Enabling Technologies for CRM Solutions

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(Manuscript received December 12, 2003)

This paper describes research and development activities for enabling technologies for Customer Relationship Management (CRM) solutions. CRM is a set of business practices for an enterprise to establish, maintain, and improve good relationships with its customers. Fujitsu provides a variety of solutions for CRM. First, we present Fujitsu's vision of CRM and give an overview of our CRM activities from the viewpoints of products and solutions, middleware, and technology. Then, we describe technologies for automatic e-mail response (BroadChannel/Internet Contact) and the Intelligent Configurator (Interstage Configurator Recommendation), both of which are Fujitsu CRM products. Our CRM solutions are reinforced with advanced technologies such as natural language processing, combinatorial optimization, and machine learning.

1. Introduction

Customer Relationship Management (CRM) is a set of business practices used by enterprises to establish, maintain, and improve good relationships with their customers. Although CRM has been developed from call-center facilities, the diffusion of the Internet has diversified the channels between enterprises and their customers. CRM nowadays needs to handle such channels as e-mail and the Web as well as the telephone. It also needs to integrate those channels so as to better respond to customers, who contact enterprises via preferred channels according to the time and situation.

This paper focuses on enabling technologies for the channels of e-mail and the Web as instances of the research and development activities for CRM solutions. We have developed technologies for analyzing e-mail messages and Web-form texts and retrieving similar inquiries from stored e-mail messages and Web-form texts. We then incorporated those technologies into an automatic e-mail response system. We have also developed technologies for a Web-oriented configurator, which provides users with an appropriate set of products, options, and services that satisfy the given conditions, and incorporated those technologies into the Intelligent Configurator.

Before describing the details of the technologies, we present Fujitsu's vision of CRM and give an overview of our activities on CRM from the viewpoints of products and solutions, middleware, and technology.

This paper describes the research and development activities for enabling technologies for Fujitsu's CRM solutions. Section 2 gives an overview of our activities by presenting Fujitsu's vision of CRM and systems of CRM products and solutions. Section 3 describes our approach to the middleware for CRM. Section 4 gives a technical overview of our enabling technologies for CRM solutions. Section 5 introduces the technologies for the automatic e-mail response system. Section 6 introduces the technologies for the Intelligent Configurator. Section 7 concludes the paper.

2. CRM overview

First, we look at the progress of CRM development.

2.1 Development of CRM

The Computer Telephony Integration (CTI) system, which we could call the predecessor of CRM, started in 1996 when the telephone number display service was introduced in Japan. CTI connected computers with the telephone and made it possible to display customer information on a database when the system received a call. It is not an overstatement to say that CTI was synonymous with customer care before the word CRM appeared. We refer to this period as the predawn of CRM

The first generation of CRM was developed from 1998 to 2000. The new channels that connected customers with enterprises, for example, e-mail and the Web, appeared with the explosive growth of the Internet. Several companies appeared to expand their business by analyzing customer information accumulated via the channels of regular mail and the telephone. Generally, the goal of the first generation was to strengthen the relation between companies and customers for each channel.

The second generation of CRM was developed from 2000 to 2002. It was becoming apparent that companies should not manage their customer information independently for each channel, but should manage a synthetic relation with customers. That is, companies need to present a single image to their customers. By unifying the customer information accumulated by various channels, knowledge about a customer deepens further. In addition to improving customer satisfaction, this approach expands the business opportunity by, for example, cross-selling and up-selling.

We are now in the "eCRM" era, in which Internet channels have been established and have spread throughout the business world. In the U.S., many kinds of goods began to be sold on the new channel of electric commerce (EC), mainly by the so-called dot com companies, from the first half of the 1990s. At the end of the 1990s, some companies succeeded by processing promotions for specific individuals and marketing them in real time based on the accumulated customer information. The flow of CRM joined with supply chain management (SCM), which was being developed in parallel with CRM, and began to evolve into the third generation of CRM, in which the customer area and the back office became united.

In 2002, we saw ADSL broadband services spread. Also, VoIP-based telephone services also spread and various customer contacts via the Internet increased, for example, advertisements, shopping, marketing, and inquiries. As a result, an immense amount of customer information from direct channels was accumulated every day.

