VIRTUAL MARKET ENVIRONMENT FOR TRADE

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Abstract: In today's society, there is a need for greater understanding of activities within electronic market environments and the role information plays in negotiation. Fuelled by greater communication reach and information flow, electronic markets are ever increasingly becoming the primary domain for trade. This paper details a collaborative virtual market environment where participants engaging in trading activities may exploit information refined from both external Internet sources and internal market signals. That information provided is retrieved and distilled using time constrained, data mining techniques.

Key words: Virtual market place, virtual emarket environment,

1. INTRODUCTION

What is the future of online trading? What kind of information will a trader require in order to complete a deal? What electronic environment best suits the social dynamic that is the market place of tomorrow?

In an information based society, with an increasingly improving technological infrastructure, there is a need for research into how these new factors will influence electronic markets of the future. Presently, few online environments in a narrow range of online market applications, supply the necessary trade information usually required in order for a buyer and seller to complete a deal. Indeed, what is required in order for a deal to be completed can be seen as an constraint satisfaction problem[1] where objectives are represented as constraints and the strategies used to fulfill them are information based.

It is therefore necessary to investigate environments that enhance the traders and entrepreneurs. If the fulfillment of objectives belonging to these actors is achieved from appropriate information, then environments which facilitate this kind of information in a timely and constrained manner will conduit market stimulation. Information here includes both external (internet) and internal market signals.

There are a number of existing models of electronic market environments around. EBay and ETrade are both examples of present day e-marking trading environments which have been around for a significant number of years. Both provide sufficient trading mechanisms in order to complete deals; however they are not reaching far enough. Their paradigm is suited to well regulated, but simplified buy/sell versions of traditional markets. This paper proposes an alternative: an online collaborative virtual environment, or "virtual e-market place".

Virtual environments are quickly becoming widespread in conjunction with rapidly improving technological infrastructure. Indeed technology seems to be moving so quickly, the potential for virtual environments appearing on hand-held devices, including 3-G mobile devices, in the not too distant future is very real [2]! In an important way, virtual environments complement market environments – market activity is intrinsically social by nature and relies on this communal "look and feel" to generate a buoyant atmosphere on the virtual trading floor. By definition, collaborative virtual environments are social.

Figure 1 details the overall conceptual framework of the e-market virtual environment. This environment incorporates the data mining, e-market and agent activities within a single system. At the *e-market place* layer, basic market transactions are managed as industry processes using a multi-agent business process management system. These transactions include the creation of particular markets, the buying and selling of goods, and the packaging of goods, services, needs and requirements. The basic market transactions take place between a set of 'major actor classes' in the market—the decision-makers. These transactions are monitored by 'supporting actor classes' that include data mining actors. At the *market evolution* layer, the entrepreneurial transactions are also managed by business process management technology. This includes the timely extraction of reliable information and knowledge, as well as entrepreneurial intervention. At the *market information* layer, atomic signals from information bots and other sources feed into the data mining actors, the reliability of these atomic signals is evaluated before the signals are combined by the process management system at the market evolution layer.

