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An Intelligent Trade Matching System for B2B Marketplace

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Abstract: With the fast growth of B2B sales, an intelligent system is greatly useful for decreasing transaction cost and increasing market efficiency on electronic platforms. In order to improve the quality of transaction processing and customer experience, this paper proposes a knowledge-based system, which employs a Case-Based Reasoning (CBR) technique for trade matching in B2B marketplace as a substitute for the manual matching process. The system function and logical architecture are discussed. And the case repository is proposed to support this CBR approach where the case representation, case base indexing, case base decomposition and the dictionary are argued in details.

Keywords: B2B, trade matching, CBR, intelligent system

1. BACKGROUND

There is strong evidence of B2B booming, which as the representative for virtual economy is driving businesses to move over the Internet. According to the “statistical abstract of the United States”, in 2008, the worldwide sales of B2B exceeded \$6.5 trillion. Another report^[1] shows that the total volume of all Chinese business activities on the Web in 2010 is about \$730 billion, while the B2B volume is about \$610 billion with more than 9 thousand B2B marketplaces to support transactions.

However, compared to their flourish cover, those B2B independent industry marketplaces are facing big challenges. In fact, most marketplaces are still information-aggregating (or information issuing) platforms till now. On those platforms, a member must manually search the whole database for business partners that meet the product requirements. With the number of member growth, it will take a very long time to find the proper counterpart even if the product is perfectly standard. At the same time, the member still takes a risk for omitting important data, for he cannot read the long candidate list carefully enough to pick out the right one. In this process, the transaction cost is tremendously high though the original intention of disintermediation is to reduce cost. A trend has been observed: some marketplaces, such as dhgate.com, begin to apply fee-for-transaction revenue model instead of traditional subscription revenue model. Thus, in order to make profit, the marketplaces have to get business concluded as more as possible because they cannot live on charging annual membership fee any more. Therefore, they are in great demand for developing the intelligent trade matching system to assist automated transactions.

2. INTRODUCTION

In the literatures, we can find plenty of studies on the trade matching system. Most of those studies are built for stock exchange market^[2], i.e. NASDAQ^[3], whose matching is based mainly on price. The second cluster of the studies is aiming to the business mode of auction where multiple attributes for trade are considered^[4,5,6,7]. Researchers use commercial software such as CPLEX and MATLAB to solve the problem. The majority of these studies is linear programming and has a specific objective function (e.g., profit maximization). The solution always depends on exact computation.

In the recent years, some commercial trade matching systems (e.g., Agro and Xiaoma) have emerged.

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These systems take a different matching approach from those used in stock exchange or auction. They use Rule-Based Reasoning (RBR) technology to assist the users of the B2B platform to filter the matching objects with heuristic algorithm so that the intelligent transaction recommendation can be realized. This kind of system has been used in spot transactions especially for bulk commodity market.

However, the match mechanism in the upper two sectors both is small-scale usages. It is hard to employ them to data-intensive area. So we choose CBR as the paradigm which has been successful in bond rating^[8], customer classifying^[9] and logistic service provider selecting. CBR has its advantages as Shank^[10] and Kolodner^[11] have mentioned: it allows the reasoner to propose solutions to a problem quickly; it allows the reasoner to propose solutions in domains that are not completely understood by the reasoner; cases are useful in interpreting open-ended and ill-defined concepts, and it is useful for knowledge re-use.

This study proposes a new system for trade matching in B2B marketplace with CBR. In section 3, we introduce the system with its function and logical architecture. Section 4 presents the detailed case base construction including case representation, case base indexing, case base decomposition and the dictionary. Section 5 concludes the paper and envisions important avenues for future research.

3. OVERVIEW OF THE CBR-BASED SYSTEM FOR TRADE MATCHING

3.1 System functions

The system works in two modes. One mode is the manual trade matching. It is the traditional way that the user selects partners in a B2B marketplace. Often, it needs the user to follow a decision tree to decrease the searching space step by step. But usually, the user has to face hundreds of candidates in his final choice. Because there are too many similar firms that meet the basic requirements like industry, sub-industry, domain function, price, etc. The user must read the detailed information of each candidate from the first to the end of the list. The worst situation is the proper one is at the last position. Further, if the user is not satisfied with the result, he has to restart the search again and again, which may take tens of minutes in a TB-scale database.

The other mode is the intelligent trade matching. After inputting product information with the requirements of price, quantity, quality, size, delivery date, etc., the user gets a short list of candidates. Lucky for him, the candidates on the list are filtered first, and then sorted in order of similarity degree of relevance, importance, and precedence. Thus, the user can easily select the best one from top lists (or any one he likes, but often the upper, the better). It sharply reduces the searching time for the user. If the user assigns other information or rules such as location and industry, the list can be condensed more. Any way, the system for him is a black box. What he feels is “automatic”.

3.2 System architecture

As shown in Figure 1, the proposed system includes three primary levels: the data source, the engine, and the graphical user interface.

