OVERVIEW OF MARKOV DECISION PROCESS APPLICATIONS

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Abstract

Markov decision making processes is a decision support system that provides decision makers with a professional framework for improving planning and management strategies aimed at increasing return on marketing investments, for example, or trying to find the best decisions in critical systems that do not accept errors and other areas. Markov's decision-making process is used to model dynamics that enable it to solve problems related to choosing the best and most profitable method and yielding decisions and studying decisions before making them. Through which, for example, improvement of procedures is achieved through dynamic programming algorithms that define procedures that give better value to investment in its various fields. This allows marketing managers to simulate multiple targeting scenarios to assess budget requirements and the expected impact of a specific policy they intend to implement.

Through this paper, a simplified brief on the decision-making processes of Markov and an explanation of the benefits of this algorithm is explained by defining it and then touching on its use and application in two different areas of its multiple use and the impact of its use on each of them and they are the field of marketing and strategic planning in addition to its use in the health field. Finally, a review of one of the major problems is designing fair and professional marketing policies and exploring the possibility of solving them using the Markov algorithm.

Keywords: marketing strategies, Customer Lifetime Value, marketing planning, Markov Decision Process.

الملخص :

عمليات صنع القرار ماركوف هي نظام لدعم القرار والذي يوفر لصناع القرار إطارًا احترافيًا لتحسين التخطيط واستراتيجيات الادارة التي تستهدف زيادة العائد على الاستثمارات التسويقية مثلاً أو محاولة إيجاد أفضل القرارات في الأنظمة الحرجة والتي لا تتقبل حدوث أخطاء وغيرها من المجالات. تُستخدم عملية اتخاذ قرارات ماركوف لنمذجة ديناميكيات والتي تمكنها من حل مشكلات تتعلق باختيار أفضل الطرق وأكثرها تحقيق للعوائد ودراسة القرارات قبل اتخاذها. يتم من خلالها مثلا تحقيق تحسين للإجراءات من خلال خوارزميات البرمجة الديناميكية التي تحدد إجراءات تمنح قيمة أفضل للاستثمار في مجالاته المختلفة. يسمح هذا لمديري التسويق بمحاكاة سيناريوهات استهداف متعددة لتقييم متطلبات الميزانية والتأثير المتوقع لسياسة محددة لديهم النية لتطبيقها. من خلال هذه الورقة يتم شرح نبذه مبسطة عن عمليات اتخاذ القرار ماركوف و توضيح فوائد هذه الخوارزمية من خلال تعريفها ثم التطرق الى استخدامها وتطبيقها في مجالين مختلفين من مجالات استخدامها المتعددة وأثر استخدامها في كلا منهم وهم مجال التسويق والتخطيط الاستراتيجي بالإضافة الى استخدامه في المجال الصحي. وأخيرًا، استعراض أحد أبرز المشاكل هو تصميم سياسات التسويق العادلة والاحترافية وبحث إمكانية حلها باستخدام خوارزمية ماركوف.

الكلمات المفتاحية: عمليات اتخاذ القرار (ماركوف)،خطط تسويقية ،استراتيجيات التسويق ،القيمة الدائمة للعميل

1. Introduction

Uncertainty is a common feature in a variety of fields, computer science, engineering, operational research, economics, and many others. Often problem-solving and decision-making in many cases, the results depend partly on randomness and partly on human-oriented decisions. It is then useful to create a framework for modelling a variety of important random systems, including but not limited to biological, epidemiological, queuing, and financial and physical systems (Nikovski,Lidicky,Kataoka& Yoshimoto,2012).

Since Markov's processes are widespread, the framework for analysing and treating such models is of particular importance and has given rise to a rich mathematical theory. This paper aims to introduce the reader to decision-making processes in Markov (MDPs), which are a special model for the decision-making aspect of Markov's nature problems. Its structure is as follows (Earl &Deem,2006). Section1 provides introduction with a definition of Markov's decision-making processes, along with key concepts and terms. Section 2 describes Markov's decision-making process in marketing planning and strategies include customer relationships as key challenge in marketing field. Next, section 3 summarizes the application of Markov's decision-making processes in the health field, with tow example of the role of MDP in improv the policies and strategies. Finally, Section 5 presents a common problem in this area, which is optimal marketing (Labbi&Berrospi ,2007).

