

# A Review on Decision Theory

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**Abstract:** Decision theory is a descriptive approach used to classify degree of knowledge and verify the outcomes that is to occur. There may be success or failure depends on the ability of making correct decisions on time. To arrive under a decision, a decision maker should be accurate to make appropriate decision. In order to identify the best one, decision theory is important. This paper attempts to say the decision aspects as a disciplined approach. Decision theory provides a framework for rational decision making in an environment of uncertainty and risk. In certain situations a decision maker needs to make either a single decision or a sequence of decisions. Actually decision theory is the study of a person or agent's choices.

**Index Terms:** Decision Maker, Problem Solver, Operation Research

## I. INTRODUCTION

Operational Research is a never ending process, which have the continuity and the results leads to other studies. Decision making is a difficult task that affect many people. Decision makers wants to fulfill this in the result. Good knowledge is required to handle research techniques. Each decision making produces a perfect result. Decision making consists of identification of a problem and ends with a correct result. The degree of knowledge is classified via the decision theory. The degree of knowledge consists of four categories: complete knowledge, ignorance, risk and uncertainty [1]. Essential components of a decision model irrespective of type- decision alternatives depend on the previous decisions made and their outcomes. States of nature is an event which is not under the control of decision makers. Payoff is a numerical value obtained through the application of decision alternatives and states of nature. For example, people are nothing more than the results of their own choices. Companies can read, attract, influence and control user's minds which contradicts the decision theory. Social media and online streaming platforms track viewer's choices, such as pages they like, dislike, share, post etc. Netflix is an example of how viewers watch more than just an algorithm to attract and become addicted. In addition, a new web series is often released a day before the holiday or only on weekends, a specific type of content is always present in the instagram feed, and one particular Youtube video suggestion is returning over and over again. Decision theory is concerned with the reasoning underlying an agent's choices, whether this is a choice between taking the bus or getting a taxi, or a more far-reaching choice about whether to pursue a demanding political career.

## II. CONTENTS

Situations of decision making:

Decisions are made on the information available as well as the decision situation. There are three types of decision making situations:

### Decision making under certainty

In this situation, only one possible state of nature exists. The decision maker has the complete knowledge of each and every consequences. Process:

Assign equal probabilities to each payoff of a strategy, determine the expected payoff value for each alternative. Select the alternative which corresponds to the maximum of the payoffs [2].

For example, every farmer has knowledge of the time periods for growing crops. Therefore they make definite decisions within the relevant time frame. That is they have prior knowledge of the decision they make.

### Decision making under uncertainty

In this situation only pay-offs are known and nothing is known about the state.

Process:

Assign unequal probabilities and determine the payoff and select the alternatives for the minimum of the payoffs.

For example, when a consumer buys goods, they know what they are getting and how much utility they get from their consumption but for some goods, it means games or lotteries outcome is uncertain.

### Maximin and Minimax Strategy

These are the criterias to obtain the decisions making under risk.

**Maximin Criteria:** This criteria is used to maximize the minimum possible pay-off. This criteria has least possible loss, so it is also known as pessimistic decision criteria.

The method is:

\*Choose the lowest outcome for each alternative.

\*Choose the alternative associated with the maximum of these.

**Minimax Criteria:** This criteria is to minimize the maximum possible pay-off. This criteria has the greatest possible gain.

The method is:

\*Choose the highest outcome for each alternative.

\*Choose the alternative associated with the minimum of these.

### Decision under risk

In this environment, decision maker should have sufficient information about the likely occurrence of each outcome. Decision maker needs to select a course of action. The widely used criteria for making decision under risk is EMV.

#### Expected Monetary Value (EMV)

EMV is obtained by adding payoff values multiplied by the probabilities with state of nature.

Process:

Construct a payoff matrix listing the possible state of nature. Calculate the EMV for each course of action. Select the course of action that gives the EMV.

For example, a man lost his job and is unable to pay his rent. Because of this, he makes the choice to steal money from the local convenience store. In this situation the man gets a risk and he knows the outcome is bad.

