WE
DEMOCRATIZE
ANALYTICS

FRONTLINE solvers

EXCEL USERS
WEB USERS
DEVELOPERS

*Data Visualization * Data Mining * Simulation / Risk Analysis * Decision Trees * Conventional / Stochastic Optimization*

Optimization

Using Analytic Solver Platform

REVIEW BASED ON MANAGEMENT SCIENCE

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What We'll Cover Today

- Introduction
  - Session II beta training program goals
- Classic Models for Common Business Situations
- Focus on Modeling with Linear and Integer Constraints
- 'Linearizing' Ratio, Either-Or, If-Then Constraints

Session II Online Beta Training Goals

To familiarize you with the following concepts:

- Art of identifying and formulating constraints
- Designing linear constraints, using binary variables
- How ASP can linearize constraints automatically

To empower you to achieve success

- State of the art tools
- Online educational training
- User guides and video demos

Typical Optimization Applications

Industry

- Energy
- Chemical
- Manufacturing
- Transportation
- Finance
- Agriculture
- Health
- Mining
- Defense
- Forestry

Functional Area

- Staff planning
- Scheduling
- Routing
- Blending
- Capacity planning
- Media planning
- Supply chain
    - Inventory optimization
    - Vendor selection
- Portfolio optimization
- Product mix

Why Focus on Linear Models

- Most common business situations can be modeled with linear functions, sometimes using integer variables.
- A linear program, with a linear objective function and all linear constraints, can be solved quickly to a globally optimal solution.
- Integer variables make a problem non-convex and more difficult to solve, but their structure can be exploited by modern Solvers.
- If there is a choice, use a linear formulation rather than a nonlinear formulation.

Common Model Structures in Business Problems

- Allocation Models – Maximize objective (profit) subject to $\leq$ constraints on capacity.
- Covering Models – Minimize objective (cost) subject to $\geq$ constraints on coverage.
- Blending Models – Mix inputs with different properties to satisfy quality constraints and minimize cost.
- Network Models – For situations with ‘flows’ from sources to destinations.
  - Transportation – Moving goods.
  - Assignment – Matching candidates to positions.
  - Network Models for Process Technologies.

Formulation

1) Determine decision variables
   - "What factors are under our control?"
2) Determine objective function
   - "What measure are we trying to optimize?"
3) Determine constraints
   - "What restrictions limit our choice of decision variables?"
     - Available resources
     - Physical constraints
     - Policy constraints

Allocation Models

- Maximize objective (profit) subject to ≤ constraints on capacity.
- Veerman Furniture Company – Page 221 – Powell & Baker.
- Determine the mix of chairs, desks, & tables to maximize profit.

Department	Hours per Unit			Hours Available
	Chairs	Desks	Tables	
Fabrication	4	6	2	1,850
Assembly	3	5	7	2,400
Shipping	3	2	4	1,500
Demand Potential	360	300	100	
Profit	$15	$24	$18	

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Allocation Models

1) What factors are under our control?
   - The product mix – number of Chairs (C), Desks (D), Tables (T).
2) What measure are we trying to optimize?
   - Maximize profit contribution.
3) What restrictions limit our choice of decision variables?
   - Production capacity
     - Fabrication
     - Assembly
     - Shipping
   - Demand potential
   - Physical Constraint

Allocation Models

- Decision variables – number of Chairs (C), Desks (D), Tables (T)
- Objective Function – Profit maximization
- Constraints –
    - Fabrication
    - Assembly
    - Shipping
    - Demand potential
    - Non-negativity

$$Max\ \ 15C + 24D + 18T$$

Subject to

$$4C + 6D + 2D \leq 1850$$
$$3C + 5D + 7T \leq 2400$$
$$3C + 2D + 4T \leq 1500$$

Limited Resources

$$C \leq 360$$
$$D \leq 300$$
$$T \leq 100$$

Limited Demand

$$C \geq 0$$
$$D \geq 0$$
$$T \geq 0$$

Physical Constraints

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Covering Models

- Minimize objective (cost) subject to ≥ constraints on coverage.
- Dahlby Outfitters – Page 226 – Powell & Baker.
- The ingredients contain certain amounts of vitamins, minerals, protein, and calories.
- The final product (trail mix) must have a certain minimum nutritional profile.
- Minimize production cost while satisfying the nutritional profile.

Component	Grams per Pound					Nutritional Requirements
	Seeds	Raisins	Flakes	Pecans	Walnuts	
Vitamins	10	20	10	30	20	20
Minerals	5	7	4	9	2	10
Proteins	1	4	10	2	1	15
Calories	500	450	160	300	500	600
Cost	$4	$5	$3	$7	$6	

Covering Models

1) What factors are under our control?
    - The package trail mix – amounts of Seeds (S), Raisins (R), Flakes (F), Pecans (P), Walnuts (W)
2) What measure are we trying to optimize?
    - Minimize cost of a package.
3) What restrictions limit our choice of decision variables?
    - Nutritional Profile
        - Vitamins
        - Minerals
        - Protein
        - Calories

Covering Models

- Decision variables – pound of Seeds (S), Raisins (R), Flakes (F), Pecans (P), Walnuts (W)
- Objective Function – Cost minimization
- Constraints –
  - Vitamins
  - Minerals
  - Protein
  - Calories
  - Non-negativity

$$Min\ \ 4S + 5R + 3F + 7P + 6W$$

Subject to

$$10S + 20R + 10F + 30P + 20W \geq 20$$

$$5S + 7R + 4F + 9P + 2W \geq 10$$

$$1S + 4R + 10F + 2P + 1W \geq 15$$

$$500S + 450R + 160F + 300P + 500W \geq 600$$

$$S, R, F, P, and\ W \geq 0$$

Blending Models

- Representing ratios/proportions in Veerman Furniture – Page 229 – Powell & Baker.
- Having 0 chairs for sale is unacceptable to Marketing – something was missing from our original formulation.
- Add a policy constraint: Each of the products much make up at least 25 percent of the products available for sale.
- Total number sold: $C + D + T$; Chairs (C), Desks (D), Tables (T).
- 25% of total sales for chairs: $\frac{C}{C+D+T} \geq 0.25$
- This is not a linear constraint and will make the model nonlinear.

