Decision–Making on a Machinery Performance using Decision Tree

Selva Nandhini.N
UG Student
Department of Mathematics
Sri Krishna Adithya College of Arts and Science, Coimbatore, India

Abstract:
The importance of taking a correct decision for the given situation has become an integral part in all fields of work. Decision making is present in our daily life, starting from what we wear to what we eat and somehow this decision making is involved to choose better and the best things that fulfill our needs. As a boundary spanning function in organizations, public relations can enhance strategic decision-making, it has grown up large in recent years, and the problems involved are made based on optimal choices. A fundamental question for every business analytics situation is to identify if a given situation can be solved with a better decision. An organization that seek to minimize conflict and maximize better growth of the firm for a particular time period can improve the likelihood of better decision-making. Now let us see how, making decision plays an important role for big forms and companies.

I. INTRODUCTION

Decision making is the action or process of making important decisions. It is a cognitive process resulting in selection of a belief or a course of action among several options; it is a method of choosing best alternative based on the values and preferences. It is also known as a problem -solving activity terminated by a solution deemed to be optional, or at least satisfactory. It is a thought process of selecting a logical choice from available options.

While making the decision, we should consider both positive and negative of each alternative. By analyzing all the outcomes we must forecast the outcomes of each option and choose the best alternative among them. The problem sometimes deals with multiple stages of decision making, in such cases it is characterized by sequencing of decisions and it is called as sequential decision problem. It is solved with the help of decision tree.

A decision tree is a graphical representation that indicates the alternatives, states of nature, and probabilities attached to it and its conditional benefits. It consists of network of nodes and branches. Decision tree has two nodes namely decision node and state of nature node.

Decision tree is represented by a square and chance or event (state of nature) is represented by circle. Strategies originate from the decision node as main branches. At the end of each decision branch, where chance events emanate as the state of nature node in the form of sub-branches, along the side of the branches, the probability for the chance events are associated.

The values of the outcome are shown at the terminal of these chance branches. To compute the expected value of each chance mode, the general approach is to work backward through the tree from right to left. Then we choose the particular branch that leaves the decision node and leads to the chance node, with the highest expected value. This is known as the roll back or fold back process.

II. METHODOLOGY

The decision tree analysis is performed by following steps, for each decision point identify the alternative courses of action and the decision point systematically. Determine the probability and the payoff associated each course of action, at each decision point. Starting from the extreme right end, find the expected payoffs (EMV) for each course of action. Choose the course of action that yields the best payoff for each decision. Proceed backwards to the next stage of decision points.

Repeat the above steps till the first decision point is reached. At last, identify the course of action to be adapted from the beginning to the end under different possible outcomes for the situation as a whole. The following are the steps that involve in making the decision tree:

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i. Identify the decision points from the given problem.

ii. From the decision point, find the probability and determine the pay-off values to the decision tree.

iii. Commencing from the extreme right end, compute the expected payoff (EMV) for each course of action.

iv. Choose the course of action that yields the best payoff for each decision.

v. Proceed backwards to the next stage of decision points.

vi. Repeat it till the first decision point is reached.

vii. Finally, identify the course of action to be adapted from the beginning to the end under different possible outcomes for the problem as whole.
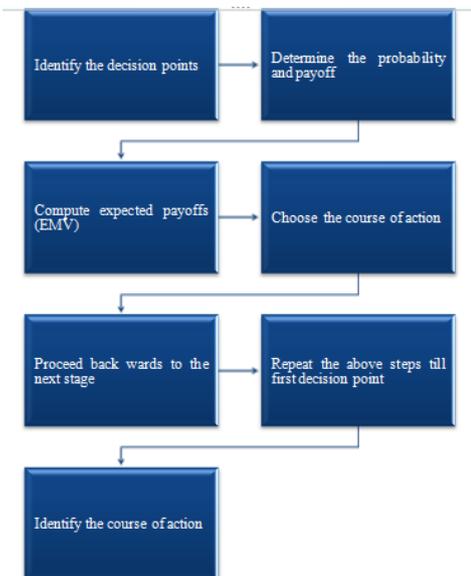
Figure.1. Steps on decision tree analysis

The tree-based approach accommodates the uncertainties, including substantial probabilistic dependence, and displays the judgmentally assessed probabilities explicitly.
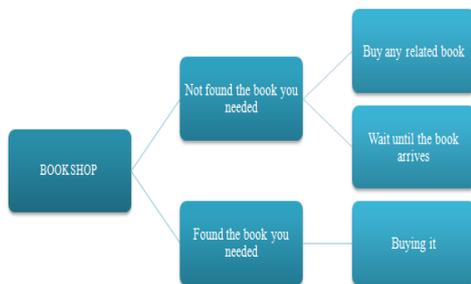

Figure.2. Sample Decision Tree

III. APPLICATIONS

An application generally has to explicitly analyze alternatives for a decision problem using judgmental probabilities and subjectively assessed utility functions. Decision theory has a rich history of applications to real-world problems in many disciplines, including economics, risk analysis, business management, and theoretical behavioral ecology, it has more recently gained recognition as a useful approach to conservation in the last 20 years. The following are the places where the decision making spread its wide branches:

- It is used in the field of agriculture and it had main extent on horticulture
- It is in filtering noise from Hubble Space Telescope and also used in star-galaxy classification, discovering quasars and determining galaxy counts.
- In the field of biomedical engineering for identifying features to be used in implantable devices.
- Automatic induction of decision trees was recently used for control of nonlinear dynamical systems.
- In financial analysis for the use of CART asserting the attractiveness of buy-writes.
- In the field of manufacturing and production, decision trees have been recently used to non-destructively test welding quality, for semiconductor manufacturing, for process optimization in electrochemical machining and for quality control.
- For medical research and practice have long been important areas of application for decision tree techniques. It is used in diagnosis of cardiology, psychiatry, gastroenterology, for detecting in mammography, to analyze Sudden Infant Death (SID) syndrome and for diagnosing thyroid disorders.
- Human genome project and Gen Bank database offer fascinating opportunities for machine learning.
- In physics, it is used for the detection of physical particles.
- It is also recently used for building personal learning assistants and for classifying signals.
- Remote sensing has been a strong application area for recognition works.
- Decision analysis plays a vital role in the areas of Manufacturing and Services, Finance, Product Planning, R&D Project Selection, Strategy and Miscellaneous.

