OPTIMIZATION IN PRACTICE

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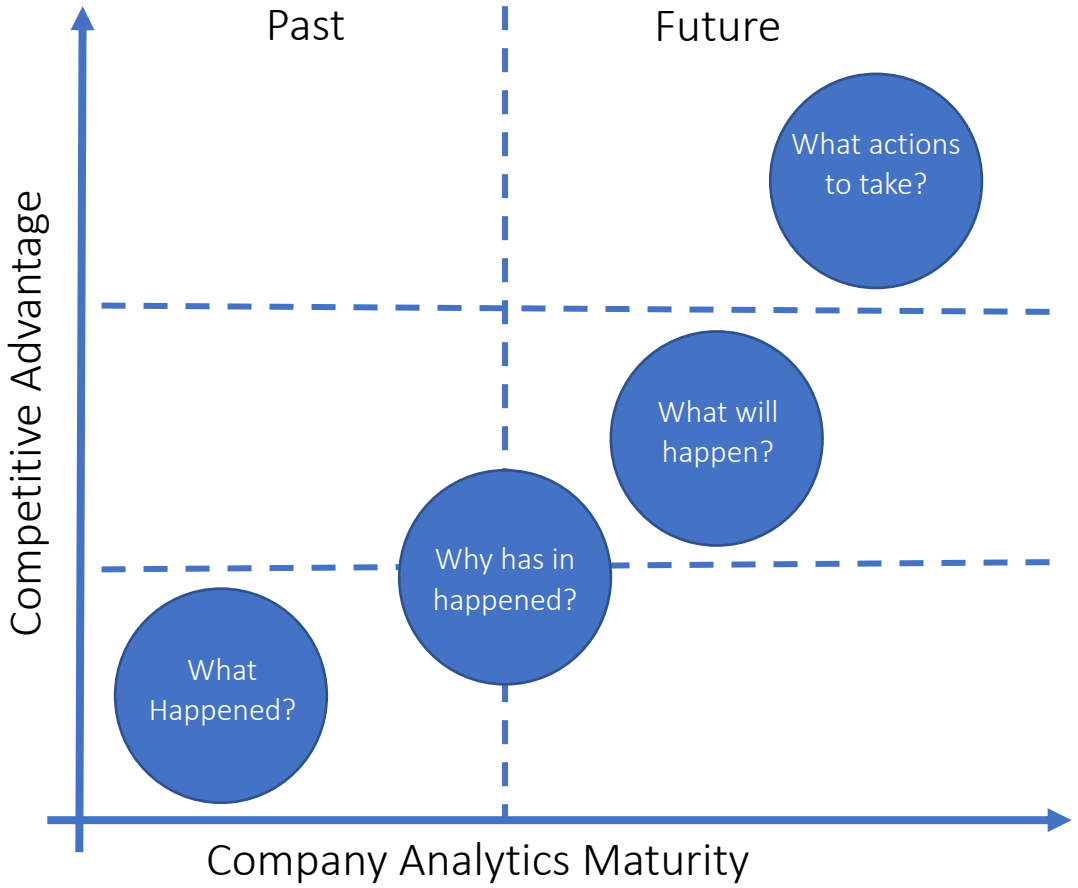
Advanced Analytics and Artificial Intelligence



Prescriptive Analytics

- Optimization
- Reinforcement learning methods: Markov Decision Processes
- Unsupervised learning methods: clustering

Predictive Analytics

- Supervised learning methods: regression, decision trees
- Time series models

Descriptive Analytics

- Data prep: cleaning and merging
- Basic analytics: correlations, plots
- Supervised learning methods: regression

Portfolio Optimization – Type 1

You have $100 to invest in stocks. You have two stock options: A and B. Stock A will give you an estimated 5% return. Stock B will give you an estimated 3% return. Assume you can invest maximum 50% of your budget in stock A. How much do you invest in each stock to maximize your return? What is the maximum return possible?