On the other hand, in the U.S. and Japan, the IT movement, which realizes operating reform through the spread of computer technology, and the number of companies that introduce Sales Force Automation (SFA), Field Force Automation (FFA), and SCM have increased. IT systems have also accumulated another type of customer contact information.

The third generation of CRM makes it possible to synthetically use various customer information accumulated in a company in order to perform effective marketing, effective production, and service activities. In the third generation, corporate activity and customer management have the relation shown in **Figure 1.**

2.2 Fujitsu's system solutions

To implement such a cycle, Fujitsu provides the following system solutions.

1) Customer care

- Contact center: BroadChannel/BASE
- Interactive Voice Response (IVR) : BroadChannel/IVR
- Self-service: BroadChannel/FAQ
- E-mail: BroadChannel/Internet Contact, Interstage e-mail Marketing

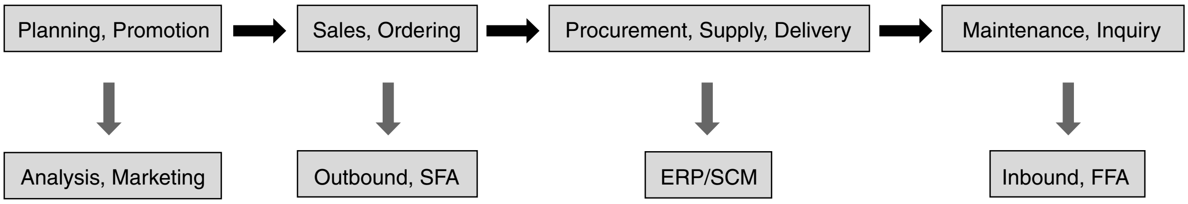

Figure 1
Corporate activities and customer management.

- SFA: eSalesManager

2) Analysis and knowledge management

- Business Intelligence (BI): Interstage Navigator
- Knowledge Management (KM): BroadChannel/Kfinity

3) Back Office

- Enterprise Resource Planning (ERP)/SCM: GLOVIA series

3. Middleware for CRM

CRM systems have evolved into very broad systems that cover many aspects and are coordinated with various systems. Moreover, they need to be flexible and fine-tuned so they can realize one-to-one marketing for individual customers and strategic marketing through information analysis. From the viewpoint of system construction, it is very important to build a CRM system as quickly as possible to enable market entry and also to enlarge and enhance the system so it can be coordinated with various other systems when necessary. Fujitsu provides a set of solution templates (also called solution parts) for building CRM systems.

3.1 CRM solution template

Figure 2 shows an overview of CRM solution templates. The BroadChannel provides contact center facilities, the BroadChannel/FAQ provides service support facilities, and the Interstage Configurator Recommendation provides facilities for retrieving recommended products. It is very important that these facilities and the infrastructure are closely coordinated for strategic customer retention, sales, and marketing.

3.2 BroadChannel/Internet Contact

BroadChannel/Internet Contact is a solution template for constructing a contact center with inquiries via e-mail. It can reduce the load of operators by analyzing the contents of an e-mail inquiry and distributing the inquiry to an appropriate operator based on its contents along with a reply candidate retrieved from previous Q&A cases. **Figure 3** shows an example screen image of BroadChannel/Internet Contact.

BroadChannel/Internet Contact can also manage the history and progress of inquiries and replies in a unified manner. When it is combined with the BroadChannel package, it is possible to construct a multi-channel contact center for telephone calls and e-mail messages.

3.3 BroadChannel/FAQ

BroadChannel/FAQ is a solution template for constructing a frequently asked questions (FAQ) system for inquiries and requests at a contact center. It is also used to construct a self-service system to efficiently respond to customer inquiries and requests at an online store and a business site. It provides an escalation function; therefore, by using an e-mail server it is easy to set up a Web site for quick responses to customer requests. **Figure 4** shows an example screen image of BroadChannel/FAQ.

When it is combined with BroadChannel/Internet Contact, it is possible to construct a comprehensive Web contact center with operators.

