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Algorithm under Uncertainty for Decision Making of Problem Domain

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Abstract:

In this paper we have discussed the decision making process under uncertainty with different four methods. These all methods used to implement the algorithm for decision analysis in the field of artificial intelligence. We introduce the LM3 algorithm for solving the problem domain under uncertainty environment for game playing and decision analysis of expert systems. Algorithm separates the different strategies with different computational process for decision making. We implements algorithm with test values with different types of nature and strategies for optimal solution.

Keywords: Agent, Payoff, Maximax, Ignorance, Risk, Decision Horizon, Nature, Strategy, Expert System, Regret, Maximin, Uncertainty.

1 Introduction:

The success or failure that an individual or organization experience, depends to a large extend on the ability of making appropriate decisions. Making of a decision requires an enumeration of feasible and viable alternative and the projection of consequence associated with different alternative and a measure of effectiveness to identify best alternative to be used .Decision Theory is also known as Decision Analysis provides an analytical and systemic approach to depict the expected result of a situation when alternative managerial action and outcomes are compared. Decision Theory is the combination of descriptive and prescriptive business modeling approach to classify degree of knowledge. The degree of knowledge is usually divided into following four areas:

1.1 Ignorance

Neither the possible states of nature nor their exact probabilities are known. This is another rarity, as only a fugitive from Mars would have absolutely no idea what states of nature might occur after a decision has been made.

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1.2 Uncertainty

The possible states of nature are known, but their exact probabilities are unknown. Most business decision situations fall into this category, and the probabilities must be estimated based on past experience or executive judgment.

1.3 Risk

Both the possible states of nature and their exact probabilities of occurrence are known. This is typical of many gambling situations, such as playing roulette. This is an extreme rarity in business decisions, since the exact probabilities are generally not known.

1.4 Certainty

Certainty if each action is known to lead invariably to a specific outcome.

2 What is Decision Theory?

Decision theory is an interdisciplinary area of study that concerns mathematicians, statisticians, economists, philosophers, managers, politicians, psychologists and anyone else interested in analyses of decisions and their consequences. Outcomes in decision theory are usually assigned utility values. In other words, Decision theory is the Framework of logical and mathematical concepts, aimed at helping managers in formulating rules that may lead to a most advantageous course of action under the given circumstances. Decision Theory provides a framework for analyzing decision problems by:
i) Structuring and breaking them down into more

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manageable parts;
ii) Explicitly considering the possible alternatives, available information, involved uncertainties, and relevant Preferences;
iii) Combining these to arrive at optimal or sufficiently good decisions.

We do not decide continuously. In the history of almost any activity, there are periods in which most of the decision-making is made, and other periods in which most of the implementation takes place. Decision-theory tries to throw light, in various ways, on the former type of period. The Decision Theory process usually proceeds by building models and using them to perform various analyses and simulations, such as "what-if" and sensitivity analysis, and Monte Carlo simulation. Such quantitative precision is only possible in problems in which all the numbers and probabilities are known ahead of time. This is true in certain gambling problems, like poker. Decision theory provides a number of suggestions for how to estimate complex probabilities under uncertainty, most of which are derived from Bayesian inference. Typical modeling techniques include decision trees, influence diagrams, and multi-attribute utility models. Decision Theory contains certain essential characteristics which are common to all listed as follow:

2.1 Alternatives

Decision alternatives are the choices available to the decision maker. There are a finite number of decision alternatives available with the decision maker at each point in time when a decision is made. The number and type of such alternative may depend on the previous decision made and on what has happened subsequent to those decisions. These alternatives also known as course of action and are under control and known to the decision maker.

2.2 States of Nature

After a decision alternative has been selected, the outcome is subject to chance and no longer under the control of the decision maker. For example, the new computer could be either competitive or noncompetitive in technology and features versus other brands on the market at the time of its introduction. Each of these possibilities is a state of nature, a future environment that has a chance of occurring.

2.3 The Payoff Table

The payoff table is a table in which the rows are decision alternatives, the columns are states of nature, and the entry at each intersection of a row and column is a numerical payoff such as a profit or loss. The table may also include estimated probabilities for the states of nature. It is important to note that the payoff is measured within a specific period. This period is sometimes called the decision horizon.

3 Steps of Decision Making Process

The decision making process involves the following steps:
Identify and define the problem.
Listing of all possible future events called state of nature which can occur in the context of the decision problem. Such events are not under the control of decision maker because these are erratic in nature.
Identification of all the course of action which are available to the decision maker. The decision maker has control over these courses of action.
Expressing the payoffs resulting from each pair of course of action and state of nature. These payoffs are normally expressed in a monetary value.
Apply an appropriate mathematical decision theory model to select best course of action from the given list on the basis of some criteria that result in the optimal payoff.

4 Role of Decision Theory in Artificial Intelligence

Decision theory was initially developed in economics and operations research (Neumann & Morgenstern, 1944), but in recent years has attracted the attention of artificial intelligent (AI) researchers interested in understanding and building intelligent agents. These intelligent agents, such as robots, financial advisers, intelligent tutors, etc. Despite their different perspectives, artificial intelligence (AI) and the disciplines of decision science have common roots and strive for similar goals. Recent analyses of the restrictions of several traditional AI reasoning techniques, coupled with the development of more tractable and expressive decision-theoretic representation and inference strategies, has stimulated renewed interest in decision theory and decision analysis. One of the goals of artificial intelligence (AI) is creating autonomous agents that must make decisions based on uncertain and incomplete information. The goal is to design rational agents that must take the best action given the information available and their goals. For achieving their goals, intelligent agents, natural or artificial, have to select a course of actions among many possibilities. That is, they have to take decisions based on the information they can obtain from their environment, their previous knowledge and their objectives. In many cases, the information and knowledge is incomplete or unreliable, and the results of their decisions are not certain, that is they have to take decisions under uncertainty. The research on decision-theoretic models in artificial intelligence has focused on these two main issues: computational complexity and model acquisition; as well as in

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incorporating these theoretical advances in different applications of intelligent agents.

