

DATA ANALYTICS

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MODELING AND DECISION TREES

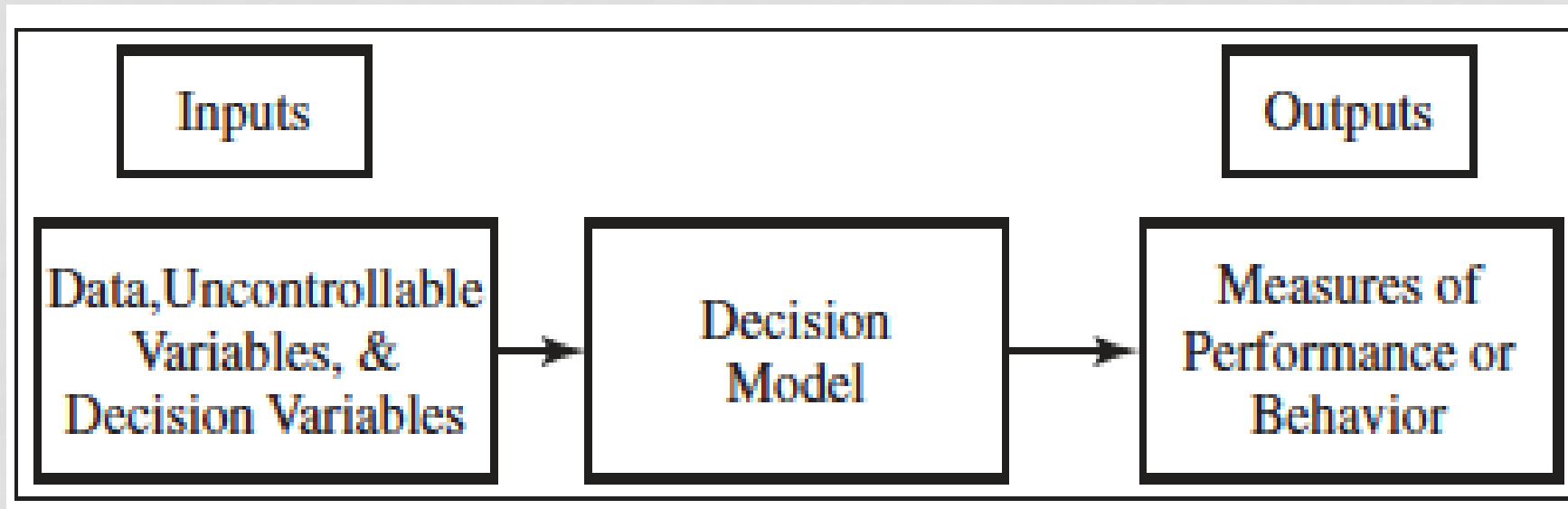
- Why do we need models?
 - Approximation of reality
 - Understand past
 - Predict future
 - Separate unpredictable and predictable
 - A picture, a spreadsheet, a set of mathematical relationships.
- What is a decision model?
 - Is a model that can be used to understand, analyse, or facilitate making 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							
3	Data				Fixed Costs	Difference	Decision
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					Fixed Cost			Variable Cost			
3	Data		Column 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 input cell		\$ 70,000	Manufacture	Manufacture	Manufacture	Outsource	Outsource	Outsource
9	Purchased from supplier				\$ 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

1
2
3
5
6
7
8
9
10
11
12
13
14

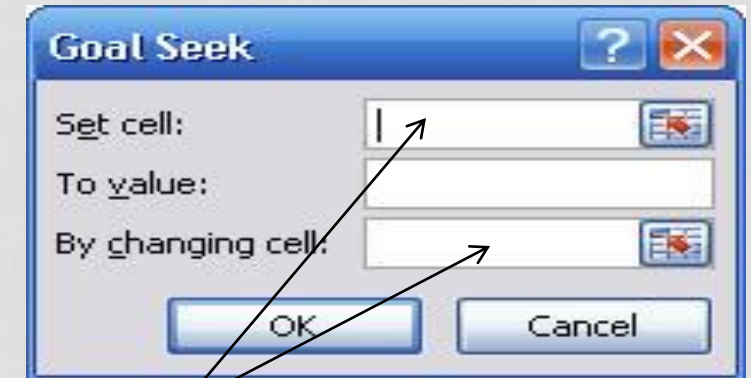
Scenario Summary					
	Current Values:		Best case	Worst case	Most likely case
Changing Cells:					
\$B\$6	\$	50,000	\$ 40,000	\$ 60,000	\$ 55,000
\$B\$7	\$	125	\$ 120	\$ 140	\$ 125
\$B\$14		1500	1800	1000	1500
Result Cells:					
\$B\$18	\$	(25,000)	\$ (59,000)	\$ 25,000	\$ (20,000)
\$B\$20		Manufacture	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

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The Goal Seek dialog box is shown with the following fields:

- Set cell:** A text box with a dropdown arrow, currently showing a blank cell reference.
- To value:** A text box, currently empty.
- By changing cell:** A text box with a dropdown arrow, currently showing a blank cell reference.
- Buttons:** OK and Cancel buttons at the bottom.

Arrows from the text below point to the 'Set cell' and 'By changing cell' fields.

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

OPTIMIZATION MODELS: EXCEL *SOLVER*

	A	B	C	D	E	F	G	H	I	J	K
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									
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16	Total Revenue	\$366,666.67									
17	Cost										
18	Fixed Cost	\$270,000.00									
19											
20	Profit	\$96,666.67									
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
32											
33											
34											
35											

Solver Parameters

Set Objective:

To: ☒ Max ☐ Min ☐ Value Of:

By Changing Variable Cells:

Subject to the Constraints:

Add
Change
Delete
Reset All
Load/Save

☐ Make Unconstrained Variables Non-Negative

Select a Solving Method:

Solving Method
Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Help Solve Close

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

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