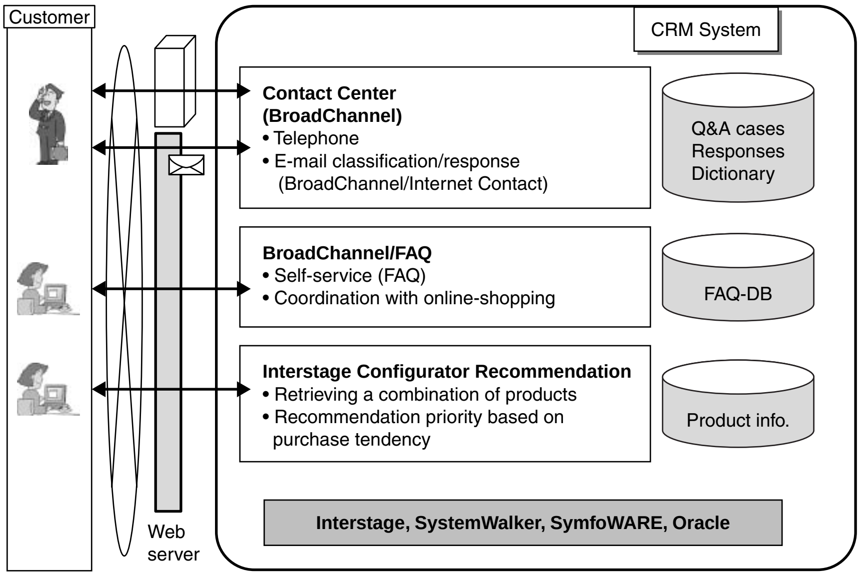

Figure 2
CRM solution template overview.


Figure 3
Screen image of BroadChannel/Internet Contact.


Figure 4
Screen image of BroadChannel/FAQ.

3.4 Interstage Configurator Recommendation

Interstage Configurator Recommendation is a solution template for retrieving product combinations. It can efficiently find product combinations and information that satisfy the given conditions from various combinations of options.

Interstage Configurator Recommendation has differentiating functions for flexible retrieval, for example, a function for presenting alternative combinations by relaxing the given conditions when no combination strictly satisfies them. It also has functions such as a function for recommending products that a seller wants to sell.

