Mobile Agent Development for Crop Production using PLE (Product Line Engineering)

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Abstract. In this paper, we will employ a multi-agent for the crop production in a distributed environment. We will use an Integrator Agent in the proposed model on the component integration. The MIRA-CP (Mobile Information Retrieval Agent for Crop Production) will address the inadequacy of other data mining tools in processing performance and efficiency when used for knowledge discovery. The Integrator Agent was developed based on CORBA architecture for search and extraction of data from heterogeneous servers in the distributed environment. Our experiment shows that the MIRA generated essential association rules which can be practically explained for decision making purposes.

Keyword Mobile Agent, Component integration, Crop Production Information Retrieval, Crop Production Knowledge Discovering, Data Mining

1 Introduction

In this paper, we study the problem of providing effective information management in support of crop production management when a diverse range of computing devices is employed. The novelty of our approach is based on combining innovative interactive devices with a framework based on agent roles in order to support the effective flow of community-related content for the people of a given locality [1]. In particular, we have integrated existing techniques for information retrieval and filtering for crop production with measures of content popularity, to ensure that documents in the community system are optimally available. After reporting on the potential presence of the system in the community, we report on the development of a framework for multi-agent systems in which agents provide a number of services aimed at facilitating personalized and location-dependent information access to members of the community. We also present a summary of the results of an expert evaluation of the information flow resulting from the communication between agents, and a user-evaluation of the information dissemination facilities provided by the system. Most of the time these are limitations that defeat typical and popular mining approach. This study investigates the formulation of the cluster analysis technique as
integrated component of the proposed model on MIRA-CP in order to partition the original data prior to implementation of other data mining tools. The model that we proposed uses the hierarchical nearest neighbor clustering method and apriority algorithm for knowledge discovery purposes to be implemented on business or transactional databases. In addition, we will develop a multi-agents based on CORBA architecture for data search and extraction in the distributed environment. Two agents such as the user interface agent and the facilitator agent will be developed for interface, search, extraction, integration and management.

2 Mobile Software Agent

There are some advantages of using mobile agent environments [2,3]:

- **Efficiency:** Mobile agents consume fewer network resources since they move the computation to the data rather than the data to the computation.
- **Reduction of network traffic:** Most communication protocols involve several interactions, especially when security measures are enabled. This causes a lot of network traffic. With mobile agents one can package up a conversation and ship it to a destination host where the interactions can take place locally.
- **Asynchronous autonomous interaction:** Tasks can be encoded into mobile agents and then dispatched. The mobile agent can operate asynchronously and independent of the sending program. An example of this would be a mobile device dispatching an autonomous search agent onto the fixed network, disconnecting, then reconnecting some time later to collect the results of the search.
- **Dynamic adaptation:** Related to the above topic, mobile agents have the ability to autonomously react to changes in their environment. However such changes must be transferred to mobile agents from the mobile agent environment.
- **Dealing with vast volumes of data:** When vast volumes of data are stored at remote locations, for example in weather information systems, the processing of this data should be performed locally to the data, instead of transmitting it over a network. Inspiring from this fact, in this thesis, instead of migrating the whole HTML text of a web page, just the meta data which is produced by the local agents is sent to the server agents.

3 Mobile Information Retrieval Agent for Crop Production

3.1 System Description

The server, called *mobile agents server*, hosts *wrapper portal* and a *knowledgebase*
(see figure 1). **Wrapper portal** is a mobile-based catalog that allows users to select and execute wrappers. Users who subscribe to the MIRA-CP service connect to wrapper portal and request wrapper or application to be executed on the client computer. In response to that request a package containing functionality necessary to perform data extraction for a particular Web source is constructed and shipped to the client computer. It will then be executed there and extract data for the user. Aside from listing and packaging wrappers, portal authenticates users, allows them to change and save their preferences, and save and retrieves previously created **queries** (references to wrappers together with wrapper parameters).

