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Machine Learning: Adaptive Negotiation Agents in E-Commerce

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Abstract: ***Automated negotiation can play a vital role in the domain of e-commerce. Researches have mainly focused on negotiation protocol and strategy design in B2C section. Less work has been done in the area of B2B e-commerce which is crucially useful in dynamic negotiation to achieve better profitability for both buyer and supplier. Lack of such researches has a bottleneck in implementing automated negotiation to real business deals. This paper studies various machine learning approaches and type of agents to get better understanding of an adaptive negotiation agent.This paper tries to reveals some insights into present and future work about adaptive negotiation which may be helpful for further development of B2B e-commerce adaptive negotiation system.***

Keywords: Machine learning, B2B, E-Commerce, Agents, Negotiation

1. Introduction

Every business runs on negotiations between different parties. These negotiations are often complex as they involve enormous factors. It has been observed from experiences that even in simple negotiations often parties involved in negotiation do not achieve best bargain [1], [2].

The problem is big when it involves multiple factors and multiple parties. To address this world wide problem various researches are done and many theories, concepts, algorithms and techniques are proposed for optimization of negotiations. This paper makes a review of work done and techniques developed so far in the domain of B2B e-commerce. The paper also looks toward fully automated system to business negotiations.

Such system consists of automated agents which can learn and subsequently provide effective negotiation strategies. These agents should able to be integrated into real e-commerce systems and provide negotiations automatically, efficiently and cost effectively.

Negotiation is a communication process among parties having conflicting interests to reach an agreement [3]. Online auction is a type of one-to-many negotiation and It is the main trading mechanism in the electronic market [4] which proves that e-negotiation is going to play a major role in e-commerce [5], [6], [7].

In addition, e-commerce oriented negotiation is playing a vital role in many organizations and its significance is increasing day by day. A number of prominent negotiation models have been developed over the past decades [8].

The need of today is an Automated Negotiation System [10] that can fully support business decision-maker persons. In such system software agents should be designed to act autonomously on behalf of the actual business doing parties [9],[10].

A fully automated adaptive negotiation system can be implemented using one or more machine learning techniques so that the agents involved in the system can adjust themselves according to changes incurring in the real world businesses.

2. Machine Learning

Machine Learning is a part of computer science which comes under the artificial intelligence (AI- branch of computer science). Machine Learning basically refers to learning of machine i.e. how the machine learns. In other words to examine and to understand the learning mechanism we use the term machine learning. Machine Learning simply means how the machine learns from the real world input data given by the end user to the machine and then with the help of these inputs the machine will give the output. Machine learning can be done using different approaches such as:

- Supervised Leaning
- Unsupervised Learning
- Reinforcement Learning

2.1 Supervised Learning

Supervised Learning is a type of machine learning in which the machine has given the real world input data with some noise or error so that machine can perform more like human brain.

This type of learning is useful in taking the real world problem and giving the solution by giving nearby values or output using its own intelligence like a human mind. Supervised learning is termed as a dominant methodology in machine learning. Supervised learning techniques are more powerful in comparison to unsupervised learning techniques

because there is more proper labelled training data that provides clear optimisation.

According to Cullingham et. al. [11] their analysis risk minimization is presented as the appropriate criteria to optimize in supervised learning and SVM's are presented as the learning model that implements risk minimization. The given overview is for multimedia analysis. Then with the help of nearest neighbour classifiers and ensembles. Most widely used learning algorithms discussed as following:

2.1.1 Support Vector Machine (SVM)
SVM is supervised learning algorithm that is used to analyse data used for classification and regression process.

(a) Advantages of SVM
SVM works better with clear margin of separation. SVM is effective in high dimensional spaces. It is also effective where no of dimensions are greater than the number of samples. SVM uses a subset of training points in the decision function that's why it is memory efficient.

(b) Limitations of SVM
SVM does not perform well when there is large data set because the required training time is higher. It also doesn't perform well when the data set has more noise.

Svore [12] proposed a method for web spam detection which used content-based features of web pages andthe rank-time features. In their work SVM classifier with linear kernel was used.Xiao [13] presented their work which proved that the contaminated data in the training datasetsignificantly degrades the accuracy of the SVM.

