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Human knowledge to be applied to communications services

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Abstract

This paper reports on an excellent secretary's knowledge for telephone handling. The secretary's knowledge has been systematically acquired by 'acquisition as modeling', and they may be reconstructed to an Electronic Secretary in a Personal Computer again systematically. Knowledge models reported are, those for conversation, information collection, and various decisions. The application of the knowledge to communications are discussed.

Keywords Electronic secretary, Telephone handling, Knowledge acquisition, Knowledge model, Expert system

1. Introduction

This paper introduces excellent secretary's knowledge applicable to communications services. In Japan, a small business starts with a small office, a telephone set and a secretary for receiving a telephone call. Due to the growth of the economy, it has become difficult to employ an intelligent woman for the secretary. Various Electronic Secretaries for the purpose had been studied, but the commercial use has not yet been reported.

This paper introduces knowledge structures of excellent secretaries during telephone handling[2, 3]. They are as follows;

1. To show secretary's knowledge structures.
2. To point out the effectiveness of introducing the knowledge in communications.
3. To use Knowledge Engineering technique in a software development.

2. A secretary for telephone service

As an excellent secretary is very helpful, only a high ranking manager can receive the service at present. If these services were also available for other people, it surely improves their productivity. The secretary's services are;

1. To make a phone call for the boss; to look for the number, make the call, to negotiate people there to talk with the desired person. If unavailable, an alternative person is arranged.
2. To receive all calls, and to treat them in an effective way, as to minimizing the disturbance to the boss but still keeping the promptness.

A secretary for a high ranking manager acts as a face of the company. The person is selected from highly educated sophisticated women, and are specially educated to serve in a uniform way. In Japan, a secretary remains just an agent

and is inhibited to get in touch with the boss's business. An electronic version of the secretary seems easy, and will be useful universally.

The first step of this study is to build a precision simulator of a secretary, and then it is deformed to fit the needs. In order to build a precision simulator of an expert secretary, the knowledge must be systematically acquired, and it must be reconstructed to an expert system again systematically.

This had been regarded as impossible or difficult. At present, however, it has become possible by knowledge 'Acquisition as modeling[1]' and as well as by reconstructing thus gained knowledge underlying the original model and following various Software Engineering practices which is a reflection of excellent human knowledge. As this paper is not a Knowledge Engineering (KE) paper, further discussions on KE are not made but Table 1 summarizes technical points in this study.

Table 1 Knowledge Engineering techniques

	Conventional	This study
Structuring or modeling	After the acquisition	Prior to the acquisition
Knowledge model	Undefined, unclear or vague	Very clear
Knowledge	Rule based or knowledge based	Model with input-to-output relationships
Knowledge acquisition	Non systematic by understanding Subjective	Systematic by anybody Objective
Reusability flexibility	Generally not so flexible	Easily reusable to a new application

6 secretaries were chosen as the experts. They are full-time general purpose secretaries dedicated to each general manager heading a business or an organization. Most of them have been well educated to behave in a uniform corporate way. After interviews to some of them for the modeling, they are asked to answer question forms. All the questions consist of the situation and they write their behavior (with comments if necessary) or correct various figures when needed. A study on a knowledge requires several times Q&A. After a kind of knowledge has been acquired, further study on the advanced (or detailed) knowledge starts.

3. Various knowledge of a secretary

3.1 Conversation knowledge

Figure 1 shows the knowledge model for a conversation between the calling side boss (A) and the secretary (Sa) together with the other side boss (B) with the secretary (Sb). A orders

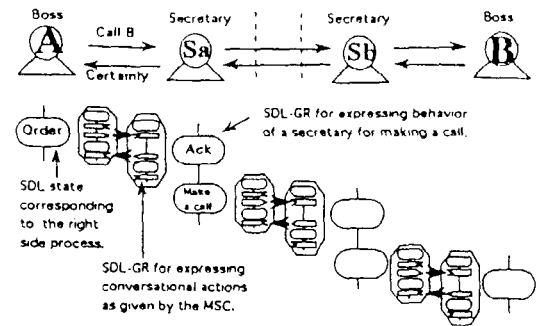


Figure 1 Conversation knowledge

Sa to 'Call B'. Sa dials B, and asks Sb to connect to B. On Sb's judge to accept it, both Sa and Sb tell their bosses to talk with.

The conversation has been acquired by a Message Sequence Chart (MSC) as shown in the top of Figure 1. The MSC is converted to a state transition diagram of each people, forming a Process (octagons in SDL) as shown in the next line. When abstracted, each Process corresponds to a respective state (e.g. 'Order' and 'Acknowledge'). These higher level states form a state transition diagram of the boss and the secretary describing the behavior.

Thus conversational protocols may be modeled by hierarchical Extended Finite State Machine (EFSM). When the structure is known, it is easy to acquire knowledge of both secretary's telephone handling procedures with conversations systematically. Knowledge is acquired as an input-to-output relationship on document basis not by understanding of Knowledge Engineer.

