SNS COLLEGE OF TECHNOLOGY

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COIMBATORE

DEPARTMENT OF CIVIL ENGINEERING

MACHINE LEARNING FOR CIVIL ENGINEERS

II YEAR / IV SEMESTER

Unit 4 : Reinforced Learning

Topic 2 : Decision Theory

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 Certainity

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

Technique Used:

System of equations

Linear programming

Integer programming etc

Decision Making under Uncertainity

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 introduce 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)

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The Criterion Of Pessimism Or Maximin: (Waldian Criterion)

It was suggested by Arabham Wald.

The decision criterion 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 OR MAXIMAX:

It was suggested by Leonid Hurwitz.

The decision criterion 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.

MINIMAX 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(HURWITZ CRITERION)

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=

(Maximum payoff for alternative)× C +
(Minimum payoff alternative) ×(1-C)

CRITERION OF RATIONALITY(BAYE'S AND LAPLACE CRITERION)

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.

DECISION MAKING UNDER RISK:

Probabilities could be assigned to future events by reference to similar previous experience and information.

Knowing the probability distribution of the states of nature, the best decision is to be select that course of action which has the largest expected payoff value.

EXPECTED MONETARY VALUE(EMV):

(maximizing expected monetary value)

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.
- 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 VALUE WITH PERFECT INFORMATION:

The expected value with perfect information is the expected return , if we have perfect information before a decision has to be made.

Expected value with perfect information

=∑(best outcome for each state of nature)×(probability of that state of nature)

The expected value of perfect information , EVPI

EVPI=Expected value with perfect information-Maximum EMV

Remark:

- Maximum EMV=Expected value without perfect information

EXPECTED OPPORTUNITY LOSS(EOL):

(minimize 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!!