Add a Ratio Constraint

- 25% of total sales for chairs: $\frac{C}{C+D+T} \geq 0.25$
- $(C + D + T) \times \frac{C}{C+D+T} \geq 0.25 \times (C + D + T)$
- $C \geq 0.25(C + D + T)$
- $C - 0.25C - 0.25D - 0.25T \geq 0$
  - $0.75C - 0.25D - 0.25T \geq 0$

- Same for Desks (D), Tables (T)
  - $-0.25C + 0.75D - 0.25T \geq 0$
  - $-0.25C - 0.25D + 0.75T \geq 0$

Ratio Constraints

- Model situations where the value of one (or more) variable, compared with the value of another (one or more) variable, must satisfy some relationship.
- **Ratio:** $\frac{x_1}{x_2} \geq 2.5$
  - This constraint can occur when a certain product mix ratio is desired between two products.
- **Percentage Constraints:** $\frac{x_1}{x_1+x_2+x_3} \leq 0.25$
  - Common in blending problems, where recipes may have a certain amount of flexibility.
  - Useful in portfolio investment problems to stay within certain asset allocation guidelines (for example, at most 25% of total portfolio should be invested in bonds).
- **Weighted Average:** $\frac{(20x_1+35x_2)}{(x_1+x_2)} \geq 10$

Linearizing Ratio Constraints

- Ratio: $\frac{x_1}{x_2} \geq 2.5$ Non-linear form
- $x_2 \times \frac{x_1}{x_2} \geq 2.5 \times x_2$
- $x_1 \geq 2.5x_2$
- $x_1 - 2.5x_2 \geq 0$

Linear forms

- Percentage Constraints: $\frac{x_1}{x_1+x_2+x_3} \leq 0.25$ Non-linear form
- $(x_1 + x_2 + x_3) \times \frac{x_1}{x_1+x_2+x_3} \leq 0.25 \times (x_1 + x_2 + x_3)$
- $x_1 \leq 0.25(x_1 + x_2 + x_3)$
- $x_1 \leq 0.25x_1 + 0.25x_2 + 0.25x_3$
- $x_1 - 0.25x_1 - 0.25x_2 - 0.25x_3 \leq 0$

Linear forms

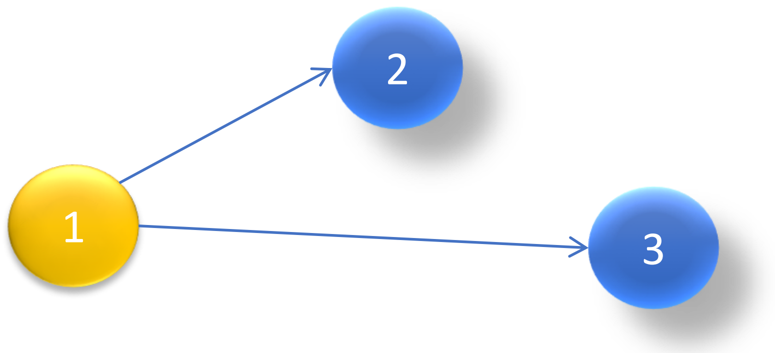
Linearizing Ratio Constraints

- Weighted Average: $\frac{(20x_1+35x_2)}{(x_1+x_2)} \geq 10$ Non-linear form
- $(x_1 + x_2) \times \frac{(20x_1+35x_2)}{(x_1+x_2)} \geq 10 \times (x_1 + x_2)$
- $20x_1 + 35x_2 \geq 10\ (x_1 + x_2)$
- $20x_1 + 35x_2 \geq 10x_1 + 10x_2$
- $20x_1 + 35x_2 - 10x_1 - 10x_2 \geq 0$
- $10x_1 + 25x_2 \geq 0$

Linear forms

Network Models

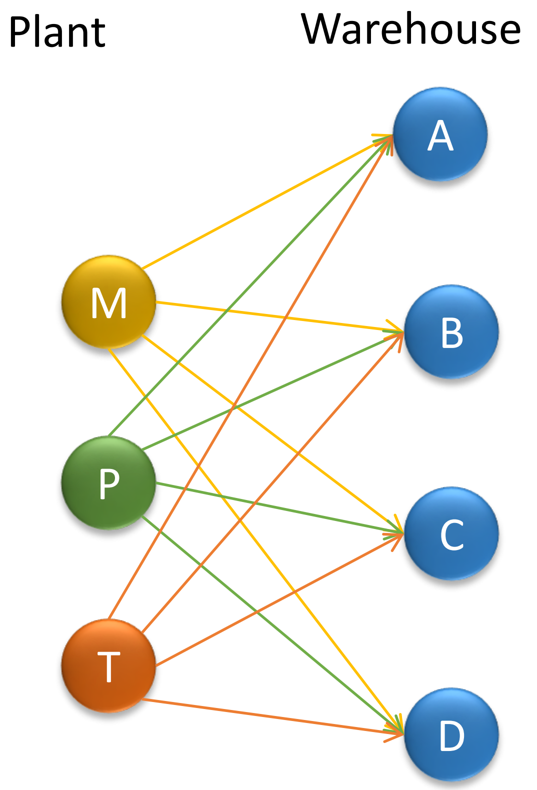
- Many business situations involve a ‘flow’ between connected elements.
- Flow might involve materials, funds, information, or just correspondence.
- Elements can be places or times such as cities, months, or production stages.
- Elements can be represented by nodes (circles).
- Direction of flow can be represented by arcs, or arrows.



