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SEMANTIC ANALYSIS OF INTERROGTATIVES AS A BASIS FOR HEURISTIC RULES

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The introduction to the most detailed and comprehensive Polish monograph on the subject of interrogative logic contains the following passage: "Constructing a logical theory of interrogatives is an undertaking that would be both interesting and scientifically relevant. One cannot help but agree with Vernoux [...]: <<*tout l'effort de l'esprit humain consiste à poser des. problèmes et les résoudre*>>" (Kubiński 1970: 9). The author of one German monograph is equally categorical: "*das Stellen von Fragen eines der entscheidenden Momente des schöpferisehen Denken ist*" (Loeser 1968: 11). Similar views are also expressed by Cackowski, who analyzes interrogatives from a philosophical and methodological perspective (Cackowski 1964).

It seems, however, that the issue is not so obvious. There are two basic points one needs to consider. Firstly, we cannot disregard the fact that a system of interrogative logic is still being made, whereas the logic of indicatives and the problems of their substantiation have been discussed for more than 2500 years. If we assume that the development of logic went hand in hand with the development of science, it might appear odd that none of the great logicians and methodologists such as Aristotle, Galileo, Bacon, Descartes or Mill devoted much attention to the issue of interrogative logic or the methods of formulating questions. This fact may be treated as an allegation against contemporary logic; however, this allegation would only be justified if we were able to prove that interrogative logic can indeed elevate scientific research to a higher level, just as the logic of deduction advances the methods of substantiation and the theory of statistics provides us with methods for verifying certain types of hypotheses.

The second dilemma is related to the discrepancies between the idiogenic and the allogenic theory of interrogatives. Allogenic theories transform interrogatives into other types of utterances: imperatives or declaratives; whereas the idiogenic theory presents questions as a unique types of utterances that cannot be reduced to any other kind. If the allogenic theory is correct, then any utterance that may be expressed in the form of an interrogative may also be presented as a declarative sentence. In this case, a system of interrogative logic, although useful as a method of formulating certain methodological directives, is not indispensable from a theoretical point of view; it may be translated into the language of the classical logic of declarative utterances. This would provide a partial explanation for the fact that the great pioneers of methodology did not discuss interrogatives *ex professo*.

The author of the present article believes that interrogatives may indeed be presented as other types of utterances, but not in the way suggested by contemporary allogenic theories. Questions are not translatable into one specific type of utterance, e.g. only declarative sentences or imperatives. Interrogatives are of a more complex construct — analysis reveals that they may be reduced to at least three types of utterances: a) sentences in the language in which the question is formulated (let us call it language P); b) sentences expressing the basics of opinions held by the inquirer which may also be interpreted as declarative sentences in meta-language P; c) evaluative, imperative or optative sentences.

Let us illustrate this with an example. The interrogative *Does the Yeti exist?* contains a descriptive element, i.e. that which may be expressed as a declarative sentence (the premise for our question): the Yeti exists or does not exist. Its epistemic element, i.e. that which pertains to knowledge or opinions, may be presented as the declarative implied by the question, namely that there is no certainty to the fact that the Yeti exists or that the inquirer is not sure whether there is such a creature. Its volitive aspect, which may be expressed as an imperative, a norm or an evaluation, is the appeal for clarification: *Let it be known whether the Yeti exists* (an imperative) or *It ought to be known whether the Yeti exists* (norm) or *It would be good to know whether the Yeti exists* (evaluation). The second and third elements may be jointly referred to as modal components, since epistemic logic and deontic logic are different interpretations of certain systems of modal logic (Koj 1971: 103).

The analysis of interrogatives provided by the present article seems very superficial and incomplete if compared to comprehensive and well-known works on the subject of erotetic logic. The reason lies in the limited aim of this study: it is only to ascertain the outlines of the method of transition from a logic of interrogatives (which focuses on the logical form of questions) to a methodology of interrogatives which defines scientifically relevant principles for forming questions. These very principles will have their use in the process of problem-oriented teaching which, at least according to some authors, constitutes a reconstruction of the process of research (Okoń 1971: 154-160).

Methodological principles may be formulated on the basis of the analysis of both the descriptive factor, i.e. declarative sentences included in the interrogatives, and the second factor which can be called pragmatic, because it expresses certain features of the inquirer: the lack of given information and the wish to acquire it. The scope of the present article makes it necessary to narrow the analysis to the descriptive factor, which may be analysed semantically and has been discussed by other scholars interested in erotetic logic.

