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Coherence Theory of Truth as Base for Knowledge Based Systems

Heinz Josef Mubhoff
Technische Univesitat Dresden, heinz@wise.wiwi.tu-dresden.de

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Heinz Josef Mußhoff
Technische Universität Dresden
Fakultät Wirtschaftswissenschaften
01062 Dresden, Germany
e-mail: heinz@wise.wiwi.tu-dresden.de

A Special Problem of Expert Systems

Usually knowledge based systems are realized as expert systems. Knowledge engineers try to build systems which 'represent' an expert's knowledge. These models typically are used by laymen lacking the specific expert knowledge in the modelized domain. Experts ared used

to provide the knowledge to solve a specific problem and

as a metaphor for constructing knowledge based systems.

The later aspect has its roots in the psychological interest dominating research in artificial intelligence. Human problem solving behavior set artificial intelligence the example. The expert system approach satisfies many types of problems. But it can be shown that there are others which cannot be solved by this approach in a proper way.

Today one special problem is that the expert system decides by its knowledge what is asked and what information is used for solving the problem. The user may provide **data** as input for the system - if the system asks for them - but nothing more. Some nice comedies deal with this situation, i. e. the doctor who does not pay any attention to the information his patient tells him and only does his routine job. In our days expert systems work in such a way. They are not able to react in an adaequate way, if their clients want to offer more than data for the problem solving process; they are not able to react on **knowledge** supplied by the user.

But, there are many situations in problem solving where it is necessary that the client can offer more than just the data the system asks for. Let us have a look on problems in management, i. e. strategy formulation, and let us examine a consultation process in a firm. Who would be envolved? There may be an external consultant with special knowledge in strategic management, but who else? The answer may depend on the special problem which is focused on, but one can suppose it will be a manager who has his own special knowledge about strategy, markets etc. Maybe he has a very special opinion about it. But the consultant has to take care for it. He would be a bad consultant if he did not. A knowledge based system in many cases has to take care for the knowledge of his clients, too.

But what is done with the knowledge from different sources? It may be in case of conflict, it may be cntradictory, inconsistent etc.

Integration of Knowledge while Consulting

What can be done when such situations with conflicting knowledge occur? Of course there may be many ways to solve that problem:

One could say, in any way we accept the opinion of the consultant, because he is paid for his consultation and so we should use his knowledge.

One could say, in any way we accept the opinion of the manager, because it is his firm and he has to take the responsibility for the strategy which will be realized.

One could look for a way to find a combination of competing knowledge. Perhaps one might thing about Hegel and his thesis, antithesis, synthesis model or something like this.

When we are looking for cognitve solutions for a problem, then only the third approach is acceptable, although the others are relevant in real life. So one has to look for methods to find an acceptable combination of competing knowledge.

For the further discussion I suggest to leave aside the expert system approach and all the cognitive psychology by which he is influenced. Knowledge is not only a problem in psychology. Knowledge has social aspects and there is a social system - **science and arts** - which is specialized in handling knowledge. What ideas can be found in science to work with knowledge?

The (major) problem of (empirical) sciences is to determine what is truth - or better - what should be accepted as truth (at the moment). There are many different approaches to determine what should be said to be true. Perhaps one could say there are four main streams:

Correspondence Theory of Truth,

Pragmatic Theory of Truth,

Intuitionistic Theory of Truth,

Coherence Theory of Truth.

Proponents of the **Correnspondence Theory of Truth** declare a sentence to be true if its content corresponds with the world. In the **pragmatic** sense one should regard a proposition to be true if the utility of its acceptance is greater than the one of its non-acceptance. In the **intuitionistic theory** there are two sorts of truths: primitive truth and inferred truths that can be achieved by an inferential machinery. Proponents of the **Coherence Theory of Truth** declare a sentence should be regarded true, if it can be accepted in our body of knowledge. True is what can be systematized. Knowlege is regarded as a system and science and arts care for it.1

Coherence Theory of Truth as a Mean for Systematization

I like to concentrate my examination on Coherence Theory of Truth which usually is confronted to Correspondence Theory of Truth. A Correspondence Theory of Truth does not work in several situations, because oft its necessary connection to the real world, where special situations are not always present and so cannot be tested, i. e. a sentence with reference to the past. But, Coherence Theory of Truth - in my eyes - seems to be very attractive. I. e. one could look at our management problem as a process of combination, where knowledge of different sources (consultants, managers, etc.) is combined to find out what should be accepted as true.

A very powerful version of Coherence Theory of Truth was developed by Nicholas Rescher.2 He shows the criteria one should use to do the job of knowledge systematization. The criteria should be used as regulative principle for for the systematization. Rescher mentions the following criteria to be relevant for systematization:

completeness,

cohesiveness,

consonance,

functional regularity,

functional simplicity and economy,

functional efficiacy,

wholeness,

self-sufficiency,

architectonic,

functional unity,

mutual supportiveness.

