

# A Distributed OA Expert System Model Based on Fuzzy Rules

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**Abstract:** By the analysis of CORBA technology, distributed technology, multi-agent, fuzzy cluster, OA system, expert system and decision support technology, a distributed OA expert system model based on fuzzy rules (DOAES) is proposed. In DOAES, the knowledge and experience of decision-makers are processed and transferred into the knowledge base. So the system has the adaptive ability and re-study function and the decision results are more scientific and more objective. The DOAES is successfully applied in the management system of invest promotion.

**Key words:** CORBA, fuzzy rule, OA system, multi-agent

Those days, combining with other technologies, such as computer network, artificial intelligence, agent and distributed technology, many new-type database technologies have been formed, including real-time database, memory database, distributed database, active database, etc<sup>[1]</sup>. The active database system (ADBS), which indicates that database system has the functions of actively responding the events and executing the relevant services, is widely applied in decision-making systems<sup>[2]</sup>.

In data mining, knowledge is discovered, expressed and processed. So an expert database system (EDS) is formed. EDS can be achieved by using either tight-coupling approach or loose-coupling approach. Because the ADBS is still in immature state now, the loose-coupling, which means the ES and DBMS manage rules-base and database separately as independently systems, is more applicative. Both ES and DBMS communicate and transfer each other and compose the EDS<sup>[2,3]</sup>.

The intelligent decision support system (IDSS) is formed by the combination of decision-making, artificial intelligence and database technologies<sup>[1]</sup>. Different from traditional DSS, IDSS introduces many other technologies, such as complex data objects, knowledge discovery, intelligent process, multi-agent and so on<sup>[4,5]</sup>. By man-machine conversation technology, the knowledge and experience of decision-maker are processed and transferred into the knowledge base<sup>[6,7]</sup>. So the system has the adaptive ability and re-study function, and the decision results are more scientific and more objective.

In this paper, by the efficient combination of CORBA, data mining, active characteristics, distribution technology, expert system, multi-agent and OA system, a distributed OA expert system model based on

fuzzy rules (DOAES) is proposed and applied in invest promotion management system.

## 1 Activity Mechanism of DBMS

The activity mechanism of DBMS means that DBMS can monitor and control the states and events of the system. When a special condition is met or an event occurs, the system will take corresponding actions automatically. This replaces the passive respond model, in which circle judgements are used. It also frees the system resource and improves the operating efficiency of other applications (such as simulation, expert judgement, optimization algorithm). The system is easy to be modularized and layered, and has the update ability. Triggers achieve the activity mechanism. The rule of event/condition/action is often used and denoted as E-C-A rule.

### 1.1 Value-driven model and event-driven model

Event-driven model is the advanced stage of value-driven model. Value-driven model is prompt and direct, but event-driven model is often indirect, uncertain and time-delay. So the event-driven model can't completely replace the value-driven model. The event-driven model has the following special characteristics:

- The fuzzy definitions of events.
- Weak correlation. Because the future state in RTS is unknown (or partly known) and useful information is lacking, it's difficult to take sequence analysis and trend analysis.
- Incompleteness of data. Integrality is very important for event judgements. Because of the lack of entire data, the event may occur or not occur in the same conditions.

So an advanced feedback model, in which

value-driven model combined with event-driven model, is introduced in E-C-A rule. The structure of this model is shown in Fig.1. The correct judgements may be made even if the data are incomplete. In addition, the agent technology is introduced in condition-action process so that the rules become intelligent and the operation errors are reduced.

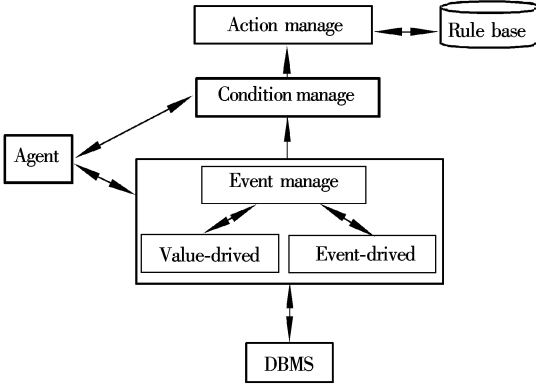


Fig. 1 E-C-A rule flow chart

## 1.2 The definition and management of triggers

The activity degree and relevance between models are mainly considered in trigger definition. Trigger should be simple and prompt. The dead-circle, in which one trigger springs another trigger and finally become circle-trigger, must be avoided. The trigger management refers to the active/stop/cancel policy. A better management model can effectively reduce invalid triggers and repeat triggers, and improve system-operating ability.

