Problem definition

Riccardo Orizio

13 October 2015

1 Problem definition

Our problem concerns the need of a company to accomodate client requests to specific time slots where the company will have more profit, given the actual requests status and the probable future requests. This problem treats a small part of a bigger problem which is the problem of the attended home delivery services for furnitures and appliances.

First of all, the company needs to choose if the new incoming request will be accepted or not: remember that every refused request is lost and cannot be recovered in the future, so every declined request will cost to the company because there will be no profit from it.

apparently we can accept EVERY new customer because the company could rent as many vehicle as it wants. Every new vehicle has a fixed rent cost.

If a request is accepted, then it has to fit in the already known request calendar, knowing that every new request has a limited set of possible time windows in which it could be served (usually the time windows are given due to geographical request studies) and that every request must respect its time window.

The goal of this problem is to bias the customers to make them choose what is more suitable for the company, so it could reach the maximum profit or it could serve the highest number of requests that it could do or has the minimum costs through clusterization of customers. The company will try to influence its customers through small price incentives[1] over the possible time windows listed to them, so there is a high probability that customers choose the time window that the company wants them to pick. The problem is to place these incentives, that is to choose in which time window they have to be placed and how big every one of them has to be.

Every customer has to pay a fixed fee for the delivery service. JF suggested something like 50$, independent to the distance traveled.

The problem is dynamic due to the fact that we keep receiving new requests even after our planning is started; it's stochastic because we try to predict future requests from the history and because we don't know when the request will come

[1] There is no need to place big incentives, small are good enough, knowledge given by home grocery delivery providers, Campbell and Savelsbergh 2006.

neither how big the demand of each one will be. We use this information with the intention to keep the best incoming requests and discarding the worsts.

2 Objective function

The objective function could vary depending on the priorities of the company, a couple examples are listed here:

- $MAX\ Profit = MAX\ \sum revenue - \sum delivery\_costs - \sum incentives$
- $MAX\ Orders\_delivered$

3 Variables

C customers spread into a limited geographical area, usually divided in subzones (e.g. ZIP-code division, districts)

V company vehicles, each one having Q^s storage and Q^f fuel capacity[2]

vehicles that the company could rent, at a fixed cost F, each one having capacity Q

T delivery time window[3] options, each being L[4] wide (time windows are chosen by the company itself)

I_t possible incentives, one per time window

p_i^t the probability that the customer i chooses the time window t to get his items delivered

4 Constraints

- Don't exceed vehicles capacity, both storage and fuel (or delivery costs)
- Make sure that every delivery will stay in the defined time-window, remembering also that every delivery has a service time[5]
- $\forall t \in T : I_t \geq 0$

[2]Every vehicle could have different capacities.
[3]Time windows could be overlapped with each other or not.
[4]The larger the better: we have more flexibility. (Campbell and Savelsbergh, 2006).
[5]Time between vehicle arrival to the customer and its departure.

5 Assumptions

- Real-time delivery are not available, we want at least 1-day notice to create the best plan that we can
- Delivered products are not subject to any particular restriction: they are unbreakable and without expiry date (e.g. no food)
- We keep a low number of C customers because the problem is hard to solve even with small sets of input
- $\forall i \in V : Q_i^s = a, Q_i^f = b, a\, b \in \mathbb{N}$

6 Future extensions

- Everything that could vary from the assumptions
- Different time-windows: different L, overlap between windows
- Predict customers: keep track of every request done by every customer so we could predict them even better, knowing their particular time window preferences and using those for placing incentives only when it's really necessary
- Negative incentives: make the delivery cost more high for those customers that demand a specific delivery that is unprofitable for the company, without a negative incentive