Analysing the Impact of Capacity Fluctuations on the Design of a Supply Chain Network

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  - low frequency, high economic impact (flooding, strikes);
  - may be correlated among facilities.
- Need of a better understanding of the impact of imperfect reliability on location patterns.

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- Perfect information: decision maker knows the state of the system and has direct influence on customers' choice;
- Imperfect information: customers visit a -probably unavailable facility- and are redirected to another one or lost.

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- Snyder, L. V. (2006). *(Complete -but slightly dated- review)*

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Berman et al. (2007, 2009) identify a *facility centralization* pattern:

> *Facilities tend to locate closer to each other as the likelihood of failure increases. On the extreme, facilities are placed in the same location in order to provide effective back-up in case of failure.*

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- Sensitivity of solution patterns to low levels of expected h-capacity (when the system is not working at planned capacity).

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- $\mathfrak{L}$ is the set of all feasible solutions (locations).

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Admissible Allocation Scheme

An allocation scheme

$$q = (q_{ij})_{|\mathcal{I}|\times|\mathcal{J}|}$$

is admissible for $\mathcal{I} \in \mathfrak{L}$ if $q \in Q_{\mathcal{I}}^{k} \cup Q_{\mathcal{I}}^{k}$, where

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$$Q_{\mathcal{I}}^k = \left\{ q : q \geq 0; \sum_{j\in\mathcal{J}} q_{i,j} \leq C_i^k \,\forall i \in \mathcal{I} \right\}$$

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and q_{ij} is the quantity shipped from a facility in $i \in \mathcal{I}$ to demand node $j \in \mathcal{J}$.

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Optimization Problem

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For any given $C^k \in \mathcal{C}$ and $\mathcal{I} \in \mathfrak{L}$

$$S_k(\mathcal{I}) = \max\{\sum_{i \in \mathcal{I}} \sum_{j \in \mathcal{J}} \pi_{i,j} q_{i,j} - \sum_{i \in \mathcal{I}} f_i \ : \ q \in Q^k_{\mathcal{I}} \cap R^k_{\mathcal{I}}\}$$

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If $Z(\mathcal{I}) = \sum_{k=1}^{K} p^k S_k(\mathcal{I})$ then the *Unreliable Capacitated Facility Location Problem* (UCFLP) becomes

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If $Z\left(\mathcal{I}\right) = \sum_{k=1}^{K} p^k S_k\left(\mathcal{I}\right)$ then the *Unreliable Capacitated Facility Location Problem* (UCFLP) becomes

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- Improvement of **average gap** by facilities ordering may have a substantial positive impact on Z.

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- Planned capacity is a factor γ of the "ideal" capacity $\overline{C}$, i.e. $C_i^1 = \gamma\overline{C}$, $\gamma \geq 1$.

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Let $\mathcal{I}^*_{\gamma,\beta}$ be the optimal location for given γ and β, therefore

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$$Z^*_{\gamma,\beta} = Z\left(L^*_{\gamma,\beta}\right) ;$$

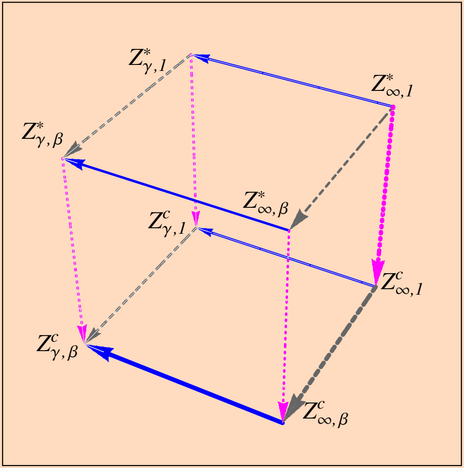
and define an ideal scenario

$$Z^*_{\infty,1}$$

where capacity is not a concern and the facility is perfectly reliable.

Analysis

Loss Cube



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- The more stable is the environment (larger α) the UCFLP will provide better solutions;
- Vulnerable facilities in volatile environments require investment in safety (larger β) or an increase in capacity (larger γ).

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- Analyse how spatial **location patterns** change with different combinations of resilience and capacity;
- Understand effects of **correlated disruptions** on objective and location patterns;
- Compute average gap from greedy policies;
- Test conjectures on real-sized instances.

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- Use different combinations of α, β and γ to evaluate effects of volatility, capacity and resilience on the the **objective function**;
- Analyse how spatial **location patterns** change with different combinations of resilience and capacity;
- Understand effects of **correlated disruptions** on objective and location patterns;
- Compute average gap from greedy policies;
- Test conjectures on real-sized instances.
- ...

Thank You!!!!