DATA ANALYTICS

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MODELING AND DECISION TREES

- Why do we need models?
  - Approximation of reality
  - Understand past
  - Predict future
  - Separate unpredictable and predictable
  - A picture, a spreadsheet, a set of mathematical relationships.

- What is a decision model?
  - Is a model that can be used to understand, analyse, or facilitate making a decision.

MODELING AND DECISION TREES

- Developing strategies to deal with how to price products, where to locate facilities, how many people to hire, where to allocate advertising budgets and how to schedule production can be a difficult task.

- Quantitative decision models can greatly assist in these types of decisions.

- Spreadsheets, in particular, provide a convenient means to manage data, construct models, and analyse them for gaining insight and supporting decisions.

MODELING AND DECISION TREES

- Three types of inputs:
  - Data
  - Uncontrollable variables
  - Decision variables
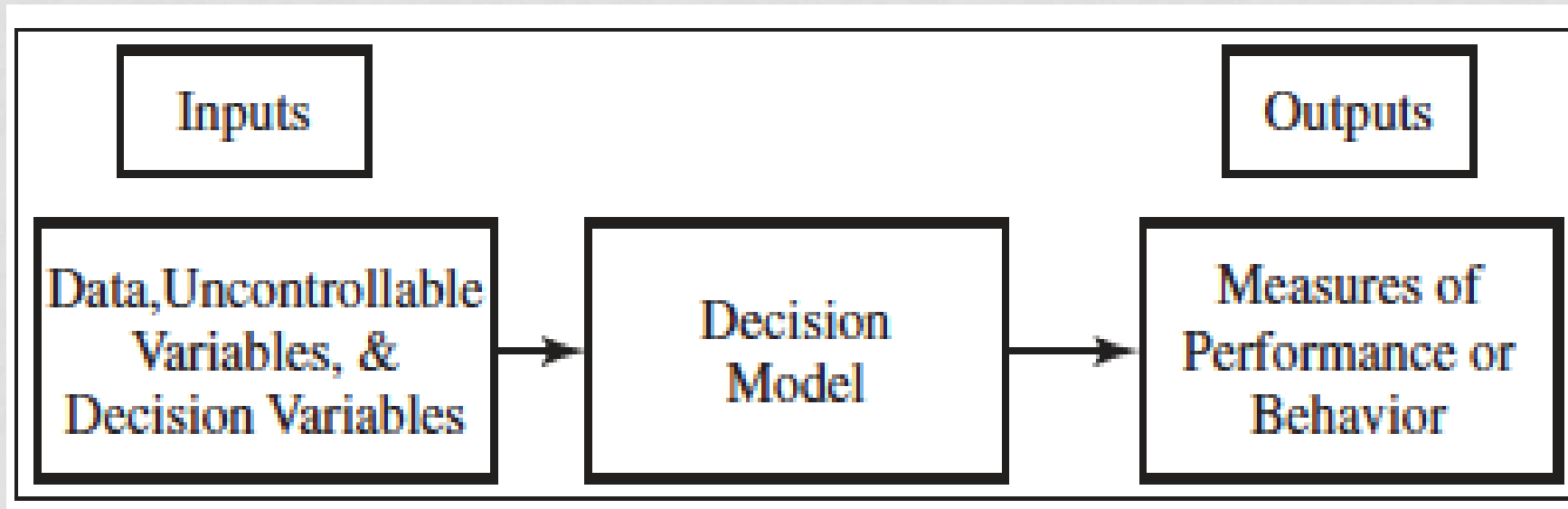
MODELING AND DECISION TREES

- Decision models characterize the relationships between data, uncontrollable variables, and decision variables and the outputs of interest to the decision maker.

- A spreadsheet is one way of expressing a decision model through the formulas entered in the cells that reflect the relationships among the model components. For any set of inputs, the spreadsheet calculates some output measures of interest.

- Spreadsheets are ideal vehicles for implementing decision models because of their versatility in managing data, evaluating different scenarios, and presenting results in a meaningful fashion.