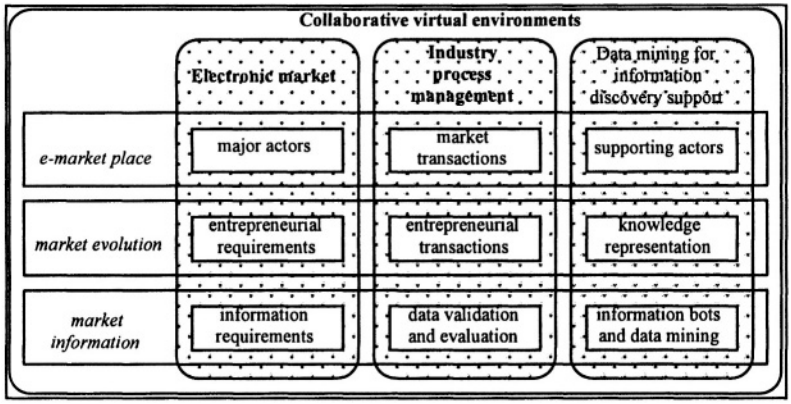

Figure 1. Conceptual framework integrating the domains involved

Section 2 will discuss more about present and future e-markets. Section 3 will discuss data mining methodologies and the relevancies in an e-market environment. Section 4 will deal with a brief overview of a process management system for integrating e-market, data mining, intelligent agent and actor activities. Section 5 will cover an exemplar collaborative virtual environment that has been built at UTS, combining the features of constrained information mining with trading.

2. ELECTRONIC MARKETS

E-markets are a rich domain of trade and entrepreneurial activity. There is a vast amount of information which resides within the e-markets and the Internet generally which assists market forces and traders alike. Little has been done to harness the rich information flowing through e-markets in order to facilitate negotiation and trade. "[T]he value of the Internet and IT lies in their capacity to store, analyse and communicate information instantly, anywhere at negligible cost" [Economist, 27 Sep. 2000].

The environment of electronic markets is quite different to traditional market environments, and so the scope for trade activity in e-markets cannot be assumed to be the same as their traditional counterpart. Substantial amounts of data may be acquired quickly and cheaply from the electronic markets themselves. Further, valuable signals may be observed by searching the Internet, by reading news feeds, by watching corporate pages, and by reading background market data such as stock exchange data. If all of these individual signals can be distilled into meaningful information, then it may

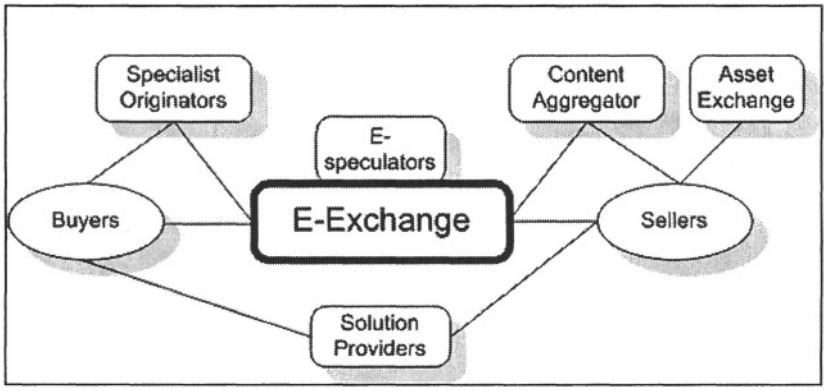

Figure 2. Actors interacting in an emerging market landscape

be useful to the trader who relies on "the right information, at the right granularity, at the right time". The scope of possible buying and selling is determined by the range of the support provided by the environment. Trading and the provision of information are intimately interrelated.

In the example model constructed at UTS, the basic market transactions take place in the "e-market place" between a set of *major actor classes;* these are based on an extension of the model given in [3]. There are eight major actor classes—see Figure 2. A central logical component is an "e-exchange" where individual markets are created, within which, subsequent deals are done. This class is essentially an "empty virtual box" for holding markets and for advertising their existence. It contains a collection of pre-packaged market protocols that may be invoked by the creation of a market. The *buyer* and *seller* classes include those wishing to buy or sell a good or service, or any combination of goods or services, in a market. The remaining actor classes are all entrepreneurial in nature, and are instrumental in market evolution. Members of the *content aggregator* actor class act as forward aggregators, they package goods and services and place these packages in markets in the e-exchange. Members of the *solution providers* class act as intermediaries in the negotiation of contracts and the development of long-term business relationships. *E-speculators* take short-term positions in markets in the e-exchange. Sell-side *asset exchanges* exchange or share assets between sellers. *Specialist originators* act as reverse aggregators, they coordinate and package orders for goods and services on behalf of various buyers. The major actors, shown in Figure 2 are all provided with distilled information by the supporting actors, which utilise a variety of data mining and information discovery methods. The buyers, sellers and entrepreneurs are all realised as avatars in the virtual market place.

