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SEPARATE MODELLING OF USER-SYSTEM COOPERATION

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Summary

Existing Legal Knowledge-Based Systems (LKBS) nowadays show themselves capable of providing reliable advice if treated by competent users. When analysing the cooperation between a user and an LKBS, it transpires that distinct interpretation of legal notions may lead to different advices, affecting the system's reliability. Therefore, each system should tune its level of communication to the level of the user's knowledge of legal notions.

This contribution first describes the main features of an adequate user-system cooperation, and then focuses on two requirements: user-friendliness and reliability. It is argued that the modelling of problem solving and cooperation handling should be separated. A new model of cooperation is proposed, in which the drawbacks of interlacement and insufficient understanding are diminished, and an efficacious suppletion of real-world knowledge is made possible.

Based on these principles the model is also applicable in non-legal areas with sufficient domain and meta-level knowledge available, since it relies on a context-sensitive component. Hence one of our conclusions is that separate modelling may invoke new ideas on the modularity of cognitive cooperation processes.

1. Introduction

When consulting a Legal Knowledge Based System (LKBS) a user will be regularly challenged by a wide range of questions on the case under investigation (e.g., questions such as 'is it a matter of libel?'). The notions used normally will have a technical-legal meaning, but it is also possible to conceive their meaning as in common parlance. Hence, the answers supplied by the user may diverge. Consequently, the consulting session can be polluted by the use of legal and non-legal, but identical, notions. This implies that in many subsequent questions it might be unclear what is (precisely) meant by the LKBS. For instance, does the system take into account the level of the user's legal expertise? This question can be formulated more scientifically as follows: is it possible to relate an LKBS's output directly to the level of a user's understanding of legal notions?

In this contribution we concentrate on the quality of an LKBS's legal advice when it is employed by an arbitrary user. We argue that the quality is highly dependent on the characteristics of the user-system cooperation. In order to improve the cooperation, we propose a separate modelling of the user-system cooperation, i.e., the modelling should be fully independent of the problem-solving process. Such a separated modelling assumes that cooperation can be described as a modular process, or - in terms of separated *modules* - the modelling process is autonomously, i.e., independent of any intervention of another module or a supervisor component, until its deductive closure is reached [Brumsen, van Oostveen and Treur, 1990]. We here investigate to what extent separate modelling has an impact on the performance of an LKBS.

First we examine which features are important for cooperation. On the basis of five features we inspect a well-known definition of cooperation and choose a point of departure (section 2). Then, in section 3, the quality of legal advices is described with the help of notions such as speed, flexibility, user-friendliness and reliability. Section 4 provides an overview of the cooperation between system and user in current LKBSs and formulates the findings in a provisional model. Some shortcomings of this model are determined in section 5. Hence, a new model of cooperation is suggested in section 6. This model is based on modularity of cooperation, which brings about new expectations and requirements. A possible application area is given in Section 7. Section 8 contains a conclusion and some recommendations.

2. Features of cooperation

As is well-known, cooperation is multi-faceted. Below we have confined ourselves to what we regard as essential features of cooperation. They turned out to be five in number. Next, we have adopted De Greef *et al*.'s [1988] definition on cooperation and explored it with respect to these features, leading to a workable definition for our modelling purposes.

The first feature of cooperation is the *form of communication* between a user and a system, i.e., how a user-system communication can be observed from the outside. Shneiderman [1986] uses the notion 'style'. Elements which define the form of communication are: which language to use (natural language, domain language, computer language, etc.), how to use the language (speech, text), which technical means to use (windows, icons, etc.). Also user-friendliness and ergonomics play a prominent role in the communication forms.

The second feature is *transparency*. The main question is to what extent should the user have insights in the intricacies of the system (and possibly *vice versa*). The better the transparency, the more intelligible the questions and answers from both sides. It is even conceivable that intentions of goals to be reached are recognized. Moreover, first-class transparency increases the efficiency of the communication (e.g., no redundant questions will be posed).

