JOURNAL OF OBJECT TECHNOLOGY

Online at www.jot.fm. Published by ETH Zurich, Chair of Software Engineering ©**JOT, 2003**

Vol. 2, No. 4, July-August 2003

Object-Oriented Intelligent Mechanism - Vital for the Success of E-Commerce

Myron Sheu, California State University, Dominguez Hills, U.S.A.
Xin (James) He, Dolan School of Business, Fairfield University, U.S.A.

Abstract

Motivated by widespread applications of e-commerce, this paper addresses the unique challenges of e-commerce by introducing object-oriented intelligence to the user interfaces of e-commerce rather than by utilizing traditional expert systems. Specifically, this research examines the intelligent mechanism settings that are aimed largely at improving knowledge representation of online transactions. In this paper, we, without loss of generality, focus on online investment due to its complexity and popularity and integrate a series of intelligent mechanism settings as a heuristic intelligence system to make the online investment user-friendlier to online investors and more affordable to online service providers.

1 INTRODUCTION

The Internet has made e-commerce increasingly more feasible and accessible. However, the success of e-commerce depends not only on the infrastructure underpinning the Internet but also on the user friendliness of the online business environment that would profoundly affect the traditional shoppers' attitude towards e-commerce. It is nevertheless challenging to balance technological difficulties faced by online stores and user friendliness sought by online customers. Some of the critical issues relevant to e-commerce are highlighted below:

1. Any attempts to facilitating such a business environment that requires sophisticated reasoning methods would be viewed by customers who are used to an intuitive shopping environment as non-user-friendly. Therefore, these attempts are too technical to be considered practical in facilitating online shopping.

2. Most online shoppers expect to pay no more, if not less, than the price that they would pay to a local traditional store. As a result, it is financially infeasible for online storeowners to charge their customers more than what traditional stores would charge in order to offset any extra services provided by the online stores.

Cite this column as follows: Myron Sheu and Xin He: "Object-Oriented Intelligent Mechanism - Vital for the Success of E-Commerce", in *Journal of Object Technology*, vol. 2, no. 4, July-August 2003, pp. 101-112. http://www.jot.fm/issues/issue_2003_07/article1

3. Now that brevity and convenience are the inherent advantages of e-commerce, complicated procedures with sophisticated tools and excessive professional opinions would deprive these advantages from the online shoppers.

Therefore, in this paper we first introduce a concept that infuses intelligence to the user interfaces of e-commerce without having to rely on the traditional expert systems. Then, based on this framework we explore a series of elements that would effectively and efficiently enhance the intelligence of e-commerce.

2 LITERATURE REVIEW

Although deploying a set of intelligent agents to monitor and integrate vast volumes of dynamic information is helpful [Wang02], improving the knowledge representation of e-commerce would help online customers better understand the value of the products under consideration and, consequently, more likely reach rational purchase decisions. Such improved knowledge representation is badly needed as the number of alternatives increase significantly [Jedets02]. Without loss of generality, we focus our research efforts on the online investment business environment due to its complexity and popularity. As the large number of alternatives increase, the possibility for online investors to make unwise decisions increase due to poor quality and limited availability of relevant information to the investors. When a piece of information is inaccurate, it would be worse than without it [Willia02]. At a typical online investment web site presently available on the Internet, for instance, an online investor usually sees all the securities in a tabular structure that merely lists primitive data and leaves the digestion of data to the online shoppers. Such a tabular structure is considered linear rather than composite, fragmented rather than granular, and segregating rather than associative. Nonetheless, a comprehension of measurable attributes on these securities, tailored by each individual's financial needs, is much more important than the tabular structure because the valuation of each security is perceived differently by various individuals.

As the information is disseminated to web sites in the tabular structure, online customers may merely stare at the numbers without knowing how to further process the data into meaningful information effectively and efficiently. Consequently, if a potential online shopper cannot correctly synthesize the data for his purchase decision, such data not only possess little value, but also irritate that individual for he may be victimized by the misinformation. Therefore, such data should either be further processed to become comprehendible to the user or be filtered out to avoid possible contradictions and redundancies [Benet02]. Hence, the ability to refine overwhelming financial data that constantly come forward to the marketplace and represent them in a suitable manner is critical to online investors. Moreover, online investors would want to view the information represented at different levels of granularity that is digestible and relevant to their concerns. Such preference subsequently demands flexibility in representing the knowledge at a desirable resolution, with various perspectives, and accessible to all the online end-users.