A SEMANTIC ANALYSIS OF INTERROGATIVES

Each interrogative has a corresponding set of declarative sentences, i.e. the set of possible answers. The person asking the question is aware that at least one of the possible replies is true, yet does not know which one it is. This means that, from a semantic point of view, an interrogative contains a disjunction of the answers which may be produced in relation to this question. This descriptive, or semantic, aspect of interrogatives which has the structure of a disjunction shall be called the ASSUMPTION of the question.[1]

From the perspective of logic it is important to distinguish between tautological and non-tautological assumptions. A logical tautology does not contain any information; it is a manifestation of utter lack of data: everything is yet to be decided. Such interrogatives are called closed questions and are formed by reversing the order of the subject and the operator in the declarative sentence. The tautology that constitutes the assumption of such interrogatives is the law of excluded middle. If we ask X: *Did you polish your shoes today?* the assumption of this question is the following utterance:

[1]The concept of an "assumption of a question" and the terms "closed questions" and "probe questions," which shall be used in the course of the present article, were introduced by Kazimierz Ajdukiewicz in his pioneering work on the theory of questions entitled *Zdania pytajne* (1938) included in the first volume of his selected works published jointly as *Język i poznanie* (1960).

X polished their shoes today or X did not polish their shoes today. Such a form does not rule out any of the mutually exclusive possible answers (in this case there are two). If it does not exclude anything, then it does not provide any information. Thus, the form is a manifestation of an utter lack of knowledge about the inquirer.

An alternative answer which does not constitute a tautology, i.e. excludes some possible answers, does provide information. It delineates the boundary between knowledge and lack of knowledge and expresses the inquirer's wish to acquire additional information. Such interrogatives are called probe questions. They are formed using various interrogative particles such as *where*, *when*, *why*, etc. The division between closed questions and probe questions is exhaustive and allows us to group all questions as belonging to either one or the other category; no interrogative may belong to both of these types at once. This division is based on the form of the question (inversion vs. interrogative particle). These differences in the external form of interrogatives result from a semantic dissimilarity in the informational content of the question: closed questions provide no data, whereas probe questions include some data and indicate the nature of the missing information.

The large number of interrogative particles appearing in probe questions and the resulting diversity of sub-types within this category may be reduced using the following method. Examples of each of the sub-categories may be translated into interrogatives that include the particle *which*. This proposition is easy to prove, if we use a certain formal language to formulate interrogatives. The language of primary logic, i.e. the language of predicate calculus in which the quantifiers bind only individual variables seems sufficient for this purpose. This language would, naturally, have to be supplemented with appropriate extra-logical terms from the field our interrogatives will refer to.

The assumption of a probe question may be translated into this language as an existential sentence, i.e. a generalised disjunction. The quantifier in this sentence binds a variable which has a limited scope, indicated by the interrogative particle: for example the word *where* suggests that the answer is to be chosen from a set of locations, the word *when* points to a set of time periods, the term *how* implicates a set of methods or ways, etc. Thus, all probe questions may be transformed into interrogatives that contain the interrogative particle *which*. *Where* is equivalent to *in which place*: the aim of this question is to indicate one element of a set of places, e.g. the place in which Napoleon lost his final battle. The particle *when* is equivalent to *in which time period* etc.

Let us present this in a more precise form using the following example of a probe question: *Where is Halle located?* The assumption of this interrogative is that there is a place (i.e. some element x in a set of places which we shall call set P) in which Halle is located and that there is a place in which Halle is not located (the relation of being located somewhere shall be signified by the symbol L). Thus, the interrogative may be presented as:

(F.1) $(Ex)\ (P(x)\ \&\ L(\mathit{Halle},x))\ \&\ (Ex)\ (P(x)\ \&\ \neg L(\mathit{Halle},x)).$