Coordination, the third important feature, deals with approved dialog patterns between a user and the system. The patterns are naturally agreed upon, and they generate some kind of *system control*. Therefore it is necessary to have scripts of how one's communication partner is expected to react in some (well-defined precarious) circumstances.

Our fourth feature, *consistency-check and recovery*, is also regarded as an inherently cooperative feature, for not all possible system faults or user mistakes are foreseeable. Since some of them are, actions can be taken to avoid invalid legal reasonings by implementing check and recovery mechanisms.

We consider *interaction* as a fifth feature of cooperation. It is believed that interaction affects the intentions. This idea is reported by the strong connection between cooperation and interaction styles [Shneiderman, 1986]. The interaction produces an interpretation of information mostly on object or meta level, viz. when recognizing the intentions of a user or a system.

Having decided that these five features should be covered by the definition of cooperation we have adopted De Greef *et al.*'s [1988] definition. According to De Greef *et al.* [1988] cooperation means "working together, in a joint effort, towards a common end". Moreover, it is stated "each of the partners contributes his skill, knowledge and information". However, they do not further explain their notions skill, knowledge and information. For the meaning of the notion knowledge, in our view for an LKBS the most important of the three, we join Chisholm [1968]. As a case in point we give Chisholm's characterization of the connection between knowledge and truth: Y has knowledge of X when Y believes X is true, when Y has reasons to believe X is true and when X is true. With skill we mean the capacity to use learned knowledge in practice. Finally, information is defined as interpreted facts (e.g., by the LKBS). Synthesizing the above mentioned features and definitions, we define cooperation in LKBSs as follows:

> *cooperation is the effectively-coordinated interactive exchange of information between an LKBS and a user, in which mutual skills and knowledge are taken into account; LKBS and user are working together towards a legal advice in optimal accordance with the user's ultimate goal.*

3. Characteristics of the user-system cooperation

The quality of an LKBS can be expressed with notions, such as speed, flexibility, user-friendliness, reliability, etc. In this section we focus on user-friendliness and reliability. In relation to these two characteristics we investigate the significance of cooperation for the quality of LKBSs' advices.

User-friendliness is a characteristic with a strong impact on the quality of a (L)KBS's results as perceived by the user. According to Shneiderman [1986] a system can be called user-friendly, if it generates "positive feelings of success, competence, and clarity in the user community" while "the users are not encumbered by the computer and can predict what happens with each of their actions". Effective cooperation should aim at such kind of user-friendliness. In that sense (a model of) cooperation is contributory to the quality of a system.

Obviously, whatever information system we use, it must be *reliable*. For LKBSs this means that a judgement by the LKBS could have been produced by a good (or not to bad) judge [Hage, 1987]. In other words, a reliable LKBS should only provide valid legal judgements. We remark that this does not imply the same reasoning procedures to be followed as performed by a judge.

However, an LKBS does not work entirely on itself: the user plays an important role when the legal advice is constructed, e.g., by supplying the system with information on the case. Ideally, this should lead to an analogous reasoning process, where the system may gradually follow the expert it is mimicking. Assuming such a procedure is possible, it at least results into a reliable judgement. However, we may question whether the system is also robust in the sense that it is still reliable when provided with *misinformation.* For instance, a user might make many kinds of mistakes, which may vary from typing errors (e.g., $ 100,000 instead of $ 1,000) via inconsistencies in situational descriptions to misinterpretations of some legal notions or even to misunderstandings of the system behaviour.

There are two extreme attitudes to the reliability issue.

1. The system is considered reliable if it provides a correct judgement regardless the quality of the input of the user. Usually this is called *robust* in computer science. In this attitude it is not relevant whether the user fails (e.g., caused by a lack of knowledge) because then the judgement is still correct. Consequently, when a user had failed the resulting argumentation is to be blamed on the failing user and not on the (reliable) LKBS. This implies that we in such cases allow claptrap argumentation. We call this the idiosyncratic reliability attitude.

