Lecture 1

Introduction

Prof. Daniel Guetta

What is this course About?

How mathematical modeling can be used to help businesses make better decisions regarding marketing, pricing, inventory, and supply chain decisions – both individually and in coordination with each other.

What demand and supply decisions happen in an integrated company?

Supply(-Chain) Management

Demand Management (aka pricing)

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Supply(-Chain) Management

- Where to build warehouses? How many?
- How much to stock?
- Which suppliers to order from. How often?
- How truthful to be with suppliers.

Demand Management (aka pricing)

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Demand Management (aka pricing)

- What list prices to set? When to change them?
- What promotions to run?
- How to incorporate the increasingly large amount of data available about our consumers.

Nowadays, more frequent than you'd expect

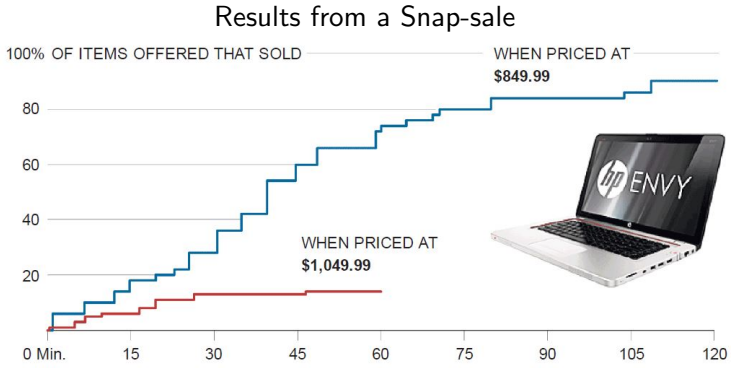
PRICING PARRIES

While Target's price on the Mario Kart DS game was stable, Amazon and Walmart tried to outmaneuver each other. Lowest prices are highlighted.

	AMAZON	WALMART	TARGET
Nov. 15	$29.17	$40.88	$33.99
Nov. 16	28.64	34.96	33.99
Nov. 17	33.78	33.21	33.99
Nov. 18	33.78	34.96	33.99
Nov. 19	28.98	34.38	33.99
Nov. 20	33.99	34.38	33.99
Nov. 21	33.99	34.96	33.99
Nov. 22	29.96	29.96	33.99
Nov. 23	29.96	29.96	33.99
Nov. 24	29.96	34.96	33.99
Nov. 25	29.96	34.96	33.99
Nov. 26	29.96	34.96	33.99
Nov. 27	30.97	34.96	33.99

Clifford, S. (November 30th, 2012). Retail Frenzy: Prices on the Web Change Hourly. NEW YORK TIMES. Retrieved from nytimes.com.

And important. . .



Clifford, S. (November 30th, 2012). Retail Frenzy: Prices on the Web Change Hourly. NEW YORK TIMES. Retrieved from nytimes.com.

The Potential Benefits are Enormous

A.T. Kearny studies:

	Overall Profit increase for a 1% improvement in category	Lever
Pricing	9.65%	pricing optimization
Variable cost	6.45%	sourcing
Sales volume	3.15%	growth strategies
Fixed cost	2.15%	asset effectiveness

Supply Chain Decisions can Make or Break a Company

Supply Chain Decisions can Make or Break a Company

Why I waited in line for Snapchat Spectacles

Edward C. Baig, USA TODAY Published 6:30 p.m. ET Nov. 23, 2016 | Updated 10:22 a.m. ET Nov. 24, 2016

(Photo: Eli Blumenthal, USA TODAY)

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"Crazy, insane, nuts."

Those were a few of the choice words I uttered under my breath as I walked the line of mostly young people snaking around 59th St. onto 5th Avenue in Manhattan. Except the same could be said about me.

We were queuing up to land Spectacles from Snap Inc., the company behind Snapchat. Snap has stoked the buzz for Spectacles by dramatically limiting the supply of these less-goofy-than-you-think $129 sunglasses. They have a camera inside that at the push of a button lets you capture short videos which are then wirelessly uploaded to Snapchat, but they're equally notable because of the way that they're sold.

Baig, E. (November 23rd, 2016). Why I waited in line for Snapchat Spectacles. USA TODAY. Retrieved from usatoday.com.

Supply Chain Decisions can Make or Break a Company


BUSINESS INSIDER

Snap wrote down nearly $40 million because Spectacles are a flop

"Unfortunately, we misjudged strong early demand for Spectacles and purchased more inventory than we now anticipate being able to sell. As a result, we recorded a $39.9 million non-recurring expense primarily related to excess inventory and purchase commitment cancellations," Snap CFO Drew Vollero said in Snap's prepared remarks for its quarterly earnings. "Moving forward, we will continue to be in the market place with Spectacles and expect modest revenue from the product line."

Leswing, K. (November 7th, 2017). Snap wrote down nearly $40 million because Spectacles are a flop. BUSINESS INSIDER. Retrieved from businessinsider.com.