The second element of the conjunction can also take the following form:

$$\neg(x)\ (P(x) \rightarrow\ L(\mathit{Halle},x)).$$

It ought to be remembered that the full assumption of an interrogative is a conjunction composed of an affirmative part, called the positive assumption of a question, and the negating part, referred to as the negative assumption. Only in this form does an assumption fully reflect the data included in the interrogative. Let us use another example. The question: *When does the next philosophical convention* (K) *take place?* expresses the thought that such a convention is planned, i.e. there is a period of time (Z) which corresponds to the duration (D) of the philosophical convention. The interrogative also implies that a convention of philosophers is not an event which takes place continually, during all given periods of time. If it was implied that a philosophical convention is a continual occurrence, no inquirer would ask the question, as the implication of the interrogative would in itself be the answer. Let us present the analysed interrogative in the following form:

$$(Ex)\ (Z(x)\ \&\ D(K,x))\ \&\ \neg(x)\ (Z(x) \rightarrow\ D(K,x)).$$

Sometimes the interrogative particle may be more specific, in which case the question contains more implied information: such an interrogative eliminates more possible answers than a less specific one.[2] If we ask: *Where in Europe is Halle located?*, we eliminate all non-European regions, thus providing our interlocutor with the information that Halle is indeed a European city; the missing piece of information is related to its precise location within Europe. The set in which European regions correspond to the territory of all countries in Europe is finite and contains a relatively small number of elements. This allows us to enumerate practically all possible answers. In our

[2]On the issue of data implied in interrogatives see: Giedymin 1964; Hintikka 1968.

symbolic representation, the set of state territories in Europe as E and the set of all state territories as P. We will now be able to demonstrate a method for comparing interrogatives on the basis of the amount of information they contain. This simple method is based on the present semantic analysis and involves comparing the number of elements in the disjunctions that constitute the assumption of the analysed interrogatives. For this method to be applicable, the sentences constituting the elements of the disjunction must be logically independent, i.e. neither of them may be implicated with the others. The example we have chosen fulfills this condition, it is therefore possible to compare the interrogatives:

(F.1) *Where is Halle located?*
(F.2) *Where in Europe is Halle located?*

P represents the set of all state territories and E stands for all state territories located in Europe. If we calculate the elements of each of these sets, we will be able to present the disjunctions which are positive assumptions of these interrogatives as a conjunction of disjunction and not as existential quantifiers; such a form of notation allows us to evaluate the amount of information on the basis of the number of elements in the disjunction. Let us assume that set E comprises k elements, whereas set P contains $k+m$ elements (where $m \neq 0$ and E is included in P). We then have the following sets:

$$E = (x_1,\, x_2, \ldots,\, x_k) \qquad P = (x_1,\, x_2, \ldots,\, x_k,\, x_{k+1},\, x_{k+2},\, \ldots,\, x_{k+m}\ ).$$

Then the question (F.1) may be presented in the following form (the letter H stands for Halle):

$$(\text{F.1}^+) \qquad (L(H,x_1) \vee \mathrm{L}(H,x_2) \vee \ldots \vee \mathrm{L}(H,x_k))\ \&\ \neg\ (x)\ (E(x) \rightarrow\ L(H,x),$$

Similarly, (F.2) is transformed into:

$$(\text{F.2}^+) \qquad (L(H,x_1) \vee \mathrm{L}(H,x_2) \vee \ldots \vee \mathrm{L}(H,x_k)) \vee \mathrm{L}(H,x_{k+1}) \vee \mathrm{L}(H,x_{k+2})) \vee \ldots \vee (L(H,x_{k+m}))\ \&\ \neg\ (x)\ (P(x) \rightarrow\ L(H,x)$$

This type of symbolic notation reveals that the difference between (F.2$^+$) and (F.1$^+$) lies in the fact that the former contains all elements of the latter plus some additional components. Thus, (F.2$^+$) is a logical implication of (F.1$^+$), yet the reverse is not true. This means that (F.2$^+$) contains more information than (F.1$^+$).

The abovementioned presentation of interrogatives leads to the following conclusions pertaining to the process of analysis and didactic methods based on it (e.g. problem-oriented teaching): Scientific research ought to be started from the specification of a problem which may be depicted as a disjunction with a certain number of logically independent elements. The next stages of the process involve limiting this disjunction further and further by eliminating some of its elements; in this process the original interrogative is transformed into successive questions each of which contains more information than its predecessor: the more elements in the original disjunction, the more stages of elimination. Thus, scientific research is a process of transforming the problem by gradual reduction of the level of uncertainty, i.e. arriving at problems whose assumptions contain more and more information.