1.1 Definition

Markov decision-making (MDP) is a random-time, random-control process. It provides a mathematical framework for modeling decision-making in cases where results are partially random under the control of the decision maker and responsible for formulating strategies or policies. MDPs are useful for studying optimization problems that are solved through dynamic programming and reinforcement learning. MDPs have been known at least since the 1950s; they are used in many disciplines, including robotics, automation, economics and manufacturing. The name MDPs comes from

Russian mathematician Andrei Markov because it is an extension of Markov chains (Hoey, Schröder & Alhothali,2016).

Markov's decision-making processes are an extension of Markov chains and their similarity to most characteristics. The difference is the addition of the procedure (allowing selection and determining the procedure) and rewards (giving motivation) which characterizes Markov's decision-making processes. Conversely, if there is only one procedure per state (such as "waiting") and all rewards are the same (for example "zero, one"), then Markov's decision-making process becomes the Markov chain (Ekinci, Ulengin , Uray & Ulengin ,2008).

A Markov decision process is 4 basic elements: (S,A,Pa,Ra)

Where,

♦ S is a finite set of states.

♦ A is a finite set of actions.

♦ Pa(s,s)=is the probability that action a in state s at time t will lead to state s' at time t+1.

♦ Ra(s,s)is the reward (or reward) achieved after transitioning from state s to state s', via the action a
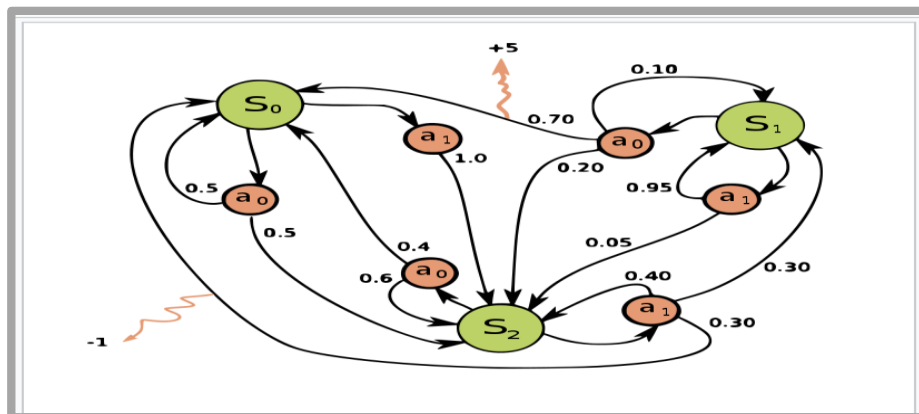
See figure (1).

Figure (1): an example of MDP with three states (green circles) and two actions (orange circles), with two rewards (orange arrows) and many of probability of transaction (black arrows).

2. Markov Decision process in Market Planning and Strategies

The field of marketing went through different stages through decades, starting from the traditional methods of marketing, its main pillars, and through the development of the marketing process by expanding its scope and introducing technologies on it, which continues to the present day (Webster&Frederick,1992). Their importance and positive impact on marketing strategy were confirmed. Among these technologies are Markov decision-making processes and their somewhat good effect in improving marketing policies and strategies and assisting decision-makers in making appropriate decisions in to adopt these policies (Pourmoayed ,2016).

Markov decision-making processes have been applied in several areas related to marketing and customer relationship management, for example but not limited to the field of aviation, and the study (Safari,Tive, Babania&Hesan,2014).shows the importance of using Markov's decision-making processes in improving and developing marketing procedures in the company to ensure satisfaction and loyalty The majority of customers, instead of targeting certain groups in the past, which many customers lost, which was not addressed by using Markov decision-making processes see figure(2).

The railway and operations management field in them also according to (Slater , Stanley &Eric,2010).was processed using Markov decision-making processes to calculate striptease files. The optimum speed, also known as the operating curves, of electric trains with renewable brakes, and are subject to operating restrictions such as speed and acceleration limits. In addition, it uses decision-making processes in many other areas such as the aircraft control unit, weather conditions, banks and many others that we cannot address from during this paper.
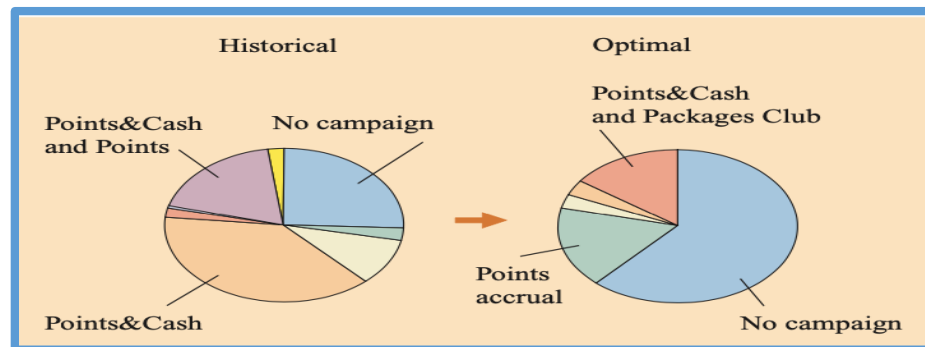
Figure (2): Comparison between historical and optimal marketing procedurals