A Network Diagram

Transportation Model

- Transportation model includes:
  - Supply locations (known capacities)
  - Demand locations (known requirements)
  - Unit transportation cost between supply-demand pairs.
- Bonner Electronics – Page 257 – Powell & Baker.
- Planning next week shipment to satisfy supply and demand constraints at minimum cost.



Plant	Warehouse				Capacity
	Atlanta	Boston	Chicago	Denver	
Minneapolis	$0.60	$0.56	$0.22	$0.40	9,000
Pittsburgh	$0.36	$0.30	$0.28	$0.58	12,000
Tucson	$0.65	$0.68	$0.55	$0.42	13,000
Requirement	7,500	8,500	9,500	8,000	

Transportation Model

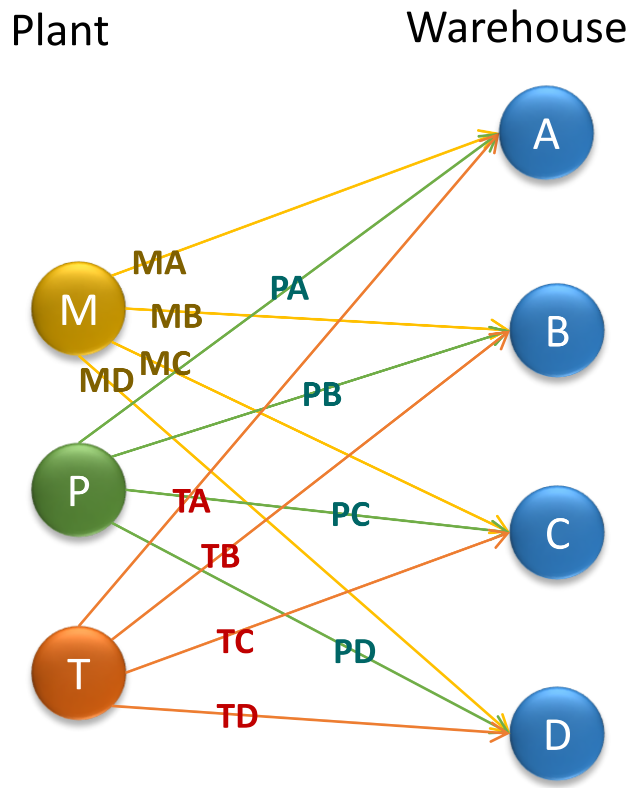
- Decision variables are number of cartons along each route.
- Objective function – Minimize the total cost.
- Constraints –
  - Minneapolis capacity
  - Pittsburgh capacity
  - Tucson capacity
  - Atlanta demand
  - Boston demand
  - Chicago demand
  - Denver demand
  - Non-negativity

$$Min\ \ 0.60MA + 0.56MB + 0.22MC + 0.40MD + 0.36PA + 0.30PB + 0.28PC + 0.58PD + 0.65TA + 0.68TB + 0.55TC + 0.42TD$$

$$MA + MB + MC + MD \le 9000$$
$$PA + PB + PC + PD \le 12000$$
$$TA + TB + TC + TD \le 13000$$

$$MA + PA + TA \ge 7500$$
$$MB + PB + TB \ge 8500$$
$$MC + PC + TC \ge 9500$$
$$MD + PD + TD \ge 8000$$