DECISION MODELS – OUTSOURCING EXAMPLE

- Decision models are models that can be used to understand, analyze, or facilitate making a decision

	A	B
1	**Outsourcing Decision Model**	
2		
3	**Data**	
4		
5	**Manufactured in-house**	
6	Fixed cost	$ 50,000
7	Unit variable cost	$ 125
8		
9	**Purchased from supplier**	
10	Unit cost	$ 175
11		
12	**Model**	
13		
14	Demand volume	1500
15		
16	Total manufacturing cost	$ 237,500
17	Total purchased cost	$ 262,500
18	Difference	$ (25,000)
19		
20	Decision	Manufacture

	A	B
1	**Outsourcing Decision Model**	
2		
3	**Data**	
4		
5	**Manufactured in-house**	
6	Fixed cost	50000
7	Unit variable cost	125
8		
9	**Purchased from supplier**	
10	Unit cost	175
11		
12	**Model**	
13		
14	Demand volume	1500
15		
16	Total manufacturing cost	=B6+B7*B14
17	Total purchased cost	=B14*B10
18	Difference	=B16-B17
19		
20	Decision	=IF(B18<=0, "Manufacture", "Outsource")

OUTSOURCING MODEL

- Model components
  - F = fixed cost of in-house manufacturing
  - V = unit variable cost of in-house manufacturing
  - C = unit cost of outsourcing
  - D = demand volume
- Total Manufacturing Cost = $TMC = F + V * D$
- Total outsourcing cost = $TOC = C * D$.

TYPES OF DECISION MODELS

- Descriptive - describe relationships and provide information for evaluation

- Prescriptive (optimization models) - determine an optimal policy, that is, the best course of action that a decision maker should take to maximize or minimize some objective

AIRLINE PRICING MODEL

	A	B
1	**Airline Pricing Model**	
2		
3	**Data**	
4	Airplane capacity	300
5	Fixed cost	$ 90,000
6	Demand function	
7	slope	-2.33
8	intercept	1900
9		
10	**Model**	
11		
12	Revenue	
13	Unit price	$ 500.00
14	Demand	733
15	Number of flights/day	3
16	Total Revenue	$366,666.67
17	Cost	
18	Fixed Cost	$270,000.00
19		
20	Profit	$96,666.67

	A	B
1	**Airline Pricing Model**	
2		
3	**Data**	
4	Airplane capacity	300
5	Fixed cost	90000
6	Demand function	
7	slope	=-7/3
8	intercept	1900
9		
10	**Model**	
11		
12	Revenue	
13	Unit price	500
14	Demand	=B8+B7*B13
15	Number of flights/day	=ROUNDUP(B14/B4,0)
16	Total Revenue	=B13*B14
17	Cost	
18	Fixed Cost	=B5*B15
19		
20	Profit	=B16-B18

MODEL ANALYSIS

- What-If Analysis – evaluate how specific combinations of model inputs that reflect key model assumptions affect model outputs (often called sensitivity analysis).
- Excel tools
  - Data tables
  - Scenario manager
  - Goal seek

DATA TABLES

- Summarizes the impact of one or two inputs on a specified output
- Excel tools
  - One-way data tables
  - Two-way data tables

ONE WAY DATA TABLE

	A	B	C	D	E	F	G
1	**Outsourcing Decision Model**						
2					Fixed Costs	Difference	Decision
3	**Data**					$ (25,000)	Manufacture
4					$ 30,000	$ (45,000)	Manufacture
5	**Manufactured in-house**				$ 40,000	$ (35,000)	Manufacture
6	Fixed cost	$ 50,000			$ 50,000	$ (25,000)	Manufacture
7	Unit variable cost	$ 125			$ 60,000	$ (15,000)	Manufacture
8					$ 70,000	$ (5,000)	Manufacture
9	**Purchased from supplier**				$ 80,000	$ 5,000	Outsource
10	Unit cost	$ 175			$ 90,000	$ 15,000	Outsource
11					$ 100,000	$ 25,000	Outsource
12	**Model**						
13							
14	Demand volume	1500					
15							
16	Total manufacturing cost	$ 237,500					
17	Total purchased cost	$ 262,500					
18	Difference	$ (25,000)					
19							
20	Decision	Manufacture					

