Questions about Answers

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In this paper I shall concentrate on questions about given answers. In doing so I recognize that a *question* may be defined as a request: "See to it that I know that, whether, who ..."

I also distinguish two types of questions 'yes–no-questions' and 'wh-questions'. In the analyses the latter ones are studied in Beth-type tables. The former may also be presented with a dialectic tree diagram, a Socratic tree

In the second part of the paper I discuss bracketing, first briefly as applied to "yes–no"-questions and then by means of a simple medical example I go into matters of bracketing as a metaquestion of interrogation.

An easy access to the interrogative model is given in *What If...? Towards Excellence in Reasoning* by Jaakko Hintikka and James Bachman, 1991. The Socratic tree model was presented in some papers of mine, in particular "Reasonable Doubt", 1997, and "Inadmissible Evidence".

2. The Interrogation

2.1. Interrogation as a method and the Interrogative Model

In scientific research and theory as in all other investigation *wonder* is the best starting point. Wonder creates questions and questions demand answers. Giving an answer is a way of satisfying the inquirer's demands. This is *de facto* the very definition of the concept of a 'question': "See to it that I *know* that, whether, ..., which, ...". But what does the inquirer want to know? She wants to know on the one hand, what, who, how, why the condition *p* appeared or was realized. "What happened?", "Who did it?", "How did

it happen?" The answers to these questions constitute instantiations of more general judgements such as "Somebody mixed the chemicals", "There is a PH-value at which blueberry soup turns red" etc. In a laboratory protocol the chemist performs a step by step book keeping about the analysis and synthesis he has performed. The tentative questions may not always even be spelled out although the answers are given.

"I solved the stuff in HCl (hydrochloric acid)"
"A part remained unsolved"
"The unsolved part was treated with ..."
"The solution was divided into two tubes ..."
"In one of the tubes I added ... A yellow substance fell out"
"In the other I added H_2S (hydrogen sulphide)"
"A black substance fell out"

This protocol looks like a list of answers to the questions "*What* did you do?" and "*What* happened?". Nevertheless, at a certain point the curiosity may be awakened and again turned into wonder: "*Why* did the substance turn yellow?". Elementary theory of chemical analysis gives us the answer. Namely, it tells us that As (arsenic) falls out in yellow flakes.

This simple laboratory protocol could be brought from any science laboratory. The method is basic. But it could equally well come from a forensic laboratory. It then becomes a task for the inquirer to ask further questions about "how", "who", "why" etc.

Before I turn to the interrogative model created by Hintikka (see e.g. 1991) let me quite shortly sketch the Socratic model as I see it:

Interrogation

Socrates' dialectic method never was out of fashion. According to this model — in a simple case — the questions he asks his opponents are of the type "either–or". "Should we say that one who helps a friend is an evil person or is he good?" The given answer immediately causes a new question "Should we say that ... or is it ...?". With this *method*

of exlusion Plato makes Socrates lead his opponents and even antagonists to admissions which they might not have thought of or intended but which satisfy Socrates. One way of representing such a dialogue is in the graphical tree-form:

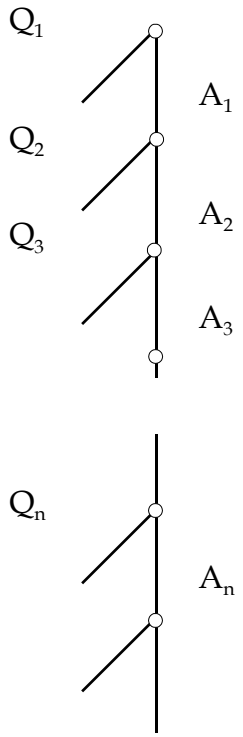

Fig. 1

At each node, m, a new question, Q_m, of the type "is it *p* or not-*p*" is asked. The given answer, A_m, leads to a new question. Many times the last answer is also the result of the interrogation but sometimes Socrates summarizes the given answers into a final result. It is then reasonable to call it a *dialectic conclusion*.

The central point in Hintikka's interrogative model, again, is the fact that judgements about facts which are to be investigated are obtained as answers to questions raised by researchers, investigators, physicians. With one word we call them the "*Inquirer*". The answers may be given by "*Nature*", as test results for instance or a witness in court. With Hintikka, we shall call the answerer the "*Oracle*".

Questions and answers are written down in a Beth type table. On the left hand side we write the truth preserving answers and inferences from them. On the right hand side we list the falsity preserving inferences.

In a court of law two types of hearing take place, direct examination and cross-examination. The judge has in his final deliberation to study these "what–who–how" questions and answers as well as the "yes–no" questions and answers from the cross-examination.