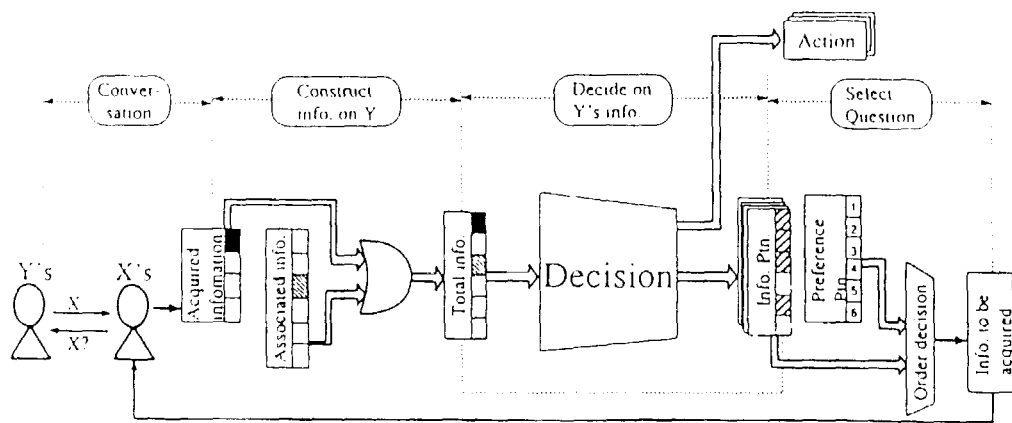


Figure 2 Information collection knowledge

3.2 Information collection knowledge

On receiving a call, a secretary collects information on the person. After 'What the calling person' and 'What the intention' are understood, the secretary decides what to do. The understanding of the former is made by a group of information (name, organization, title, and so on). The information collecting knowledge is modeled as shown in Figure 2.

It consists of following blocks;

1. S_x asks S_y 'Who are you?'
2. On receiving the name, it is referred to an associative memory storing all the people's information in concern.
3. The decision unit decides next action. When several Y 's are read-out, the decision supplies a confirmed information pattern to the next.
4. The next necessary information is identified by comparing with preference pattern. This starts next conversation. 'Of what company Mr. Y are you?'

As these two examples show, a knowledge model is a dedicated mechanism inherent to a human behavior or thinking. Once it is understood, not only the acquisition of the knowledge but also the application may be made easily.

3.3 Decision knowledge

Figure 3 shows a model for decision. It consists of cascaded three stages.

A Filter type decision

detects a special set of inputs or conditions, lead to a distinctive action prior to a normal decision point.

On hearing the boss's wife's voice, a secretary connects the call to the boss skipping further procedures. This is an example. It saves time as well as mental energy, and reduces variations of inputs to the following decisions.

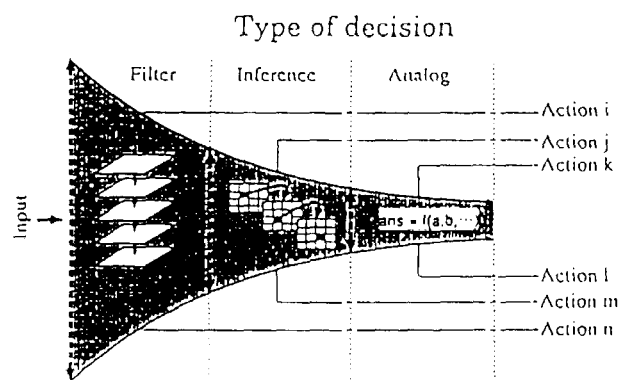


Figure 3 Decision knowledge

Most cases are decided by Inference type. A matrix type decision table is used. The columns are for the boss's status and the lines are for the other party's status. Question forms are sent to secretaries, and they fill in the next action in each cross point blank space of a matrix. Use of table type logic makes the implementation easy.

For delicate situations, Analog type is used. It became clear in the case when the boss is in 'don't disturb' condition. The secretary decides

considering not only the boss's condition but also;

1. the urgency, together with
2. the importance of the call, and
3. the difference of two person's difference of their positions.

Another series of Q&A (by matrix table) have been made. For each cross point actions thus gained are weighted and averaged. They show a curved surface, and the approximating equation is obtained using Mathematica. Figure 4 shows contour lines of the function corresponding to next actions.

Thus a black box containing an analog function followed by a multi-level slicer is the knowledge model.

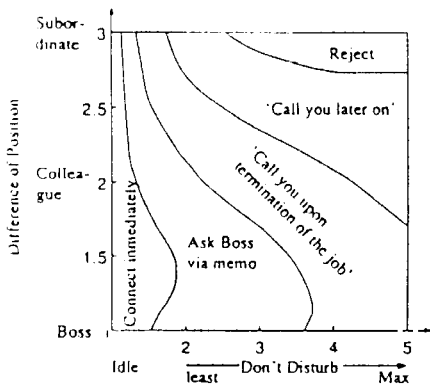


Figure 4 Sliced planes at various levels

4. Applications

4.1 Don't disturb service

'Don't disturb' is a basic service of a hotel. Likewise, it is an indispensable service of an Electronic Secretary for communications. An excellent secretary guards the boss from trivial calls, still the person connects a necessary or important call immediately.