Portfolio Optimization – Type 2

You have three stock options: A, B and C. Stock A will give you an estimated 5% return. Stock B will give you an estimated 3% return. Stock C will give you an estimated 2% return. Assume you need $60 to invest in stock A, $120 to invest in stock B and $80 to invest in stock C. Partial investments are not allowed and your budget is $200. Which stocks do you choose to maximize your return? What is the maximum return possible?

Business Applications

Advertisement Scheduling in TV Network

Business Problem Definition

Tesla wants:

Advertise Model X on Jan-Mar 2016
Spend at most $350,000
Reach at least 1M Female 31-50 viewers

Business Problem Definition

7 Dayparts:

Early Morning
Daytime
Early Fringe
Primetime
Late Fringe
Late Night
Weekend Day

×

10 Channels:
CNN
TNT
FOX
Etc…

=

1680 hours of programming

×

30 spots of 30 secs per hour

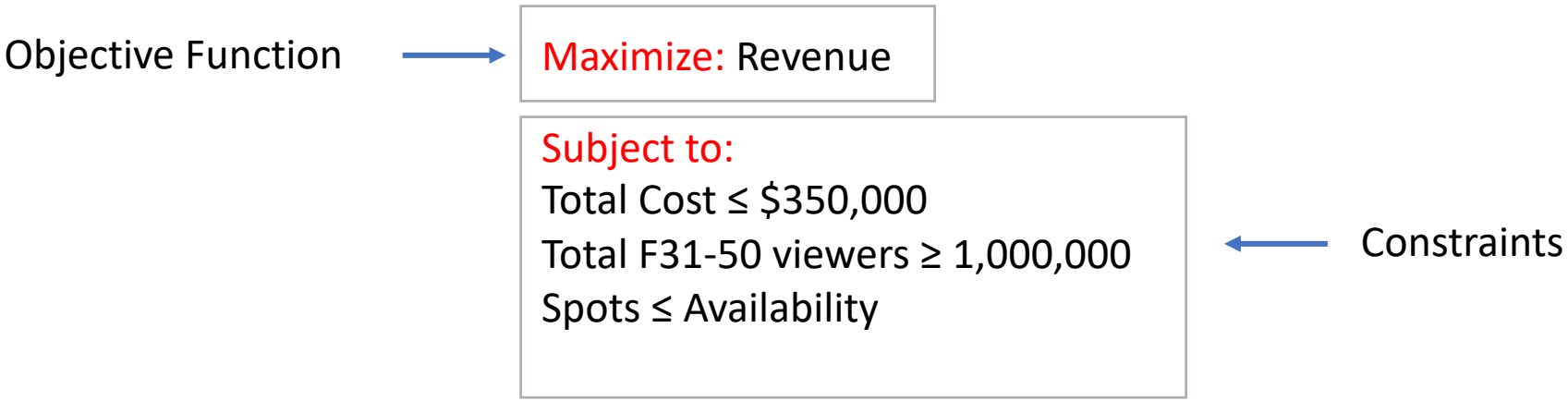
×

12 weeks planning horizon

=

604,800 options

Analytical Formulation



Mathematical Formulation

Daypart	Week	Channel	SPOTS	Imp	CPM
Daytime	5/10	FOX	2	500	$24
Daytime	5/10	CNN	0	710	$46
Daytime	5/10	ABC	5	210	$15

Decision Variables:

$Spots_{daypart,week,channel}$ INTEGER

Parameters/Inputs:

$Impressions_{demo,daypart,week,channel}$

$CPM_{daypart,week,channel}$

$Available_{daypart,week,channel}$

Objective Function:

$$\max \sum Spots_{daypart,week,channel} \frac{Impressions_{demo,daypart,week,channel}}{1000} CPM_{daypart,week,channel}$$