According to the Socratic model one has to follow the given answers and a) make sure that they are coherent with one another, b) that they coincide and are coherent to other testimonies, c) that they coincide with facts collected by other methods (forensic analysis, measuring on the crime scene etc.).

Assume that, in a study of yes–no-questions, some answer, say A_k, leads to unreasonable results or contradictions. Then a particular, specifying question say Q_k, is needed.

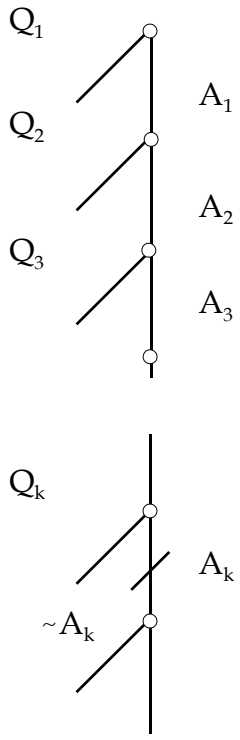

Fig. 2

If it now turns out that the opposite answer, say $\sim A_k$, leads to a more reasonable result and in addition better corresponds with all the other testimonies in a trial, then it is correct that the judge *brackets* the obscure answer A_k and everything that follows

therefrom.

What has happened so far with the proof is that the judge was not convinced by A_k but instead by $\sim A_k$. This will now have to replace A_k in the chain of evidence — after thorough auxiliary questions which clarify the node k of course.

If we carefully study the reasoning at Q_k we shall see that implicit additional questions and answers have been added. "Does A_k correspond with ...?", "What is the conclusion if we accept $\sim A_k$?", "What follows if we exclude A_k and then of course A_{k+k_n}?"

These are auxiliary questions asked either by the judge or the jury in order to be helpful in his/its search for the truthfulness of the evidence, i.e., whether the evidence is convincing — for him/it. But how does this fit into the Socratic interrogative model? Not all questions are "yes–no" questions. This problem we will have to return to, later. Here we shall see how the new "yes–no" questions fit in.

Schematically the matter may be presented in the following way: at each node, m, a question is asked. The given answer A_m to the question Q_m is added to previous given answers A_{m-1}..., in an unbroken line. The denial of these answers are seen as broken branches:

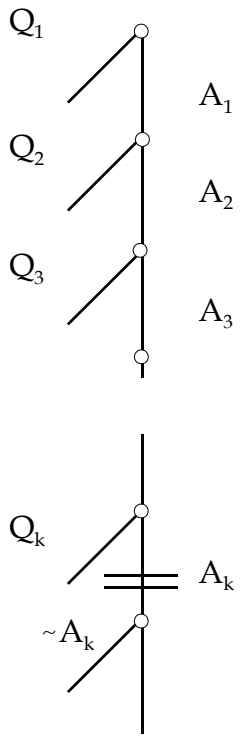

Fig. 3

In the original scheme we break the path from Q_k (actually this happens at each node, but in case of unproblematic answers A_1–A_{k-1} this will not show). At Q_k we add some auxiliary questions which are of the type "either–or".

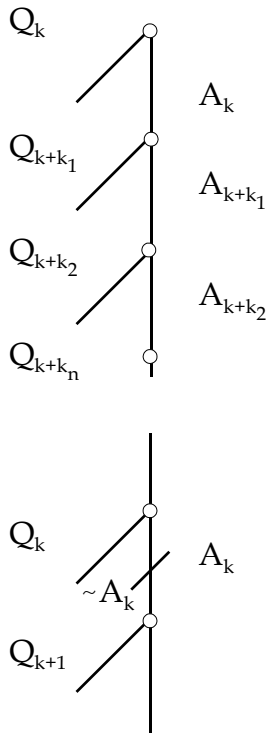

Fig. 4

After this we raise the question Q_k again but, since A_k had to be excluded, i.e., *bracketed* we choose the answer $\sim A_k$. In the end of this answer there comes the question Q_{k+1} already raised before and which was answered by one of the witnesses by A_{k+1}. But, since A_k had to be bracketed so has A_{k+1}. But then, is it so sure that $\sim A_{k+1}$ is adequate, actual or even reasonable anymore? These are the very questions which have to be raised at the node Q_{k+1}. Depending on the answers one has to either bracket the answer on Q_{k+1} once more and then see what follows from its denial, or else continue as before. In this manner one has to proceed step by step until the final answer — or conclusion — is *convincing*. Each answer has in principle to fulfil the requirements of evidence, *to convince the agent* (judge or jury) about the occurrence of that condition, the answer in

question is expected to confirm.

In an interrogative table which contains all questions raised and all answers given the bracketing happens in an analogous way. Each evidence or answer can be questioned. We obtain a complex metamodel of second- and higher-order interrogation. This can rapidly become difficult to handle but we should not forget that this practice is in use as a part of the researchers' and lawyers' daily life, to find evidence for evidence and to bracket inadmissible evidence.