A simulation for evaluating the effectiveness of the service has been made. Table 2 shows a result. The left side tables show the case without the service, while the right side tables with the service. The upper circled part in the left side table (without 'don't disturb') shows that, as a person forced to answer any calls, 8.2~8.4% of time is used for these calls. But in the right side table (with 'don't disturb') the time disturbed by trivial calls is decreased to 1/10. Referring to the lower circled part, the waiting for the delayed calls ranges from 11.9~37.8 minutes for ordinary calls, which is allowable inviting no problems.

4.2 Other applications in communications

Except for don't disturb, secretary's knowledge may be applied to communications enabling an

Table 2 Effectiveness of 'don't disturb'

Without secretary					With secretary's 'don't disturb'				
Called side					Called side				
Grade of don't disturb	Occupancy in time	Terminated calls, percent occupancy in time			Grade of don't disturb	Occupancy in time	Terminated calls, percent occupancy in time		
		2 ranks higher	1 rank higher	Basic			2 ranks higher	1 rank higher	Basic
None idle	16.7%	16.1%	16.1%	16.4%	None idle	16.7%	48.0%	42.5%	22.6%
A little	33.3%	32.6%	33.7%	33.6%	A little	33.3%	41.4%	43.8%	46.2%
Don't disturb	25.0%	26.3%	25.1%	25.1%	Don't disturb	25.0%	9.9%	12.8%	29.0%
Very	16.7%	15.6%	16.9%	16.5%	Very	16.7%	0.6%	0.7%	1.6%
Ultra	8.3%	8.4%	8.2%	8.4%	Ultra	8.3%	0.1%	0.2%	0.6%

Calling side					Calling side						
Grade of don't disturb	Occupancy in time	Percent of calls	Time until to be connected			Grade of don't disturb	Occupancy in time	Percent of calls	Time until to be connected		
			2 ranks	1 rank	Basic				2 ranks	1 rank	Basic
Important business	Very urgent	1.9%	1.2min.	1.4min.	1.1min.	Important business	Very urgent	1.9%	0.5min.	1.0min.	0.6min.
	Urgent	5.7%	1.3min.	1.4min.	1.5min.		Urgent	5.7%	0.4min.	1.6min.	0.9min.
	Ordinary	17.3%	1.2min.	1.1min.	1.2min.		Ordinary	17.3%	4.4min.	7.2min.	19.2min.
Non-important business	Very urgent	5.8%	1.4min.	1.3min.	1.5min.	Non-important business	Very urgent	5.8%	0.8min.	1.6min.	1.4min.
	Urgent	17.3%	1.2min.	1.2min.	1.2min.		Urgent	17.3%	10.4min.	10.9min.	13.9min.
	Ordinary	51.9%	1.0min.	1.2min.	1.2min.		Ordinary	51.9%	11.9min.	19.7min.	37.8min.

intelligent services.

An example is 'information collection knowledge' in Figure 2 as applied to the protocol for a service. A human conduct in co-operating with other person forms a hierarchical system as modeled by a hierarchical EFSM's. Prior to start a service, an information exchange for validating the service is made, and the mechanism collects necessary information in a flexible way.

When a secretary gets a guest's name, but if it is insufficient for the identification, the person's company is asked and further the person's title is asked. During the course, occasional noise might cause a difficulty in hearing. The secretary repeats the question, and asks 'Are you Itachi or Hitachi, h for hotel?'

On the contrary, present protocol systems do not allow any discrepancies from what determined, even if it is only a bit. It seems too strict. It irritates people. Using a Personal Computer, the user feels frequently that 'What an un-intelligent system it is. It sometimes allows a retry, but it does not allow any errors where human mistakes are probable. The design philosophy is not uniform.'

As communications advances, it will happen also in communications service. 'Oh! this simultaneous language translation service does not work when it is needed.' As communications service advances and is enriched, various services will be introduced evolutionary and also many kinds of protocols will appear. Though service provider's systems may be updated at a time, users' terminals will not be updated at the instant. A system must co-exist and co-operate with terminals of various generations. In such an environment, a more flexible protocols becomes indispensable.

Secretary's knowledge, such as one for conversation, information collection as well as

the decision might enable an agent for such a flexible and intelligent protocols.

5. Conclusion

In this paper, systematic ways of acquiring secretary's knowledge and the knowledge models have been reported. As a model is clear, systematic acquisition of knowledge becomes easy. The application to communications service have been discussed. As far as the model is kept, it is easy to reuse, modify and apply the knowledge in various ways.

These systematic nature comes from modeling or 'structuring', which is made prior to the acquisition. (In Knowledge Engineer's (KE's) way, structuring follows after the acquisition.) Following the model, knowledge may be objectively acquired as an input-to output relationship. (In KE's way, it is subjective.)

From Requirement Engineering view point in Software Engineering, this way of acquiring knowledge seems to be a new approach for formalizing the users' conducts.

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