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DECISION ANALYSIS & TREES: RISK & UNCERTAINTY

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DECISION ANALYSIS

Decision analysis is a systematic and quantitative approach to decision-making that involves evaluating and choosing among different courses of action based on their potential outcomes and associated uncertainties. The goal is to make informed decisions that maximize positive outcomes or minimize potential losses. This analytical process is particularly valuable in complex situations where various factors and uncertainties come into play.

By combining quantitative methods, probability theory, and decision criteria, decision analysis guides decision-makers in selecting the most favorable courses of action based on their objectives and potential outcomes. Ultimately, decision analysis enables rational and informed decision-making in the face of uncertainty.

Six Steps in Decision Making Process

1. *Problem Definition:* Begin by clearly articulating and understanding the problem that needs a decision.
2. *Alternative Generation:* Enumerate the various alternatives or possible courses of action available to address the defined problem.
3. *Outcome Identification:* Identify the potential outcomes or states of nature associated with each alternative, considering all possibilities.
4. *Payoff Listing:* List the payoffs, often in terms of profits or benefits, for each combination of alternatives and outcomes.
5. *Decision Theory Model Selection:* Choose a suitable mathematical decision theory model based on the nature of the decision problem and the available data.
6. *Model Application and Decision:* Apply the selected model to the collected data and information to arrive at a decision or recommendation based on the analysis.

Type of Decision-making Environments

Decision-making is influenced by the level of knowledge about a situation, leading to three distinct decision-making environments:

- *Decision making under certainty.*
- *Decision making under uncertainty.*
- *Decision making under risk.*

The type of decision-making environment significantly impacts the choices individuals make, with decision making under uncertainty posing greater challenges due to unknown probabilities and varying perspectives.

Aspect	*Decision Making Under Risk*	*Decision Making Under Uncertainty*
Information Availability	Complete information is available for all possible states.	Information may be incomplete or insufficient for analysis.
Probability Assessment	Probabilities for each state of nature are objectively known.	Probabilities for outcomes are not objectively quantifiable.
Decision Criteria	Decision criteria include Expected Monetary Value (EMV), Standard Deviation, and Coefficient of Variation.	Decision criteria may involve subjective assessments, qualitative analysis, or non-probabilistic methods.
Outcomes	Outcomes can be quantified and measured with certainty.	Outcomes may be uncertain, and their measurement is often subjective or qualitative.
Examples	Investment decisions with known probabilities and market conditions.	New product launches, strategic decisions in uncertain markets, or responses to unforeseen events.
Risk Tolerance	Risks are often quantifiable, allowing for risk management.	Managing uncertainty may involve a higher level of risk tolerance due to the lack of precise information.

DECISION-MAKING CRITERIA UNDER UNCERTAINTY

In decision-making under uncertainty, where outcome probabilities are uncertain or unavailable, various criteria are employed to guide choices. The decision-making criteria under uncertainty are outlined as follows:

1. *Optimism (Maximax) criterion:*
   i. Identify the maximum payoff values for each decision alternative.
   ii. Choose the decision alternative with the highest payoff value (maximum for profit).
2. *Pessimism (Maximin) criterion:*
   i. Identify the minimum payoff value for each decision alternative.
   ii. Select the decision alternative with the highest payoff value (maximum for profit).
3. *Equal probabilities (Laplace) criterion:*
   i. Assign equal probability values to each state of nature using the formula:
   1 ÷ (number of states of nature)
   ii. Calculate the expected (or average) payoff for each alternative by adding all payoffs and dividing by the number of possible states of nature.
   iii. Choose the alternative with the highest expected payoff value (maximum for profit).
4. *Hurwicz criterion:*
   i. Determine the coefficient of optimism, α, and the coefficient of pessimism, (1 – α).
   ii. For each decision alternative, select the highest and lowest payoff values and multiply them by α and (1 – α) values, respectively. Calculate the weighted average as follows:
   w = α(Maximum in column) + (1 – α)(Minimum in column).
   iii. Select the alternative with the highest weighted average payoff value.