$$MA, MB, MC, MD, PA, PB, PC, PD, TA, TB, TC, and\ TD \ge 0$$



Transshipment Model

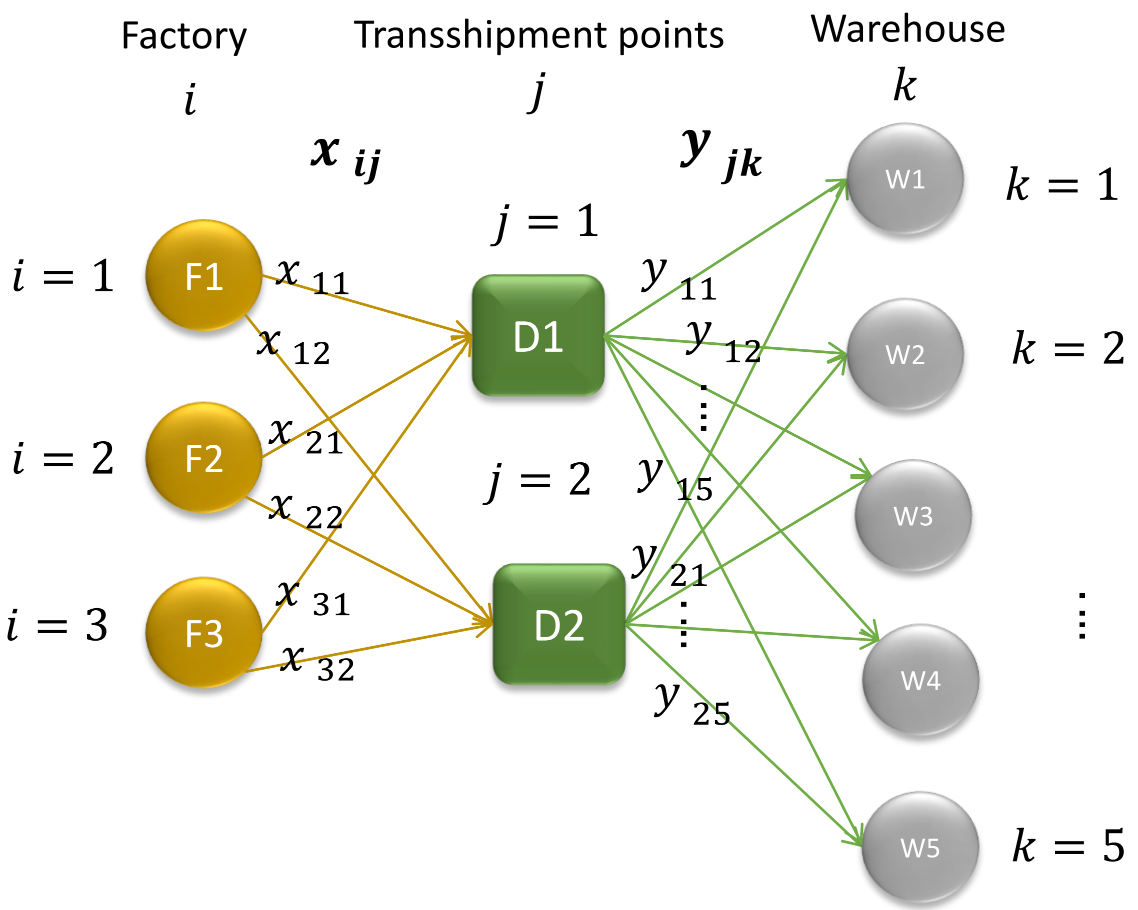
- Western Paper company – Page 269 – Powell & Baker.
- Manufacturing paper at three factories (F1, F2, &F3) with known monthly production capacity.
- Products are shipped by rail to depots (D1&D2).
- Repacked products are sent by truck to warehouses (W1,W2,&W3) with known demand.
- Determine the scheduling the material flow at minimum cost.

Factory	Depots		Capacity
	D1	**D2**	
F1	$1.28	$1.36	2,500
F2	$1.33	$1.38	2,500
F3	$1.68	$1.55	2,500

Depots	Warehouse				
	W1	**W2**	**W3**	**W4**	**W5**
D1	0.60	0.42	0.32	0.44	9,000
D2	0.57	0.30	0.40	0.38	12,000
Requirement	1,200	1,300	1,400	1,500	1,600

Transshipment Model

- Decision variables –
  - First stage x_{ij}: quantity shipped from factories to depots
  - Second stage y_{jk}: quantity shipped from depots to warehouses
- Objective – Minimize total cost
- Constraints –
  - Balance
  - Supply
  - Demand
  - Non-negativity



Balance constraints

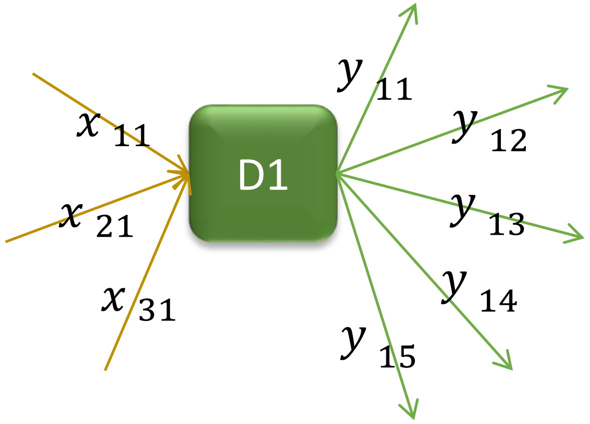
- Used to model processes where the "inputs" must equal the "outputs."
- They have an equality form “=.”
- Also used to model balance between time periods.
- The process of carrying inventory is modeled with a balance constraint.
- Western Paper’s depots are temporary holding points.

Flow Out = Flow In

Flow Out − Flow In = 0

Depot 1: $y_{11} + y_{12} + y_{13} + y_{14} + y_{15} = x_{11} + x_{21} + x_{31}$

$$y_{11} + y_{12} + y_{13} + y_{14} + y_{15} - x_{11} - x_{21} - x_{31} = 0$$



Transshipment Model

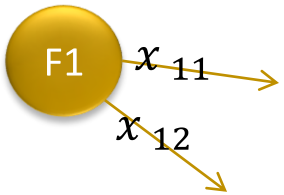
- Objective –

$$Min \quad 1.28x_{11} + 1.36x_{12} + 1.33x_{21} + 1.38x_{22} + 1.68x_{31} + 1.55x_{32} + 0.60\,y_{11} + 0.42y_{12} + 0.32y_{13} + 0.44y_{14} + 0.68y_{15} + 0.57\,y_{21} + 0.30y_{22} + 0.40y_{23} + 0.38y_{24} + 0.72y_{25}$$

- Constraints –

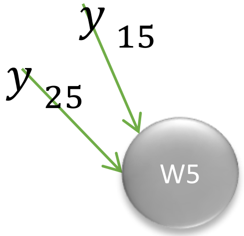
Supply: at each factory

$$x_{11} + x_{12} \le 2{,}500$$
$$x_{21} + x_{22} \le 2{,}500$$
$$x_{31} + x_{32} \le 2{,}500$$