The model of analysis presented above may be applied to interrogatives which aim at obtaining information about a certain fact: e.g. what took place, where or when it happened, etc. However, answers to such questions seldom constitute the ultimate aim of scientific research. Usually they are but the starting point, as their purpose is to accumulate factual data that lead to some generalisations, hypotheses, etc. It is therefore justified to ask whether the suggested model (treating problems as a complex disjunction and scientific research as a process of gradual elimination of some elements of the set) may be used with other types of questions that appear in the research.

These questions may be divided into two basic categories — interrogatives asking for proof or asking for explanation (Ajdukiewicz 1965). Both of these types are connected with logical relations between opinions — which can either be the relation of logical causality defined within the framework of formal logic (a theory of deduction) or the relation of increasing probability defined within the framework of the logic of induction. The present analysis shall be limited to the former relation, which is simpler and has been researched more thoroughly. The conclusions pertaining to interrogatives of this type may *mutatis mutandis* still apply to questions aimed at increasing probability.

If sentence B is a logical consequence of a certain sentence A, then sentence A is a logical cause (or simply: cause) of sentence B. The concept of logical cause may be applied to describe both types of interrogatives mentioned above, namely asking for proof and asking for explanation. This notion takes into account the connection between the answer which is sought and the set of theorems comprising the adopted system or theory (in the present article it shall be referred to as 'the system').

The process of PROVING consists in finding a cause for a sentence which has not belonged to the system from among sentences that are included in the system.

The process of EXPLAINING consists in finding a cause for a sentence within the system from among sentences which do not belong to the system.

Both these processes result in expanding the system to include a sentence that had not been a part of it, thus adding new information. One typical example of proving are the procedures used in systems of deduction, e.g. mathematics, if a derived statement is proved on the basis of axioms. Explaining may be exemplified in procedures used in empirical sciences and consisting in finding hypotheses which would explain and predict the progress of an experiment. Both in proving and in explaining the logical cause is an answer to a question which includes the interrogative particle *why*, in other words — a probe question. Such interrogatives may also be presented as a set of possible logical causes for the sentence which is being proven or explained.

When attempting to prove a theorem, we take into account many theses which already are a part of the system, analysing whether they may be used as premises for the theorem we are tying to prove. Thus, the initial stage of research may be presented as a disjunction of the potential premises of the sentence being proven. They shall be represented by the symbol b; G will stand for the relation of being a logical cause (of b). The demand for a proof may then be presented as a question the assumption of which is the following disjunction: $G(b,x_1) \vee G(b,x_2) \vee \ldots\ G(b,x_k)$ where $b \notin S$ and $x_1 \ldots x_k \in S$; $x_2, \ldots x_k$ are theses of the system S taken into consideration as potential premises which are logical causes of sentence b.

When searching for the explanation for some facts known to us or, more precisely, for sentences that refer to such facts, we take into account various hypotheses aspiring to the role of explanatory theorems. These shall be represented with h_1, h_2, etc.; e will stand for the sentence or the set of sentences which are being explained. The assumption of the problem would then take the following form:

$G(e,h_1) \vee G(e,h_2) \vee \ldots \vee G(e,h_n)$, where $e \in S$ and $h_1 \ldots h_n \notin S$.

In the case of explaining the set of possible causes is not given, as it is given in the process of proving, where the set of sentences included in the system is always finite and well-specified. The set has to be created over the course of the research. This process requires the utmost degree of creative effort; it may therefore be assumed that the formulation of the problem is the most difficult and demanding research task. The following section shall try to answer the question to what degree can this task be made easier and more successful by the use of methodological principles of forming interrogatives (formulating the problem).

RULES OF PUTTING QUESTIONS

To arrive at the correct answer to a question, one has to base the interrogative on a true assumption. For example, it is impossible to answer truthfully to the question: *Where was Paradise located?*, because this interrogative contains a false assumption that there is a place which used to be the location on Paradise. This question may only be answered with: *There is no such place*, yet such a reply would not be determined by the structure of the question; it is merely a negation of one of the assumptions — the positive one.

