Decision Analysis I

ISE/OR Stochastic Models in Industrial Engineering
Hong Wan, Fall 2022

Example 0

what kind of economy?

An investor has a certain amount of money available to invest now. The estimated profits of each portfolio under each economic condition are indicated in the following payoff table:

less risky one

	Event	Portfolio Selection		
		A	B	C
p?	Economy Declines	$500	-$2,000	-$7,000
p?	No change	$1,000	$2,000	-$1,000
p?	Economy Expands	$2,000	$5,000	$20,000

long term investment

Example 1 Travel Decision

Erica is going to fly to London on December 5 and return Raleigh on December 20. On Aug 29th, she may buy a one-way ticket (for $400) or a round-trip ticket (for $750). She may also wait until November 1 to buy a ticket. On November 1, a one-way ticket will cost $450, and a round-trip ticket will cost $850. It is possible that between now and November 1, her sister (who works for the airline) will be able to obtain a free one-way ticket for Erica. The probability that her sister will obtain the free ticket is 0.30. If Erica has bought a round trip ticket on September 1 and her sister has obtained a free ticket, she may return “half” of her round-trip to the airline. In this case, her total cost will be $375 plus a $50 penalty.

How to make decision with uncertainty

We describe how to handle decision problems using only the information that is currently available about the problem: you cannot know the future for sure

Decision criteria: gains or losses associated with alternative decisions and the probabilities of occurrence of these gains and losses.

eliminate as many ~~best~~ possible outcomes as possible.

Decision Making under Uncertainty

→ if you know what will happen, do it.

1. entails the selection of a course of action when we do not know with certainty the results that each alternative will yield
2. If a decision maker is faced with choosing one action from among two or more alternative actions, and
3. at least one of these actions has possible outcomes that depend on the chance occurrence of one of a set of states of nature

↘ at least one of those is random.

Questions to Ask

1. What are my alternatives?
2. What are the critical uncertainties that affect the outcomes of my decisions?
3. What objectives am I trying to achieve in making a decision? What decision criteria will I use to choose among the competing alternatives?

• Which option I want to optimize?

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	A	B	C
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Decision Criteria: EMV

Expected Monetary Value → trying to optimize the

EMV: Expected Monetary Value

Indicate the average profit that would be gained if a particular alternative is selected

Four-Step Decision Process

1. Identify the set of *alternatives* from which to choose
2. Identify the set of critical *uncertainties* that affect the outcomes of the decisions
3. *Identify criteria* for choosing among the competing alternatives
4. We represent alternatives and uncertainties in chronological order using a **decision tree**

Decision Tree

Pictorially represents the states of nature or events and courses of action through a set of branches and nodes

☐ denotes a decision fork and signals that a decision must be made

❍ denotes a chance fork and signals that the next branch of the tree the decision maker will follow will be determined by the chance occurrence of a state of nature.

Example 2

Sarah Chang is a owner of a small electronics company. In six months a proposal is due for an electronic timing system for the 2024 Olympic Games. For several years, Sarah's company has been developing a new nanoprocessor, a critical component in a timing system that would be superior to any product currently on the market. However, progress in research and development has been slow, and Chang is unsure about whether her staff can produce the nanoprocessor in time.

If R&D succeeds (40% chance) in developing the nanoprocessor, then there is an excellent chance(90%) that Chang's company will win the $1,000,000 Olympic contract. If they do not, then there is only a small chance (5%) that she will still be able to win the same contract with an alternative inferior timing system that has already been developed.

If she continues the project, Chang must invest $200,000 in research and development expenses. In addition, making a proposal requires developing a prototype timing system at an additional cost of $50,000. Finally, if Chang wins the contract, the finished product will cost an additional $150,000 to produce. Chang must decide whether to abandon the project or whether to continue investing in the venture.

Decision Structure

1. Actions
   The set of alternatives the decision make has chosen to consider
   The decision maker's problem is to choose one action from the list.

   What are chang's action set?

Decision Structuring

States of Nature (Uncertainties:)

Events that can occur and the probability of their occurrence

What are the critical uncertainties that affect the outcomes of Chang's decisions?

1 dly they get the contract } 2 uncertainties.
2 succesfully develop new product or not

Decision Structure

Outcome

The set of sequences resulting from all possible action/state of nature combinations (payoffs).

decision continue or abandon

What are the possible outcome for Chang?

Decision Structure

What is the objective variable: how to select the best actions

What is the EMV of making a proposal if the project success? Fail?

Let us do the decision tree

Revisit Example One

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Sensitivity Analysis

Determine if the decision is sensitive to changes in probabilities, valuation of outcome, or other assumptions you have made.