COVID-19 Resource Allocation

Given the shortage of materials in the COVID-19 situation, we wanted to focus on how to allocate limited resources

KEY QUESTION

How can we best allocate a limited number of ventilators to the 48 mainland states?

motivation | description | formulation | demonstration

CONSIDERATIONS

weekly cases	production	fairness
Weekly new cases recorded for the last 8 weeks : Feb 26 - April 26	5 factories produce a given number of ventilators per week: NJ, MS, NE, CA, OH	Each state needs to have X percent of their need met at any given time

Decision Variables

$$X_{ij} - \#\ ventilators\ to\ send\ from\ state\ i\ to\ state\ j$$
$$y_k - \#\ ventilators\ to\ produce\ from\ state\ (factory)\ k$$

Data

$$C_k - production\ capacity\ of\ factory\ k$$
$$CO_k - cost\ of\ production\ per\ ventilator\ for\ factory\ k$$
$$CT_{ij} - cost\ of\ transporting\ one\ ventilator\ from\ state\ i\ to\ j$$
$$d_i - projected\ demand\ for\ ventilators\ in\ state\ i\ next\ week$$
$$v_i - existing\ \#\ of\ ventilators\ from\ previous\ week\ (base = 0)$$

Pre-determined: $f - fairness\ parameter\ (default{:}\ 0.5)$

FOR EACH WEEK:

$$\min \overbrace{\sum_{k=1}^{5} CO_k * y_k}^{\text{Production Costs}} + \overbrace{\sum_{i \neq j} X_{ij} * CT_{ij}}^{\text{Transportation Costs}}$$

s.t.

Non-producing States:

$$v_i - \sum_{\substack{j=1 \\ j \neq i}}^{48} X_{ij} + \sum_{\substack{j=1 \\ j \neq i}}^{48} X_{ji} \geq f * d_i \qquad \forall i \notin k$$

States with Factories:

$$v_i - \sum_{\substack{j=1 \\ j \neq i}}^{48} X_{ij} + \sum_{\substack{j=1 \\ j \neq i}}^{48} X_{ji} + y_i \geq f * d_i \qquad \forall i \in k$$

Number of ventilators in state i must at least be meet a percentage of its demand

<u>Surplus</u>: how many ventilators **sent out** of state i

<u>Shortage</u>: how many ventilators **coming into** state i

$$X_{ij}, y_k \geq 0 \ \forall i, j, k$$

Update for Next Week:

$$v_{i,next\ week} = v_i - \sum_{\substack{j=1 \\ j \neq i}}^{48} X_{ij} + \sum_{\substack{i=1 \\ j \neq i}}^{48} X_{ij} + y_i$$

Only if state i has a factory

FINDINGS

Takeaways

- Keeping up with exponential growth is hard--requires informed policies
- Collecting/estimating accurate data for large-scale problems is challenging

Model Improvements

- Integer programming
- More robust production capacity model

Extensions

- Different political philosophy (federalist vs. decentralized)
- Different moral philosophies (fairness parameter)