3. Markov Decision process in Health Field

Among the most important matters affecting human life is health, speed of procedures and their safety in the health field, and this requires development in performance and finding the best policies that ensure making sound decisions at the right time, which makes decision-making processes Markov the best solution in making some important decisions in the field of health. According (Sloan,2007). The study confirms to us the importance of Markov's decision-making processes in the most critical and sensitive matters in the health field, namely ensuring rapid response and timely access to ambulance operations, which are very complicated due to many factors such as different call priorities, and changing the times of Suit, turn the ambulance from one call to the highest priority, etc. After adopting the Markov model, the response time was reduced, and the optimal ways to reach faster were chosen, and the model was applied to one ambulance and then to two to obtain the results (Zhang,2012).

In addition, the authors (Tasadduq, Shervani&Liam,1999) emphasize the importance of decision-making processes in Markov (MDP) in solving a problem that is considered to be The biggest problems that countries face in overcoming expenditures in health care have exceeded nearly $ 2 trillion in USA only, and hospitals and health care providers are under tremendous pressure to reduce these expenses, causing them to reconsider

disposing of single-use medical devices and reuse them again Irrigation, after sterilization, refurbishment, or remanufacturing and re-sale thereafter at a lower price by partners in this field, which is rejected by device makers and considered by them to be a valid and insecure practice(Tirenni, Abderrahim, Cesar, Andre & ,2007)). The researcher asks: Is this practice safe? Is reliance on single-use devices sustainable? Therefore, the researcher suggested using Markov's decision-making processes to obtain the best possible decisions and to study the trade-offs involved in these decisions. By examining the main key elements: device costs, probabilities of device failure, and the cost of failure penalty. For each of these elements, expressions that define the point of indifference between the use of new and reprocessed devices are developed(Tirenni ,2005).

The aim of the decision maker is to reduce the expected average cost in the long run, given the basic parameters of device costs, and by using Markov decision-making processes, expressions have been developed that define the point of indifference between new devices and reprocessed devices, and it has been shown that there is a unique switching point for each of them (Todor ,2016).

4. Problem: The Marketing Policy

Various development models and techniques have been proposed to support the development of corporate marketing. However, the developers still lacked the tools and techniques needed to help verify the efficiency of appropriate decision-making and the efficient and effective use of available resources to improve their marketing plan and strategies. Given the central role of the decision-making process and its impact on enterprise development, recent research has proposed many measures and techniques to improve the corporate marketing plan, but the focus has mostly been on theories that do not keep pace with technology development or contemplate profitability more than quality and accuracy in decision making. Therefore, this problem has emerged from what needs to be discussed to better implement it, develop marketing policies and develop a model to improve marketing planning and strategies according to the Markov decision-making process and take advantage of the characteristics of the Markov algorithm that

are used to achieve the best expected outcome or the best pathway that achieves the desired results.

5. Conclusions

Markov's decision-making processes are essentially Markov chains with direct cost functionality and can be used to model a variety of situations where decision-makers have partial control of the system. They have a large number of applications, both theoretical and practical, and various algorithms have been developed to solve them. In Section 2, we provided a formal definition of MDP, while Section 3 and Section 4 aim to provide a comprehensive overview of the role of Markov's decision-making processes in customer service and the health aspect as simple examples of the importance and role of this algorithm in our lives. In particular, a common subject with some non-deterministic properties is the subject of strategic marketing planning, where systems can be formulated as decision processes from Markov. In conclusion, after a brief overview of this field, we notice how particularly important this problem is in environments that require a lot of computing, so that more efforts have been made and should be devoted to the development of research in this field.

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