Subject to:

$$\sum Spots_{daypart,week,channel} \frac{Impressions_{demo,daypart,week,channel}}{1000} CPM_{daypart,week,channel} \leq \$350000$$

$$\sum Spots_{daypart,week,channel} Impressions_{demo,daypart,week,channel} \geq 1{,}000{,}000$$

$$\sum Spots_{daypart,week,channel} \leq Available_{daypart,week,channel}$$

Business Applications

Price optimization in b2b

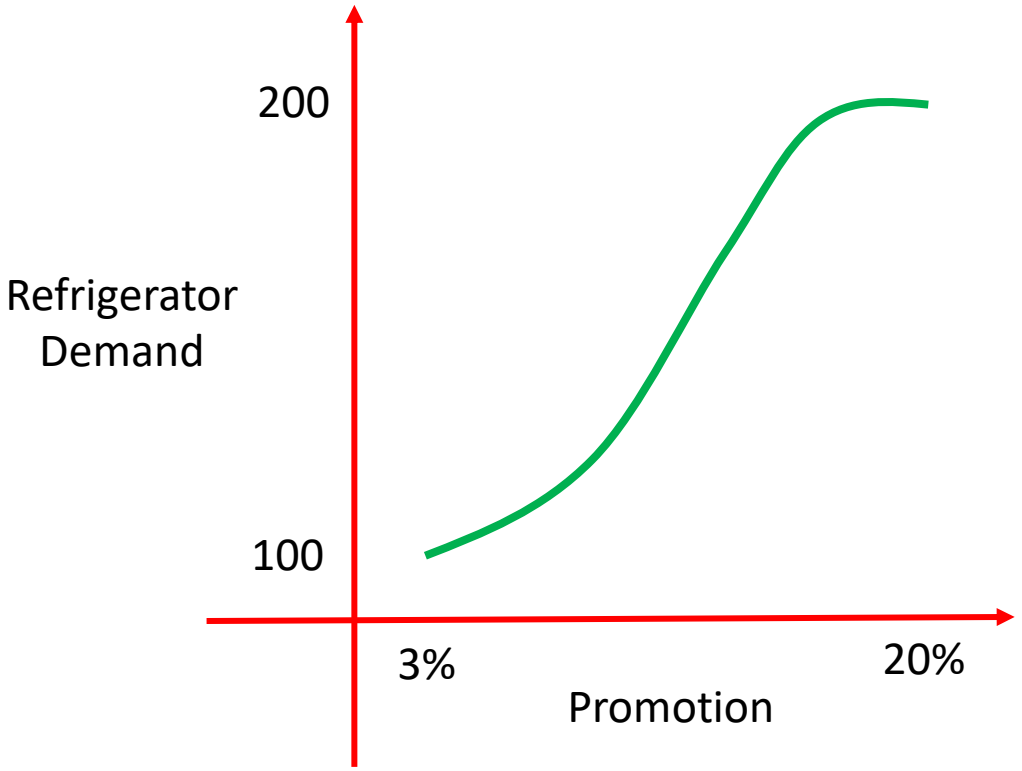
Business Problem Definition

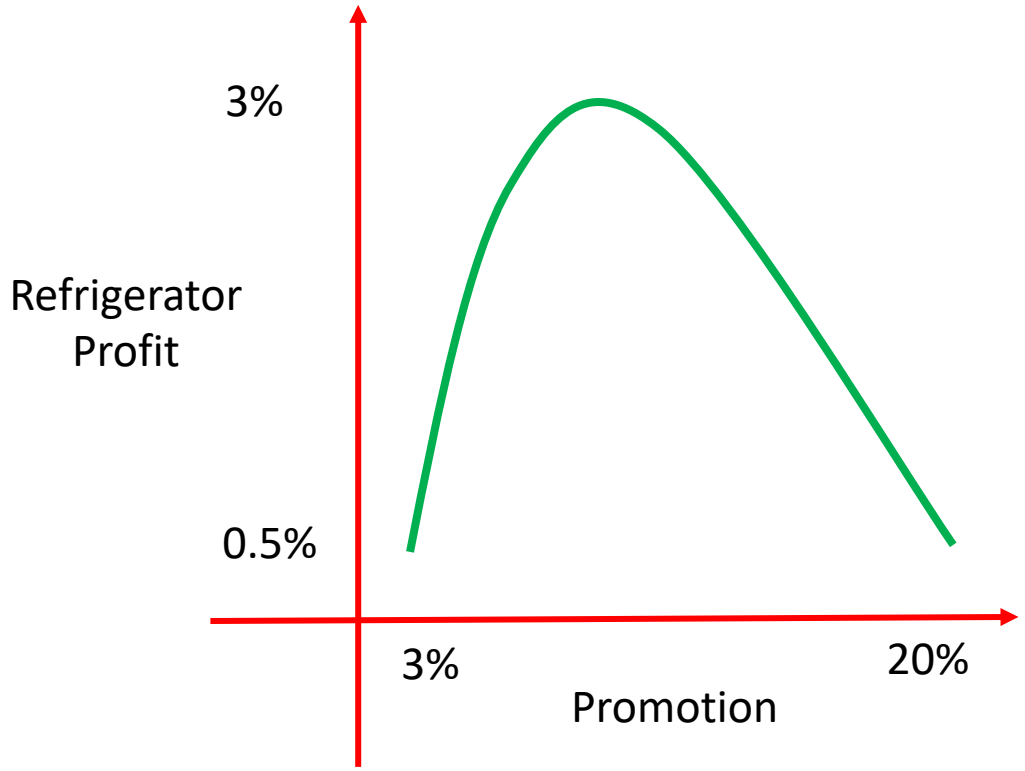
Optimization Consultant ⟷ Revenue Manager at Bosch ⟷ Distribution Manager at Sears ⟷ End Users

Sears wants:

100-200 Refrigerators
50-100 Microwaves
Delivered by October 31st 2016
They want a promotion from you

Business Problem Definition





Analytical Formulation

Objective Function →

Maximize: Profit & Demand

Subject to:
Sales ≤ Availability
Profit ≥ 1%
100 ≤ Fridge Demand ≤ 200
50 ≤ Microwave Demand≤ 100

← Constraints

Mathematical Formulation

Product	Promo	SELECT	Demand	Profit
Fridge	5%	1	100	1%
Fridge	10%	0	150	2%
Fridge	15%	0	180	0.8%

Decision Variables:

$Select_{product,promo}$ BINARY

Parameters/Inputs:

$Demand_{product,promo}$

$Profit_{product,promo}$

$Available_{product}$

