainfreight for a cost of $1200 for every four hours of on-duty time, charged in four-hour blocks. Foodstuffs would ideally like to minimise the use of these leased trucks where possible. However, Foodstuffs policy is that if a leased truck delivers pallets to a store, then the leased truck should ship all the required pallets for that store.

Foodstuffs would like to determine the best way to route each truck such that total transportation costs are minimised. They have provided you with the number of pallets delivered to each store they operate over a 4 week period, and also the GPS coordinates of each store.

## Part I

1. Analyse the data provided to develop an appropriate estimate of the number of pallets required at each store on each day.
2. Create a set of possible feasible trucking routes that satisfy the requirements given.
3. Formulate and solve a mixed-integer program to find the least-cost routing schedule for the truck fleet. Leased trucks should not be used unless absolutely required.

## Part II

4. Create visualisation(s) of your proposed trucking routes, suitable for presentation to management.
5. Evaluate the quality of your schedule by creating a simulation to estimate the actual cost of satisfying all pallet demand at each store. Your simulation should take into variations in demand and sensibly approximate the effect of traffic. Hence, give an estimate of the cost of operating your proposed routing schedule.
6. Discuss the impact of aspects of the problem that were not explicitly modelled in your formulation, and its impact on the cost of operating the trucking schedule that you have proposed.
7. What are your recommendations to Foodstuffs after conducting this study?

Note: this project does not have just one correct answer!

## Deliverables

### Group Model Report (5%)

**Due Friday 11 October, 1:30pm**.

Your group should submit a document that addresses Part I of the project description. This document should focus on your modelling and analysis of the problem and the assumptions made in formulating your model. It should be no longer than 5 × A4 sides. The document does not need to be in a formal report form (i.e. introduction / conclusions are not required). Appropriate visualisations are expected.

**Your group should also submit the code used for points 2 and 3, above, in a zip file.**

### Lab 6 (3.33% - Group Submission)

**Due Friday 17 October, 1:30pm.**

In your group, produce appropriate visualisation(s) of:

- proposed trucking routes
- simulation results in terms of cost of operation or other relevant metrics.

Interpret your visualisations and make appropriate comments. Submit this as a PDF document to Canvas. These do not have to be your final results!

### Individual Report (12%)

**Due Wednesday 23 October, 1:30pm.**

The individual report should cover all aspects of your model, with particular emphasis on Part II of the project description. You may appendicise parts of your Group Model Report that you refer to in the report.

The report must be in an engineering report format suitable for presentation to management (who have a good OR / Analytics expert on their team, so some technical language can be used).

This will be in formal report form and will be no more than 6 × A4 sides (12pt Times New Roman) from introduction to conclusions, i.e. not including front-matter (cover/title page, table of contents, executive summary etc.) and back-matter (appendices, references, bibliography etc.).

The page limit may not give you enough room for a detailed description of any models (code, worksheets, data, plots, other visualisations, etc. can go in the appendices), so you will need to present a concise description of any models and their implementation. For example, do not simply say: "Using the integer programming model from the Excel worksheet in Appendix A…", instead you should briefly outline the model in the body of the report and refer the reader to the appendix for further information. You may include sections from the Part 1 report in the appendix of this document.

In your report you need to describe your group's overall approach to solving this problem (using the pronoun "we"); however, emphasise your contribution to the project using the pronoun "I".

Although this report must be written individually, group members may share visualisations and tables.

**In a separate submission,** provide a reflection of your experiences in this group project, with an explicit summary of your own contribution to the project, and the contributions of your teammates. This should be no more than one page. Marks for the individual report will be withheld if this is not complete.

As with the Computational Mechanics project, marks in the project will be reduced by up to 75% depending on the degree of non-participation.

**Your group should also submit the code used for points 4 and 5, above, in a zip file.**

Notes:

1. There is a lot of scope in this problem. You may need to simplify parts of the problem, which is fine, but please state in your report what assumptions/simplifications have been made.
2. Treat this as a real-world project so if there is any information that is not initially provided, you should find it from public source, request it from us (although we may not have it, or it may be too slow or expensive to obtain), or create artificial data that is (ideally) representative of real data. However, do not contact Foodstuffs about this project…