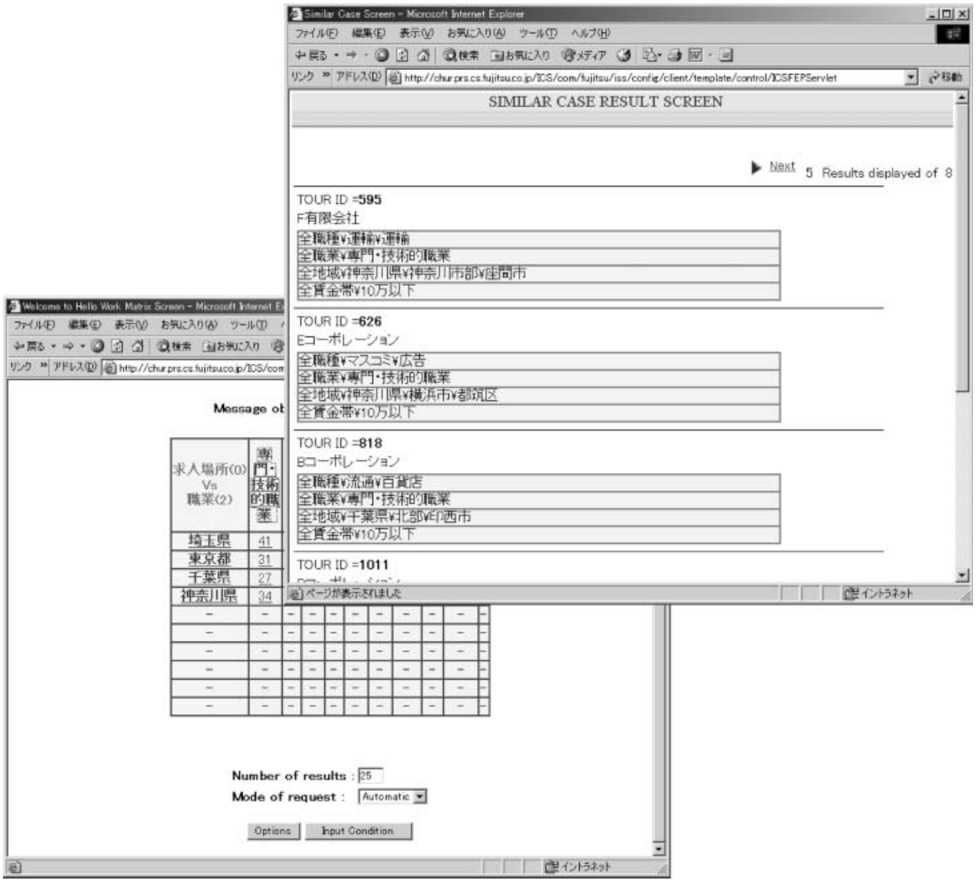

Figure 5
Screen image of Interstage Configurator Recommendation.

Figure 5 shows an example screen image of Interstage Configurator Recommendation.

4. Technology overview of CRM

CRM was started in call centers, where the core technology was CTI. Fujitsu produced CTI-based call center packages by taking advantage of its expertise in both computer and telecommunications technology.

The diffusion of the Internet has diversified the channels between enterprises and their customers. CRM nowadays needs to handle such channels as e-mail and the Web as well as the telephone. It also needs to integrate those channels so enterprises can provide better responses to customers, who contact enterprises via a particular channel depending on the time and situation.

4.1 Responding to inbound e-mail inquiries

We have developed an automatic e-mail response system for responding to inbound e-mail inquiries. The system does the following:

1) Analyzes the inbound e-mail

The system preprocesses the e-mail, for example, decodes MIME (Multipurpose Internet Mail Extensions) protocol and transforms it into an XML form. It extracts characteristic keywords from the XML form using Japanese language analysis.

2) Classifying the inbound e-mail and distributing it to an appropriate operator

The system classifies the e-mail into predefined categories based on keywords that are extracted using the Bayesian method. The system manager can write classification rules and add them to the system if necessary. The precision of classification can be improved by automatic learning with more cases as the system continues to operate.

3) Retrieving similar Q&A cases and generating a candidate reply message

The system retrieves similar Q&A cases and generates a candidate reply message by inserting the answer part of a similar Q&A case in the message body. High-precision retrieval is the key here, and the enabling technologies are described in the next section.

4.2 Sending outbound e-mail messages

It is also important to approach customers with appropriate outbound e-mail messages by taking advantage of the stored customer information. From the viewpoint of taking advantage of the stored customer information, data mining technology is the key. We developed a data mining method by using MBR (Memory-Based Reasoning) technology.[1] This method enables us to do an effective sales promotion by narrowing down the target prospects and sending them e-mail promotion messages. A comparison between the MBR-based method and the conventional one using real data shows that the hit ratio can be improved by about 1.7 times.

4.3 Web-oriented CRM functions

The self-service FAQ system, which can be searched by the user, is closely related to the automatic e-mail response system. The technology behind it is described in the next section.

Another featured Web-oriented system is the Intelligent Configurator, which provides the user with an appropriate set of products, options, and services that satisfy the given conditions. It has a number of differentiating features, and the technologies behind it are described in Section 6.

5. Dialogue act analysis for high-precision Q&A case retrieval

5.1 Background

The management of knowledge is acknowledged as a key for achieving efficiency and quality in contact centers and support centers. In the case of online contact centers, it is possible to realize a more automated Q&A process by combining the FAQ system with the e-mail contact center system. **Figure 6** shows the flow of the Q&A process in the online contact center. The customers first access the self-service FAQ system, and if it does not return the correct answer, they send e-mails to the human operators.

By adopting this kind of self-service Q&A process in the contact center, we can expect the support cost to fall to less than half that of a traditional call center receiving phone calls. However, although the cost of support can be reduced, the efficiency depends on the precision of the Q&A case retrieval and the quality of the cases stored in the repository.