2. The system is called reliable only if both the resultant judgement and argumentation are correct. This implies that the system is considered to be co-responsible for the input of the user. If the user fails, the system has to recognize this and to reinstate. We call this the context-sensitive reliability attitude.

The second attitude brings about the highest level of requirements and comes close to the ultimate research goal of mimicking a judge by an LKBS. After all, a good judge not only attends to the validity of his reasoning, but also to the validity of the information on which his judgement is based. Accordingly one should aim at implementing comparable skills. However, it is not to be expected that these skills can be fully modelled and realized at the moment. We merely state that it is worthwhile to continue research efforts.

It is remarked that both attitudes illustrate the interlacement of cooperation and reliability. But in the idiosyncratic attitude reliability is not dependent on *interaction* and hence easier to achieve; as a consequence it is less reliable than the second attitude. In the context-sensitive attitude reliability can only be achieved when the skills needed for interaction are modeled explicitly. This should be our task.

4. Cooperation in current LKBSs

In this section we discuss the cooperation of two well-known LKBSs (JURICAS and TESSEC) currently used in legal practice in the Netherlands. We remark that both systems are typical (experimental) LKBSs which may be considered as frontrunners. Other potentially comparable LKBSs are chiefly used for research purposes in the field of legal reasoning. The latter systems mainly serve specific (research) goals and are often meant to be used by specialized users only. Accordingly, those systems do not aim to satisfy the requirements for cooperation as posed by the context-sensitive attitude.

As stated above, the chosen operational systems are JURICAS, developed at the Workshop for Informatics and Law of the Erasmus University [van Noortwijk, 1990; Van Noortwijk et al., 1991] and TESSEC developed at the Technical University Twente by M.A. Nieuwenhuis [1990].

JURICAS is a shell for developing LKBSs. Several legal applications have been built with this shell. For reasons of comparison we have chosen the legal advice system for welfare decisions developed by the Social Security Office of the city of Haarlemmermeer.
The program TESSEC covers the same legal domain. It is used successfully by the city of Groningen [Nieuwenhuis, 1991].

Models of cooperation
In our investigation we did not find any report on methodologies used by the developers of either system, nor were any conceptual (system)models made public. Only the formal representations of the domain knowledge have been published.
While studying the cooperation process of these systems we can only look at *ad hoc* remarks with regard to the topic and then additionally scrutinize the formal representations.

Cooperation
Although there is no explicit model of cooperation available, from the descriptions of both systems we can induce what (implicit) requirements and (implicit) assumptions with respect to cooperation have been used. By way of illustration we provide a compilation.

It is *assumed* that:
- all relevant facts of the case will be made available [Nieuwenhuis, 1990 p. 35];
- the system has no 'real world knowledge' [Nieuwenhuis, 1990 p. 37];
- transparency is determined by the knowledge representation [Nieuwenhuis, 1990 p. 45];
- there is a direct relation between the knowledge representation and the questions asked [Nieuwenhuis, 1990 p. 46];
- an n-to-n representation of knowledge is at the expense of transparency and maintainability [Nieuwenhuis, 1990 p. 49];
- communication occurs on the basis of the current states of problem-solving by the system [Nieuwenhuis, 1990 p. 78; van Noortwijk, 1990 p. 37];
- interpretation of notions is exclusively by the user; if needed supported by textual instructions [Nieuwenhuis, 1990 p. 82; van Noortwijk, 1990 p. 41];
- justifications of legal conclusions are presented as (direct translations of) state-space sequences ending in the conclusion state [Nieuwenhuis, 1990 p. 83];
- the user has the final responsibility for the legal advice [van Noortwijk, 1990 p. 40];
- a multiple-choice has to be made by the user [Nieuwenhuis, 1990 p. 82];
- there is only one type of user [Nieuwenhuis, 1990 p. 38].