2.1.2 Linear Regression
Means obtaining a best fine line. The attribute x is the input variable and y is the output variable that is predicted.Linear Regression is the algorithm used to predict scalar values given some inputs. Linear Regression can have a single input or more than one input. The goal of linear regression is to fit a line to a set of points.

$$y = mx + b$$

2.1.3 Logistic Regression
Logistic Regression means obtaining a best fit logistic function. Logistic Regression is probability function that is used by input values to belong to its classifications. It is used to predict categorical variables BINARY VARIABLE and MULTINOMIAL VARIABLE.

Binary Variable can take only two values '0' and '1' which represent result such as pass/fail, win/lose. Cases where the dependent variable has more than 2 outcome are analysed in multinomial logistic regression.

2.1.4 Naive Bayes Classifier
Naive Bayes is a classification algorithm for binary and multi class classification problems. It is called naïve bayes or idiot bayes because the calculation of the probability for each hypothesis are simplified to make their calculation tractable. The representation of naïve bayes is probabilities. Naive Bayes classifier are a family of simple probabilistic classifiers based on applying Bayes' theorem. For example a fruit may be considered to be an apple if it is red, round and about 10cm in diameter. A Naïve Bayes classifier considers each of these features to contribute independently to find the probability that the fruit is an apple. It does not take into account any possible correlations betweenthe features like colour, roundness and diameter.

2.1.5 Linear Discriminate Analysis
Linear Discriminate Analysis (LDA} is also known as Fisher's Linear Discriminate as well as Canonical Variant Analysis. LDA is used for finding linear combinations of observed features which best characterizes or separates two or more classes of objects or events. LDA explicitly attempts to model the difference on the classes of data.

2.1.6 Decision Trees
A decision tree or a classification tree is a tree in which each non-leaf (internal) node is labelled with an input feature. The arcs coming from a node have a features. Each leaf of the tree is labelled with a class or probability distribution over the classes.

2.1.7 k-Nearest Neighbour Algorithm
It is a non-parametric method which is used for classification and regression. It is a type of instance based learning or lazy learning where the function is approximated as local and computation is deferred until classification. It is sensitive to local structure.

2.1.8 Artificial Neural Networks (ANN)
An Artificial Neural Network consists of small processing units called neurons. These neurons communicate with one other through a various weighted connections. Each neuron gets input from neighboring neuron or from external source. They process the input and produce output which is transmitted to other neighboring units. ANN has a mechanism to adjust weights of the connections. ANN can either be supervised or unsupervised. A neural network is said to be a learned supervised if the desired output is already known. For example the target patterns are given in form of binary values of the decimal numbers. It is termed as learned unsupervised when there is no known targets.

ANN performs better and produce higher accuracy even in noisy data in [14] supervised ANN approach obtained up to 92% accuracy.

2.2Unsupervised Learning

Unsupervised Learning is defined as a machine learning in which there is only input given by the programmer and then the output is produced by the machine.

In this type of machine learning, we donot use any type of noise or error. The machine has to give the output using only input, this input may be a set of rules/algorithms / commands or knowledge /experience.

"*Automated Pattern classification by unsupervised learning using dimensionality reduction of data with mirroring neural network"*

The algorithm purposed in [15] is the method of unsupervised learning. The result of the algorithm over three different input patterns were beneficial.

2.2.1 Clustering

Cluster analysis is the method of grouping the different types of objects in such a way that the object from same group is much more similar to the other object in comparison to the other group. It is used in many fields like machine learning, pattern recognition, image analysis, information retrieval, bioinformatics, data compression and computer graphics.

(a)Hierarchical Clustering

It is also called as connectivity based clustering which is generally related to an idea of objects being in relation to the nearby objects rather than in comparison to the far away objects. These algorithms used to connect the "objects" to form clusters based on the distances they have maintained. They are generated from those algorithms which do not provide a single part of the information but instead of this it provides the cluster of objects that combines together to form the hierarchy at different distances.