Even though the correctness of retrieval is the key factor, the rate is usually not so high, for example, 15% to 30%. From experience gained in contact centers, search failures are caused by inadequate search keys given by the customers or contact center agents. Also, when customer inquiry texts such as e-mails and Web-form inputs are used as search keys, most search failures are caused by redundant expressions in the original inquiry texts.

To solve the problem caused by redundancy in inquiry texts, we have proposed a search system that analyzes the discourse structure, called the dialogue act (DA) structure, in the original texts. An evaluation based on real contact center Q&A data shows the search precision is twice that in a regular full-text search system.

5.2 Inquiry text expressions and dialogue acts

Customer inquiry texts such as e-mails and Web-form inputs are not dialogues. However, there

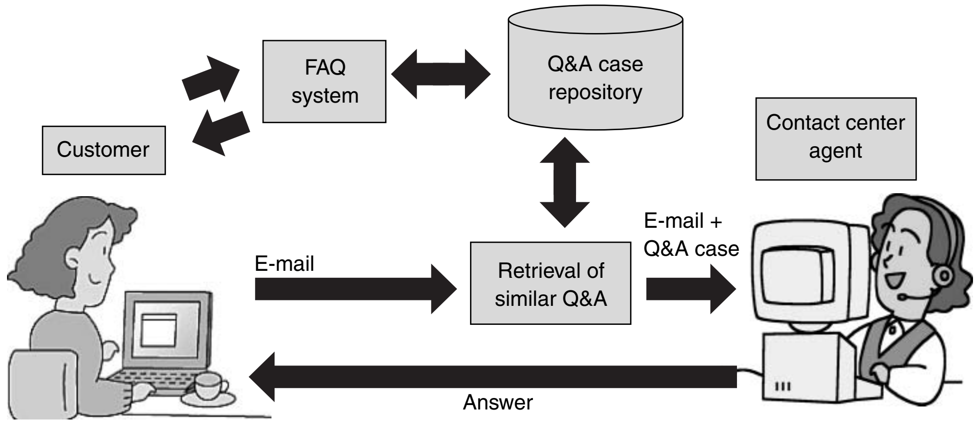

Figure 6
Question answering assistance based on previous Q&A cases.

is a similarity between the linguistic style of inquiry texts and conversational dialogues; for example, they both include functional elements such as questions, requests, greetings, and closings.

In the research for defining the discourse structure of the spoken dialogue, a group of researchers called the Discourse Resource Initiative (DRI) have proposed the Dialog Act Markup in Several Layers (DAMSL) markup scheme[2] for the spoken dialogue structure. DAMSL provides a set of tags to annotate elements in the dialogues, called dialogue acts (DAs), and the tags are designed to be used for domain-independent annotation work.[3]

The DAMSL tag set is a good standard for discourse tagging. However, when we analyzed customer inquiry texts by ourselves, we found that many tags for spoken dialogue are useless and tags related to the explanation of a situation should be added to the tag set for annotating the customer inquiry texts. In this first-step analysis, we defined the following four tags for the DA structure analysis:

- <Question>: The question itself.
- <Statement>: An explanation of the situation when a problem occurs
- <Action>: Action that the user took before the problem occurred.
- <Wish>: What the user wants to do.

Figure 7 shows an example of an annotated e-mail text. In the example, the DAs are given as XML tags and the underlined expressions in the text characterize the DA elements. In general, each of the four DA elements corresponds to the characterizing Japanese expression patterns, and the following example shows a typical characterizing expression of each DA.

- Statement: “～できません。” “deki masen.”: this means “...cannot be done.”
- Question: “～できるでしょうか？” “dekiru de shouka?”: this means “Is it possible to ...?”
- Action: “～しましたが、” “shi mashita ga”: this means “I did ...”
- Wish: “～したいのですが、” “shitai no desu ga”: this means “I want to ...”

The dialogue structures are analyzed by using these patterns.

5.3 Automatic dialogue structure analysis based on Japanese expression patterns

The DAs in the text are analyzed using a Japanese language pattern-matching (JLPM) engine developed for the information extraction application.[4] The characterizing patterns corresponding to the DAs are coded into the pattern-matching rules of the JLPM.

