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Customer Acceptance of Telecommunication Technologies during Pre-Launch Stage

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1. Introduction

Telecommunication technologies in the recent times are evolving at a fast pace. Faster and better communication networks enable a variety of service offerings. Whether it is new services on existing network technologies or staple services on new technologies, the challenging question that Telecom Service Providers (TSPs) frequently face is -"How many users will subscribe to this service?" Similarly TEMs are challenged with the question -"How many users will buy the new device?" Answering these questions is fundamental to network investments, network planning and provisioning, marketing and R and D strategies. However, in most cases, no past data is available on adoption of the new service or technology. Acceptance of a telecommunication technology is based on individual adoption decisions. In the case of services on new technology, a large numbers of consumers are not aware of the technology. They learn about the services through media and other channels. They hold back their decision to adopt till they become fully aware of its benefits. The consumers also observe that any new product or service is invariably expensive during the initial phase. They adopt a wait and watch approach to avail the product or service at a discounted price after a certain period of time. Also when a new product or service is just launched, the early adopters positively or negatively influence the potential adopters over a period of time. Thus, consumer adoption of the new service changes with time over the life cycle of the product and is stochastic. Several models are in use for consumer acceptance of technology products and services. Notable among those are - Fred Davis, Richard Bagozzi and Warshaw proposed the Technology Acceptance Model (TAM)1, primarily based on two factors - perceived usefulness and perceived ease of use of a new technology. The model was later modified to TAM2 by Venkatesh et al2. Another model is UTAUT3 again by Venkatesh et al., later extended to include individual differences in adoption in UTAUT24. These models evaluate the acceptance level of a group of customers who are already aware of the new technology. However, a significant probability of acceptance also lies with the section of customers who may be unaware of the new technology, but can transition into potential adopters over a period of time.

Stochastic models using its differential equations for new product growth are considered in7, 8. It is important to note that these models do not consider customer perception changing with time.

Though the TAM model is the most popular, Bagozzi5 and Mohammad10 have accepted that the model does not take into account the uncertainties that might influence an individual's decision of adoption of a new technology. Both emphasize the lack of probabilistic approach. Also, TSPs/TEMs who invest heavily in new technology would like to have an estimate of customer adoption rate a priori in the absence of past data. In this paper, we propose to incorporate uncertainties in an individual's decision making by developing a probabilistic model. The proposed model estimates customer adoption rate during prelaunch stage with the help of Hidden Markov Modeling. The proposed model presents an inclusive dealing of the problem, in the sense that it takes into account the probability of the customer market segment that is unaware of the new technology turning into potential adopters at a later point in time.

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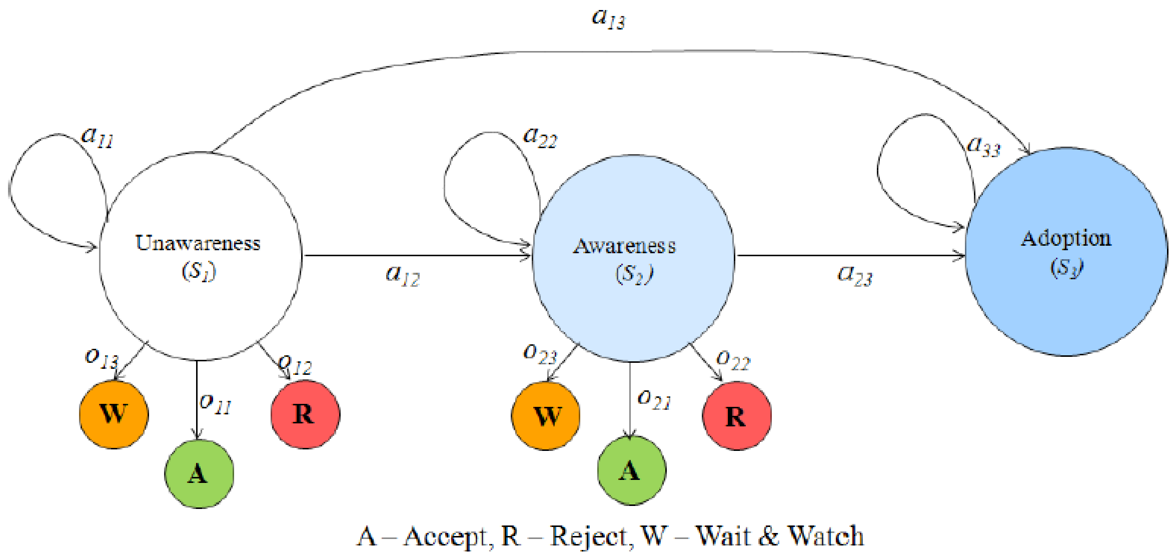
Figure 1. Hidden Markov Model for customer acceptance of new technology.