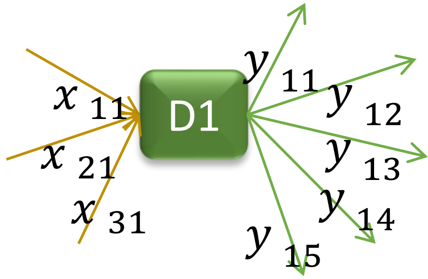


Demand: at each warehouse

$$y_{11} + y_{21} \ge 1{,}200$$
$$y_{12} + y_{22} \ge 1{,}300$$
$$y_{13} + y_{23} \ge 1{,}400$$
$$y_{14} + y_{24} \ge 1{,}500$$
$$y_{15} + y_{25} \ge 1{,}600$$



Balance: at each depot



$$y_{11} + y_{12} + y_{13} + y_{14} + y_{15} - x_{11} - x_{21} - x_{31} = 0$$
$$y_{21} + y_{22} + y_{23} + y_{24} + y_{25} - x_{12} - x_{22} - x_{32} = 0$$

Network Models for Process Industries

- Delta Oil company – Page 281 – Powell & Baker.
- Refining process separates crude oil into components that eventually yield gasoline, heating oil, lubricating oil, other petroleum products.
- Distillation tower uses 5 barrels of crude oil to produce 3 barrels of distillate and 2 barrels of low-end by products.
- Some distillate is blended into gasoline products. Rest is feedstock form the catalytic cracker.
- Catalytic cracker produces catalytic gasoline.
- Distillate is blended with catalytic to make regular gasoline and premium gasoline.

Network Models for Process Industries

- Variables:
  - CR: amount of catalytic that is combined into regular gasoline.
  - Crude, Dist, Low, Blend, Feed, Cat, High, BR, BP, CR, CP, Reg, and Prem.
- Balance Equation at T:

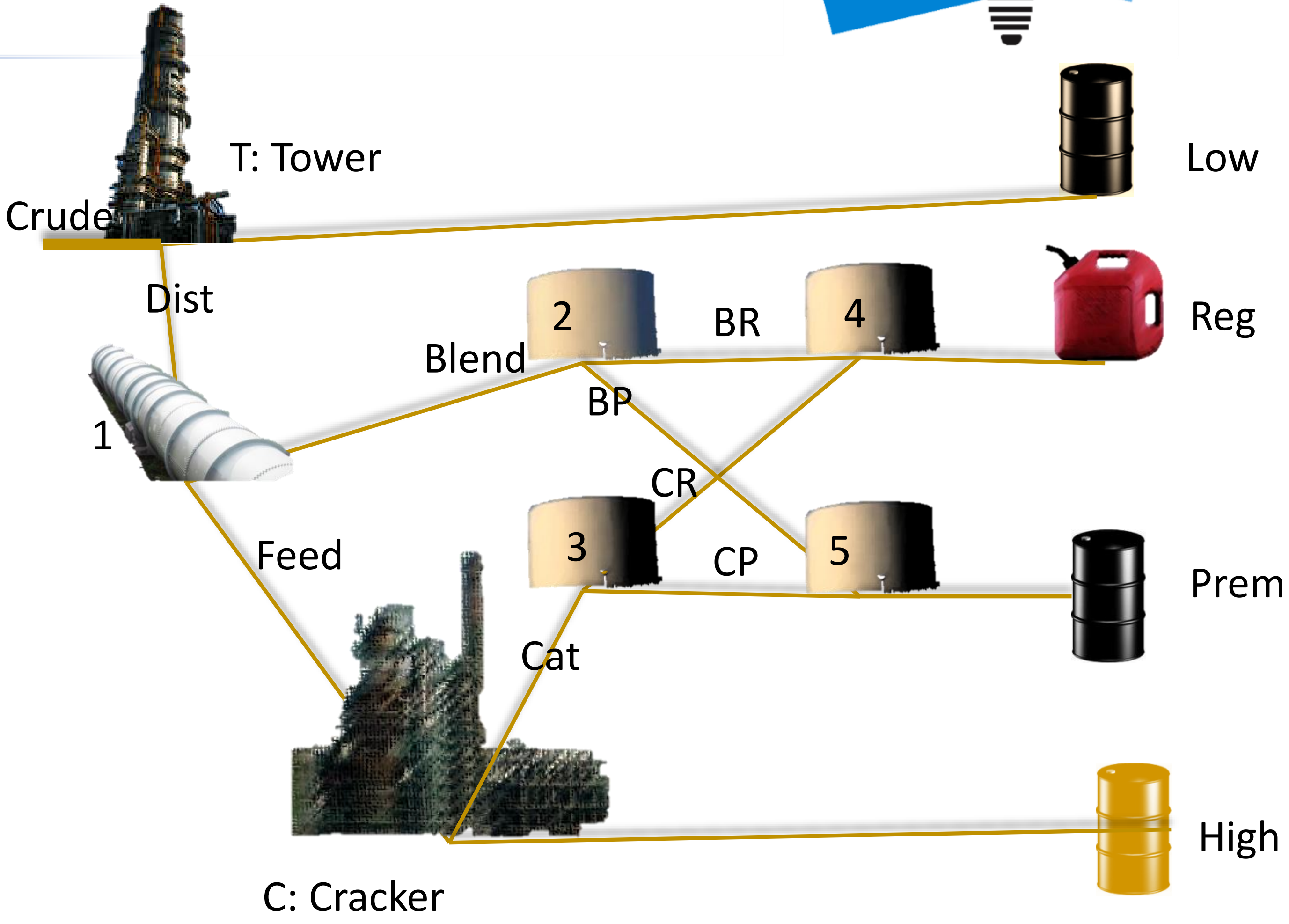
$$Dist - 0.60\ Crude = 0$$
$$Low - 0.40\ Crude = 0$$