After all, suitable intelligent ingredients must be built into the knowledge representation of an e-commerce web site such that it would possess three desirable attributes: derivability, digestibility, and integrity. By derivability, we mean that the knowledge is well organized so that the whole representation facilitates an informed decision to be readily derived. Digestibility is the intuitiveness of knowledge representation perceived. Integrity is the quality of knowledge representation that fosters a comprehensive understanding of security without being excessively driven by current news in the market. The next section therefore examines a framework that incorporates crucial intelligent components aimed at effectively facilitating online investment in light of these fundamental requirements.

3 FRAMEWORK FOR INTELLIGENT MECHANISM

Situating Knowledge in an Object-Oriented Schema

Before identifying a feasible framework for structuring the knowledge that best represents merchandises, e.g., stock securities, we should first think about how we should categorize the knowledge relevant to investment in accordance with different functional roles of knowledge. For example, marginal utility is a concept exercised often when one considers his preference of risk avoidance before making any investment decision. Marginal utility to an individual is usually profound and does not change on a daily basis, which, though quite overwhelming, should not be mixed with other less fundamental knowledge. Similarly, the time horizon of investment to an individual does not vary significantly. Knowledge, which can be applied to guide how other knowledge shall be applied, is considered as meta-knowledge. When certain market news arrives, one exercises an evaluation model in order to come up with some conclusions. The chosen evaluation model is thus considered a part of heuristic knowledge. Such knowledge should also deserve certain degree of recognition by individuals whose investment decisions have been influenced by the model.

In search of a suitable representation framework, we think, first, it has to deal with granularity of knowledge; namely, a knowledge entity that can be primitive or composite. Second, since knowledge is often temporary and relative due to its dynamic nature, it should be understood in reference to history and trend. Third, knowledge entities are functionally relevant to each other; i.e., one knowledge entity may influence another by changing the related attributes. Fourth, knowledge entities possess different states; that is, they can move from one state to another driven by events. Finally, knowledge entities can be evaluated from various perspectives in light of investment goals. Thus, we find that a truly object-oriented model would provide a sound framework that naturally delivers intelligence in a robust manner, representing not only all the properties discussed but also their dynamic and customizable forms [Minsky75]. While this conclusion is no surprise to many computer scientists, it is worth noting that few investment web sites have had their knowledge representation nearly object-oriented. In the following, we elaborate a series of intelligent elements resulting from such a representation model.

Implied Reasoning

Figure 1 shows that a primitive object class can be defined to describe an instrument of investment in light of a general conception, where an object instance of the instrument object class can be generated to represent a bond holding, a stock holding, or even a portfolio of investment. It is seen from Figure 1 that additional object classes can be derived from the original object class: One derived object class is called Sector while the other is called Industry.

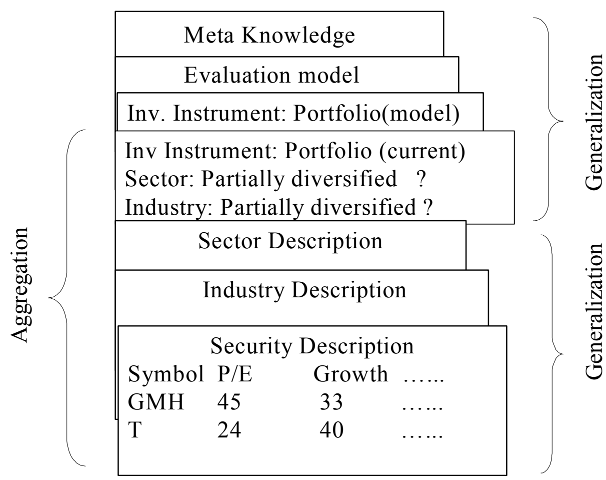

Fig.1: Using an Object Model to Express Aggregation and Generalization.