(b)k-Means

It is also called centroid–based clustering in which the clusters are represented by a central vector that will not be the member of the information. When the multiple clusters are fixed to k, k-means clustering is obtained that gives a formal definition as an optimization problem in which the k cluster centres are to be found and then the assigning of the centres are performed such that the squared distances from the cluster are minimized. There are some theoretical properties of k-means which are given below:

- The data space is partitioned into a structure which is known as a Coronoid diagram.
- The concept is much more similar to the neighbour classification and which is mostly used in machine learning.
- Variations are accepted.

(c) Mixture Model

In this model the clustering produces complex model for cluster that can be correlated and dependent between attributes. Example of mixture model is Gaussian distribution.

2.2.2 Anomaly Detection

In unsupervised machine learning an anomaly detection is a technique in which the anomalies are detected in an unlabelled test data set with an assumption that the majority of the instances are normal by looking for instances that seem to fit least to the remained for the data set. It is applicable for the different fields such as intrusion detection, fraud detection, fault detection, system health monitoring, event detection in sensor networks and detecting eco-system disturbances.

2.2.3 Neural Network

They are of two types: Habana Learning and Generative Adversarial Network.

(a)Habana Learning

In this the activation of cells is taking place simultaneously which leads to pronounced increase in synaptic strength between those cells and provides a biological basis for errorless learning which are basically used for education and memory rehabilitation.

(b) Generative Adversarial Network

In an adversarial networks the generative model is used against an adversary i.e. a discriminative model that are used to learn the determination whether a sample is from the distribution or the data distribution. The generative model can be thought of as analogous counterfeiters which are used to produce the fake currency and used as such without being detection.

2.3 Reinforcement Learning

Reinforcement learning is also another type of machine learning in which the machine has given some input like other learning mechanism and it produces the output using those inputs. But unlike supervised and unsupervised learning reinforcement learning uses another term "environment " as a input and with the help of these input it produces the output.

The environment also contains pre-defined information of the real world but is different from error that is used in supervised learning.

There are very few reinforcement learning techniques that work on larger problems because it is so different to perform solutions of arbitrary problems. To solve highly complex problems, we begin to in-cooperate bias. Following are the forms of important bias:

- Shaping
- Local Reinforcement Signals
- Imitation
- Problems Decomposition
- Reflexes

There are following types of reinforcement learning

2.3.1 Q- Learning

Q-learning is a type of reinforcement learning technique which is model free. It can be used for finding an optimal action selection policy for any given Markov Decision Process. Its working is based on an action value function that can be used for giving the utility of given actions in a given state and following the optimal policy. The strength of Q-learning is that it can do the comparison of the excepted utility of the available actions without any requirement of an environment.

2.3.2 SARSA

The word SARSA stands for State Action Reward State Action. It is an algorithm which is used for learning a Markov Decision Process policy which is used in the reinforcement learning area of machine learning. It simply means that the function for updating the Q-value depends on the current state of the agent 'S1' where the action is chosen 'A1' and reward 'R' then the agent gets for choosing this action where the state 'S2' will take the action on 'A2'

2.3.3 Markov Decision Processes

Markov Decision Process (MDPs) provides a mathematical framework for modelling a decision making in situations where the outcomes are partly random and partly under the control of a decision maker. They are mostly useful for studying the large range of optimization problems that are solved with the dynamic programming and reinforcement learning. They were known at least as early as the 1950s (Cf. Bellman 1957). The core was resulted from Ronald A. Howard's book published in 1960 named Dynamic Programming and Markov Processes. MDPs are widely used in Robotics Automated control Economics and Manufacturing. MDPs is a Discrete Time Stochastic Control Process. MDPs can be solved by learning programming or dynamic programming.

2.4 Designing a Machine Learning System

The main design decisions are as following:

- **Training Experience:** It basically tells about the assessing of the system and the usage of the data.
- **Target Function:** It basically tells about that what should be learned exactly?
- **Hypothesis Representations:** It tells about the way of representing the concepts that have to be learned.
- **Inductive Inference:** It tells about the type of algorithms that should be used to learn the target concepts.

