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Basic Definitions

What Is the Decision Making Process

- D M P consists of three major steps
  1. Identify the DM situation and understand objectives.
  2. Identify possible course of actions or alternatives.
  3. Decompose and model the problem

What Is the Decision Making Process

1. Choose the best alternative
2. Sensitivity analysis
3. Is further analysis needed ?
4. If yes go back to steps 1, 2 or 3.
5. otherwise implement the chosen alternative.

Identifying Courses of Actions

- Define Problem
- Identify variables
- Identify major factors
- Every feasible solution is a course of action

Approached to Decision Making

- Intuitive
- Programmed
- Analytic

Examples of Decision Making Problems

Car Exchange Problem

Consider the case of a person who would like to exchange his car. The garage where he does the exchange provides good buys and bad ones.

The net operating cost for a good buy is 120 MR and for operating a bad buy is 160 MR.

If he kept his car the cost is estimated to be 140 MR. The good buy or bad buy will be identified after the buying and using the car. The person would like to minimize his cost. What he should do?

Investment Plans

- A company manager has five investment plans for the year. The net profit is a function of inflation. The plan are given below:

	a_1	a_2	a_3	a_4	a_5
High	1.5	2	5	3	3
Low	6	3	2	5	3.5

Book Ordering

- A book store is faced with the problem of ordering books for course X.
- Every student who does not receive a book at the beginning of the semester will receive a book rush ordered and that means the store will loose 20 KR on each book supplied this way.
- On every untaken book the store will loose10 KR. How many books the store should order every semester?

Two Major Steps in DM

- Structural Specification of the problem
- Criteria specification

Structural Specification

- Define the variables and parameters
- Identify alternatives
- Develop relationships
- Identify constraints

Example for Structural Specification

In a personnel portfolio investment you are faced with investing X R. There are three options. The first option offers a safe fixed rate r_s per month and the return is is to invest

$$Y = X (1 + r_s)$$

Option II offers a weekly rate r_1, r_2, r_3 and r_4

Example Cont.

The return from option II is:

$$Y = X (1 + r_1) (1 + r_2) (1+ r_3)(1+ r_4)$$

The third option is to divide X into two parts one to be invested in option I and the other part in option II.

X_1 = Amount invested in option I

X_2 = Amount invested in option II

Example Cont.

$$Y = X1\,(\,1 + r_s) + X_2\,(1 + r_1\,)\,(1 + r_2\,)\,(\,1 + r_3\,)(1 + r_4\,)$$

$$X = X_1 + X_2$$

Then optimize to maximize return.

Criteria for Analysis

- Are assumptions of the model listed
- Are assumptions of the client listed
- Are any of the assumptions tested
- Are probabilities used to measure uncertainty
- Are sensitivity analysis conducted
- Is more than one problem structure used
- Are the possible alternatives from client considered

A Good Decision

A good decision is a one that explicates the decision maker assumptions, values and perspectives on the problem to attain the highest practical level of coherence

What Constitute a Good Decision

1. That elicits favorable from superiors
2. That elicits favorable response from colleagues
3. That responsibility that has been nicely delegated
4. That achieves quick committee response
5. Provides the ideal outcome
6. That results from a through understanding of the problem.

Coherence Principal

- A necessary condition for rational belief and actions on the part of the individual is that they should all be logically consistent with each other, involving no mutual contradictions.

Perpetual Money Maker

Incoherent who says

E is less likely than F,

F is less likely than G and instead of saying

E is less likely than G,

he says G is less likely than E.

Demonstrate you can make him in a perpetual money making machine

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Decision

Why are decisions hard?

- Uncertainty
- Multiple, conflicting objectives
- Complexity
  - Difficult to structure problem
- Different perspectives can lead to different conclusions

Four distinct cases

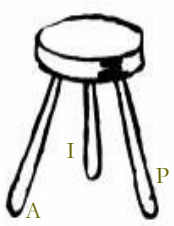
	Single attribute	Multiple attributes
Certainty	■	■ Multi-objective value functions
Uncertainty	■ utility theory	■ Multi-objective utility functions

Four distinct cases: dominance rather than optimization

	Single attribute	Multiple attributes
Certainty	■	■ Multi-Criteria DM
Uncertainty	■ Stochastic Dominance	■ ???

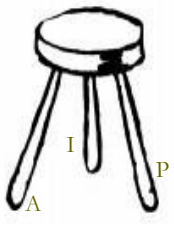
The elements of a decision

- Alternatives
- Information
- Preferences



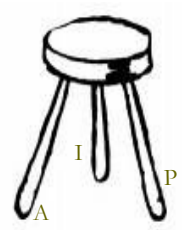
The elements of a decision

- Alternatives
  - Possible actions that you can choose.
- Information
- Preferences



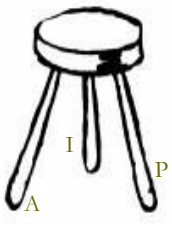
The elements of a decision

- Alternatives
  - Possible actions that you can choose.
- Information
- Preferences
  - An ordering over outcomes/consequences.
  - Preferences reflect values



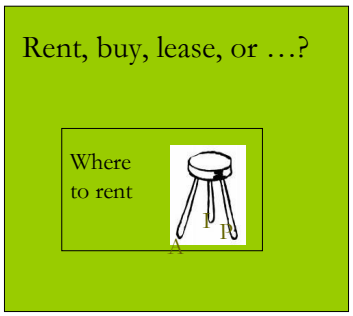
The elements of a decision

- Alternatives
  - Possible actions that you can choose.
- Information
  - Information ties Alternatives to Outcomes/Consequences
  - If there is uncertainty, the information will be in the form of probabilities.
- Preferences
  - An ordering over outcomes.
  - Preferences reflect values



Decision Frame

- Another element is the decision frame.
- Where should you put your 3-legged stool?
- Are you solving the right problem? Should you look at a larger, more general problem? Or a smaller, more specific problem?



Decision problem

- : There is 100 cc of a gas at 1500 mb of pressure in a closed container. Determine how much gas should be added to or expelled from the container to make sure that when the gas in the container is compressed to 3000 mb of pressure its volume will be 40 cc.
- The only decision variable in this problem is:
  - x = cc of gas to be added to or taken out of the present container

- pv(p) = a constant a
- So, v(p) = a/p. In our decision problem we know that v(1500) =100 + x. Substituting, we find that a = 1500(100 + x). So we have

v(p) =(150, 000 + 1500x)/p

- This provides the volume of gas in the container as a mathematical function of its pressure. The requirement is that v(3000) = 40. This can be expressed as the constraint

150, 000 + 1500x = 3000 × 40, or

- 1500x = -30, 000

$$\text{Minimize} \quad \theta(x) \tag{1.3.1}$$

$$\text{subject to} \quad g_i(x) \quad \begin{cases} = b_i, & i = 1, \ldots, m \\ \leq b_i, & i = m+1, \ldots, m+p \end{cases} \tag{1.3.2}$$

$$\ell_j \leq x_j \leq u_j, \quad j = 1, \ldots, n \tag{1.3.3}$$

$$x_j \in \Delta_j, \quad j \in J \subset \{1, \ldots, n\}. \tag{1.3.4}$$

Different decision models

- Single Versus Multi objective Models
- Static Versus Dynamic Models
  - multi-period or dynamic models
- Stochastic Versus Deterministic Models

Home work

- Think of some decision problems involving optimization, and
- state them clearly in your own words.
- Explain what data you will need to solve them.
- Discuss how you will handle these problems using your present state of knowledge without looking at the rest of this book.
- Keep these with you.