- Balance Equation at C:

$$Cat - 0.64\ Feed = 0$$
$$High - 0.40\ Feed = 0$$

- Balance Equation at 1:

$$Feed + Blend - Dist = 0$$



Network Models for Process Industries

- Balance Equation at 2,3:

$$BP + BR - Blend = 0$$
$$CP + CR - Cat = 0$$

- Balance Equation at 4,5:

$$Prem - BR - CP = 0$$
$$Reg - BR - CR = 0$$

- Tower Capacity: 50,000
- Cracker Capacity: 20,000
- Sale potential Reg and Prem: 16,000
- Blending floor: Reg 50% catalytic, Prem 70%

- Objective Function:
  - Crude oil: $28 per barrel
  - Cost of operating the tower: $5 per barrel
  - Cost of operating the cracker: $6 per barrel
  - Revenue for high-end and low-end byproducts: $44 and $36 per barrel
  - Revenue for regular and premium gasoline: $50 and $55 per barrel

Building Integer Programming Models

Binary Variables and Logical Relationships

Uses of Integer Variables

- Discrete quantities: number of airplanes, cars, houses, or people.
- Yes/No decisions: zero-one (0-1) (or binary) variables. $\begin{cases} \delta = 1 \\ \delta = 0 \end{cases}$
  - $\delta = 1$ indicates that a depot should be build.
  - $\delta = 0$ indicates that a depot should not be build.
- Indicator variables - to impose extra conditions:
  - Use a variable to distinguish between the state where $x = 0$ and $x > 0$.
  - Extra constraints enforce the conditions.
  - Threshold levels.

Capital Budgeting Problem

- Allocating a capital budget, invested in multi-year projects.
- Maximize the value of projects selected, subject to the budget constraint.
- Marr Corporation – Page 292 – Powell & Baker.
- Each project has a required expenditure and a value (NPV of its cash flows over the project life).

	Projects				
	P1	**P2**	**P3**	**P4**	**P5**
NPV	10	17	16	8	14
Expenditure	48	96	80	32	64

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Capital Budgeting Problem

- Decision variables: $y_j = 1$ if project j is accepted; 0 otherwise.
- Objective function: $Maximize\ 10y_1 + 17y_2 + 16y_3 + 8y_4 + 14y_5$
- Constraints: subject to:
  - Budget limit $48y_1 + 96y_2 + 80y_3 + 32y_4 + 64y_5 \leq 160$
  - Integer constraint y_j binary

	Projects				
	P1	**P2**	**P3**	**P4**	**P5**
NPV	10	17	16	8	14
Expenditure	48	96	80	32	64

Relationship Among Variables

- Projects can be related in number of ways:
  - At least m projects must be selected.
  - At most n projects must be selected.
  - Exactly k projects must be selected.
  - Some projects are mutually exclusive.
  - Some projects have contingency relationships.
- Capital budgeting policy constraint:
  - Need to select at least one international project.
  - Projects P2 and P5 are international and others are domestic.
  - Add $y_2 + y_5 \geq 1$ which ensures that combination $y_2 = y_5 = 0$ is not allowed.

Relationship Among Variables

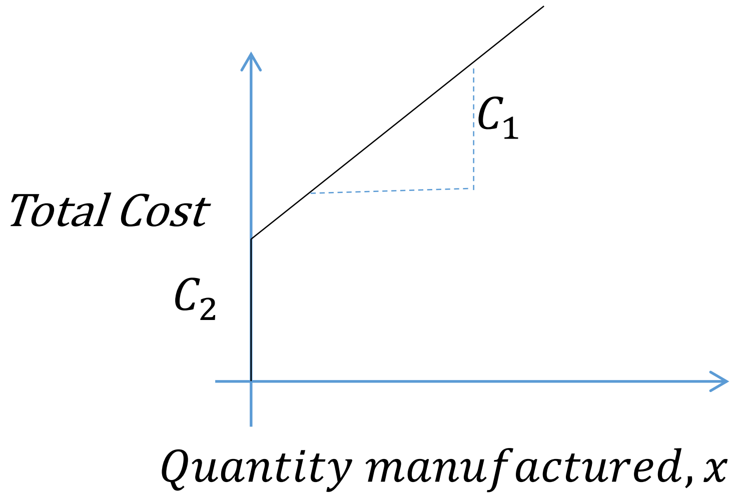
Capital budgeting policy constraints:

- P4 and P5 are mutually exclusive (they could require same staff resources). $y_4 + y_5 \leq 1$ which ensures that combination $y_4 = y_5 = 1$ is not allowed.
  - Special case of "at most n out of m". Here it is 1 out of 2.
- P5 is contingent on P3: P5 requires that P3 be selected. $y_3 - y_5 \geq 0$

P5	P3	Consistent?
0	0	Yes
1	0	Yes
0	1	No
1	1	Yes

Fixed Charge Example

- Example: machine has a start up cost if used at all.
- x represents the quantity of a product to be manufactured at a marginal cost C_1 per unit. If product is manufactured at all, there is a set up cost C_2 to prepare the machine.
  - $x = 0$ total cost $= 0$
  - $x > 0$ total cost $= C_1 x + C_2$
- Total cost is not a linear function of x. It is a discontinuous function.
- Introduce indicator (binary) variable y.
- If any of product manufactured y=1.
  - Add $x - My \leq 0$
  - Total cost: $C_1 x + C_2 y$



Fixed Charge Example

- Allocating capacity, to produce a mix of products.
- Mayhugh Manufacturing – Page 299 – Powell & Baker.
- Maximize the production profit (there is a variable profit and a fixed cost for each product family) subject to demand and production constraints.