**Knowledgebase** used in MIRA server system contains information about available wrappers, their parameters and status. It may also contain information required by the wrapper portal. For example, it could store user account information, such as access privileges and preferences. Names and execution parameters of wrappers that users have run so far can also be stored in this database. Using this information, wrappers can be executed with the same parameters on a regular basis without users having to specify parameter information every time. Finally, lightweight applications that use wrapper output or act as intermediaries between wrapper and applications on client computers can be stored in the knowledgebase, together with necessary composition and parameter information.

![Fig. 1. MIRA-CP Composition, Delivery and Execution](image)

Architecture of agents generated and packaged by mobile agents server is based on the architecture of Data Extractor system. The internal structure of a Mobile Information Retrieval Agent is shown in figure 3. It consists of the following components:

- **Mobile wrapper controller.** Wrapper controller is responsible for controlling the behavior of wrappers, passing parameters to them and directing the flow of data from them. In this sense it is very similar to wrapper controller used in Data Extractor system, but, perhaps, optimized for shipment to client computer and execution there.

- **Wrappers.** The same wrappers are used in the Data Extractor and MDRA implementations. They will be created and stored on the server and managed
centrally for all users of MDRA service. This significantly simplifies service maintenance, ensures correct operation and makes timely updates available to all users of the system.

- **Data Extraction Library.** Data Extraction Library contains functionality that is essential for performing data extraction and networking operations and has to be shipped with every MDRA. Our implementation of it is very compact and will be transmitted to the client computer quickly even on slow links.

### 3.2 MIRA-CP Modeling

In this paper, the researchers developed the proposed architecture for the data mining system which we named MIRA model as shown in Figure 2 and will be presented in refined view in the subsequent sections.

![Figure 2. The Proposed MIRA-CP Model in a Distributed Environment](image)

Figure 3 shows the implementation of the cluster analysis using the hierarchical nearest neighbor clustering algorithm and the implementation of association rule discovery method. It also shows the refined view of Phase 3. The successions of transforms for association rule algorithm which are represented by bubbles are shown in the shaded rectangle. Multi-agent will be used for data search and extraction in a distributed environment. We proposed a Facilitator Agent (FA) to attempt to integrate some of the information that can assist users in locating information they need either within their local information systems or on the Web. We have designed the functionality of agents using roles, and for the purpose of information management we have identified different roles according to whether an agent acts on behalf of a person, a location or the institutions that may be managing the communal memory generated by and stored in the system. We have relied upon agent communication to
support dissemination of the most popular information to people or locations and innovative human–computer interaction mechanisms to visualise this information in the community's environment. The resulting multi-agent system has been developed on a sophisticated software platform that supported agent communication and interaction based on well-defined agent development standards.

Building and testing the system in a real community has given us the opportunity to experiment with some of our ideas, and validate some of our original intuitions about the usefulness of agents in community settings.

- **Agent-based interaction design**—is concerned with the lack of a generic framework for designing interactions between agents and between agents and users of the community-based system. Although in the human–computer interaction literature the concept of interaction design attracts more and more attention, the relationship between this new field and the design of agent functionality is not yet well established.

- **Community interaction models**—the modelling of interactions in connected communities begs for a systematic way of modelling the network of links resulting from the social activities of people at different places of a local community. An interaction model is needed here to act as a high-level specification for the computational and infrastructure requirements of the connected community system.

- **Verifiable agent-behaviour**—we are also concerned with the possibility that connected communities will move control and privacy away from people's hands to autonomous software agents. The frameworks that allow a user to verify that the behaviour of an agent indeed complies with the intended functionality the agent was given at design time.

![Diagram of MIRA architecture](image)

**Fig. 3.** Detailed view of the MIRA architecture
4 Conclusion

We have presented the implementation of query enhancement in MIRA based on the user’s interaction with a concept hierarchy. Preliminary experiments have shown that the system significantly improves the effectiveness of the search query. Our future work will involve a formal evaluation of the system. The evaluation method will be modeled after the extended example that was described above. We expect to see two types of improvement in the search results using the enhanced query.

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