2. Hidden Markov Model for Customer Acceptance of New Technology

Hidden Markov Models (HMM) have been used in a variety of applications like speech recognition, signal processing, artificial intelligence, computational biology, finance, image processing and bio-statistics. These models possess the ability to present unobservable developments that take place with observable outputs. A comprehensive treatment of Hidden Markov models can be found in9. In this section we formulate the Hidden Markov Model for new technology acceptance. Hidden Markov Models are an extension of Markov models to study systems in which the observation is a probabilistic function of the state. They are effective in modeling a stochastic process, the states of which are not observable (i.e. hidden), and can only be observed through a set of observations that are probabilistic functions of the hidden states. The hidden states are described by a Markov Process and the probabilities of transitions amongst them are given by a Transition Matrix. The observations stochastically depend on the hidden states and are termed as emissions. HMM is, therefore, a doubly embedded stochastic process. The probabilities of occurrence of emissions from hidden states are given by an Emission Matrix. We can now formulate the model for the current problem of customer acceptance, by defining the basic elements of HMM as below:

2.1 Number of States in the Model (N)

We define three hidden states for the customers -unawareness, awareness and adoption (Figure 1). We denote the states as S = {fS1;S2;S3}. Customers in state S1 are completely unaware of the new technology and its capabilities. In state S2, customers are aware of the new technology and are probably exploring its capabilities by assimilating information from various sources. The final or absorbing state is the state of adoption S3, where the customers have accepted the new technology for use. Customers can transition from the state of unawareness to awareness and from state of awareness to adoption. Though theoretically state transitions from any state to another can be modeled, we restrict the transitions from left to right, as it makes practical sense in this case. The state at any time t is denoted as qt.

2.2 Number of Distinct Observations Per State (M)

In the first two states, we define three possible observations viz., accept, wait and watch, reject. The adoption state is the absorbing state hence no observations need to be defined for this state. In the states of unawareness and awareness, the customers may choose to accept, wait and watch or reject the new technology with some probability. We denote the observations as O = {o1; o2; o3}.

3) State Trasition Probability Matrix (A): The state transition probability matrix represents the transit of customers from the states of unawareness to awareness and adoption. It is given by $A = \{a_{ij}\}$ where

$$a_{ij} = P[q_{t+1} = S_j \mid q_t = S_i] \quad 1 \leq i, j \leq N, a_{ij} \geq 0 \, \forall i, j \tag{1}$$

denotes probability that the state at $t+1$ is S_j given the state at t is S_i .

4) Observation (or Emission) matrix (O): The emission matrix represents change in perception of customers (regarding adoption) over a period of time. It is denoted by $O = \{o_j(k)\}$ where

$$o_j(k) = P[o_k(t)t \mid q_t = S_j] \quad 1 \leq j \leq N, 1 \leq k \leq M. \tag{2}$$

$o_j(k)$ is the probability that the observation is o_k given the current state is S_j. The three observations are - accept, reject, wait & watch.

5) Initial state distribution π: The initial state distribution $\pi = \{\pi_i\}$ where

$$\pi_i = P[q_1 = S_i] \quad 1 \leq i \leq N \tag{3}$$

π_i represents the initial probability of the customers in state i.

The HMM is completely specified by these five elements N, M, A, O and π. The model may, hence be donoted compactly as

$$\lambda = (A, O, \pi) \tag{4}$$

The three important problems that can be solved using the above HMM are:

- Given the model, what is the probability of the occurrence of a given observation sequence?
- Given the model, what is the state sequence that maximizes the joint probability of state sequences and a given set of observations sequence?
- How can we adjust the parameters of the model to maximize either of the above two probabilities?

Applied to the current problem, we are interested in evaluating, for a given observation sequence (customer responses to adoption – accept, reject, wait and watch collected from a survey), the maximum probability of ending up with adoption state. So, our problem falls under the second category. The methodology to apply the HMM discussed in this section to a practical scenario and find the maximum probability of adoption is elaborated in the following section.

3. Working Methodology to Calculate Maximum Probability of Adoption

Consider a population of potential customers of the new technology during the introductory or launch phase. Initially, the customers belong to one of the three states of the model -unawareness, awareness and adoption. Since the technology is new, the initial probability of the customers is higher in unawareness and awareness states, and small in the adoption state. These three states are the hidden states S1;S2;S3. (N = 3). The customers in the awareness and unawareness state have three options to choose -accept the technology, reject it or wait and watch. These are the observations o1; o2; o3 (M = 3). This implies that the customer, though unaware of the new technology, can accept or reject or can adopt a wait and watch policy. Customers transition from left to right viz., unawareness to awareness/adoption, awareness to adoption. We assume that the observations can come from customers of unawareness or awareness states. Since we have considered transitions from left to right only, the transition matrix is not ergodic. Adoption of the new product is the absorbing state. For non-ergodic transition matrix, Viterbi algorithm can be used to choose the best state sequence with maximum likelihood for a given observation sequence.

We can evaluate the maximum or minimum probability for the given observation sequence ending with the adoption state.

4. Conclusion

A stochastic time evolving model is proposed for new technology adoption. The model takes into account customer perception changing with time. The minimum and maximum probability of adoption of new technology during pre-launch phase could provide TSPs/TEMs with corrective strategies towards successful marketing of the technology.

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