The data source consists of case base, dictionary and database. The database keeps all the basic information mainly including customer, product and transaction records. Most intermediaries keep only the customer and product information. But we must assume transaction information is stored

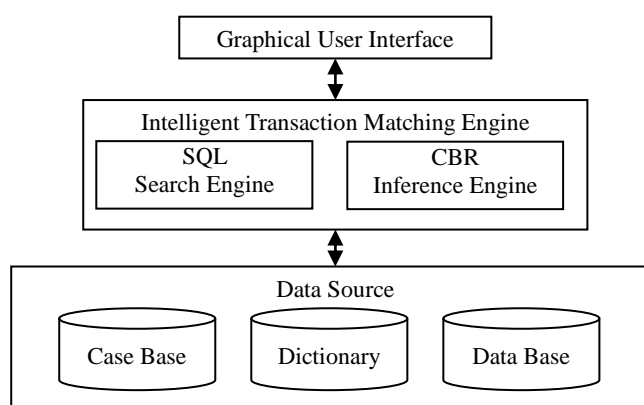


Figure 1. System architecture

step by step with more and more fee-for-transaction business popular. The case base is extracted from the database. Based on it, the calculation of similarity between the incoming transaction and the old ones is executed. The case base cannot be used by the trader directly. The dictionary is a pre-defined data source that provides industry standard terms for both the case base and the database. The detailed description of the case base and dictionary is illustrated in section 4.

The engine consists of a SQL search engine and a CBR inference engine. The SQL search engine works for traditional trade matching. It mainly depends on the relational database management technology. The CBR inference engine helps automatically match the trade for transaction partners with a dynamic genetic algorithm used. The recommended partners are optimized though the final decision is still taken by the user. In the marketplace-owner's view, the system provides a mechanism that the matching rules, algorithm parameter, selected case features and period of weighting can be modified. The CBR inference engine will be discussed in another paper considering its special and complicated processing strategy.

The graphical user interface helps the trader access customer data. It receives trader's requirements, asks them for specific information, accepts the answers, presents the detailed product description, and shows the results.

4. CASE BASE CONSTRUCTION

4.1 Case representation

A number of approaches, including predicate logic, frame, script, and semantic-net, can be used to case representation^[12]. We use frame to represent the transaction case. There exist two reasons for choosing frame. First, for frame, knowledge is represents by slots, each of which has some facets or properties where other attributes are attached^[13]. Second, our case base is extracted from the database, so we cannot implement a much complicated representation.

The frame, as a data structure, is like the object-oriented paradigm. We give two frames as the demonstration. One is TRANSACTION; the other is CUSTOMER. Here are the BNF style representations.

```

Frame<TRANSACTION>
  <transaction_id>::=string
  <buyer>::=<customer>
  <seller>::=<customer>
  <product>::=<products list items>// different product should be decomposed into different cases.
  <price>::=number
  <quantity>::=number // in different unit of measure
  <quality>::=<quality grade items> // different scales with different products
  <place_of_origin>::=<nationality> | <location>
  <date-and-time>::=time stamp
  <size>::=number
  <lot_size>::=number
  <delivery>::=<delivery list items>
  <shipping>::=<shipping list items>
  <special_requirements>::= string // description that hard to formalized
  .....
Frame<CUSTOMER>
  <customer_id>::= string

```

```

<customer_name>::= string
<credit_level>::= number // it is a dynamic level based on its transaction history record
<location>::= string
<transaction_account>::= number
<boss>::= string
<products>::=< <products list items>
<min_order_size>::=number
<industry>::=< <industry list items> // use National Industry Classification System(GB/T4754-2002)
<standards>::=< <standard list items> // including ISO, HACCP, ASTM, DIN, etc., industry related
<certificates>::=< <certificate list items> // including TUV, RoHS, QS, EMC, CSA, CQA, PSE, etc. ,
industry related
<business_type>::=<manufacturer>|<OEM>|<ODM>|<design service>|<trading>|<buyer label>
|<agent>|<distributor/wholesaler>|<association>|<other>
.....

```

4.2 Case base indexing

Index is needed to classify and store the cases through feature combination. We apply an industry-oriented indexing policy depending on the characteristic of the transaction on a B2B platform where different kinds of industry adopts different standards, uses different unit of measure with various specifications, and has different quality grade classification.

There are four levels in the National Industry Classification System: 20 categories, 95 second-level classes, 396 third-level classes and 913 fourth-level classes. However, because there are so many companies that attracted into the marketplace, the platform still returns a very large amount of candidates. For example, 85918 products are found at Alibaba.com when we focus on the steel wire. So, the standard and business-type should be considered as part of the index. The standard is either industry-related or industry-independent. The business-type is industry-independent. The indexed hierarchy of the case base is shown in Figure 2.