The following *requirements* with respect to cooperation are mentioned:
- system messages are clear [van Noortwijk, 1990 p. 41];
- the user/expert is able to build and maintain the system [van Noortwijk, 1990 p. 41];
- the user has a certain level of knowledge (of the system and the domain) in order to use the system correctly [van Noortwijk, 1990 p. 40];
- the system builder anticipates on the knowledge and experience of a single user type [van Noortwijk, 1990 p. 40];
- the system is transparent [Nieuwenhuis, 1990 p. 44];
- the user knows the operating procedures and system constraints [van Noortwijk, 1990 p. 40];
- even unexperienced users can work with the system [van Noortwijk et al. 1991, p. 41].

The assumptions and requirements mentioned above did not result in explicit models of cooperation in the publications of their originators. Still, we can induce a rudimentary model of cooperation from this overview.
This *implicit* model (henceforth the 'traditional model of cooperation') can be described in terms of a collection of functions. Such a description is quite common [Winston, 1984]. By means of these functions we may analyse the traditional model on which, according to our opinion, cooperation in JURICAS and TESSEC has been based. The foundations are:

- ask
When the system cannot determine a fact, this function asks it from the user (sometimes accompanied by an explanatory text).

- why
The system provides (a description of) the goal to be reached.

- why-not
The system shows (a description of) those rules, which could have led to a conclusion, but failed due to already defined facts.

- how
The system provides (a description of) the rules which have led to the conclusion under investigation.

- facts
The system provides (a description of all) facts given, to the system, or derived or asked by the system.

- what-if
This function enables the user to change facts or intermediate conclusions in order to let the system derive new conclusions.

In the next section we point out that the functions described above are not sufficient for modelling a context-sensitive cooperation.

5. Shortcomings on the traditional modelling of cooperation

A fundamental feature of the traditional model of cooperation is the interlacement with the inference mechanisms. For instance, the moment at which the *ask* function is used directly depends on the actual inference process; and so, the *why* function straightaway reports on the states to be investigated by the inference process. In other words: the above-mentioned cooperation functions are closely related to the problem-solving procedure of the system.

We remark that in most knowledge-based systems - and certainly in the systems mentioned above - it is not intended to imitate the problem-solving approach and reasoning methods of the expert. Most LKBSs are based on artificial models only meant to produce reliable results. In these systems the direct relation between communication and artificial-inference methods in the traditional model of cooperation causes some problems. We believe that these problems can be best analyzed when derived from the observations by the original authors.

In his evaluation of TESSEC Nieuwenhuis [1990] draws attention to a number of problems due to misunderstandings in cooperation (although he does not explicitly qualify these problems as cooperation problems). We have singled out the following problems.

- Users aim at guiding the system towards specific situations, normally not reachable with the current input. This issues the input of improper facts in order to influence the system's control. Obviously, the correct input leads to ignoring of formally correct conclusions.

- Users may misinterpret notions presented by the system, despite the textual explanation.
- Users do not understand the explanation of the conclusions, since the structure of their (domain) knowledge and reasoning pattern differs from the system's structure.

We remark that the traditional model of cooperation originally has been developed for medical and technical applications. So far the users of these systems have been experts themselves, for whom the interpretation of notions and concepts is less difficult.
In law - and certainly in statute law - the interpretation of concepts is an important aspect especially in legal problem-solving procedures. However, legal rules refer to situations in the real world, and according to Nieuwenhuis [1990] and others, it is not possible to represent all the knowledge of the real world. Making references to the real world is possible, but it imposes severe restrictions on the domain and, moreover, the users' help is compulsory. Furthermore, restricting the domain is never sufficient to reduce the amount of necessary real-world knowledge to such an extent that it can be represented adequately.

In summary, research should address the following points with regard to cooperation:

- the interlacement of cooperation and inference mechanisms;
- the insufficient understanding of concepts and notions;
- the user's suppletion of real-world knowledge to the restricted storage of the system's real-world knowledge.