An adaptive agent negotiation technique for B2B e-commerce deals with the machine learning. An adaptive agent means that there is an agent (machine) which adapts information from the real world problems and then applies this in negotiation process. Negotiation refers to a mutual agreement by both seller and buyer for purchasing of a product. E-commerce refers to electronic commerce which deals with buying and selling of goods and services over the internet. There are various e-commerce websites in real world e.g. Flipkart, Amazon etc.

In business to business e-commerce we mainly focus on the purchase and sell of products between business to business enterprises. Both seller and buyer side there will be agents or there may be multiple agents which will perform negotiation between business to business enterprises on different issues which may include warranty, guarantee, durability, product rating, quality, quantity, price etc. Here, trying to make or establish a deal between both the enterprises which will make profitable deal for both sides i.e. for both buyer and seller.

In short profitable deal will take place between buyer and seller so that there will be no loss in the business with the help of supervised learning algorithm the agents will adapt the knowledge.

3. Agents

An agent is defined as a system or machine which is used for performing some intelligence work. In other words, an agent is a set of instructions / algorithms/information which performs actions as gives the output according to the input that has given to it. There are many types of agents such as simple reflex agent, model-based agent, goal based agent, utility based agent, learning agent. An agent is the term given to that way which is used for viewing as perceiving its environment through sensors and acting upon the environment through actuators. An agent is able to take the initiatives and exercise a non-trivial degree of control over its own actions. An agent accepts the high level requests that will be indicating the requirement of a human and its responsibilities for deciding how and where to satisfy the request. It does not obey the commands but it has the ability of modifying requests and clarifying questions or even refuse to satisfy certain requests. It is able to transport itself from one machine to another and across different system architectures and platforms.

3.1 Types of Agents

According to RUSSELL and NORGIV [21] the agents can be described as the following:

3.1.1 Simple Reflex Agents

Simple reflex agents acts on the basis of the current percept, ignoring the rest percept history. The agent function is based on the condition rule that says if there is a specific condition only then the action can take place. This agent function only succeeds when the environment is fully observable. Some of the reflex agents can also contain the information on their current state which allows them to disregard conditions whose actuators are already triggered. In simple reflex agents there are infinite loops which are often unavoidable in the operation of partially observable environments.

3.1.2 Model Based Reflex Agents

Partially observable environments are easily handled by model-based agents. Its current state is stored inside the agent maintaining some kind of structure which describes the part of the world which cannot be seen. The knowledge about how the world works is called a model of the world so it is called model-based agent. It should consist of an internal model that depends on the history and so it reflects at least some of the unobserved aspects of the current state. Percept history and impact of action on the environment that can be determined by using internal model. It can then choose an action in the same way as it reflex agent.

3.1.3 Goal- Based Agents

Goal-based agents are expanded on the capabilities of the model-based agents by goal information. Goal information describes the situations which are desirable, this allows the agent a way to choose among multiple possibilities, selecting the one which reaches a goal state. The agent's goals can be achieved by the subfields of artificial intelligence as search and planning devoted to find action sequences. It is more flexible because the knowledge that supports its decisions is represented explicitly and can be modified.

3.1.4 Utility-Based Agents

As the goal based agents only distinguish between the goal states and non-goal states. It is used to define as a measure of how desirable a particular state is. This measure is obtained from the use of a utility function which maps a state to a measure of the utility of the state. Measure should allow a comparison of different world states according to exactly

how happy they would make the agent. How happy the agent is can be described by the term utility. A rational utility-based agent chooses the action that maximizes the expected utility of the action outcomes that is what the agents expects to derive on average for given the probabilities and utilities of each outcomes.

3.1.5 Learning Agents

Learning has the advantage that it allows the agents to initially operate in an environments which it has no knowledge and gradually adapt itself by gathering knowledge of the environment. The learning elements use feedback from the critic on how the agent is working and it determines the performance of element that should be modified to do better in the future. The performance element is what we have considered to be the entire agent as it takes in the decision for deciding the actions. Learning agents are also called as problem generator as theyare responsible for the suggestion of new and informative ideas and experiences for different actions.