Original Japanese question (E-mail question)

Windows98でデスクトップの「@niftyインターネット接続」アイコンからインターネット・サービスを起動しようとしたのですが、インストールの途中で止まってしまいます。ソフトの設定が何が悪いのでしょうか?

Analyzed and tagged question

<action>Windows98でデスクトップの「@niftyインターネット接続」アイコンからインターネット・サービスを起動しようとしたのですが、</action> <statement> インストールの途中で止まってしまいます。</statement> <question>ソフトの設定が何が悪いのでしょうか?</question>

English translation of the analyzed and tagged question

<action>I have tried to run the @Nifty Internet Service from the "Internet Connection" icon on the Windows 98 desktop,</action> <statement>but it hangs up during the installation. </statement> <question>Is there something wrong with my software?</question>

Figure 7
Example of analyzed question.

In Japanese syntax, words such as verbs, auxiliaries, and particles that characterize the DA of a sentence appear at the end of the sentence. Therefore, most JLPM rules consist of these kinds of words and their combination patterns.

The next example shows a combination pattern rule.

macro oshiete
(教えて | おしえて | お聞かせ | お教え)
macro itadake (頂け | いただけ | もらえ)
macro desuka (ますか | ませんか)
typedef oshieteitadakemasuka
(.*&oshiete;&itadake;&desuka;)

The first three lines define sets of similar expressions called macros, and the last line defines the combination patterns of the three macros. By using these rules, the JLPM engine recognizes sentences such as "教えていただけますか", "お聞かせ頂けませんか" and "教えてもらえますか" as question DAs.

The current JLPM rules contain about 150 macros and 600 typedef rules; these rules cover 60 to 70% of the DA patterns in inquiry texts.

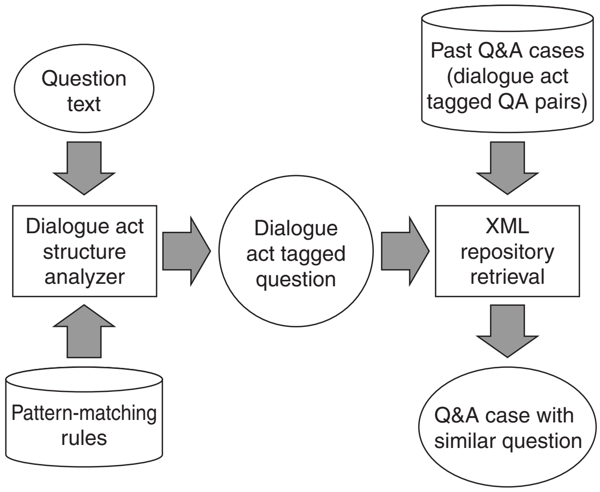

Figure 8
Processing flow of Q&A case retrieval.

5.4 Q&A case retrieval

Figure 8 shows the processing flow of the Q&A case retrieval. When a question text is received, the JLPM engine in the dialogue structure analyzer applies the pattern matching rules to the question text and outputs the result of matching as a DA-tagged XML text. Then, the DA elements that are XML tagged in the question text are extracted and sent to the XML repository retrieval process.

Because all previous Q&A cases have been processed by the dialogue structure analysis and stored in the XML repository before retrieval, the retrieval process can limit the targets of the search to cases with the same DA tag as the one in the question. If the question has no DA element or the search with a tag fails, the search process ignores the DA tag.

5.5 Evaluation

For the evaluation, 27 000 Q&A e-mails processed by a contact center during four months are used. The Q&A e-mails are separated into two groups of 17 000 Q&A cases to be searched and 7000 question e-mails. From the question e-mails, 100 are randomly chosen and used as the test queries. The Q&A cases are processed by the dialogue structure analyzer and stored in the Q&A case repository.

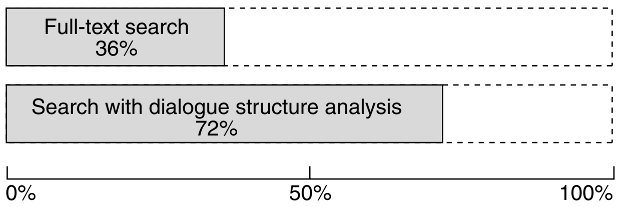

Figure 9
Comparison of search precisions.

