Primitive Decision Models

- Still widely used
- Illustrate problems with intuitive approach
- Provide base for appreciating advantages of decision analysis

Payoff Matrix as Basic Framework

BASIS: Payoff Matrix

Alternative	State of “nature” S_1 S_2 . . . S_M
A_1	Value of outcomes
A_2	
A_N	O_{NM}

Primitive Model: Laplace (1)

- **Decision Rule:**
  - a) Assume each state of nature equally probable => $p_m = 1/m$
  - b) Use these probabilities to calculate an "expected" value for each alternative
  - c) Maximize "expected" value

Primitive Model: Laplace (2)

- **Example**

	S_1	S_2	"expected" value	
A_1	100	40	70	
A_2	70	80	75	"best"

- **Ex: A1, A2 = weekend at Beach or in NY City**
- **S1, S2 = the sunny and rainy scenarios**

Primitive Model: Laplace (3)

- **Problem: Sensitivity to framing**
  ==> "irrelevant states" change "best"

	S_{1A}	S_{1A}	S_2	"expected" value	
A_1	100	100	40	80	"best"
A_2	70	70	80	73.3	

- **Ex: A1, A2 = weekend at Beach or in NY City**
- **S1A, S1B = Sunny on Saturday or Sunday**

Maximin or Maximax Rules (1)

- **Decision Rule:**
  - a) Identify minimum or maximum outcomes for each alternative
  - b) Choose alternative that

    <u>maxi</u>mizes the global <u>min</u>imum (maximin)

  or

    <u>maxi</u>mizes the global <u>max</u>imum (maximax)

Maximin or Maximax Rules (2)

- **Example:**

	S_1	S_2	S_3	maximin	maximax
A_1	100	40	30	☑	2
A_2	70	80	20	2	3
A_3	0	0	110	3	☑

- **Problems**
  - discards most information
  - focuses on extremes

Regret (1)

- **Decision Rule**

  a) Regret = (max outcome for state i) - (value for that alternative)

  b) Rewrite payoff matrix in terms of regret

  c) Minimize maximum regret (minimax)

Regret (2)

- Example:

	S_1	S_2	S_3
A_1	100	40	30
A_2	70	80	20
A_3	0	0	110

→

0	40	80
30	0	90
100	80	0

☑

- Original Payoff Matrix   Regret Matrix

Note: diagonal zeros a chance not necessary feature

Regret (3)

- Problem: Sensitivity to Irrelevant Alternatives => Potential Intransitivities

A_1	100	40	30	0	40	0
A_2	70	80	20	30	0	10

☑ (A_2)

NOTE: Reversal of evaluation if alternative A_3 dropped !
Is A_3 "vaporware" – meant to keep customer
from switching from A1 to A2? (this happens!)

Weighted Index Approach (1)

- **Decision Rule**

  a) Portray each choice with its deterministic attribute -- different from payoff matrix

  For example:

Material	Cost	Density
A	$50	11
B	$60	9

In this case (vehicle production), lower cost and weight is better, so choice is not obvious

Weighted Index Approach (2)

b) Normalize table entries on some standard, to reduce the effect of differences in units. This could be a material (A or B); an average or extreme value, etc.

For example, normalizing on A:

Material	Cost	Density
A	1.00	1.00
B	1.20	0.82

c) Decide according to weighted average of normalized attributes.

Weighted Index Approach (3)

- **Problem 1: Sensitivity to Normalization**

Example:

	Normalize on A		Normalize on B	
Matl	**$**	**Density**	**$**	**Density**
A	1.00	1.00	0.83	1.22
B	1.20	0.82	1.00	1.00

Weighting both equally, we have

A > B (2.00 vs. 2.02)   B > A (2.00 vs. 2.05)

Result depends on basis of normalization!

Weighted Index Approach (4)

- **Problem 2: Sensitivity to Irrelevant Alternatives**

  As above, evident when introducing a new alternative, and thus, new normalization standards.

- **Problem 3: Sensitivity to Framing**
  “irrelevant attributes” similar to Laplace criterion (or any other using weights)

Example from Practice

- Sydney Environmental Impact Statement
- 10 potential sites for Second Airport
- About 80 characteristics

- The choice from first solution
- … not chosen when poor choices dropped
- … best choices depended on aggregation of attributes
- Procedure a mess -- totally dropped

Summary

- Primitive Models are full of problems

- Yet they are popular because
  - people have complex spreadsheet data
  - they seem to provide simple answers

- Now you should know why to avoid them!