As a result, inherent relationships in the object model facilitate the expression of a set of knowledge entities and the resulting knowledge representation naturally provides a reasoning bed. With multiple object classes defined, the information describing the attributes of an object instance at one level of a hierarchy can be derived from the instances of these associated object instances at a lower level. This composed information then can be used to characterize the security with an emphasis on the fundamental facts of the security concerns. The implication is that if an individual stock performs consistently as poorly as its industrial index does but inconsistently worse than its sector index, an online investor may interpret the poor performance of that stock as the overall industrial weakness rather than the organizational incompetence. This phenomenon may also indicate that the market situation remains sound and, consequently, a wide spread of investment would render a fair market return.

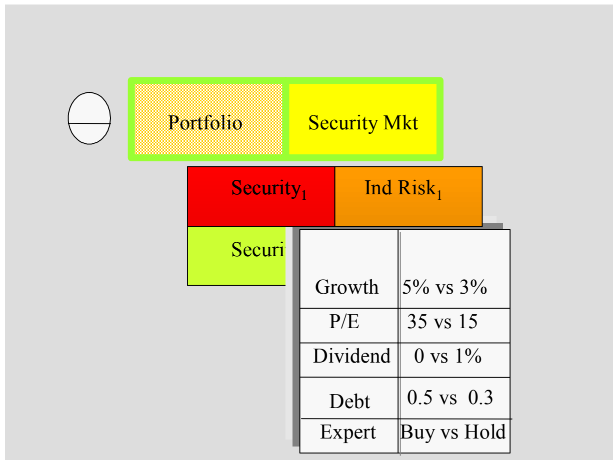

Fig. 2: Graphical Representation of Stock Portfolio in Light of Object Orientation

Figure 2 illustrates that a graphical object-oriented representation of an individual portfolio, when it is displayed on a web page, would be more intuitive to ordinary investors and require less time and knowledge to understand the information represented. If we assume that risk free is indicated with green whereas high risk is expressed in red, we may figure out a color close to yellow to indicate a market risk. An individual portfolio then may be marked in a color somewhere between green and red. Similarly, a preferred model portfolio would also be marked with an appropriate color, determined by the individual risk tolerance and marginal utility and calculated by collecting answers from a few questions of one's financial situation or investment plan. It is seen from Figure 2 that a model portfolio is represented by a transparent rectangle surrounding the actual portfolio and stock market index. Polymorphism plays a role in this graphical representation by showing different colors to indicate inconsistency between the model portfolio and actual portfolio. Abstraction, a unary relationship, could help avoid dealing with unnecessary details whereas projection, another unary relationship, generalizes the knowledge of a security instrument by choosing a subset of attributes of concern. The deviation of an individual risk from the market risk is indicated, for example, with different resolutions. A low resolution of the portfolio entity may send a warning signal about a possible deviation from an average market return due to lack of portfolio diversification. The more the portfolio diversifies, the better resolution an individual investor can achieve. As far as an investment decision's rationality is concerned, an investor can model his or her portfolio by choosing various securities to see if it matches with the model portfolio, as well as the individual risk with the market risk. This simple illustration of representing a stock portfolio with an object-oriented model can be enhanced by incorporating more expressive interface components including zooming, nesting, and multiple views [Perlin99]. The following discussion reveals that such a knowledge representation would also inherently support other reasoning mechanism.

Default Reasoning on Constraints

The next intelligence element, naturally supported by the above-proposed object model, is to apply constraints, which is particularly effective for extracting knowledge from a mass of information. The resulting structure is a constraint object, and constructed together, constraint objects form an implicit reasoning bed at a chosen abstract level. This further facilitates the abstraction of knowledge and thus derives a layered structure of knowledge. The implementation of constraints initiates from defining default constraints [Reiter80]. A default constraint is identified to depict the intrinsic value of a security that should be less volatile because of the arrival of news events concerning the security. To help investors stick with the intrinsic value of a security, default constraints should also be arranged into a hierarchy.

Figure 3 shows, in support of fundamental analysis, that the valuation of a security such as GMH is assessed with a set of constraints, some of which are self-declared exceptions to its parent object that represents a typical valuation in the industry. In particular, DBS (direct broadcast services) is also described by a set of default constraints, some of which are overridden by its child object.