The most general type of assumption, i.e. a question of existence, is lest likely to be incorrect, but provides the least information. Only by transforming it into a disjunction that specifies all possible elements in the set of answers are we able to test each constituent and see whether it has the quality mentioned in the question. A disjunction in the form of a statement of existence: *There is a person who committed a given crime* does not provide any data for identifying this individual. Only a limitation of the set of people which produces a disjunction with a relatively small number of elements and involving individuals who may be identified, gives us a chance to find the answer. Naturally, such a form is more likely to contain an error than general statements (e.g. *There exists such a z that L*). A disjunction which specifies the actions leading to a solution and does so by enumerating the possible answers shall be called an EFFECTIVE assumption of a question.

Thus, a disjunction which constitutes the assumption of an interrogative needs to be true and effective. These two postulates may be regarded as conflicting, because general (and thus more likely to be true) assumptions are not effective, while in the case of specific assumptions (and thus effective) the risk of an error is higher. For example, the interrogative *When will world society become classless?* has a very general assumption: *there is a point in the future when the society of the world will become classless*. The *a priori* probability of this sentence is relatively high, but shall decrease if we make the interrogative more specific, limiting the choice to a set of years comprising the remaining part of the 20^{th} century. We shall then arrive at a question based on the following assumption: *In a certain year of the 20^{th} century world society will become classless.* With regard to the type and the level of effectiveness, such an assumption is similar to futurological problems related to long-term prognosis. However, the risk of error is much greater than in the case of the previously analysed one, which had a minimal degree of effectiveness.

The main problem with the strategy of formulating questions is finding a balance between effectiveness and probability optimal for a given case. There are two factors influencing the degree of effectiveness of an assumption that may be helpful in this search for the optimum: the number of elements in the disjunction and the possibility of identification of the items mentioned in each of the elements. The more elements we include, the less effective the disjunction becomes, because each addition increases the risk that there will be no time to analyse all elements. The less specified the items mentioned, the lower the effectiveness of the assumption (the least specific are statements of existence, such as: *there exists such an x that...* that pertain to the entirety of the analysed subject). In order to increase effectiveness without affecting the probability we need to form assumptions with a large number of elements but a well-defined set of items to which the assumption pertains. Detectives conducting an investigation start from formulating a disjunction that includes many suspects, and gradually eliminate certain individuals from this list. If they limited the analysis to a very narrow group of suspects, they might overlook the actual culprit, i.e. start from an incorrect disjunction. It is no surprise that an ill-formed question based on an inaccurate assumption does not lead to a correct answer. Similarly, a scholar at the initial stage of the research often takes into account many hypotheses aimed at explaining the same group of facts; a disjunction including all of these numerous hypotheses (an assumption based on the interrogative particle *why*) is more likely to be true than one which contains only some of them. It is therefore advisable to start with the largest possible number of ideas that might be the solution, with full unrestricted creativity and attention to suggestions made by colleagues or found in the relevant literature. We need to beware of the preconceptions and prejudices which lead to the *a priori* exclusion of some of the solutions. This stage of research calls for inventiveness and openness — the time for criticism comes later. Such openness and boldness ought to be taught at school, with the help of the methods specific to problem-oriented education.

After presenting the problem as a disjunction of many possible solutions, we need to start eliminating some of them. This process is called reducing the disjunction. There are many methods of doing this, yet each of them has a specific impact on the effectiveness and economy of the research. The first stage involves eliminating the elements of the disjunction which were included as a result of the ambiguity or fuzziness of certain terms appearing in the interrogative. If a statement contains an ambiguous term and one meaning of this word refers to the set of items M_1 whereas the other meaning pertains to the set of items M_2, then this statement is in itself a disjunction of two statements, in which one pertains to the set M_1 and the other to the set M_2. If the author of such an utterance does not intend to refer to both of these sets, then one of the elements in the disjunction is not needed. The person making the statement ought to realise which set of items is meant and eliminate the superfluous one, thus reducing the disjunction. Various terms may be considered ambiguous: in some contexts this category includes for example the word *socialist*, as it pertains to two different sets: Marxists and social democrats. Let us imagine a research project which aims at ascertaining the opinion of socialists on the monetary crisis in capitalist countries. A disjunction formed on the basis of this interrogative might be presented as: *Among socialists there are people holding the opinion X or people holding the opinion Y*, etc. If we do not specify the meaning of the term 'socialist', we will be forced to include a greater variety of opinions; thus our disjunction shall be composed of a larger number of elements. This surplus will be unnecessary and detrimental to the research, if the author only wanted to know the opinion of Marxists and did not specify this out of negligence.