5 Development of LM3 Search Algorithm for Finding the Optimal Value with Decision Methods:

In this paper we developed a new LM3 algorithm with four functions on the bases of decision theory of decision environment. Before discussion of algorithm we fist try to understand the basic concept of decision making under uncertainty of decision theory. To arrive at good decision it is required to consider all variables data, an exhaustive list of alternative, knowledge of decision environment and use of appropriate approach for decision making. The knowledge of these environments helps in choosing appropriate quantitative approach for decision making. One of them is decision making under uncertainty In which the absence of known about the probabilities of any state of nature occurring, the decision maker must arrive at a decision only on the actual conditional payoff values, together with a policy. For example, in a given game, a player cares not only about what he plays but also about what other players play. Hence, the description of consequences includes the strategy profiles. In that case, in order to fit in that framework, we would need to give other players' mixed strategy profiles in the description of the game, making Game Theoretical analysis moot.

There are several different criteria of decision making in this situation. The criteria that we will discuss in this paper are:

Maximin Criterion
Maximax Criterion
Minimax Regret Criterion
Laplace Criterion

5.1 Maximin Criterion

The maximin criterion specifies that we select the decision alternative having the highest minimum payoff. This is a conservative, pessimistic strategy that seems to assume that nature is "out to get us." In fact, the word maximin is equivalent to "maximize the minimum possible payoff."

5.2 Maximax Criterion

The maximax criterion specifies that we select the decision alternative having the highest maximum payoff. This is an optimistic strategy, making the assumption that nature will be generous to us. The word maximax is equivalent to "maximize the maximum possible payoff."

5.3 Minimax Regret Criterion

Using minimax regret, we must first construct a regret table. This is a table in which, for each state of nature, the entries are regrets, the differences between each payoff and the best possible payoff if that state of nature were to occur.

5.4 Laplace Criterion

Since the probabilities of states of nature are not know, it is assume that all states of nature will occur with equal probability .As state of nature are mutually exclusive and collectively exhaustive, so the probability of each of these must be one. This criterion is also known as the criterion of insufficient reason because, except in a few cases, some information of the likelihood of occurrence of states of nature is available.

5.5 Framework of algorithm

The algorithm completely based on the decision making under uncertainty of decision theory. The algorithm based on f for function maximin_criterion( ), maximax_criterion( ), minimaxregret_criterion( ) and laplace_criterion( ) that are used to execute the problem on the bases of available information. These functions define the following formal code of algorithm:

```
Method maximin_criterion( )
Start
Loop, 1 to no_of_strategies
min= fist value of strategy of nature
        Loop, 2 to no_of_natures
                If , min >next nature of strategy
                min= next nature of strategy
        End Loop
Payoff2=min
End Loop
max=payoff2(1)
Loop, 1 to no_of_strategies
If , max <next element of payoff2
        max= next element of payoff2
End Loop
result (final value)
End Fuction

Method maximax_criterion( )
Start
Loop, 1 to no_of_strategies
max= fist value of strategy of nature
        Loop, 2 to no_of_natures
                If , max <next nature of strategy
                max= next nature of strategy
        End Loop
```

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```
Payoff2=max
End Loop
max=payoff2(1)
Loop, 1 to no_of_strategies
If , max <next element of payoff2
        max= next element of payoff2
End Loop
result (final value)
End Fuction

Method minimaxregret_criterion( ) ( )
Start
Loop, 1 to no_of_strategies
max= fist value of strategy of nature
        Loop, 2 to no_of_natures
                If , max >next nature of strategy
                max= next nature of strategy
        End Loop
Payoff2=max
End Loop
Loop, 1 to no_of_natures
        Loop, 1 to no_of_strategies
payoff3=payoff2- value of strategy of nature (1 to nature*strategy)
End Loop
End Loop
Loop, 1 to no_of_strategies
max= payoff3(1)
        Loop, 2 to no_of_natures
                If , max <next of payoff3
                max= next of payoff3
        End Loop
Payoff2=max
End Loop
min= payoff2(1)
Loop, 1 to no_of_natures
        If , min > next of payoff2
        min= next of payoff2
End Loop
result (final value)
End Fuction

Method laplace_criterion( )
Start
Loop, 1 to no_of_strategies
sum= null
        Loop, 1 to no_of_natures
        Sum+=value of payoff1(strategies*natures)
        End Loop
Sum=sum/no_of_natures
payoff2=sum
End Loop
max=payoff2(1)
Loop, 1 to no_of_strategies
If , max <next element of payoff2
        max= next element of payoff2
End Loop
result (final value)
End Fuction
```

6 Conclusion

The discussed algorithm is based on decision making under uncertainty of the decision theory which implements in area of artificial intelligence. The developed algorithm are good for the area of game playing and Expert systems for the computation of decision making for right path or representation of knowledge domains. The algorithm provides the framework of four different strategies for calculating the different optimum values of given problem space. The algorithm not efficient for all areas of artificial intelligence but good framework for game playing like tic tac toe , chess and poker games and decision analysis of Expert system. In future work we try to implement the algorithm for decision making under certainty and information of heuristic knowledge in different area of artificial intelligence.

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