Finally, we would argue that the traditional model of cooperation is not sufficient, at least not for LKBSs aiming at context-sensitive cooperation.

6. A new model

Approaching the problems mentioned above, other models of cooperation should be designed and realized. Since these models must be flexible to the user, they will be more complex than the traditional model.

Separate modelling
For a palpable investigation of the relation between the characteristics of cooperation and the performance of an LKBS (working towards a legal advice) we propose to model the user-system cooperation separately. Moreover, if (separated) models of user-system cooperation prove to be generic, they can much easier serve in a framework for modelling cooperation modules for other LKBSs. In addition, maintenance of cooperation tasks and of user types can be simplified because the cooperation functions and problem-solving functions are no longer intertwined.

A schematic representation of the traditional model of cooperation
In Figure 1, a formalized problem-space representation [van den Herik, 1991] shows the problem-solving process in an abstract form. For details we refer to Ollongren and Van den Herik [1989].

Solving a problem is presented as a process in which a sequence of states should be followed (the inferencing path). New states are created and/or linked to previous states by operations on existing states. The operations are based on rules in the rule base. A user can influence the (intermediate) states and the search direction in a limited way by means of the ask and what-if functions. Newly added facts may generate new

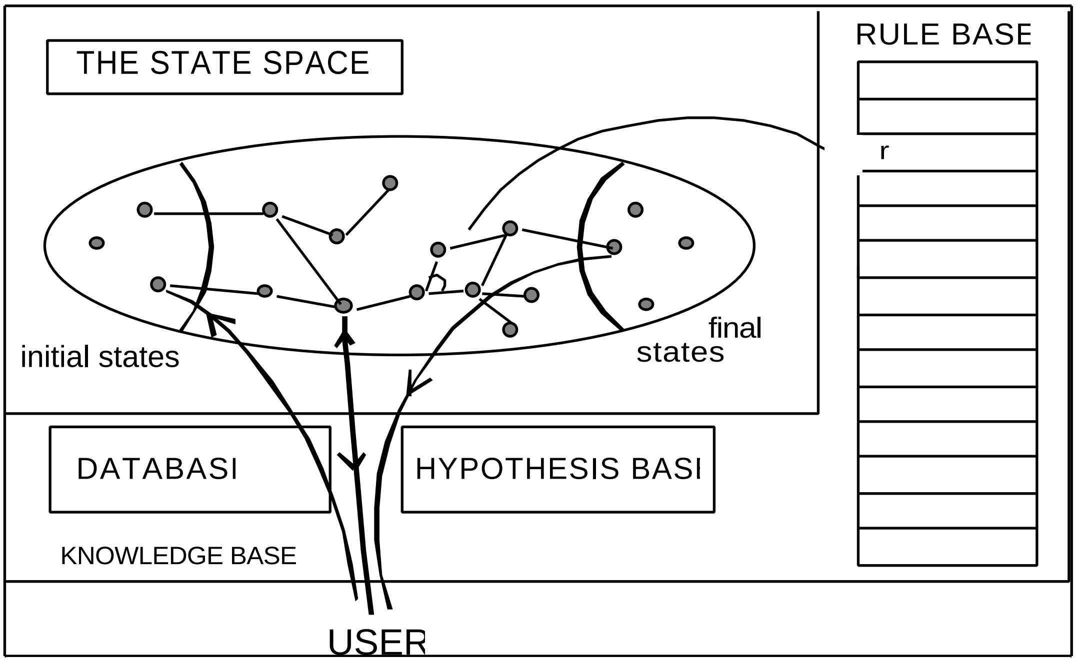

Figure 1: A formalized problem space.

sequences and also withdraw existing sequences. In the traditional model only the two functions mentioned above are able to guide the search direction. The other functions provide explanations of the system behaviour.
Notably, the cooperation normally presents itself to a user as system behaviour since it is directly related to the atomic elements of the system, being the states and the rules. Therefore, the essential elements and the strategy to be followed in the cooperation is determined by the implemented search techniques and strategies.