3.2 Applications of Agents

Intelligent agents are applied as automated online assistants where they function to perceive the needs of customers in order to perform individualized customer service. Such an agent may basically consist of a dialog system, an avatar as well as expert system to provide specific expertise to the user.

3.3 Architectures for Seller and Buyer Agents

WEISS [22] described the agents into the following types:

3.3.1 Logic-based agents

It is that type of agents in which the decision is taken for the type of action that have to be performed with the help of logical deduction.

3.3.2 Reactive Agents

It is that type of agents in which the decision is implemented in direct mapping from the situation.

3.3.3 Belief-desire-intention agents

It is that type of agents in which decision making depends upon the manipulation of data structures representing the benefits,desires and intentions of the agent.

3.3.4 Layered Architectures

It is that type of agents in which decision making is realized with various software which is more or less explicit reasoning about the environment at different levels of abstraction.

3.4 Agent Communication Languages

The agent communication languages can be as following: KQML

3.4.1 KQML

KQML is that language and protocol which is used for the information as well asknowledge exchanges. In support of the knowledge support between the agents the KQML is used which can be either in message format or message handling protocol. It is that type of language which can be used either for one or more intelligent systems for the knowledge sharing that will help in supporting cooperative problem solving.

3.4.2 AOP

It is written as the language which is called as AO. AO is a programming language of Agent Oriented Programming.

3.4.3 AGENT TALK

It is a coordination protocol description language for multi-agent system. It allows coordination that canbe easily customized to suit application domains by incorporating an inheritance mechanism.

3.5 Characteristics of Agent

The following are the characteristics of agents:

- An agent is a program or set of rules which will perform the agent work.
- Agents are autonomous. Agents have their own command over themselves.
- Agent can have predefined actions or can be embedded.
- Agent can learn from its environment and can perform various actions.
- In a multi-agent system,agents can communicate to other agents because they are social.
- Some of the agents learn from their previous experiences and then perform the given task.
- Some agents are mobile, they move from machine to machine without any network delay.

3.6 Use of Agents in Enhancing the Performances of Search Engines

Existing search engines provide limited information to the user. With the use of the intelligent agents users can do the work by creating such platforms which will use such types of tools that will used and trained by the users to search the specific tasks. With the agents the real information for the particular object is known such as whether the object isliked, disliked or ignored by the user according to the information given by the user base. Agents can learn from its experiences that will help them in reviewing the search results and rejecting the information that is not relevant. The search engines are basically based on the intelligent agents which are used by Yahoo,Lycos and web-crawler. With the help of agents the information about a particular thing in the search engines is gathered according to the submission of the information by opening to the different links through the search engines.

3.7 Multiple Agents

Multiple agents are basically that type of agents in which the different types of agents are working together. Problems which are difficult or impossible to be solved by an agent can be solved by the multiple agents easily. It is totally different from the agent based model as agent based model is basically used for searching the information according to the behaviour of the agents. Agents are divided into the following parts based on the capabilities such as passive agents, active agents and cognitive agents.

3.7.1 Characteristics of Multiple Agents

Agents that are present in the multiple agents have different characteristics which are stated below:

(a) Autonomy

Agents are autonomous, independent and self-aware.

(b) Local View

Single agent has no full view over the information so in multiple agents system it is viewed globally.

(c) Decentralised

It means that there is no control over the positions of the agents where they have been used.

3.7.2 Applications of Multiple Agents

There are various applications of multiple agents that are used in the real world that are given below:

- Computer games
- Films
- Coordination in defence systems
- Transportation
- Graphics
- GIS
- Logistics
- Mobile technologies to achieve automatic and dynamic load balancing, high scalability and self healing networks.

4. Automated Adaptive Agents Applied in Business Negotiation

Dirk Moosmayer and Martin Liu(2012) [16] examined the predictors of B2B price negotiation outcome. This research examined B2B negotiations of a major chemical firm in Germany and its buyers. This research have several implications. Firstly for companies, the result imply that it would be wise to support their sales personnel in setting ambitious targets and translating these into a specific target price for each negotiation. Secondly the results explained variation in price negotiation outcome better that existing experimental research. Thirdly, this research showed that neural network can be used as a means to overcome multi-collinearity issues in data.