Column input cell

TWO WAY DATA TABLE

	A	B	C	D	E	F	G	H	I	J	K
1	**Outsourcing Decision Model**										
2			Column		Fixed Cost			Variable Cost			
3	**Data**		input cell		Manufacture	$ 100	$ 110	$ 120	$ 130	$ 140	$ 150
4					$ 30,000	Manufacture	Manufacture	Manufacture	Manufacture	Manufacture	Manufacture
5	**Manufactured in-house**				$ 40,000	Manufacture	Manufacture	Manufacture	Manufacture	Manufacture	Outsource
6	Fixed cost	$ 50,000			$ 50,000	Manufacture	Manufacture	Manufacture	Manufacture	Manufacture	Outsource
7	Unit variable cost	$ 125			$ 60,000	Manufacture	Manufacture	Manufacture	Manufacture	Outsource	Outsource
8			Row		$ 70,000	Manufacture	Manufacture	Manufacture	Outsource	Outsource	Outsource
9	**Purchased from supplier**		input cell		$ 80,000	Manufacture	Manufacture	Manufacture	Outsource	Outsource	Outsource
10	Unit cost	$ 175			$ 90,000	Manufacture	Manufacture	Outsource	Outsource	Outsource	Outsource
11					$ 100,000	Manufacture	Outsource	Outsource	Outsource	Outsource	Outsource
12	**Model**										
13											
14	Demand volume	1500									
15											
16	Total manufacturing cost	$ 237,500									
17	Total purchased cost	$ 262,500									
18	Difference	$ (25,000)									
19											
20	Decision	Manufacture									

SCENARIO MANAGER

	Fixed Cost	Unit Variable Cost	Demand Volume
Best case	$40,000	$120	1,800
Worst case	$60,000	$140	1,000
Most likely case	$55,000	$125	1,500
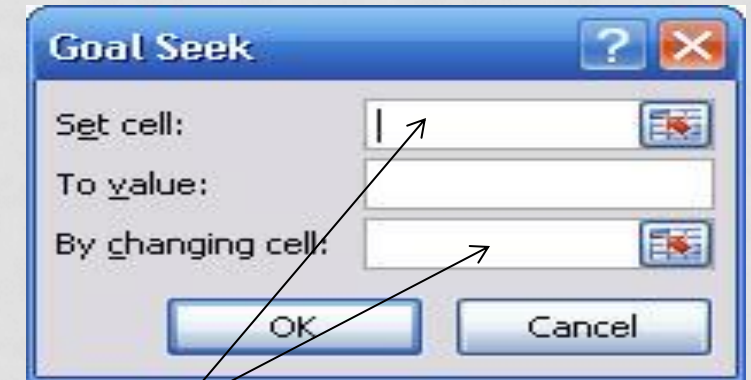
		Scenario Summary							
2		**Scenario Summary**							
3			Current Values:		Best case		Worst case		Most likely case
5		**Changing Cells:**							
6		B6	$	50,000	$	40,000	$	60,000	$	55,000
7		B7	$	125	$	120	$	140	$	125
8		B14		1500		1800		1000		1500
9		**Result Cells:**							
10		B18	$	(25,000)	$	(59,000)	$	25,000	$	(20,000)
11		B20	Manufacture		Manufacture		Outsource		Manufacture

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

GOAL SEEK

- Find the value of an input that produces a known result within a spreadsheet
- Example: find the breakeven point in the outsourcing decision model

Set cell is B18;
To value = 0;
By changing cell is B14

OPTIMIZATION MODELS: EXCEL *SOLVER*

Solution:
Price = $428.57;
profit =
$115,714.28

TOOLS FOR MODEL BUILDING

- Logic and business principles
- Common mathematical functions
- Data fitting
- Spreadsheet engineering

LOGIC AND BUSINESS PRINCIPLES

- Profit = Revenue - Cost
- Revenue = (Unit price)(Quantity sold)
- Cost = Fixed cost + Unit cost*Quantity produced
- Quantity sold = Min(Quantity produced, Demand)

- Profit = (Unit price)Min(Quantity produced, Demand) – [Fixed cost + (Unit cost)(Quantity produced)]

MODELING EXAMPLE: GASOLINE CONSUMPTION

- m = miles/day driven
- d = days/month
- f = miles/gallon

- Miles driven/month = md
- Gallons consumed/month = md/f