A proposed conceptual separation
One of the serious problems of the traditional model is that the user finds it impossible to fathom the system.

It is of interest to make the user familiar with the problem-solving procedure. On the one hand this may be achieved by providing the user with (more) insight in the available search techniques and strategies. On the other hand this may be achieved by giving the user a certain amount of control. Consequently, search techniques and strategies become subject of cooperation.

Of course, control issues make cooperation more complex, for not only states and rules are subject to cooperation, but also combinations of them and the strategies to be followed in the reasoning process. If a system wishes to inform a user on these topics, it must be able to understand them and even interpret them accordingly. This is a prerequisite, cooperation knowledge on analysis and processing must be available. Therefore, in the cooperation-handling process the system should be able to abstract from its own problem-solving process.

In Figure 2, we consider the cooperation-handling process separately from the problem-solving process. The cooperation-handling process itself is presented as an individual state space. As a result, communication between the problem-solving and the cooperation-handling processes must be specified. Consequently, specification of the

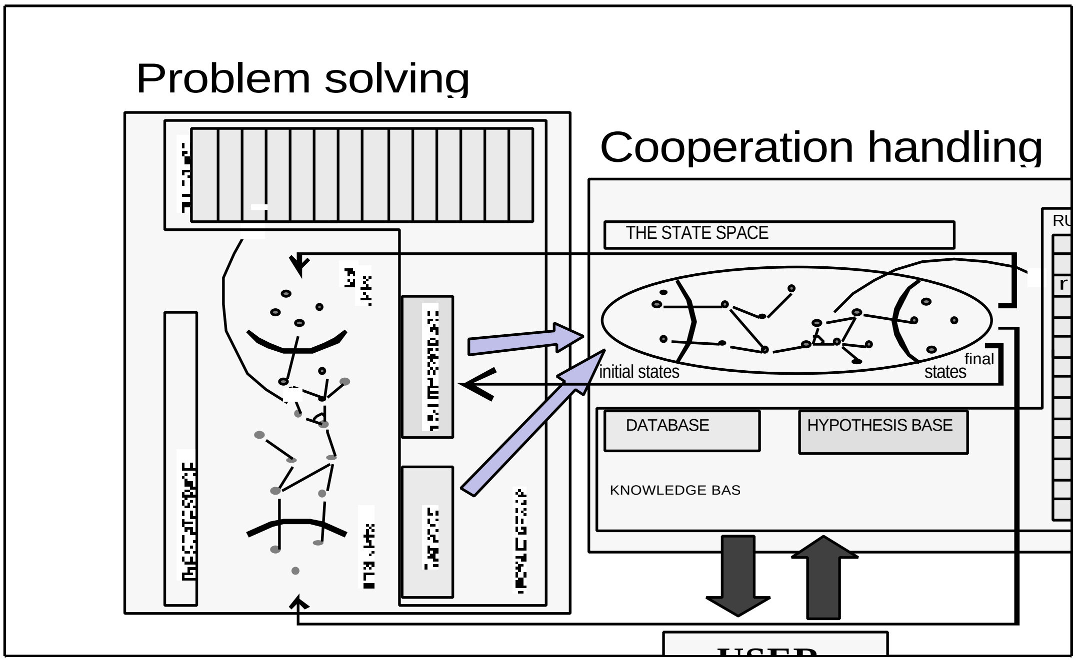

Figure 2: Separated problem solving andperation.

messages to be passed on between the separated processes becomes a major topic of research. An analysis of the information that should be available to the different processes in order to work properly may initially yield the necessary conditions to be met in this communication. We tentatively propose the following.

(1) A separated process of problem solving should have available internally: initial states, goals (final states), rules (among which problem-solving heuristics) and a database (containing the problem-solving history). Since we suppose the user to provide the cooperation process with real-world information and strategic choices relevant to problem solving, the cooperation process should, in its turn, provide the problem solving process with additional initial states and with urgent hypotheses to be investigated. Accordingly, the communication from the cooperation process to the problem-solving process necessarily contains information on initial states, on goals and on strategic choices.