	Projects			Hours Available
	F1	F2	F3	
Profit per unit	$1.20	$1.80	$2.20	
Hours Required Per Thousand Units				
Department A	3	4	8	2,000
Department B	3	5	6	2,000
Department C	2	3	9	2,000
Sales Cost ($000)	60	200	100	
Demand (000)	400	300	50	

Fixed Charge Example

- Decision variables x_1, x_2, x_3, binary variables y_1, y_2, y_3
- Objective function – Maximize the total profit.

$$Max\ 1.2\ x_1 - 60y_1 + 1.80x_2 - 200y_2 + 2.20\ x_3 - 100y_3$$

- Constraints –
  - Department A capacity
  - Department B capacity
  - Department C capacity

$$3\ x_1 + 4\ x_2 + 8\ x_3 \leq 2000$$
$$3\ x_1 + 5\ x_2 + 6\ x_3 \leq 2000$$
$$2\ x_1 + 3\ x_2 + 9\ x_3 \leq 2000$$

  - Linking constraints

$$x_1 - My_1 \leq 0$$
$$x_2 - My_2 \leq 0$$
$$x_3 - My_3 \leq 0$$

→

$$x_1 - 400y_1 \leq 0$$
$$x_2 - 300y_2 \leq 0$$
$$x_3 - 50y_3 \leq 0$$

  - Integer constraint

y_j binary

Threshold Levels

- A common requirement: a decision variable x is either 0, or $\geq$ a specified minimum.
  - This is sometimes called a semi-continuous variable.
- Introduce a 0-1 indicator variable y.
- m is the minimum feasible value of x if it is nonzero. M is an upper limit for x.

$$x - My \leq 0$$
$$x - my \geq 0$$

Therefore:

$$y = 1 \rightarrow \; m \leq x \leq M$$
$$y = 0 \rightarrow \; x = 0$$

- Mayhugh Manufacturing – Page 303 – Powell & Baker. $250 \leq x_2 \leq 300$

$$x_2 - 250y_2 \geq 0$$

Non-Smooth Models: Hardest to Solve

Linear: =SUM(A1:A10)

