Workstream 1: “Desktop” evaluation of Tiramizoo algorithm

This workstream will focus on validating the Tiramizoo are generating optimum route plans. From the discussions in Poland, we concluded that their algorithm should work well in theory, but there is a risk that limitations in the accuracy of journey time data may mean that in practice it generate suboptimal routes.

Scope:

1. Compare actual travel times with predicted travel times using data from the Connected Freight system back to May to understand the accuracy of Google traffic data and whether drivers are finding quicker routes using local knowledge. This will provide an indication of whether predicted travel times are accurate enough to enable advanced optimization algorithms to outweigh local knowledge. This analysis will be led by the AA CoE team using historic data provided by Tiramizoo.
2. Compare actual travel times from GPS data from the Centro Asia fleet with predicted optimal travel times from the Tiramizoo algorithm. This will provide evidence of the extent to which Connected Freight could generate savings for single suppliers without cross optimization.
3. Tiramizoo have published reports describing the performance of their algorithm against benchmarks. AA CoE will review these documents and produce a summary relevant to the Connected Freight use case.
4. Understand the impact of using cached Google travel time data. This will involve creating a sample of reasonably complex scenario that has scope for optimization (i.e. more than 3 deliveries), optimizing the route based on cached and latest travel time data, and evaluating the difference in total route duration based on latest travel time. This will need to be led by Tiramizoo with the AA CoE team supporting identification of scenarios to run and analysis of the outputs.

Timing:

Assuming Tiramizoo can provide the required data by end September, we would expect to be able to share interim results for items 1, 3 and 4 by end October. The analysis using GPS data will not be able to start until the data has been collected.

Workstream 2: Scenario Analysis

This workstream will focus on estimating how the benefits of Connected Freight will increase under different scale up scenarios. This will help the team validate the business case for Connected Freight and also provide commercial insights to help the team understand what type of customer to focus on to accelerate the route to profitability for Connected Freight.

This workstream will involve the AA CoE team generating scenarios for Tiramizoo to run through their algorithm and then analyzing the outputs.

Scope:

1. Evaluate the potential benefits from optimization across Mr Donut and Centro Asia
2. Evaluate the additional benefits if Shell’s orders from all other suppliers were added (this ignores any negative impact of removing these deliveries from the supplier’s routes)
3. Evaluate the additional benefit if Blue Coffee brought all their orders into Connected Freight
4. Develop “what if” scenarios assuming other suppliers with different characteristics brought all their orders into Connected Freight. This will necessarily be assumption driven using a bootstrapping approach to generate theoretical supplier profiles.

Timing:

Initial results from 1 and 2 could be available by end October provided the source data is available by end September and Tiramizoo are able to run the scenarios quickly.

Results from 3 and 4 require additional data to be acquired from suppliers and so are unlikely to be available until end November.

Workstream 3: Develop In House Algorithm

Scope:

AA CoE will allocate 10-15 man days of Data Science resource to development of an optimization algorithm that aims to identify the optimum route plan for Manilla. This will build on the work that was done in 2016.

The 2016 work was focussed on building minimal viable product to meet the business objective of understanding the value of route optimisation, rather than building code that could be converted into a production solution.  The team successfully developed a Genetic Algorithm which could find globally optimal solutions for reasonably large routes, but required several hours to run, and would not be suitable for full scale routes once Connected Freight is at full potential.  The team also looked at an alternative approach, Compressed Annealing, which runs orders of magnitude faster but is not guaranteed to identify the optimum route.  This work produced some promising initial results, but the algorithm was not fully developed to enable it to handle all constraints and scenarios required to model a real business scenario, and was not build to fully leverage parallel processing capabilities.

We believe that with the 10-15 days we have budgeted from Tim, we could deliver the following:

* Understand the Genetic Algorithm model and get it running
* Progress the Compressed Annealing model to enable it to optimise real business scenarios and leverage parallel processing power
* Evaluate the performance and accuracy of the Compressed Annealing approach by comparison to both the routes optimised by Tiramazoo and the GA, leveraging scenarios developed for the other workstreams in our scope
* Identify alternative approaches and enhancements to improve the speed / accuracy of the optimisation and estimate the effort to incorporate these in a future phase of work (e.g. Dynamic Programming and Computational Shortcuts), OR
* Develop a high level work plan and cost estimate for what would be required to develop and integrate a production version of the Compressed Annealing approach

This rests on the following assumptions:

* The code is well documented and can be easily understood by Tim
* Neil and Arnab can make time available to support Tim, we should also reach out to Alexander Williamson and Phil
* Open source libraries exist to enable us to parallelise the Compressed Annealing approach
* The business problem has not changed since 2016, i.e. there are no new constraints or scenarios we need to include that were not in the GA

To clarify, the main objective of this work will be to assess the speed and accuracy of the Compressed Annealing can run fast and accurately enough to form the basis for a production solution.  If the results are positive, we would provide a rough order of magnitude estimate of the cost and timeline for developing this.  If the results are not positive, we would propose a second phase of work to build and test more complex approaches.