The correctness of the search results is judged according to whether the top five results include the correct answer, and the search precision is given by the rate of correct searches. For a comparison with the traditional search system, the 100 test queries are given to the full text search and the results are evaluated using the same conditions.

As **Figure 9** shows, our retrieval method achieves twice the precision rate of traditional full-text retrieval.

6. Intelligent Configurator

The Intelligent Configurator (IC) is a system for retrieving product information. It differs from usual retrieval systems in that it can retrieve not only products but also products combined with additional products. Even if a certain product violates a given user requirement, IC tries to satisfy the requirement by combining the product with its options and related products. For example, to configure a personal computer, IC selects base models and modifies them by combining additional memories, exchanging internal storages and video cards, and selecting external options such as displays and keyboards. When combining products, IC must satisfy various constraints such as the types and numbers of connectors. This kind of problem, in which products are combined according to user requirements, is called product configuration and has been widely applied for customizing industrial products with many optional parts, for example, computer systems and automobiles. It can also be applied to service domains such as tour planning and insurance planning.

To achieve practical product configuration systems, there are three important problems: 1) acquisition of accurate knowledge about the products to be retrieved and the constraints on their combination, 2) effective search techniques for solving configuration problems, and 3) user support abilities to navigate users to the best products and product combinations for them. In this section, we describe how IC resolves these problems and makes it easy to start a configuration service.

6.1 Knowledge acquisition

First of all, it is impossible to configure products correctly without accurate knowledge about the specifications of the products to be combined and the constraints for rejecting unsuitable product combinations. This kind of knowledge must be updated when new products are introduced and old products become discontinued.

Of the two types of knowledge, knowledge about the product specifications is usually stored so it can be used by other applications, for example, supply chain management. IC prepares a data conversion tool to extract product specifications from the databases of other applications. For the knowledge about combination constraints, IC prepares a Graphical User Interface (GUI)-based problem definition tool to define the relationship between products. With these two tools, IC can reduce the cost of knowledge acquisition.

6.2 Search techniques

Product configuration finds product combinations that meet the users' requirements. This is a kind of combinatorial optimization problem and sometimes requires a long time to solve. IC tries to reduce the problem solving time by using constraint propagation techniques based on arc-consistency algorithms. If IC decides a product is unsuitable for inclusion in a configuration, constraint propagation propagates this information through the constraints related to the product and rejects any other products that require it. This makes it possible to reduce the search space and dramatically reduce the problem solving time.

6.3 User support abilities

In many applications of product configuration, for example, online cataloging of the Web sites of manufacturers and online shops, users often lack the knowledge needed to use configuration systems to get the products they want. Therefore, it is quite important to help users set appropriate requirements and find the best products for them. The biggest feature of IC is that it has various functions for meeting these requirements. IC uses a new kind of knowledge that consists of pairs of two types of information: the requirements of a previous user and the corresponding product combination the user selected. IC extracts the relationships between these pairs by decision-tree learning. Then, when a new user inputs requirements, IC uses these relationships to calculate the probability that the user will select a certain product combination.

Figure 10 shows an example of a learned decision tree for personal computers. The internal nodes in the decision tree divide the set of all solutions (i.e., all possible product combinations) based on product categories and specifications such as the CPU and memory size, and the leaf nodes represent the subsets of solutions. Each leaf node represents a sub-problem of the original configuration problem that covers the product combinations satisfying all conditions on the path from the root node to the leaf. This sub-problem has fewer products than the original problems and is easy to solve. In addition, IC assigns a probability for each product that represents the goodness of selection in the sub-problem. This probability is calculated based on the frequency of the product in the previous requirements and corresponding solutions that also belong to the sub-problem; that is, corresponding solutions that satisfy all conditions on the path from the root. It is worth noting that a product may appear in multiple leaf nodes and have different probabilities. This means that the goodness of the product depends on the context of the configuration represented by the conditions from the root to the leaf nodes.

