Overview

Hours spent: 5-7. CS login: `aagvania`. Display name: `evander`.

Decision Variables

The model for solving this problem consists of one set of decision variables, facility-customer matrix, which represents the supply by a given facility to a given customer. The variables in this model should be non-negative.

Constraints

There are three sets of constraints that are enforced by the model:

1. Capacity constraints: the total supply by every facility should be less than or equal to its capacity.
2. Supply-demand constraints: the total supply to every customer should be equal to its demand.
3. Constraints on trucks: for each facility, the sum of distances to each customer, calculated as the actual distance multiplied by the proportion of demand served to the given customer, is less than or equal to the maximum number of vehicles per facility times the maximum distance per vehicle.

Minimization Objective

The total cost consists of three parts, as described in the handout: opening cost, service cost, and vehicle usage cost:

1. Opening cost: calculated per facility as the actual opening cost multiplied by the proportion of capacity used in this facility.
2. Service cost: calculated per facility-customer pair as the allocation cost multiplied by the proportion of the current customer demand the current facility-customer arrangement satisfies.
3. Vehicle usage cost: taking the calculation of distances per facility from the constraint 3 (the actual distance multiplied by the proportion of demand served per customer), this cost is calculated per facility, with its "total distance" divided by the truck distance limit and multiplied by the truck usage cost.

Limitations

Some of the limitations the model acquired due to being a linear relaxation are listed below:

1. Each customer can be served by multiple facilities, which decreases the cost but violates the model.
2. Trucks are used as a "divisible" resource: it is possible for two trucks to complete one delivery once the first one runs out of the distance limit. Moreover, it is possible to have a fractional number of trucks assigned to a facility.

Conclusion

One important characteristic of the constraints and costs is that the proportions used in them are correct with regard to the problem specification at the ends of the intervals (when equal to 0 or 1). Allowing them to take any value in between its ends is the linear relaxation of the problem. Similarly, allowing the trucks to be used as a "divisible" rather than discrete resource achieves the same goal, resulting in a .