Terms may be considered 'fuzzy' if their scope is difficult to ascertain — certain items are easy to classify to a given category, whereas in the case of others there is no method of specifying whether they may be considered designates of a given term or not. Let us use the example of the term *child*. Our understanding of this word leads us to include certain individuals in this category and exclude some other. There are, however, cases in which it is difficult to ascertain whether a given individual ought to be counted among children or among adults. There are some methods for reducing or eliminating the fuzziness, e.g. assuming that a person over 16, 17 or 18 should not be considered a child. Differing interpretations of fuzzy terms lead to differences in meaning, it may therefore be assumed that fuzzy terms are potentially ambiguous. From this point of view, a fuzzy term is a disjunction of two or more terms resulting from the various possible interpretations. For this reason, using fuzzy terms to formulate problems makes the assumptions of these sentences into disjunctions whose level of complexity is much higher than necessary. We may for example ask: *What is the role of monographic lectures in higher education?* By 'monographic lectures' we might mean lectures during which the teacher presents certain results of their own research, but the term is in fact fuzzy: the degree of 'monographic-ness' (if we may call it thus) depends on the detail and originality of the given text. If we include the different definitions of the term 'monographic lecture' into the disjunction, the number of elements will be greater than in the case of a more precise definition.

The use of fuzzy terms is associated with one more risk other than the excessive length of the disjunction. The possible interpretations of a fuzzy term leading to its specification must be enumerated. There is, however, a possibility that one or more interpretation will be omitted; if it happens to be the interpretation included by the inquirers, they will not get the answer they were looking for. Let us use an example. A pedagogical questionnaire distributed among academic teachers included the following question: *What features of our students are worth mentioning?* The expression 'worth mentioning' is highly fuzzy, and thus may be interpreted in very different ways. Some of them involve indicating a certain point of view: moral, political, intellectual, custom-related etc. Some of the surveyed may, for example, be particularly struck by the influence of the academic environment on lifestyle and consider it 'worth mentioning' that after a few months at the university students start to dress more elegantly. If we assume that the author of the questionnaire was more interested in the moral aspect (this may be deduced from the fact that the survey was related to interpersonal relations) and sought information about the students (and not about the people surveyed), then an answer pertaining to the dress code shall make no important contribution to their research.

Let us assume that the problem has been formulated in a clear and unambiguous manner, *ergo* the disjunction of all possible answers that constitutes the positive assumption of the problem does not include any unwanted elements, i.e. ones which would not correspond with the intentions of the inquirer. If our problem is highly complex, i.e. the disjunction is composed of many elements, the next stage is to reduce it to a simpler question by identifying the component problems; the answers to these issues put together shall provide the answer to the entire problem. Sometimes at a given stage of research it is possible to ascertain the answer to only some component questions — then we will provide merely a partial answer to the main interrogative. A ‘component problem’ is a question whose assumption is based only on a certain part of the disjunction that constitutes the assumption of the main issue. Reducing the problem to one of its component issues is often necessary in teaching, e.g. in determining dissertation subjects. If a subject is too demanding for a student or could not be fully analysed due to time constraints, difficulties in finding relevant literature, lack of the necessary laboratory equipment, etc., then the problem must be limited to one of its compound issues.

Let us use the example of a question pertaining to pedagogy: *How does a student’s home environment influence their learning abilities?* It can be limited in a number of ways, e.g. take into account only some sub-set of all students or limit the set of abilities to certain skills (such as the ability to remember new information). To present this question in the form of a disjunction, it is necessary to enumerate all possible sub-sets. This process allows us to evaluate the complexity of the problem and, if necessary, limit it. For example the set of ‘home environment’ may be analysed according to various criteria: the material status of the family, the parents’ education; the number of children in the family, the parents’ level of commitment to work, etc. Each of these aspects of home environment has to be confronted with learning abilities (evaluated e.g. on the basis of school grades). Then the question: *Which aspect of a student’s home environment influences learning abilities?* has a corresponding disjunction of the answer: *Learning abilities depend on the material situation of the family, the parents’ education or the level of family violence*, etc.; as with all disjunctions, at least one of the elements is true, which does not exclude the possibility that more than one sentence in the disjunction (or even all of them) is correct. If, for some reason, the factors mentioned in some of the elements of the disjunction are difficult to analyse or if the sheer number of factors constitutes an obstacle, it is justified to limit the research to only some of the components. However, the researcher then runs the risk of eliminating the true sentences and leaving only the false ones. Thus, the process of reducing the disjunction must be performed carefully, on the basis of well-grounded knowledge of the analysed phenomenon. If, for example, this knowledge suggests that there is a connection between the emotional situation of the family and the learning abilities of children, we will not disregard this factor in our analysis, but ask further questions that will allow us do describe this connection in more detail.