(2) A separated cooperation-handling process should have direct access to information derived from the problem-solving process. Then the initial states of the cooperation-handling process can be supplemented by this information which provides a basis for explanatory reasoning. Consequently, the communication from the problem-solving process to the cooperation-handling process necessarily contains information on the state of the problem-solving session. Moreover, the cooperation-handling process must be able to provide the user with strategic choices. As a result, the available strategic choices must be supplied by the problem-solving process - again supplementary to its initial states.

We conclude that minimal communication between separated problem-solving and cooperation-handling processes contains reciprocal object and control information. Further investigation of the communication between cooperation-handling and problem-solving processes is required, since the aforementioned types of reciprocal communication may lead to several problems. We mention the well-known logical issues regarding object and meta-level reasoning as well as the overhead problems regarding multi-process communication.

Modularity of knowledge
The KADS methodology provides some heuristics for conceptually modelling cooperation separately on a meta-level basis. However, these heuristics are presented rather tentatively, as an "open ended idea" [de Greef *et al.* 1988, p. 31] and as yet no generic models of cooperation for legal applications have been reported. Nevertheless, our research will (partly) elaborate on the available insights provided by the KADS projects [cf. De Wildt *et al.*, 1991].

When assuming that problem-solving knowledge and cooperation-handling knowledge should be modelled separately, we must consider an intensive exchange of information between the two processes. We opine that this can be *formally* associated with the typology of communication between modules described by Brumsen, van Oostveen and Treur [1990], in which they distinguish upward and downward reflection (meta - object and object - meta, respectively) and neutral communication (object - object or meta - meta).
Moreover, it can be *conceptually* associated with the modularity of human knowledge [Fodor, 1983]. Fodor gives the following features of modular (input)systems: (1) domain specificity, (2) mandatory operation, (3) central access to its representations is limited, (4) fastness, (5) informationally encapsulated, (6) shallow outputs, (7) associated with fixed neural architecture, (8) characteristic and specific breakdown patterns, (9) characteristic pace and sequencing in the ontogeny.
According to Fodor in human information processing there are modular and non-modular, *diffuse* faculties (central systems). He argues that modular faculties are computational and diffuse faculties are not. This line of thought may set up a usable frame for answering the question of to what extent problem solving and cooperation *can* be modelled separately. In that case some of the features of modularity are *prima facie* important conditions of separated modelling.

7. Applications area

The conceptual separation of the problem solving process and the cooperation-handling process is not only usable in LKBSs. Especially KBSs in a domain with more than one solution per problem, such a model of cooperation-handling can make the system flexible. Providing the user with more control over the problem solving process the system can be forced to generate other (heuristically anomalous) solutions. An example is the situation in which the system is naturally inclined to produce the optimal solution. But there may be other (not domain-specific) considerations which lead to another satisfactory, but not optimal, solution. These other considerations can be based on financial accounts, principles of justice, marketing policy, tuition policy (in intelligent CAI systems) etc. In summary, if a LKBS's output is used in a broader context, where other considerations play a role, the proposed model of cooperation handling can be more useful than the traditional model. At least, here we have incorporated enhanced possibilities for modelling strategic interaction.

8. Conclusion and recommendations

Our inspection of the disadvantages of the traditional model has established that context-sensitive cooperation will improve the reliability of LKBSs. The cooperation-

handling process will improve the insight and flexibility of automated legal reasoning and therefore also its reliability.
Modelling cooperation separately is considered to be helpful for (1) avoiding unsophisticated treatment of logic (using different logics for problem solving and cooperation), (2) facilitating maintenance and (3) creating generic cooperation models (reusability). Finally, we may conclude that separate modelling of context-sensitive cooperation raises questions as to the modularity of cognitive cooperation processes.

Consequently, we recommend further research into the modularity of cooperative skills.

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