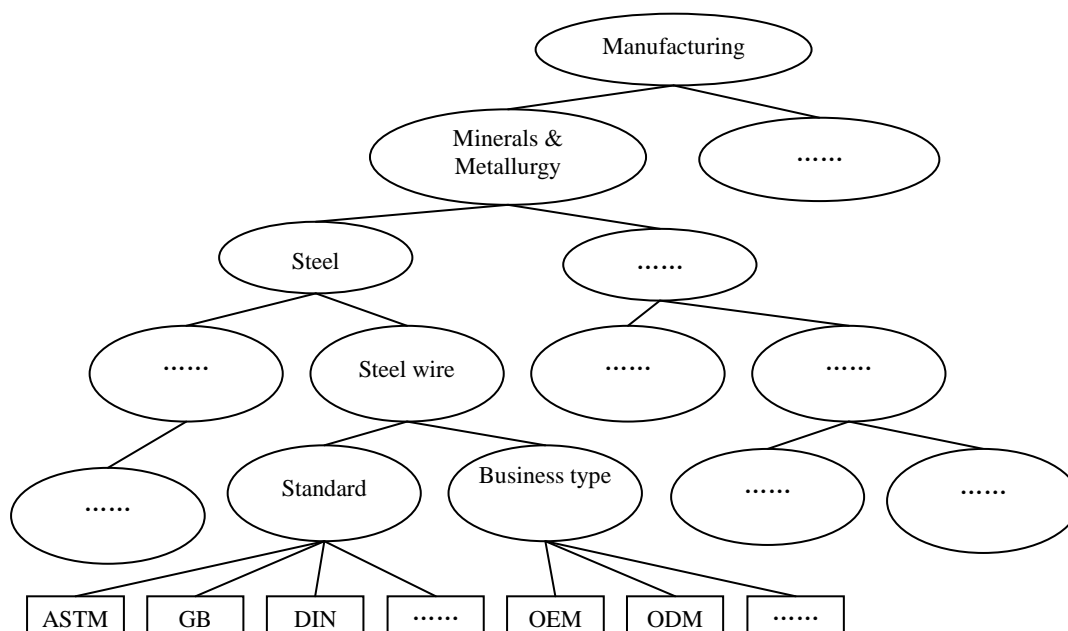


Figure 2. Indexed hierarchy of the case base

4.3 Case base decomposition

The knowledge in the case base is so complicated that we have to divide it into several sub-case-bases. It

can be seen in Figure 3. Logically, those sub-case-bases are in two layers. The general history case base is an abstract case base who reflects the entire knowledge of all the cases. But the detailed knowledge is distributed into three partial sub-case-bases for transaction, customer and the context each. They are concrete case bases.

Associated with the history case base, there exists a temporary case base whose function is to facilitate the calculation of similarity. It has two relevant sub-case-bases who act as the half-finished suggestion for the trade candidates and the final To-Be suggestion with all the filters activated, respectively.

4.4 Dictionary

We give the E-R (entity-relationship) conceptual model of the dictionary in Figure. 4. The main content of the dictionary is the lexicon of elements for transaction, which, referencing National Industry Classification System, all kinds of standards, all sorts of formal business terms. The dictionary item has is-a relationship with its synonymous terms and abbreviations. The synonym with the weight assigned by experts is critical for similarity calculation when there do exist different denotations for the same thing.

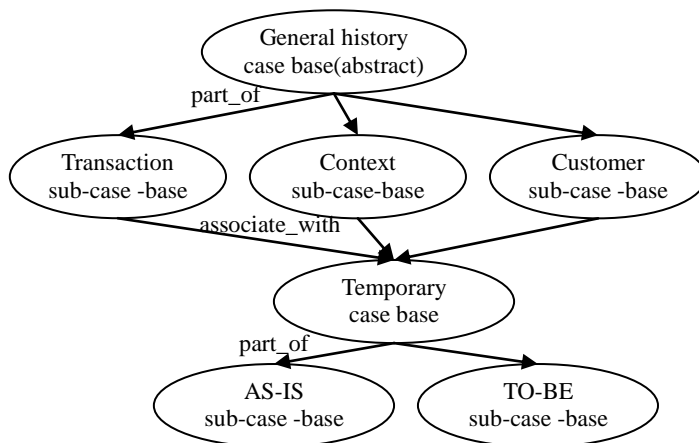


Figure 3. Case base decomposition

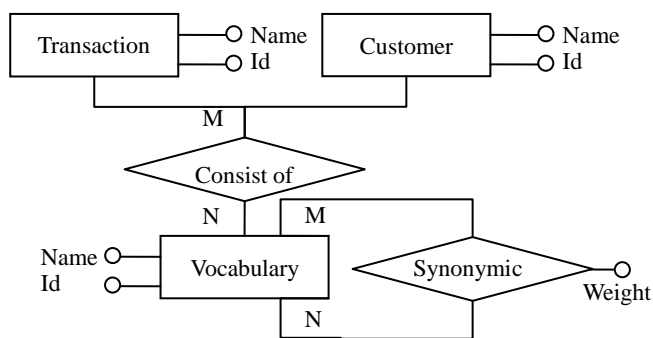


Figure 4. A schema for the dictionary

5. CONCLUSIONS

This research makes an instructive exploration to use the knowledge-based approach where CBR has not been applied to B2B trade matching before. The architecture is useful for not only helping traders find the proper partners, but also automating the transaction process for the platform owner. But we have many hard nuts to crack beyond the prototype system. In the future, as part of this project, fast feature extraction in mass data environment and avoiding overfitting in GA will lead to other deep-going research. And industry ontology may be embedded in the dictionary as another research.

ACKNOWLEDGEMENT

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