The final stage in the formulation of a problem, which directly precedes the start of the research, is the creation of a research plan. To do this, we have to begin with identifying compound problems (this issue has already been described). Then we need to decide, which of these problems are to be included in the research and which are to be disregarded. Having agreed on the list of problems to be analysed, we need to consider the order in which we want to solve them and the means needed to do so. Factors such as time, the staff of assistants, sources and relevant literature, need to be secured beforehand, if our research program is to be realistic. Otherwise there is a possibility that the research will have to be discontinued due to lack of resources — squandering those that had already been allotted for the purpose.

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The rules of formulating questions described above are very similar to the principles that govern heuristics, i.e. the science of problem-solving. These rules were specified by the famous mathematician George Pólya in his book *How to solve it* (Pólya 1945). His guidelines refer only to mathematical problems and may be considered a generalisation of the experience in teaching and research. This makes the similarities between them and the rules presented over the course of the present analysis (strarting from a semantic analysis of interrogatives and moving towards highly general principles useful in all types of research) all the more interesting. Here are the most basic principles mentioned in Pólya's book (without the the particularisations relating to each of them):

a. Try to understand the problem;

b. Find the relation between the given and the unknown;

c. If you cannot find the relation using direct methods, you may have to start by solving auxiliary problems;

d. Devise a plan for solving the problem.

The remainder of Pólya's guidelines pertains to the process of solving the problem, and thus goes beyond the scope of our subject.

Principle (a) is similar to the second rule determined in the present article, namely the one that advises to determine the meaning of the words included in the interrogative, in order to eliminate all polysemantic and fuzzy terms. These directives are related, but not fully equivalent, because mathematical problems do not include any linguistic defects such as ambiguity or fuzziness. The only risk is that the researcher may misunderstand the meaning of the problem. Our principle allows for a situation in which the recipient of the question is at the same time the inquirer and the value of the answer depends, among other things, on the accuracy of the form of the interrogative, including terminological precision. Precision of form allows the inquirer to realise what information they are trying to obtain — in other words, how this problem is to be understood.

Guideline (b) resembles the principle which was discussed at the very beginning of the present article, i.e. the one postulating that the assumption of the question ought to be formulated as a disjunction including all possible solutions. The assumption of the question is our given, whereas what is unknown is which elements of the disjunction are true. Thus, a disjunction which is the assumption of an interrogative does, in a way, reveal the relation between what is given and what is unknown.

Principle (c) is a type of a particularisation of the rule postulating the limitation of the analysed problem, i.e. choosing the elements of the disjunction which constitute certain compound problems. Since solving such problems leads to finding the answer to the original question, they may be called auxiliary problems.

Finally, guideline (d) resembles, even in its formulation, our principle of creating a research plan; it must, however, be added that with mathematical problems the plan does not need to include as diverse factors as in the case of empirical research, which are often conducted in teams and call for more financial resources — an issue that also has to be specified in the full research plan.

The analysis of interrogatives presented in this article together with its application in heuristics may be used for solving practical problems colloquially communicated by expressions such as "what to do?", "how to do it?", etc. The mathematical theory of decision making is a type of an ideational theory of practical questions. This mathematical theory presents the issue of deciding on a system which includes, among other things, the disjunction of all possible courses of action, i.e. the disjunction of possible answers to the question "What to do?" This leads to analogical conclusions postulating the completeness of such a disjunction, the specification of compound or auxiliary problems, etc. This is, however, an issue for further analysis, which would have to be conducted using the terminological system of the theory of decision-making. For this reason, the present article was limited to a general consideration of the issues related to the theory of questions.

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