Behavioral issues in supply chains

Trust in Supply Chains

THE WALL STREET JOURNAL.

JR: EXEC ADVISER AUG 10 | SUPPLY CHAIN

Keep Your Suppliers Honest

As the complexity of supply chains has grown, so has the likelihood of a catastrophe

By Mark Vandenbosch And Stephen Sapp

August 23, 2010

Globalization and its relentless drive for efficiency have led us into a world of long and complex supply chains. Even "simple" products, such as cereal bars, can be made of ingredients from more than eight countries on four continents.

Vandenbosch and Sapp (August 23rd, 2011). Keep your suppliers honest. THE WALL STREET JOURNAL. Retrieved from store.wsj.com

Coordination

Coordination

the Atlantic

What Walmart Gets From Jet.com

Second is technology: Jet uses an algorithm that minimizes supply-chain, logistics, and shipping costs, as well as software that shows different prices to different customers. It's been speculated that this pricing technology is a main component of the deal.

Lam, B. (August 8th, 2016). What Walmart Gets from Jet.com. THE ATLANTIC. Retrieved from theatlantic.com

This Course

- Broad with a few deep dives.
- Insights but no formal proofs.
- Case studies, examples, and exercises to help you put the concepts into practice.

This Course

- Part 1 - Demand Analytics

- Part 2 - Supply Analytics

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  - Static and dynamic price optimization
  - Pricing segmentation and nonlinear pricing
  - Quantity-based revenue management
  - Miscellaneous topics (markdowns, auctions, customized pricing, consumer choice models, behavioral issues)
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- Part 2 - Supply Analytics
  - Basics of inventory management
  - Inventory management under uncertainty
  - Decentralized inventory systems
  - Trust and coordination in supply chains

Course Requirements

- A solid understanding of probability and probabilistic modeling; Normal, Poisson, and Binomial distributions. Conditional probabilities. Calculation of expected values using integrals.
- A good understanding of deterministic modeling; specifically, linear programming.
- Some familiarity with dynamic programming will be useful, but not essential.
- Rudimentary computational skills
  - Programming not *required*, but you'll get far more out of the course with basic programming knowledge.
  - Basics of Python will be covered in class.

Your movie theatre has 100 seats. Customers buy tickets randomly, at an average rate of 3 customers per day, and sales begin 30 days before the performance. In the interests of fairness, you offer each customer a random price, normally distributed with a mean of \$15 and a standard deviation of \$3. Once a customer buys a ticket, there is a 10% chance they won't show up because they're busy that day.

Probability and Probabilistic Modelling continued

What distribution(s) would you use to answer each of the following questions:

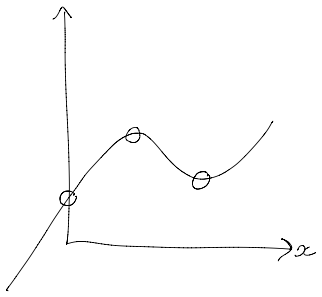
1. What is the probability I'll make more than $100 for a given performance?
2. Suppose I sell 110 tickets (i.e., oversell my theatre). What is the probability someone won't get a seat on the day of the performance?
3. My staff is busy, and can only handle the sale of 5 tickets per day. If I want to ensure that there is a 95% probability I can handle all sales, do I need to hire more staff?

Optimization

What value(s) of x and y solve(s) the following optimization problem

$$\min_{x \geq 0, y \geq 0} \left(2x^3 + 3y^2 - 102x + 12xy - 60y + 305\right)$$

$$\min_{\substack{x\geq 0\\ y\geq 0}} \left(2x^3 + 3y^2 - 102x + 12xy - 60y + 305\right)$$



(1) $\frac{\partial}{\partial x} = 6x^2 - 102 + 12y = 0$

(2) $\frac{\partial}{\partial y} = 6y + 12x - 60 = 0$

(2) implies that $y = 10 - 2x$

Putting this into (1)

$$6x^2 - 102 + 12(10 - 2x) = 0$$

$$6x^2 - 24x + 18 = 0$$

$$x = \frac{24 \pm \sqrt{24^2 - 4 \cdot 6 \cdot 18}}{12}$$

$$x = 2 \pm 1$$

$\Rightarrow$ Stationary points $(1, 8)$ $(3, 4)$

$\boxed{x = 0}$ $3y^2 - 30y + 305$

$\Rightarrow$ minimized at $y = 10$

So $(0, 10)$ is a candidate

$\boxed{y = 0}$ $2x^3 - 120x + 305$

$\Rightarrow$ minimized at $x = \sqrt{17}$

So $(\sqrt{17}, 0)$ is a candidate

$(1, 8) \Rightarrow 13$

$(3, 4) \Rightarrow 5$

$(0, 10) \Rightarrow 5$

$(\sqrt{17}, 0) \Rightarrow 24.6$