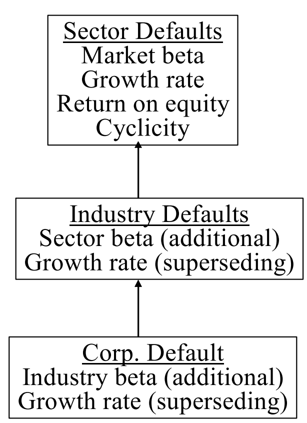

Fig. 3: Defaults at a Lower Layer May either Depict Additional Attributes or Supersede Defaults Adopted from a Higher Layer.

Furthermore, there could be another object above the DBS object, where the grandparent object is created to describe a typical valuation in the sector, e.g., telecommunication. A set of default constraints is defined to typify a default valuation of an enterprise in the sector. Equipped with such a hierarchy of defaults, the web site may be able to remind an individual of the following issues implicitly:

- Is GMH a typical business entity in the telecommunication sector? If yes, the valuation hall is heavily influenced by the top set of default constraints.
- Is GMH a typical business entity in the DBS industry? If yes, the valuation of GMH is entailed using the default constraints at the second layer to supersede the top set of defaults if any conflicts between two sets occur.

Any additional constraints appearing at the third layer would imply that GMH either has additional attributes about its valuation or holds exceptional constraints superseding some constraints at the parent layer. Note that a constraint at a non-bottom layer is always considered a default constraint.

The use of constraint objects in a hierarchical structure makes complex constraints manageable, because a group of constraints may then be possibly organized to constitute a macro concept with a desirable granularity. In fact, a default hierarchy in correspondence with an object hierarchy provides an inference mechanism, namely inheritance [Reiter85]. The hierarchy in this example infers that an industry in a depressed sector should not be marked attractive unless the industry possesses some exceptional qualities. Similarly, a business entity within a depressed industry shall likely deliver the depressing results, unless it has peculiar strength to supersede those defaults attributed by the industry to which it belongs.

Two observations are worth mentioning in regard to the default hierarchy. First, the knowledge represented with a default hierarchy reminds an investor of the valuation of a typical corporation in the sector or industry, but it does not enforce that most corporations in the sector or industry should have to be so evaluated. Instead, the force of the default hierarchy implies that in the absence of any evidence to the contrary, a corporation possesses such a typical valuation. Assisted with a default-reasoning framework, an individual investor may not speculate whether the individual observes contrary facts. If a P/E ratio is displayed in green but the growth rate for the same business entity is displayed in red, that contrast in color should serve as an alert to individual investors. Such assistance should be more effective than finding the facts elsewhere. Secondly, with the default hierarchy, reasoning only proceeds down to a preferred layer by an individual. A mutual fund investor may only need to know which sector or industry holds better potentials. Likewise, an investor who is interested in value stocks may like to dig into one or two layers below a depressed industry or sector to find out some outstanding corporations underneath.

The advantages resulting from the adoption of a hierarchy of constraint objects are primarily as follows. The complexity of the financial market has to be highly abstracted so that an average online investor can perceive fundamentals of a security of his interest. The online performance dictates that a lengthy reasoning process is impractical, and thus a reasoning bed in which logical implications naturally entail shall circumvent needs for explicit reasoning. The intent to achieve the user-friendly knowledge representation demands no maintenance for reasoning process from end-users. Thus, default reasoning fits the scenario nicely. The probabilistic nature of true or false in predicating the financial future mandates the arbitrary reasoning be unsuitable. The constraint-based reasoning, supported with inheritance indicated through a hierarchy of objects, offers a flexible structure in which default reasoning conducts inherently.