When user requirements are given, IC first selects the leaf nodes that satisfy the requirements. For each selected leaf node, IC solves the sub-problem at the leaf with the given requirements. Next, IC calculates the probability for each solution from the probabilities for each product at that leaf using an independence assumption (i.e., multiplication of probabilities of products in the solution). At the end, IC gathers the solutions with their probabilities for all selected leaf nodes. As a result, IC can get not only the product combinations that satisfy the user requirements, but also the probabilities that they will be selected by the user.

In the example shown in Figure 10, if a user requires a desktop computer with a 1 GB memory, only the leftmost leaf node does not violate the requirements. IC solves the sub-problem corresponding to this leaf; that is, it enumerates combinations of base models, memories, and hard drives. In this case, four combinations satisfy the requirements. IC calculates their goodness by multiplying the probabilities for the selected items. As a result, IC selects an FMV-W610 with a 1 GB memory and a 160 GB hard disk drive as the best personal computer for the given requirements.

The direct usage of the probabilities of solutions is to rank the product combinations that satisfy the user requirements and return only the combinations having high probabilities. This is quite useful if the given requirements are too weak and a huge number of product combinations satisfy them. In addition, IC prepares the following functions based on the probabilities.

1) Presentation of additional requirements as candidates to specialize the current requirements.
2) Relaxation of the requirements if they are

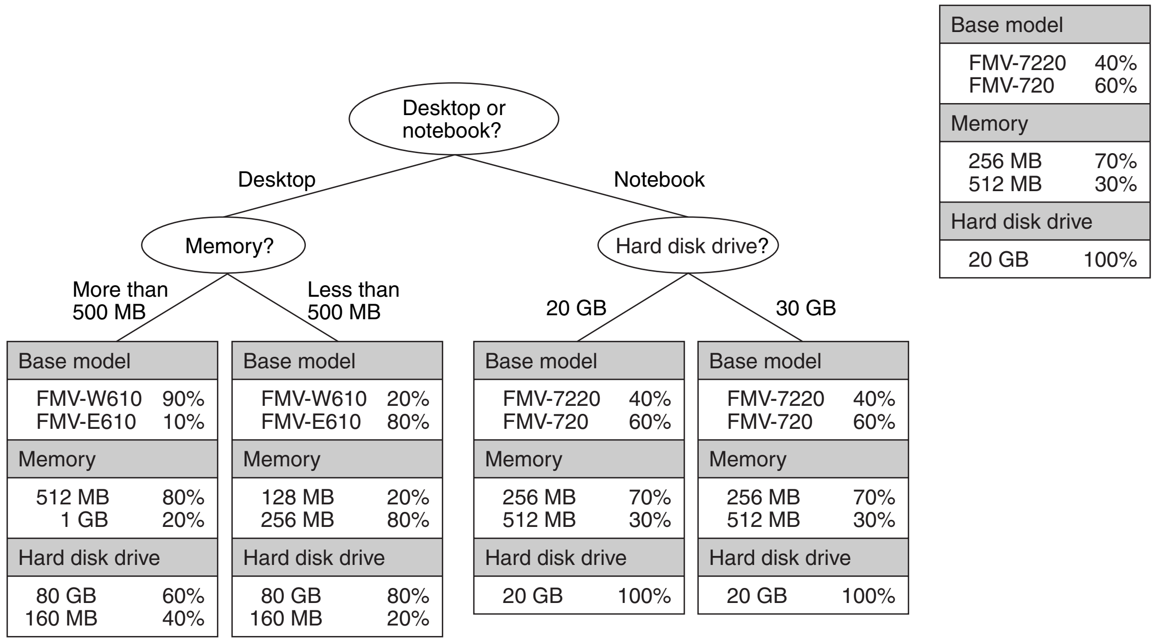

Figure 10
Example of extracted decision tree and conditional probabilities for configuration of personal computers.

too strong and no product combination satisfies them.

3) Grouping of product combinations to show a summary of the configuration result.

These functions are quite effective if a user does not have enough knowledge for the target products and cannot set appropriate requirements to find the best products.

7. Conclusion

We have described research and development activities for enabling technologies for CRM solutions. Our CRM solutions are reinforced with advanced technologies such as natural language processing, combinatorial optimization, and machine learning. We are continuing our efforts to enhance Fujitsu's products and solutions with our technologies.

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