

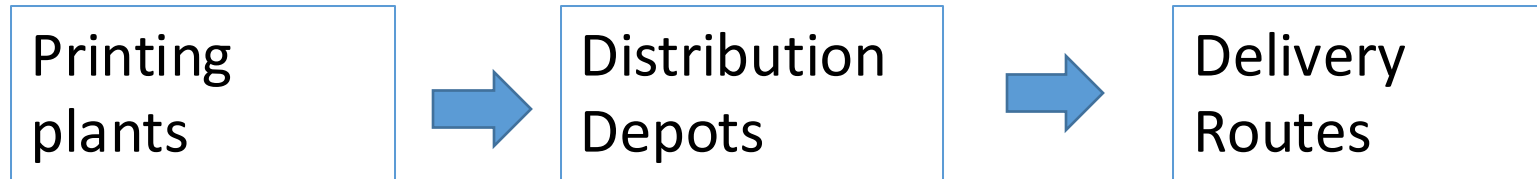
Analytics in Practice: Quick Vignette

Supply Chain Optimization

- The purpose of a well-designed supply chain is to deliver the right products to customers in a cost-effective and timely fashion.
- *Supply Chain Network Optimization* is a strategic planning process whose purpose is to determine or improve:
 - the structure of the supply chain
 - the location of facilities
 - the sizing of facilities
 - the sourcing and distribution flows
- Examples where supply chain network design is performed:
 - Expansion into a new market
 - Launching a new product
 - **Evaluating mergers and acquisitions**
 - Responding to supply, demand, or distribution disruptions
 - Responding to cost, demand, or other economic realities
 - Responding to new regulations
 - Simply evolving to adapt to changes in the business environment
- **Optimization is a critical success factor in supply chain design and operation.**

Newspaper Distribution*

- Newspapers are typically distributed through a two-level supply chain



- A larger newspaper/media company had the opportunity to buy distribution assets (a set of distribution depots and associated paper delivery routes) and needed to determine how much to bid for the assets
- To determine the maximum bid price, the newspaper wanted to understand the cost savings from combining the new depots/routes with its existing supply chain

*Simplified version of a problem from my professional experience

Newspaper Distribution

- This is a supply chain network optimization problem!
- Decision variables: which depots and routes to use
- Constraints
 - Each newspaper subscriber has to be on at least one route
 - A route can be used only if its associated depot is operational
- Objective function: Minimize Cost of Newspaper Delivery*
 - Each depot (current or new) has a fixed monthly cost of ongoing operation if we use it
 - Each paper delivery route has a variable monthly cost depending on the length of the route

*simplified version

Newspaper Distribution

Integer Optimization Approach

- Decision Variables: A binary decision variable x_D for each depot D and binary decision variable y_R for each route R
- Constraints
 - Each newspaper subscriber has to be on at least one route
 - For each subscriber, identify the routes that include that subscriber i.e. let's say routes 1, 4, 7 and 8 include that subscriber's address. Then, the constraint is:
 - $y_1 + y_4 + y_7 + y_8 \geq 1$
 - A route can be used only if its associated depot is operational
 - For each route-depot combination: route binary variable \leq depot binary variable
 - $y_R \leq x_D$
- Objective function: Minimize Cost of Newspaper Delivery
 - Each depot (current or new) has a fixed monthly cost C_D of ongoing operation if we use it
 - Each delivery route has a variable monthly cost L_R depending on the length of the route

$$\text{Total Delivery Cost} = \sum_{\text{all depots}} C_D x_D + \sum_{\text{all routes}} L_R y_R$$

Newspaper Distribution

- By solving this problem and comparing the cost of the optimal solution with the current delivery cost, we estimated the incremental cost savings IF we owned the new depots and routes.
- These savings helped inform the maximum price we would want to pay for the distribution assets

Key Themes

- Optimization models, especially those utilizing **binary variables**, are **extraordinarily applicable**.
- We have seen several applications where optimization has made significant **business impact**
- But equally important, **optimization** is:
 - A framework for **structuring** one's thinking about decisions
 - A **bridge** from data and predictive models to decisions
 - A must-have **fluency** for **analytics bilinguals** (like you!)

What's Next

- *Today*: Deliverable #8 (the last one – yay!) will be posted today, due only on December 3rd
- *Thursday*: Deliverable #7 due
- *Friday*: Recitation on Discrete Optimization
- 1-on-1 Meetings
 - Please book via <https://calendly.com/ramamit>
 - I have added more Calendly slots. If the Calendly times don't work, please email my assistant Laura (brentrup@mit.edu) to find a time.