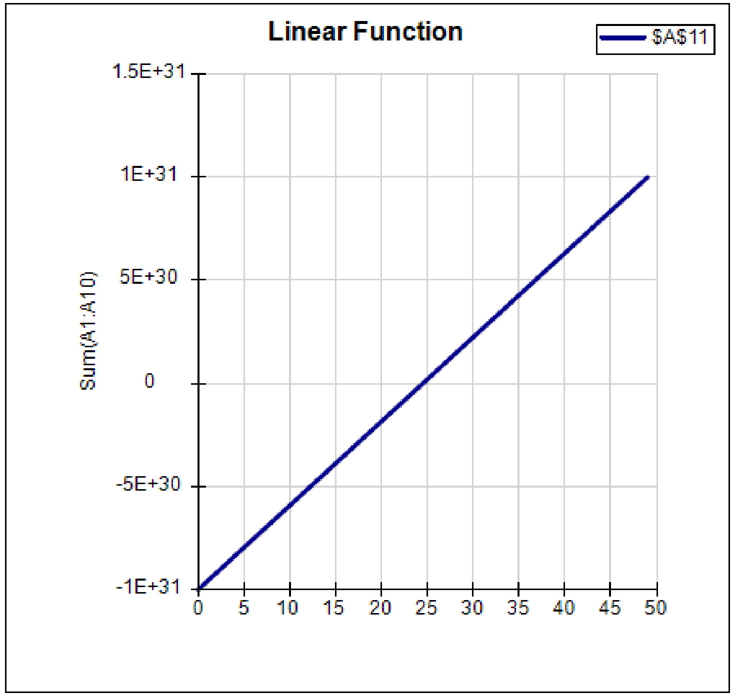
Easiest/Fastest

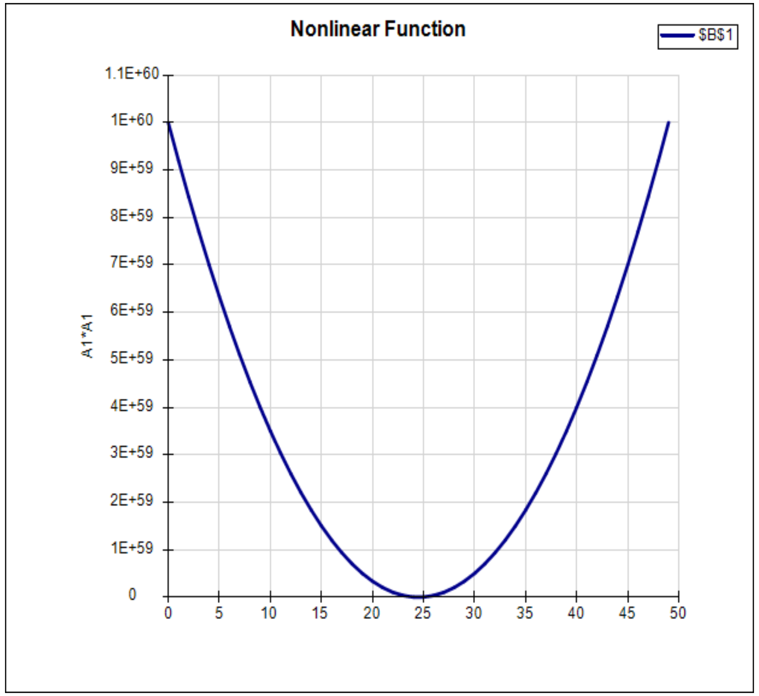
Non-linear: =A1*A1

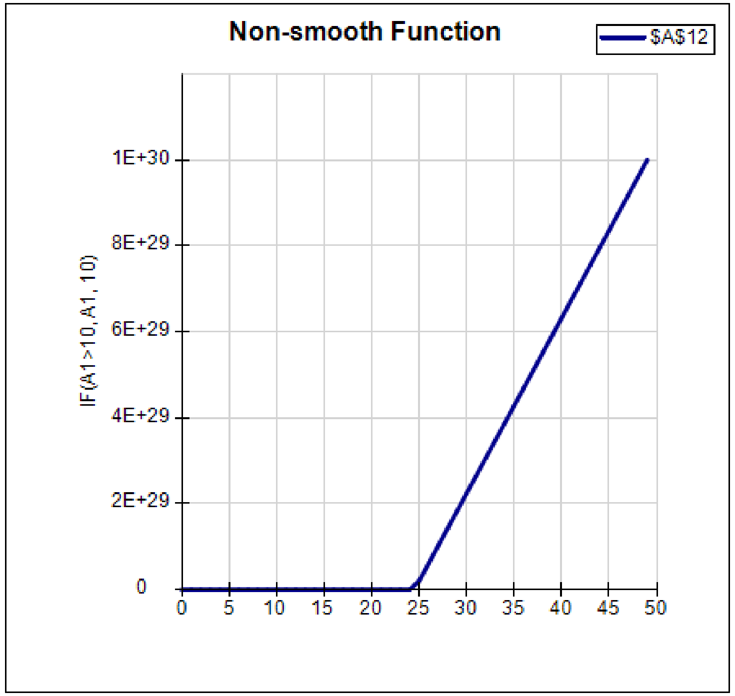
Slower

Non-smooth: =IF(A1>25, A1, 0)

Hardest/Slowest







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Non-Smooth Transformation

- Applies to the following functions:
  - IF, nested IF, AND, OR, NOT
  - ABS, MIN, MAX
  - CHOOSE, LOOKUP (up to 100 levels)
- Will be used only if result is a linear function.

IF Functions in Spreadsheet

- =IF(J5> 500,L5,M5), where only J5 depends on the decision variables.
- Introducing a binary integer variable (say H5) that is 1 if the conditional argument of the IF is TRUE, and 0 otherwise.
- Add the constraints:
  - J5 –500 <= M*H5
  - 500 – J5 <= M*(1–H5)
- Replace IF function with L5*H5 + M5*(1-H5).

IF Functions in Spreadsheet

- $\text{IF}(f(x) > 0, h(x), g(x))$
- We introduce 2 new variables: a binary Y, indicating if $f(x) > 0$, and a new variable r, which will replace the if function completely.
- Then add the constraints:
  - $-M * Y + h(x) <= r <= h(x) + M * Y$
  - $-M * (1 - Y) + g(x) <= r <= g(x) + M * (1 - Y)$
- To make sure Y has the right value, add:
  - $M * Y + f(x) >= 0$ (this forces $Y = 1$ when $f(x) < 0$, and is always true otherwise)
  - $-M * (1 - Y) + f(x) <= 0$ (this forces $Y = 0$ when $f(x) >= 0$, and is always true otherwise)

Absolute Value (ABS)

- A1 is a product tolerance and C1 is the desired value.
- $ABS(A1 - C1)$ is the deviation from the desired value.
- **Objective function:** $\boldsymbol{Min\ \ ABS(A1 - C1) + \cdots}$
- Introduce $X = A1 - C1$. So we want: $Min\ \ ABS(X)$
- Add a new variable Y; Add constraints:

$$X <= Y$$
$$-X <= Y$$

- We replace in objective Min Y.

MAX()/MIN()

- **Minimize** $\mathbf{MAX}(\boldsymbol{x_1}, \boldsymbol{x_2})$
- Introduce a new variable Z equivalent to $Max\{x_1, x_2\}$
- Add constraints:
  - $\mathrm{Z} \geq x_1, \mathrm{Z} \geq x_2$
- We replace in objective Minimize Z
- **Maximize** $\mathbf{MIN}(\boldsymbol{x_1}, \boldsymbol{x_2})$
- Introduce a new variable Z equivalent to $Min\{x_1, x_2\}$
- Add constraints:
  - $\mathrm{Z} \leq x_1, \mathrm{Z} \leq x_2$
- We replace in objective Maximize Z

Benefits of Optimization

- A properly formulated model will give you the benefits of an optimal solution.
- Most common business situations can be modeled using the techniques we discussed today.
- Ideally, start the modeling process with these techniques in mind.
- For existing models, Frontline's Solvers can automatically transform IF, CHOOSE, LOOKUP, and other functions into linear integer form.

Further Benefits of Modeling

- Building a model often reveals relationships and yields a greater understanding of the situation being modeled.
- Having built a model, it is possible to apply analytic methods to suggest courses of action that might not otherwise be apparent.
- Experimentation is possible with a model, whereas it is often not possible, or desirable, to experiment with the situation being modeled.
- Analytic Solver Platform is a complete toolset for descriptive, predictive and prescriptive analytics.

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- Best way to contact me: Consulting@Solver.com
- You may also download this presentation from our website at www.solver.com/training/premsolver-2.
- You can download a free trial version of Analytic Solver Platform at Solver.com.

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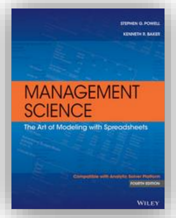

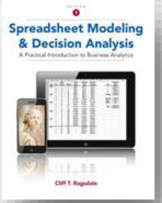

Q & A

Thank You!