Neil and Arnab have confirmed that the 2016 code base and reports are available on GitHub and that they would be able to provide some limited support to the core project team to progress this over the next two months.  Their view is that the code is relatively simple, so could be picked up by a new team relatively quickly.

The solution will run in as a stand-alone process with manual data input. Significant additional effort would be required to deploy the algorithm into a usable solution that could be leveraged by the business to optimize actual routes.

The solution will require a matrix of travel times between every pair of retailer or supplier locations. It is assumed that this will be provided by Tiramizoo or by the local connected freight team. The AA CoE team do not have capacity to build an integration with the Google API to obtain this data automatically.

AA CoE expect to be able to develop an algorithm that runs in a few minutes and can identify the optimum route for a limited number of orders but cannot predict in advance whether the limit will be a few hundred orders or several thousand.

We understand that the Tiramizoo algorithm includes functionality that allows orders to be added while the optimization is running. AA CoE will not seek to replicate this.

The scope of this work will include running a limited number of scenarios through our algorithm and comparing the outputs with those from the Tiramizoo algorithm. It is assumed that this will reuse scenarios developed for other workstreams as we do not have capacity to create new scenarios specifically to test the algorithm.

Timing:

This workstream will deliver in early December, the nature of the work means that we are unlikely to be able to share any meaningful interim results on the accuracy of our algorithm.

Purpose:

1. Validate that the TMZ algorithm produces optimum routes
2. Understand whether the TMZ algorithm includes valuable proprietary technology that could not be easily developed by others
3. Learn what would be involved in deploying an in-house solution
4. Reduce the time it would take to deploy an in-house solution if the decision is taken to replace TMZ

Data Requirements

A set of scenarios containing orders, supplier, retailers and strategies will be required to test the algorithm. This should include some scenarios with large numbers of orders to enable us to understand performance and optimality scales.

The algorithm will also require a matrix of travel times between each pair of locations in the optimization scenario. Ideally this will be exported from the Tiramizoo solution, alternatively it will require the CF local team to manually call out to the Google API.

It should be noted that the Google’s free API has a limit of 2500 route requests per day, which equates to a matrix of 50 x 50 locations, while the standard paid API has a limit of 100k route request per day, which equates to a matrix of 300 x 300 locations for a cost of $50. This may limit the scale of scenarios that can be tested unless data can be exported from Tirimazoo.

Detailed assumptions

Objective Function:

The algorithm will minimize the total journey time required to deliver all orders

In a later phase of work (after December 2018), the algorithm could be relatively easily adapted to minimize distance travelled, estimated fuel consumed (based on distance and fuel economy), number of vehicles required, or any linear combination of these variables.

In a later phase of work (after December 2018), the algorithm could be relatively easily adapted to minimise the use of 3PL vehicles in favour of using suppliers own fleet

Constraints:

Each order must be delivered within a specified time window

Each van can carry up to a maximum weight of goods

Each van can carry up to a maximum volume of goods

Each van can only carry orders from specified suppliers

Each van can only operate at specified times of day

Each delivery route must be less than a maximum duration

Each depot can only put orders on to a van at specified times of day

Assumptions / Limitations:

All products from one supplier to one retailer will be delivered together (no split deliveries)

There are no restrictions on which vans can carry which product except that some vans cannot carry products from some suppliers (so no refrigerated vans, etc)

Each van can make a single trip each day

Each van will start its trip at its home depot

The time taken to load a van at the start of its trip at its home depot will not be included in the optimization (i.e. it is assumed that vans are loaded before they start)

The time taken to load a van with orders from a depot that is not its home depot will be assumed to be

The service time varies for each retailer but does not depend on the quantity of products delivered

3PL vans will be assumed to start their journey at a specified depot location

Input Data:

Orders: Order ID, Retailer ID, Supplier ID, Depot ID, Product ID, Product Quantity, min Delivery Time, max Delivery Time

Products: Product ID, Unit Weight, Unit Volume

Retailers: Retailer ID, Lat, Long, Service Time

Depots: Depot ID, Lat, Long, Pick up duration, Pick up time windows

Vans: Van ID, maximum weight capacity, maximum volume capacity, average fuel consumption, home depot ID, owning supplier

Supplier Cross Optimisation Matrix: Indicates whether supplier A orders can be delivered by supplier B vans

Distance Matrix: Travel time between every pair of retailer and depot locations