Li Pan et. al. (2013) [17] proposed a two-stage model of win–win negotiation for tackling the challenge of negotiation with multiple interdependent attributes. The model proposed, agents need not to disclose their own utility function to others nor a third-party. This model also supports dividing the gain fairly between agents. They also propose a family of time-independent concession strategies, which can cover various concession strategies in real-world negotiations. The experimental results also show that this win-win negotiation model is stable and efficient in finding fair win-win outcomes.

Chunxia Yu,T.N. Wong(2015) [18] proposed the central idea of the paper is that the strategy selection is a novel negotiation concession model and should be considered as a requisite component in negotiating agent architecture. This study is built upon the goal deliberation mechanism to enable a negotiating agent to select appropriate strategy dynamically to deal with the ever-changing opponent's offer and get agreement successfully. Their study is expected to bridge the gap between the theoretical and practical aspects the negotiating agent development.

KASBAH proposed in [19] is an automated agent implemented on e-commerce website for buying and selling of goods where users take advantage of autonomous agents that buy and sell goods on behalf of them. The application provides information to opposite parties about new sellers or buyers. The negotiations process considers various factors like price, delivery time, warranty, product quality etc. and uses a decay function to lower the asking price over its given time frame.

Huang [20] proposed a multi-issue negotiation model for B2C e-commerce which consists of 4 phases: information collection, search, negotiation, and evaluation. It is an agent-based architecture known as intelligent negotiation agent (INA). This model defines four roles. (i) A negotiator to negotiate with sellers according to buyer's requirements. (ii) A manager to transfer messages between negotiator and clients. (iii) A searcher to search products and (iv) an agent interface to communicate between the customer and other agents. This model searches a seller then applies utility function to compute utility of the seller's offer. If it satisfies utility threshold, negotiation is continued.

5. Conclusion

- For any B2B business, negotiation is one of the most crucial stages. Automated and intelligent agent mechanism and web service implementation can be employed to develop advanced and dynamic e-commerce business systems to provide automated negotiation for both merchant and supplier.
- Negotiations in B2B domain are characterized as combinatorial complex negotiation spaces. It includes narrow negotiation deadlines and have little information about the opposite party in negotiation. There must be a practical negotiation mechanisms able to address these issues.
- Such web services and intelligent agents based automated negotiation system will address most of the requirements of a B2B e-commerce. This system should support multi-party negotiations having multiple issues.

Automated Agent Mechanism Comparison

The Table 1 illustrate advantages and disadvantages of using different machine learning mechanism in automated agents.

Table 1: Margin specifications

Mechanism	Advantage	Disadvantage
Supervised Learning	Higher Accuracy in classification	Prior dataset required to train and test.
Unsupervised Learning	Average Accuracy	No prior dataset is required
Support Vector Machine	Higher Accuracy if clear classification boundaries are present in dataset. Efficient performance for small dataset.	Low accuracy in case of noisy dataset. Hard to interpret for decision making.

Artificial Neural Network	High Accuracy even in case of noisy data. Performs well in case of large dataset.	Complex to understand. Works as a black box so decision making and prediction is difficult. Difficult to choose appropriate topology.
Non Adaptive Learning	Simple to implement	Require prior knowledge
Adaptive Learning	No prior knowledge is required. Performs well for next prediction values.	Complex to implement.
Logistic Regression	Easy to understand for prediction and decision making	Lower accuracy than ANN or SVM. High correlation the x and y axis values are required for good prediction.
Decision Tree	Do not require the problem to be linear separable. Easy to interpret and explain.	Prone to over-fitting.
Naïve Bayes	Converges quickly. Performs well in case of simple problem of decision making and prediction.	Does not allow rich hypothesis.
Linear Discriminate Analysis	Good prediction performance for small feature set on large sample data.	Does not perform well in case of linearly non separable problems. Sensitive to overfit.

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