3. DATA MINING TECHNIQUES

Data mining techniques have successfully been applied to stock, financial market analysis applications [4] and research has been conducted into e-commercial applications of data mining [13]. A variety of structured and unstructured techniques have been developed to mine data from a variety of sources, such as relational databases, web pages and text files. Presently in the e-market environment the main methods have been primarily limited to the B2C framework. This paper describes set of classes which utilise both "classical" and e-commerce based mining methods [5] in order to present timely and essential information to the actors. A set of concurrent mining processes are supported by bots, supported in turn by specialised agents.

The structure for the data-mining task is outlined in Figure 3. An actor in the marketplace requests some kind of information. *Information bots* scour the market place and Internet for relevant information ranging from text in Internet news feeds, to latest stock reports, to price updates and so forth. The information retrieved is stored in a *database* in an unstructured format. *Pre-processors* are separated processes which engage in parsing raw data into formats for data-mining. The *data mining bots* mine the pre-processed data for information discoveries as required by the actor. *Process Agents,* on behalf of the actor, retrieves the information mined by the data mining bots in a constraint enforced manner. Information returned to the agents finally undergoes a visualisation transformation enacted by the *Information Visualiser* in order for the actor to understand its importance.

Delivering relevant information at the right granularity and within tight time constraints are important features of the data mining interactions model. One final feature exists which is important to the information – its visualisation. This will be outlined in section 5. Information is returned in the form most easily digestible by the actor (for humans, natural language, for agent, statistics and numbers are more easily crunched).

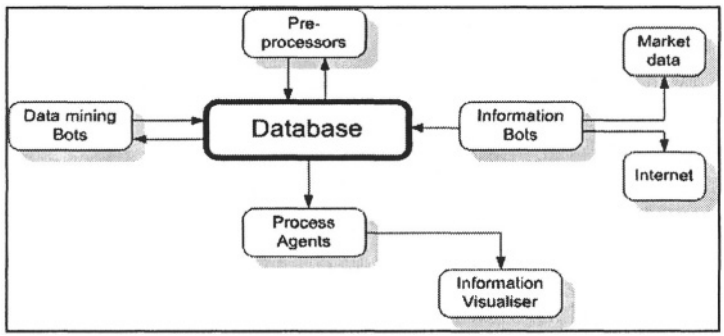

Figure 3. Data mining interaction model

4. INDUSTRY PROCESS MANAGEMENT

The term *industry processes* is used here to refer to processes that are triggered by both e-market transactions and entrepreneurial intervention. This is in-line with the term *industry process re-engineering* which concerns the re-engineering of trans-corporate processes as electronically managed processes. Industry process re-engineering addresses four issues: complexity, interoperability, communication and management. Of these four issues, complexity, communication and management are particularly relevant here. Communication and management are dealt with by an agent architecture described below.

All e-market transactions are managed as industry processes. The problem of delivering information to both traders and entrepreneurs at the right granularity and at the right time is also a process management problem, as is the problem of effecting any intervention that may be triggered indirectly by that information. A single business process system manages the e-market transactions, the entrepreneurial intervention, and its delivery of information. The complexity in managing e-market transactions stems from the distributed nature of e-markets and from the complex time constraints that govern the operation of e-markets. The complexity in information delivery here stems from the unreliable and unpredictable nature of the Internet, and the problem of delivering something useful and reliable in the required time. This means that a powerful process management system is required, particularly in its capacity to manage heavily constrained and possibly interdependent processes of high value. The system used is a multi-agent system that is based on a three-layer, BDI (Belief-Desire-Intention) hybrid agent architecture.