The operating of triggers may be classified into two modes according to the responded time:

- Prompt trigger mode. When an event occurs, the corresponding actions are processed immediately.

- Delay trigger mode. When an event occurs, trigger delays unless conditions of the event completely meet. This is used in key operations.

There are also two trigger modes according to the event aggregation:

- And operating mode. When all of the events occur, the corresponding actions are processed.

- Or operating mode. When one or some of the events occur, the corresponding actions are processed.

## 2 CORBA-Based Distributed Objects

The common object request broke architecture (CORBA) provides services, which include event service, naming service, transaction service, security service, etc. It provides an event channel for distributed objects to make asynchronous communications. The supplier-consumer model is used and intercommunication between applications is prompt and vigorous.

Compared with other design methods of distributed objects, CORBA technology is more efficient and more stable. It's also more suitable for different OS platforms and more easily combining with java applications.

The common objects defined in invest promotion management system include pro-invest object, declare object, invest object, attack document object, etc. Each object is consisted by a series of attributions and sub-objects and an object can dynamically transfer to another when the conditions are suitable. The transferring process is the integration of polymorphism and inhericy. The CORBA-based OA system architecture is shown in Fig.2.

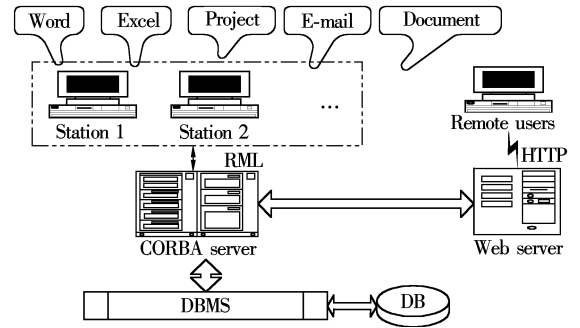


Fig. 2 The CORBA based OA system architecture chart

## 3 Distributed OA System

The OA system is a new technology and is widely applied in information management of governments and enterprises. In invest promotion management system, the OA system includes modules of information collecting and data transferring (invert to database), project examining and approving, document automatically creating and approving, document managing, e-mail processing and so on. The users in different places can communicate each other by distributed OA applications. The distributed application module has the following functions:

- Distributed invest review and project application.

- Integrating with OS system. In client applications, the document management, statistical reports and projects schedule are achieved by dynamic executing other applications, such as MS Word, MS Excel and MS Project (using dispatch interface).

## 4 Fuzzy Cluster Analysis with Data Mining Technology

In expert system, data mining is important and complex. Now there are many tools for knowledge discover in database. The different methods are used in different applications. In this paper, a fuzzy mining

approach is introduced to discover fuzzy rules. Mode identification, data analysis and other technology are used in model to discover rule-type knowledge and the uncertain of data is well resolved. The prediction model and classification model are also formed.

Cluster analysis technology is a good method to appraise the value subjection relations among the objects in database. The relative rules in data are discovered by using minimum support and minimum conference. Rules, including user-defined rules and discovered rules, are all dynamically saved in database. When a query occurs, the relevant rules are checked out and transferred to structure query language, and corresponding data are showed in user mode. For instance, the maximum invest-rate continent can be listed by the cluster analysis on investor countries and invest amount. The cluster analysis structure is shown in Fig.3.

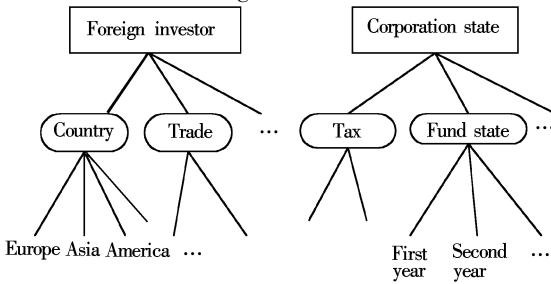


Fig.3 Fuzzy cluster chart

The fuzzy-cluster analysis refers to uncertain expressions and classified statistics among attributions of objects. The relations between manage scopes and industries are complex many-to-many relations and the calculation of industries from manage scope is a self-leaning process of cluster/fuzzy quantitative analysis/study(including interaction)/fuzzy classification. New knowledge is also discovered in self-leaning process.