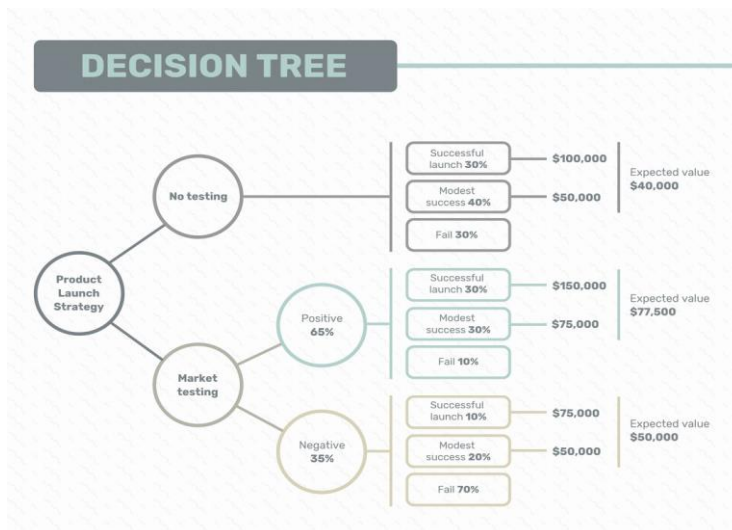
### Bayesian Rule

Bayesian analysis is a statistical paradigm that answers research questions about unknown parameters using probability statements. It uses the posterior distribution to form various summaries for the model parameters including point estimators such as means, medians, percentiles and interval estimators known as credible intervals. Moreover all statistical tests about model parameters can be expressed as probability statements based on the estimated posterior distribution [3]. Unique features of Bayesian analysis include the ability to incorporate prior information and an ability to assign an actual probability to any hypothesis of interest. In data analytics, Bayesian rule is a powerful tool in machine learning available to data scientists. One of the most fantastic examples of real-world Bayesian machine learning applications is detecting credit card frauds. Bayesian machine learning algorithms can help detect patterns that suggest potential credit card frauds. Bayesian Theorem in machine learning is also used in advanced medical diagnosis and calculates the probability of patients developing a specific ailment based on their previous health data. Other significant applications include teaching robots to make decisions, predicting the weather, recognizing emotions from speech etc.

### Decision Tree

Decision making problems is used to arrive at a decision. A decision tree analysis shows the construction of diagram that decisions are made. A decision tree has nodes, branches, probability estimates and payoffs. There are two types of nodes: decision node and chance node. Decision (act) node: It is represented by square. Point of time represents in this node. The courses of action are shown as branches out of this node. Chance (event) node: Each course of action results in a chance node. It is represented in circle and shows a point of time in decision making. There are two types of branches in decision tree [4]. They are decision branch: it is the branch leading away from a decision node. Chance branch: It is the branch leading away from a chance node.

Example of a decision tree:



### Applications of Decision Tree

Assessing prospective growth opportunities: One of the applications of decision trees involves evaluating prospective growth opportunities for businesses based on historical data.

Using demographic data to find prospective clients: Another application of decision trees is in the use of demographic data to find prospective clients. They can help streamline a marketing budget and make informed decisions on the target market that the business is focused on.

Serving as a support tool in several fields: Lenders also use decision trees to predict the probability of a customer defaulting on a loan by applying predictive model generation using the client's past data.

### DECISION MAKING WITH UTILITIES

There are some conditions where monetary payoff may not be appropriate. This problem arises because different people attach different utility to money. Utility is a measure of preference for many alternatives. The utility is always unique to individual decision makers. The basic axioms of utility :

1. The outcome A is preferred to outcome B, then  $U(A)$  is greater than  $U(B)$  where  $U(A)$  is the utility of outcome A and  $U(B)$  is the utility of outcome B.
2. If the decision makers did not see the difference then  $U(B) = pU(A) + (1-p)U(C)$ .

### III.ADVANTAGES

The decision theory helps operations manage with decisions on process, capacity and location. It is used by managers in other functional areas. It is used to list the possible alternatives. Defining and identifying problem is the main approach of decision theory. It refers to an optimal choice under condition of certainty. Decision theory primarily contains of helping people and organization in making decisions.

If we have faced lot of problems at that time we take a good decision called decision making. It help us to solve the problems without risks. It gives a set of alternatives. Decision theory offers simple procedures for choice. Decision theory is the utility function of payoffs. It analyse and compare alternatives. Helps in good selection of alternatives and developing alternatives.

### IV.DISADVANTAGES

Decision Theory is time consuming. The degree of certainty of possible coming events cannot be predicted. Payoffs is combined with each combination of alternatives. Responsibility is diluted. There will be limited analysis and there are various uncontrollable environmental factors that stops the decision making. Decision theory relies on the use of sophisticated technologies and models like computers, decision support systems, matrix etc. Experts are required for this purpose. The total aspect of management is ignored.

### V.APPLICATIONS

Decision theory helps managers discharge their roles effectively using various tools. The theory has helped for the diagnosis of problems in a scientific manner. Decision theory helps entities determine how a professional or consumer makes rational choices while making a decision. When a person makes a decision, their belief system, morals, values, social, even fears and uncertainty plays a big role in this [6]. This theory has helped for the diagnosis of problems in a scientific manner. This is an evidential base for the development of different mathematical models and computer programs. This theory has helped managers to improve communication incentives and analyze human values.

### VI.CONCLUSION

As per the changing scenario, the role of Operational Research and its techniques justify its role for decision making in the field of business and industry, and computer facility makes it stronger. OR techniques may develop to tackle the ever-increasing problems of the business and industrial panorama and provide effective aid to the decision making process. By using it decision makers can arrive at an optimal policy that would be best for the whole organization under that how to go ahead to solving the problems. The state of nature likely is learned after decision making. It is possible to estimate probabilities of the state of nature. Sometimes while making a sequence of decisions additional information is obtained about the probabilities of various states of nature. The expected value of perfect information provides, a view to understand whether taking a decision might be of any worth. A decision tree is used to display graphically the progression of sequential decisions and random events. The concept of utilities helps a decision maker's attitude towards risk.

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