



SNS COLLEGE OF TECHNOLOGY



AN AUTONOMOUS INSTITUTION

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COIMBATORE**

DEPARTMENT OF CIVIL ENGINEERING

MACHINE LEARNING FOR CIVIL ENGINEERS

II YEAR / IV SEMESTER

Unit 1 : Introduction

Topic 5 : Statistical Decision Theory



DEFINITION

- A process of selecting an act out of several available alternative courses of action judged to be the best action according to some pre-determined criteria.

OBJECTIVE

- The main aim of decision theory is to help the decision-maker in selecting best course of action from amongst the available course of action.



Structure Of Decision Making



Decision Maker:

The decision maker refers to individual or a group of individuals responsible for making the choice of an appropriate courses of action amongst the available courses of action.

Courses of action:

The alternatives courses of action or strategies are the acts that are available to decision maker.

Example: The number of units of a particular item to be ordered for stock.



States of nature (outcomes):

The events identify the occurrence which are outside of the decision maker's control and which determine the level of success for a given act.

Example: The level of market demand for a particular item.

Payoff(conditional profit values):

Each combination of a course of action and a state of nature is associated with a payoff, which measures the net benefit to the decision maker that accrues from a given combination of decision alternatives and events.



Payoff table:

For a given problem , lists the states of nature (outcomes) and a set of given courses of action. For each combination of state of nature and courses of action ,the payoff is calculated.

Regret or opportunity loss:

The opportunity loss has been defined to be the difference between the highest possible profit for a state of nature and the actual profit obtained for the particular action taken.



Types Of Decision Making

- ❑ Decision making under certainty
- ❑ Decision making under uncertainty
- ❑ Decision making under risk



Decision Making Under Certainty



The decision maker knows with certainty the consequences of selecting every course of action or decision choice.

Technique Used:

- (i) System of equations
- (ii) Linear programming
- (iii) Integer programming etc



Under this condition ,

There is no historical data available or no relative frequency which could indicate the probability of the occurrence of a particular state of nature.

In other words ,

The decision maker has no way of calculating the expected payoff for the courses of action.

Example: When a new product is introduced in the market.



Methods

- I. The criterion of pessimism or **maximin**
- II. The criterion of optimism or **maximax**
- III. **Minimax regret** criterion
- IV. Criterion of realism (**Hurwitz criterion**)
- V. Criterion of rationality (Baye's or **Laplace criterion**)



The Criterion Of Pessimism / Maximin

It was suggested by **Abraham Wald**.

The decision criterion **Maximin** locates the alternative strategy that has the least possible loss.

Steps:

- i. Determine the lowest outcome for each alternative.
- ii. Choose the alternative associated with the best of these



The Criterion Of Optimism / Maximax



It was suggested by **Leonid Hurwitz**.

The decision criterion **Maximax** locates the alternative strategy with the highest possible gain.

Steps:

- i. Determine the best outcome for each alternative.
- ii. Choose the alternative associated with the best of these



Maximax Regret Criterion

It was suggested by **Leonard Savage**.

It is used to identify the opportunity loss (regret) associated with each state of nature if a particular course of action is undertaken.

Regret payoff

= **maximum** **payoff** **for each** **state** **of**
nature **– payoff.**



STEPS

- I. **Construct a payoff table.**
- II. **Compute the opportunity loss or regret for the alternatives.**
- III. **Identify the maximum regret for each alternatives.**
- IV. **Select the alternative associated with the lowest of these.**



Criterion Of Realism

This criterion is a compromise between an optimistic and pessimistic decision criterion.

❖ In this method, a coefficient of optimism C ($0 \leq C \leq 1$),

$C=0$ for pessimism and $C=1$ for optimism.

❖ Decision maker will select the alternative for which Hurwitz value is maximum.

Hurwitz value=

$$(\text{Maximum payoff for alternative}) \times C + (\text{Minimum payoff alternative}) \times (1-C)$$



Criterion Of Rationality

It was developed by **Thomas Baye's and Laplace.**

Steps:

- I. Calculate the average outcome for each alternative .
- II. Select the alternative with maximum average.



Expected Monetary Value

- ❑ construct a **payoff table**.
- ❑ List the **conditional payoff values** associated with each combination of course of action and state of nature along with the corresponding probabilities of the occurrence of each state of nature.
- ❑ Calculate the **EMV for each course of action** by multiplying the conditional payoffs by the associated probabilities and add these weighted values for each course of action.
- ❑ Select **the course of action that gives the optimum EMV**.



Expected Opportunity Loss

Steps:

- ❑ Construct a **payoff table**.
- ❑ List the **conditional payoff values** associated with each combination of course of action and state of nature along with the corresponding probabilities of the occurrence of each state of nature.
- ❑ Construct a conditional opportunity(regret) loss table
Regret payoff
=maximum payoff for each state of nature – payoff.
- ❑ **Calculate the EOL for each course of action** by multiplying the conditional opportunity(regret) loss



- Select the course of action that gives the **minimum EOL.**

- Here,
Minimum EOL=Expected value with perfect information (EVPI).



Thank You!!