- Step 1** Choose an attribution value.
- Step 2** Fuzzy decomposition of semantic data. The data are decomposed according to the frequency of existed data. Such as the “car manufacture” decomposed to “car” and “manufacture”.
- Step 3** Type-base searching by key words. If relevant item can be found in type base, next step will be taken. Otherwise step 2 is repeated for expand decomposition. For a single word, a new cluster type is defined by man-machine interface and is inserted to knowledge base.
- Step 4** General judgement on results from multi-keyword. The industry value can be obtained by frequency and subjection value.
- Step 5** Knowledge saving (data, relations, frequency value, fuzzy rules).

## 5 Distribute Multi-Agents Cooperative Work Model

Agent is a new branch of artificial intelligence applied in distributed calculation. It has the abilities of independence, adaptability, continuity, cognition and activity. Agent mechanism can autonomously adapt to the environment changing and can search for the different objects. It also has the active-spring function and takes different actions (or policies) in different events (or queries). So agent mechanism is necessary in DAOAEDS.

Multi-agent has three types of modes coupled to the system model:

- Fuse mode (tight-coupling mode). Agent is fusing with system model and forms the intelligent system (as calculation intelligence). This mode is used in where knowledge expressing, data consistence and integrality are perfect, such as the object states and communication process in CORBA applications.
  - Coordinate mode (loose-coupling mode). Agent is outside of model and communicates with it through well-defined interface. Agent provides intelligent support so that the OA system has the self-study ability and independent function. For instance in OA system, the documents are received, processed and sent automatically.
  - Sequence mode. Agent is a step of system calculation and makes intelligent judgement on middle-result of model. If the result meets the rules, the next calculation will be taken. Otherwise, the last calculation will be repeated until the result meets rules or users abort the process.
- ## 6 Multi-Technologies Integration System
- The system integration technology becomes more and more important now and loose-coupling mode is widely used. The combination of distribution technology, ES and IDSS technologies form the distributed OA expert system (DOAES). This provides scientific decision support. Every sub-system keeps self-function and communicates with each other by well-defined interface. A communication system can understand the interior functions of the other sub-system's and can make remote access. We should pay a special attention on the following items:
- Universality of interface. Every module can communicate with each other by methods such as share physic resource, dynamic data exchange and network transfer.
  - Dual-direction's communication function. The client/server mode is used.
  - The communication module can response to the

queries (operations) or active asks for the services of other sub-system.

- Concurrent control. In multi-course, the operation (course) with higher priority operates first.
- Real-time monitor function. The system states are monitored so that the system is active and realtime. Data are keeping consistently and integrally.

7 Application

The DOAES model is applied in invest promotion management system. It includes modules of invest review recepting, projects tracking, key project pushing, data automatic inputting (from excel, word, project to database), projects examining and approving, document automatically reversing,document managing, statistical report generating and integrate appraising.

The integration structure of DOAES is shown in Fig.4.

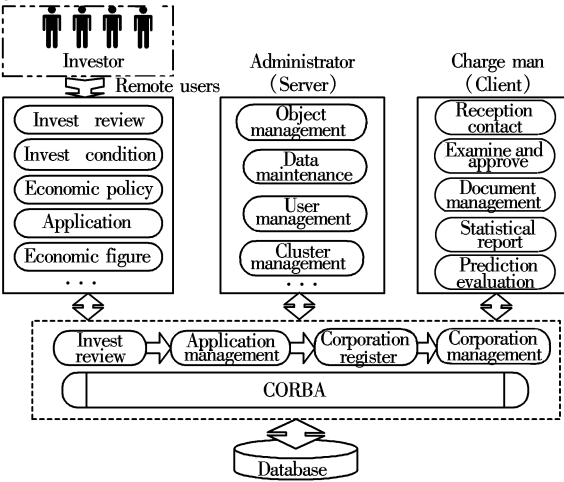


Fig.4 The integration structure of DOAES

8 Conclusion

By integrating with other technologies, the OA system becomes more automatic and more intellectual. The introduction of CORBA technology enhances system’s distributed characteristics. Now the system integration technology is improving promptly and the CORBA, ES, OA, and multi-agents technology are also improved. Integration of DBMS with OA, ES, IDSS is a trend in system science and this will be applied in many fields in the future.

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一种基于模糊规则的分布式 OA 专家系统模型

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摘 要 通过对 CORBA、分布式、多 agent、模糊聚类、OA 系统、专家系统以及决策支持等技术的分析,提出了一种基于模糊规则的分布式 OA 专家系统模型(DOAES).在该模型中,决策者的知识和经验经处理转化到知识库中,从而使系统具有自适应和自学习能力.DOAES 模型成功地应用在招商引资管理系统中.

关键词 CORBA,OA 系统,模糊规则, multi-agent

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