Multi-agent technology is an attractive basis for industry process re-engineering [6] [7]. A multi-agent system consists of autonomous components that interact with messages. The scalability issue is "solved"—in theory—by establishing a common understanding for inter-agent communication and interaction. KQML (Knowledge Query and Manipulation Language) is used for inter-agent communication [8]. Specifying an inter-agent communication protocol may be tedious but is not technically complex. Standard XML-based ontologies will enable data to be communicated freely [9] but much work has yet to be done on standards for communicating expertise. Any process management system should take account of the "process knowledge" and the "performance knowledge". *Process knowledge* is the information that has been accumulated, particularly that which is relevant to the process instance at hand. *Performance knowledge* is knowledge of how effective people, agents, methods and plans are at achieving various things.

5. E-MARKET AS A COLLABORATIVE VIRTUAL PLACE

The collaborative market environment should seamlessly integrate the mining and process models with the underlying technology and support both social and negotiation interactions. Market activities are distributed by nature, so there's also a need to be able to handle all interactions in a single 'logical' location, which in turn allows convenience for research observation and collection of strategies and behaviours within the market place.

Much research and development involved with collaborative virtual environments (CVEs) [10] has been towards the implementation of 'virtual place' models offering ways to handle information, communication and additional functionality [11] [12]. Our approach describes a 'virtual e-market place' that provides 'virtual e-markets' with an environment in which the complete range of market and trade activities are naturally represented.

The model for the e-market place is shown in Figure 4. The *Virtual environment* is at the centre of all activity. It is a distributed collaborative environment implemented using Adobe Atmosphere technology and facilitates the 3D representations of actors and markets over the Internet. Within this environment we have built an *e-market place.* The e-market place is a centralised location for the populations of *e-markets.* It is essentially the hub for existing markets and for the creation of emerging new markets alike. An *e-market* is a market area designated for trade and activities. Markets are split into market areas and each e-market describes a set of goods and/or services which are traded within the market. Fig. 4 shows a screenshot of the implementation of the virtual UTS environment.

The implementation of this virtual environment is divided to three areas. These areas are marked as 1, 2 and 3 in Figure 5. Area 1 displays the 3-D environment in which the user moves and interacts with the various agents. The movement of the user's avatar can be controlled through the keyboard and mouse, and the interaction with the various environmental objects, such as walls, desks etc., is as one would expect in the natural environment. Area 2 is used to display general information about a product (for example, its 3-dimensional representation), comparisons between products in tabular format, and tools that can facilitate the creation of new markets by the user. Area 3 is used for facilitating the actor communications and dialogue and displays the history of the dialog as it continues between a user and a virtual agent. It is through this that the actors can converse with one another.

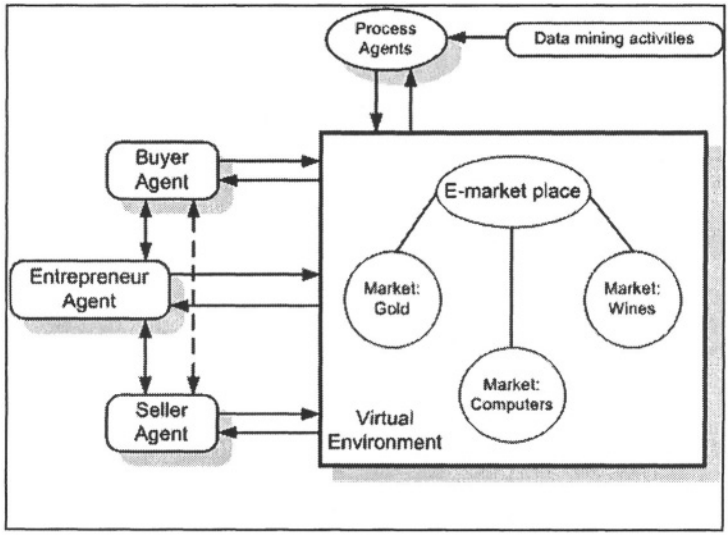

Figure 4. E-market model for basic trade in 3 classes of goods

Another aspect of the virtual environment model is establishing a 3D representation of the actors (including traders, etc). In the context of an e-market, the representation should be understandable to all other actors, thus a human who has entered the virtual environment should have an avatar model assigned which shows where they are, the direction they are facing, and any gestures communicated. Avatar models may also be customised to signify specific traits, which may be used to identify individuals from others.