Dynamic Indices

Applying multiple indices to compiling temporal behavior is another intelligent mechanism that shall make the framework express the properties of investment flexibly. In order to express the temporal data at various levels of abstraction and projection, a supportive KR framework should offer a variety of chains for individuals to compile historical events and future indications that jointly help individual investors arrive at a comprehension of investment [Ladkin86]. Well-organized indices could associate supporting premises to the conclusive knowledge so that the logic expressed through implicit reasoning could be justified upon request. While a fundamental analysis mainly focuses on the current financial situation of a company, supported by the KR framework presented thus far, the appropriate indices shall extend from the current snapshots of a company to its historical data and thus facilitate the technical analysis. In addition, many distinctive perspectives of a portfolio may be analyzed through multiple chains that help reveal causes and effects. For example, the instant dissemination of available events may make online investors believe what they see are current and that the resulting effect has not yet reflected by the security price. As a matter of fact, quite often, the just arrived information has already excessively impacted the price of a related security. Therefore, it is desirable for an online investor to capably see the events and the price changes in the same time dimension.

A feasible format to express them in terms of the time dimension is the before/after chain since most events naturally fall into a sequence. In consistence with the object-oriented paradigm, events should be chained in parallel with reactions. Furthermore, the before/after chain should be organized to express the fundamentals of the events; i.e., these events should be delivered at an appropriate level of economic entity. In accordance with importance, the various abstractions of time interval and event granularity should also be made available for end-users to navigate efficiently. For example, at a higher-level abstracted chain, there could be a chain of the more significant events during a time interval parallel with the sub-chains of these events that are less significant.

In modeling temporal behavior, the indices should also enable an online investor either to scan many snapshots of a changing object or to summarize data based on a chosen time interval. An index based on time stamp can satisfy the queries concerning the specific moments associated with an event. The former supports a point-based representation while the latter assists an interval-based representation. Both index structures are useful: one can effectively support fundamental analysis whereas the other is often helpful in support of technical analysis.

Exception Handler

This default hierarchy, however, has to incorporate exceptional valuations of a security derived from changing perspectives. Consequently, the hierarchy may extend from the default valuation of a security that is estimated, for example, by its S&P 500 beta value along with the S&P 500 return and risk-free return. The branched layers of the hierarchy may display exceptional valuations [Beck99]. While the methods of expanding a default hierarchy may vary, depending on the degree of supervision of learning, this paper just examines how to represent exceptions when they have come into existence. As shown in Figure 4, the default hierarchy may extend another branch at the Sector layer to adapt the Sector defaults. An example in hand is an exceptional valuation for the Sector entity in the event of a significant increase of interest rate.

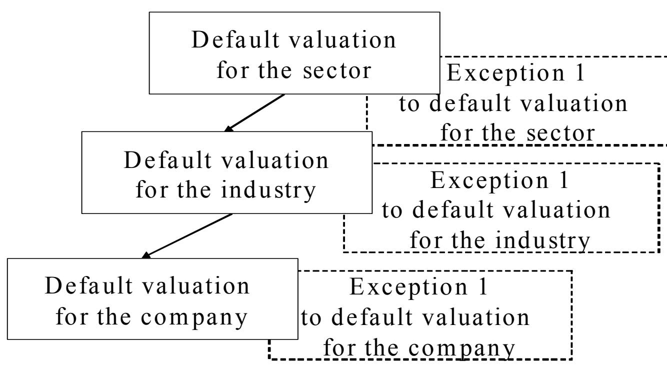

Fig. 4: A Default Hierarchy Can Have Exceptions at Each Layer,
and Defaults at Each Child Layer Are Considered Exceptional to Defaults at Their Parent Layer.

When exceptions arise, properly incorporating their existence in the KR framework would enhance the knowledge base that initially consists of defaults but, theoretically speaking, incomplete. One way to exhibit exceptions is to display them in a pull-down list in which the default is at the top while the exceptions are listed in order of confidence. In this format, constraints are applied in terms of priorities determined in accordance with confidence. However, the exceptions that violate a joint consistency should warrant a special indication. For example, a strong buy recommendation of a stock in an industry that is known to be avoided should be informed along with an alert if neither the growth rate nor earnings of the underlying business is positively exceptional. The theory exercised here again is called the constrained default logic but the constraints in this example come from siblings rather than from parents. In the absence of direct evidence to confirm or to suppress the exception, the KR framework should reflect the inconsistency without correcting it based upon inadequate information. Such an alert signal may be delivered by showing inconsistent colors among sibling attributes of the stock. The exceptions that violate joint constraints shall consequently be cautiously promoted and shall probably rarely replace defaults. In support of multiple levels of confidence, exceptions could be organized into subclasses within a list of values; those satisfy joint constraints may be separated from the others that do not. As more attributes take exceptional values in a consistent manner, non-monotonic reasoning should allow an exceptional valuation of the stock to replace a typical valuation that is originally adopted as default.