The Beth-table in Medical Use

Now, let me turn to the Beth-table and let me start with an example of a different kind.

Chris participates in a weekend hiking tour in the wilderness. In the evening he begins to feel ill and his condition worsens along the night and becomes distinctly a stomach pain. The group leader who is the first one to examine him cannot find a particular hurting spot, the temperature is slightly elevated and so he decides to send for the wilderness rescuers. Meanwhile Chris is getting worse. The rescuers examine him a second time and find that he has a high fever so they decide to evacuate him. This may be a case of appendicitis.

Appendicitis is often difficult to diagnose but, in additional to pain in the abdomen one feature is a distinct difference of more than 2°C between the oral and the rectal temperatures. Except for an elevated temperature none of these other features are necessarily very clear and yet the patient may suffer from a long gone appendicitis. However, in case of appendicitis time is a consideration.

In Chris' case a fast examination at the hospital gives the following results:

Oral temp	38°C
Rectal temp	39.7°C
Stomach pain	Yes

Put in the logical form Chris' status may be presented as follows:

TABLE I

1. If the patient suffers from stomach pain and the oral–rectal temperature difference is about 2°C then the patient suffers from appendicitis
2. The patient suffers from pain in his abdomen
3. The temperature difference is 1.7°C

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4. The patient does suffer from appendicitis

In the Beth-like table we imagine the statements listed to be answers to questions. The Inquirer is the one who asks the questions and Nature or the Oracle answers. In this table we also need to list tacit knowledge which might not otherwise show explicitly:

TABLE II

							T	C
1.	p & q → r						(IP)	11. r
2.	p						P_1 or: obs.	
3.	1.7°C is almost 2°C						(tacit knowl.)	
4.	q						(LI from 3)	
5.	~(p & q) ∨ r						(LI, 1)	
6.1	~(p & q)			(5)	6.2	r	(5)	
7.1	~p ∨ ~q			(6.1)				
8.1	~p	8.2	~q	(7.1)				
9.1	p (2)	9.2	q	(4)				
10.1	x	10.2	x				bridge	

At 10.1 and 10.2 we see a contradiction, x, whereas at 6.2 we have an *open path*. As the result r coincides with the final conclusion on the left hand side we have a bridge from left to right. The inference is valid. Thus, the final conclusion is that Chris suffers from appendicitis.

The examining doctor later questions the conclusion. This means that she questions, is in disbelief about the final conclusion. Being a logical inference the inference itself cannot be doubted.

The doubt, however, concerns the conclusion in this case, i.e., the condition or

state of affairs that the inference leads to.

What the physician, investigator, Inquirer has to do in a case like this is to step backwards along the ladder which lead to this conclusion.

The questions which the doctor will have to ask concern the previous answers in the table. If the final conclusion, in her mind, is unacceptable where along the path does the difficulty arise? As the steps 1–4 are plain logical inferences, the first interrogative move (IM) she meets is 3:

1.7°C is almost 2°C.

Bracketing

The questions about this answer, call it A_3, should be first,

$Q(A_3)$	Is this answer true?
$A(Q(A_3))$	The answer is false
C	1.7°C is not 2°C.

The next question should then be, if we replace 3 with its denial, how does this reflect the final conclusion?

In our simple example it is easy to see that we end up with an open path in the table and thereby ~3 gives us a counterexample needed to disprove Chris' diagnosis.

In the theory of interrogation we talk about *bracketing*. This is a term for a method which deals with false or uncertain answers. The general idea is to locate and neutralize such answers in the table. The way of neutralizing them, once they are detected, is to delete themselves *and all inferences* where they have or may play a role.

Bracketing also means that we take a closer look at presuppositions for other questions where these false answers may have played a role. Cf. a witness examination.

Another feature of bracketing is that it may have only a temporary impact. We can always reinstall the previously false or uncertain answer in all its dimensions. This happens for instance when the Inquirer receives evidence from other, independent

sources.

Let us go back to table II and see what goes on.

Step I

1. Ask yourself: Is the conclusion reasonable?
   Q(C) Yes or no
2. It is reasonable | 3. It is not reasonable

If the answer is "yes", it means that the conclusion is accepted and the inference functions as an evidence of the consequent.

If the answer to the question Q(C) is "no" then the Inquirer has to step backwards one step at a time along the ladder which lead to this conclusion.

In our example the physician is taken to what is labeled the confirmation of the antecedent.