Some of these criteria can be formalized to work in knowledge based systems. Others seem to be more informal and one has to look for an adaequate substitute. If this is done successfully, a knowledge base system could accept knowledge of the user at runtime while consultation. It could combine it to a new system of knowledge using the criteria or its substitutes.

The Logic of Coherence

Below I will describe the Logic of Coherence in a very short form. This is necessary for sketching an software architecture that will meet the requirements of the theory. In "Coherence Theory of Truth"3 (pp. 72 - 97) Rescher describes the search for truth in a coherentistic sense. The analysis starts with a set S of 'raw' data, the truth candidates. They are only candidates and not all data will be accepted as true. This set is the starting point of the analysis. Normally, not all elements of S can be true, because they may be in conflict. S is not necessarily consistent. Therefore the Set S has to be reduced. Here Rescher uses the concept of **maximal consistent subsets (m.c.s.)**. Si is a m.c.s. of S if (1) it is not empty, (2) it is consistent, and (3) no S-element that is not already member of Si can be added to it without producing an inconsistency.

Now, one can distinguish to sorts of elements: (1) elements which are member of all m.c.s. of S. They are called **innocent-bystanders**. (2) All other elements of S are called **culprits**. For every Si there is a set of its (logical) **consequences C(Si)**. P is element of C(Si) iff it is the logical consequence of the conjunction of all the propositions of Si. The next step is do decide two sorts of consequences. A Consequence P might be an **inevitable consequence (I-Consequence)** of S iff P is a **deductive consequence (L-consequence)** of every m.c.s. Si of S. P is called a **weak consequence (W-consequence)** of the set S if there are some m.c.s. Si of S such that P is a logical consequence of Si.

The next step is to decide what propositions should be accepted to be true. Generally one can say:

No proposition should be accepted which does not follow from at least one m.c.s.

Every proposition P which follows from every m.c.s. has to be accepted to be true.

These statements mark an upper and lower limit for the decision which propositions which propositions should accepted to be true. Rescher uses the concept of the **P-Consequence (preferential or plausible consequence)** to intermediate these limits. He starts the determination of P-Consequences by selecting some m.c.s. which are called **preferred m.c.s.** P is called a P-Consequence of S if it follows from all the preferred m.c.s. of S. Rescher proposes to accept the P-Consequence as true relative to the 'raw' data S.

In 'Coherence Theory of Truth' Rescher mentions a number of methods to determine the preferred m.c.s., i. e.:

Propositional Pivot-Points,

Majority Rule,

Probabilistic Preference,

Plausibility Indexing,

Most of these methods are formal and can be realized on a computer system. They use further knowledge to evaluate the m.c.s. which in many cases can be ask by the user of an information system.

Sketch of a Knowledge Based System based on Coherence Theory of Truth

In the following I will try to describe in a very short way an information system which will use some aspects of Rescher's Coherence Theory.

(1) The starting point of such a system is a knowledge base. It contains generalized sentences about a special domain: theoretical and/or technological knowledge. The source of the knowlege is not import: experts, science, books etc.

(2) A second component of the system is necessary to describe the problem which should be solved by the system. It is necessary for the description to meet the knowledge.

(3) From the description and the generalized sentences of the knowledge base the system in relation to the problem desribed can instantiate special sentences. I call these sentences arguments. They are relevant only for the actual problem. The arguments must not be consistent and must not be accepted to be true.

(4) From this set of all the derived arguments (and perhaps of the user arguments) maximal-consistent-sets are generated and presented to the user.

(5) In a dialog the user and the system can evaluate the generated m.c.s. to derive preferred m.c.s.

(6) All the arguments which can be derived from all preferred m.c.s. are presented as a solution of the problem.

(7) The user may accept the presented solution. But, it may be the case that he rejects it, because of some special arguments he wants to supply by his own knowledge about the problem. Therefore a further system component is necessary to add arguments or even generalized sentences to the system. After adding the sentences to the system the process of generating m.c.s. (or - if necessary - arguments) starts again and a further solution (must not be another) is generated.

(8) One critical point of the process is the evaluation of the m.c.s. It must be emphazised that it is an evaluation of sets by certain criteria not an evaluation of single arguments. Therefore it is rather difficult for an user to build his own solution from single arguments. There must be high coherence between the arguments.

Further Prospects

There are some interesting side effects of such a system. It is easy to see, that if one implements and uses a knowledge based system based on Coherence Theory of Truth a special sort of learning or knowledge acquisiton can be realized. Because the system can use the knowledge acquired from a competent user, and systematized in the system's knowledge base for future consultations. There will be a richer fund of knowledge in future consultations.

Another interesting aspect could be occur in the explanational skills of such a system. It can generate an explanation from out of the system the knowledge builts and will not be dependent on the trace of the fired rules. This is, because the solution of a problem in coherence theoretic approach is a system of arguments.

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