4 CONCLUSION

The intelligent mechanism, proposed in this research to facilitate online customers in a dramatically different approach, has addressed the challenges unique to e-commerce by improving the knowledge representation of online investing as a typical e-business environment. In response to peculiar characteristics of online investing, the paper has demonstrated how heuristic intelligence can be developed in a robust knowledge representation framework. Departing from the traditional approaches, such an intelligent e-commerce environment enforces no rules but merely guidance to online customers, which should best suit the present e-commerce environment.

In anticipating significant improvement on facilitating online investors, the described intelligent mechanism is bound to have limitations. Primarily, the resulting knowledge representation framework may be unable to respond to certain specific events quickly enough. While the model can be effective in preventing online investors from making common mistakes, it could also be cumbersome when the financial market is turbulent. However, this framework, which can be applied flexibly, should benefit certain segments of online investors who are naive and participating for a long-term capital appreciation. In addition, online investing is a representative example of e-commerce and hence the framework of intelligent mechanism proposed here can readily benefit other sectors of e-commerce.

REFERENCES

[Beck99] Beck, T.J., & Bommel, M.R. (1999). "Incremental encoding of multiple inheritance hierarchies". *Proceedings of the eighth international conference on Information knowledge management* (November 2 – 6), 1999, pp. 507-513. Kansas City, MO.

[Benet02] Benetti, H., Beneventano, D., Bergamaschi, S., Guerra, F., & Vincini, M. (2002). "An information integration framework for e-commerce". *IEEE Intelligent Systems* (Jan/Feb 2002).

[Jedets02] Jedetski, J., Adelman, L. & Yeo, C. (2002). "How Web site decision technology affects consumers". *IEEE Internet Computing* (April 2002), pp. 72 - 79.

[Ladkin86] Ladkin, P. (1986). "Time Representation: A taxonomy of interval relations". *Proc. AAA' 86* (pp. 360-366). Los Altos, CA: Morgan Kaufmann.

[Minsky75] Minsky, M. (1975). "A framework for representing knowledge". In P.H. Winston (Ed.), *The Psychology of Computer Vision* (pp. 211-217). New York: McGraw-Hill.

[Perlin99] Perlin, K. & Meyer, J. (1999). "Nested user interface components". *Proceedings of the 12th Annual ACM Symposium on User interface Software and Technology* (pp. 11-18).

[Reiter80] Reiter, R. (1980). "A logic for default reasoning". *Artificial Intelligence, Vol. 3* (pp. 81-132).

[Reiter85] Reiter, R.(1985). "On Reasoning By Default". In R. J. Brachman and H. J. Levesque (Eds.), *Readings in knowledge representation*. Los Altos, CA: Morgan Kaufmann.

[Wang02] Wang, H., Mylopoulos, J., & Liao, S. (2002). „Intelligent agents and financial risk monitoring systems". *Communications of the ACM,* (March 2002), pp. 83 - 88.

[Willia02] Williams, J. (2002). "Practical issues in knowledge management". *IEEE IT Pro* (Jan/Feb 2002), pp. 35 -39.

About the authors

Myron Sheu is Assistant Professor of Computer Information Systems at California State University, Dominguez Hills. Previously, he was systems and applications architect at Boeing Space & Communications and Hughes Electronics where he played a key role in promoting enterprise information systems integration. His research interests include artificial intelligence, object orientation, and e-business. He received his Ph.D. in computer science from Old Dominion University. He can be reached at msheu@csudh.edu.

Xin (James) He is Associate Professor at Dolan School of Business, Fairfield University, USA. His current research interests include supply chain management, ERP implementation, total quality management, and the integration between information systems and operations management. He received his Ph.D. from the Smeal College of Business Administration, Pennsylvania State University. He can be reached at xhe@mail.fairfield.edu.