Step II

1. Is the antecedent confirmed?
   Q(p & q) Yes or no
2. Q(p) Yes or no
   If yes, the original table stands.
   If no, ~p in this simplified case constitutes a counterexample.
   Let us assume that
   p
3. Q(q) Yes or no

3.1 $q = t_2 - t_1$
$= 1.7°C$

3.2 $1.7°C \neq 2°C$

If the interpretation of $1.7 \approx 2$ is accepted for truth then the ultimate conclusion stands.

If the answer is *no*, i.e., $1.7 \neq 2$ then ~q constitutes a counterexample.

Let us assume now that ~q.

Thus, the answer on 3 is

4.	A(Q(q))	No
5.	~(p & q),	the antecedent is not confirmed

Therefore, if the antecedent is not confirmed — or disconfirmed, so is the consequent, i.e., the ultimate conclusion.

Finally, the Initial Premise (s), IP, may be questioned. Does this theory hold? Are there exceptions to this principle?

When the Inquirer questions a theory or a principle there are often several subtheories and fractions involved. A good starting point is to analyze the very theory so as to locate its details.

Assume our simple example. The theory has it that a patient who suffers from pain in his abdomen and whose oral–rectal temperature difference is about 2°C is suffering from acute appendicitis.

The subparts in this theory are obvious. (a) The patient suffers from pain in his abdomen and (b) the oral–rectal temperature difference is ≈2°C, (c) p & q → r.

The antecedent was already examined in the previous evaluation. Now comes the turn to the very principle. If the consequent, in this case the ultimate conclusion, is in doubt and the antecedent assumed to be confirmed maybe the whole connection is wrong.

In order to disprove this principle the physician will have to disconfirm the consequent. But, this is a very risky task when she is dealing with a possible appendicitis. If she is wrong and if the patient, despite her doubts, does suffer from an acute appendicitis, then time is scarce and a fast surgery required.

One option, and a safe one, is to perform the surgery. In case of appendicitis the patient is saved although the theory still stands. Otherwise, if it turns out that the appendix is in tact the theory has been, if not disproved at least disconfirmed. The patient will of course loose his appendix in either case.

In theory, the physician could have taken the risk of not operating. She could have bracketed the entire initial premise and could have gone to medical literature in

order to find independent sources to back up her doubts. This method is still available for her but in reality she has to take care of the patient's safety first.

We may say that the physician *postponed* the bracketing or we may say that she, for a short while made the thought experiment what bracketing of the initial premise would mean and then *reinstalled* the bracketed premise.

Evaluating interrogation by interrogation

What is remarkable in this method of bracketing or evaluation if we wish, is that the very method of the interrogative model is used — and re-used in this process of self-evaluation.

Strategies of bracketing again are dependent on *utilities*. The physician has bracketed and unbracketed of strategic considerations which in turn depend on the utility, the safety of the patient in this case.

This basic example is taken to show the fundamental strategy of argument evaluation.

The Inquirer begins with a hunch which raises questions about the conclusion of an argument. If the conclusion seems unreasonable the reason for it must lie either in earlier stages of the argument — as in our example or it can lie in some other results and knowledge the Inquirer has from other sources.

If the reason for her doubt is to be found in the very argument a thorough evaluation of the argument is in place. Our sketch may function as a guideline but the details must be worked out carefully.

If the Inquirer's doubt arises from a comparison of one argument with another both arguments have to be evaluated separately. If a conjunction of the two arguments lead to a contradiction either one (or both) needs to be disregarded.

References

Ekelöf, Per Olof, 1982, *Rättegång*, Vol. IV 5. ed. Studentlitteratur, Lund. (First published 1963).

Hintikka, Jaakko and Bachman, James, 1991, *What If …? Towards Excellence in Reasoning*, Mayfield Publishing Company, Mountain View, California.

Holmström-Hintikka, Ghita, 1995a, "Evidence, Experts and Legal Reasoning" in G. Holmström-Hintikka (ed.), *Legal Reasoning* a special issue of *Communication and Cognition*, Gent, Belgium, Vol. 28, Nr 1.

Holmström-Hintikka, Ghita, 1995b, "Expert Witnesses in Legal Argumentation" in *Argumentation*, 9:1–13, Kluwer Academic Publishers, Dordrecht/Holland.

Holmström-Hintikka, Ghita, 1995c, "On the Use of Experts in Legal Reasoning" in M. Karlsson (ed.), *ARSP, Beihefte*.

Holmström-Hintikka, Ghita, 1997, "Reasonable Doubt", CD-rom from the XVIII IVR World Congress, Buenos Aires, modified and reprinted in *Festschrift for Aulis Aarnio*, 1998.

Holmström-Hintikka, Ghita, 1998, "Inadmissible Evidence", in *Not Without Cause, Festschrift for Paul Needham*, ed. By Lars Lindahl, Jan Odelstad, and Rysiek Sliwinski, Uppsala UPS 48.