$Weigth$

Objective Function:

$$\max \sum (W * Demand_{product,promo} + (1 - W) Profit_{product,promo}) Select_{product,promo}$$

Subject to:

$$\sum Select_{product,promo} Demand_{product,promovalue} \leq Available_{product}$$

$$\sum Select_{product,promo} Profit_{product,promo} \geq 1\%$$

$$100 \leq \sum Select_{fridge,promo} Demand_{fridge,promo} \leq 200 \qquad \sum Select_{fridge,promo} = 1$$

$$50 \leq \sum Select_{microwave,promo} Demand_{microwave,promo} \leq 100 \qquad \sum Select_{microwavepromo} = 1$$

Operations Research

- Scientific decision-making tool
- Use of mathematical formulation and programming
- Operations Research includes other areas as:
  - Optimization
  - Simulation
  - Network Flows
- Optimization
  - Minimization/Maximization (Objective Function)
  - Under certain conditions (Constraints)
  - Algorithm (Solver)

Optimization

- Linear Programming
- Mixed Integer Linear Programming
- Non-Linear Programming
- Multicriteria Programming

Business Applications

- Media Advertisement
- Hospital Management
- Portfolio Management
- Price Optimization
- Personnel Assignment
- Transportation Scheduling
- Inventory Management
- Facility Location