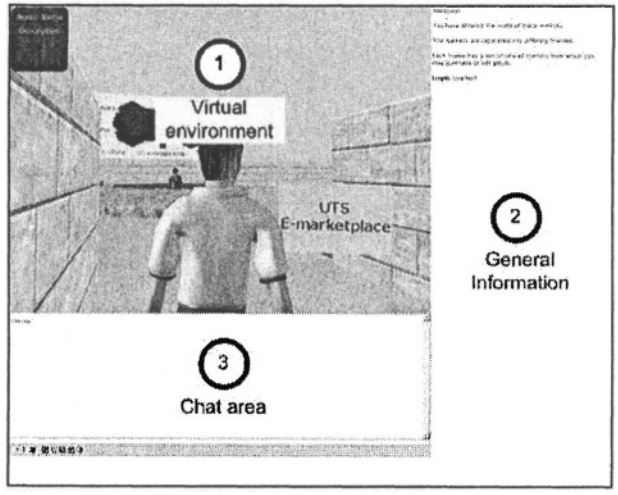

Figure 5. The virtual environment market place

Finally, the virtual environment enables *agent* interaction in order to interface *data-mining* information. The process agents described here are the same as those described earlier in the data mining section and have representations in the 3D context. Actors may utilise the mining methods provided by the agents (via an agent avatar visualisation) in order to search for relevant information from many sources across the Internet. They do this in one of the two ways outlined earlier: data driven and hypothesis driven. Agents will seek out information based on the goal and retrieve what is available in a time constrained manner. The results are displayed in a manner that is appropriate to the information to be visualised.

In order to fulfill these, further information will be required. How one may determine whether a product is reasonably priced in this instance might be a combination of comparing Internet prices, market trends for similar products, and being able to negotiate a better price with the seller. The former two would be something an agent might be able to provide visually with data mining techniques, the latter is a social feature inherently tied with markets. How one may determine whether a product is of good quality in this instance might be a combination of Internet published reviews about the product, technical forum views about the seller, and a visual 3D inspection of the product itself.

Precisely what information is required and by when is another matter for further research. Furthermore, there are a wide variety of other e-market scenarios for which the constraints and the satisfying of the constraints become considerably more complex. An example is for a multi-tier auction for e-procurement over the Internet involving steel. In the e-market context, it becomes a much more complex problem of how one would best go about to achieve the best price (as a buyer and seller), however, it is reasonable to suspect that it certainly involves timely, accurate and reliable information, visualisation, and the ability to interact socially with those involved.

6. CONCLUSION

This research has described an implementation of a collaborative virtual environment for e-markets permitting market activities and trade between actors represented as virtual avatars. By enabling a singular virtual location for activity, a smarter way of business is engaged by reducing information overload to well organized visualisations and an environment for interactive decision making and data mining. The merger of e-business with the feeling of ‘place’ supplied by the 3D virtual context provides for a more coherent and effective way of doing business.

By constructing e-markets in the virtual world context, we are also facilitating further research into what drives trade in the e-market context. Having a centralised market activity centre allows unobtrusive observations to be made about the way business is done, allowing discoveries about the emerging processes between actors to be uncovered.

The reader may enter the UTS e-market place from the following URL (you will need Internet Explorer 6 or newer, and the Adobe Atmosphere plug-in): http://research.it.uts.edu.au/emarkets/tech_vw/demo/demo.html. The e-market is still in prototypical form and consequently no formal evaluations have been made at the time of writing.

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