IV. ILLUSTRATION

The example given understudies the alloy company which got a proposal from a dealer for four different machineries. The stability, profit and loss of machineries are given below. The following (Table.1) provides the specifications of four different machineries.

Table.1. Performance of machinery

MACHINERY PERFORMANCE		MACHINE-1	MACHINE-2	MACHINE-3	MACHINE-4
LOSS	CHANCE FOR PROBABILITY	30	-	20	-
	LOSS PERCENTAGE	10	-	20	-
STABLE	CHANCE FOR PROBABILITY	20	45	35	-
	STABLE PERCENTAGE	-	-	-	-
PROFIT	CHANCE FOR PROBABILITY	50	55	45	100
	PROFIT PERCENTAGE	20	20	30	-

Using the decision tree, the structure of alternative machinery available for the company and expected value criterion can be found which is helpful in choosing the alternative machinery with high expected value. Assuming that the company invested Rs1000/- for machinery and the required decision tree is shown in Fig.3
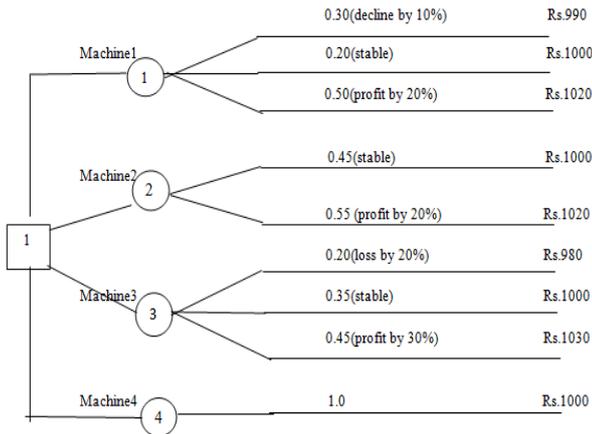

Figure.3. Decision Tree on Machinery Performance

RESULT AND INFERENCE:

E.M.V at node1= $(0.3×990) + (0.20×1000) + (0.50×1020)$
         $=297+200+510$
             $= $ **Rs.1007.**
E.M.V at node 2 $= (0.45×1000) + (0.55×1020)$
         $=450+561$
             $= $ **Rs.1011**.
E.M.V at node 3 $= (0.20×980) + (0.35×1000) + (0.45×1030)$
         $=196+350+463.5$
             $= $ **Rs.1009.5**
E.M.V at node 4 $= (1.0×1000)$
             $= $ **Rs.1000**
Thus, from the following E.M.V's the alternative of the **Machinery 2** yields the highest expected value of **Rs.1011**.

V. ADVANTAGES AND LIMITATIONS
Advantages:
Decision trees are very initiative and easy to explain.
•   The algorithm is simple to understand, interpret and visualize as the idea is mostly used in our daily lives.
•   Trees are easy to create and visually simple to follow and easy to understand and interpret.
•   Results are clearly explained from the model using simple math.
•   The value and likelihood of outcomes can be quantified directly on the tree chart.
•   They easily accommodate new assumptions with probabilities when facts are not readily available.
•   Other decision making techniques can be used to evaluate specific options through the tree.
•   Tree diagrams continue to grow as you move from the beginning node to final outcomes. This will limit tree size for those drawn manually.
•   Decision trees are better matched to attributes with a finite set or fixed possibilities.

Disadvantages:
Though decision tree has many advantages, they also face some disadvantages:

•   They are unstable, meaning that a small change in the data can lead to a large change in the structure of the optimal decision tree.
•   They are often relatively inaccurate. Many other predictors perform better with similar data.
•   This can be remedied by replacing a single decision tree with a random forest of decision trees, but a random forest is not as easy to interpret as a single decision tree.
•   For data including categorical variables with different number of levels, information gain in decision trees is biased in favor of those attributes with more levels.
•   Calculators can get very complex, particularly if many values are uncertain and/or if many outcomes are linked.

VI. CONCLUSION

As decision making plays an important role in our daily life. It can also be used to predict our future. By analyzing all the outcomes we can choose the best alternative solution to our problem. The decision analysis framework can allow scientists and managers to explicitly address uncertainty and systematically compare the outcomes, utilities, and uncertainty associated with different management options. While dealing with the industrial part, it includes many alternatives and so we use decision tree to get best results among them. Here the decision tree plays an important role in finding the best alternative among the given choices. It is also a descriptive means for calculating conditional probabilities. The tree is easy to be drawn but it gets complicated when a single data changes. Apart from that decision tree is always the best alternative to solve the problem in this digitalized world with the help of our updated software. Somehow this decision making is involved in our daily life in any of the norms and we are using it every time when we are confused about the options. Thus, this decision making plays integral part in our routine life.

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