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Artificial Intelligence as a Tool of Classification, or: The Network of Language Games as Cognitive Paradigm

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It is shown that the cognitive paradigm may be an orientation mark for automatic classification. On the basis of research in Artificial Intelligence, the cognitive paradigm – as opposed to the behavioristic paradigm – was developed as a multiplicity of competitive world-views. This is the thesis of DeMey in his book "The Cognitive Paradigm". Multiplicity in a loosely-coupled network of cognitive knots is also the principle of dynamic restlessness. In competition with cognitive views, a classification system that follows various models may learn by concrete information retrieval. During his actions the user builds implicitly a new classification order. (Author)

1. AI – topic for two research problems

Formulated in such a general way, the title of my lecture can be easily misunderstood. You may think that I want to introduce a precise classification system for storing and investigating knowledge. This is not my aim. Instead I want to elaborate theoretically those principles which form the basis of Artificial Intelligence as far as it is used in accordance with its medial principles. Artificial Intelligence is neither a science nor a substantial device, but rather indicates a question referring to two research problems:
1. How can the computer be programmed to work in a way comparable to that of human intelligence? The answer is the TURING-Programme.
2. How can I learn something new about human cognition by constructing and programming intelligent operations?

Understood correctly, Artificial Intelligence is a paradigmatic research strategy which follows a cognitive paradigm. This is what I want to discuss. Another topic shall be what results from following this cognitive paradigm when dealing with a classification problem. What does this mean as far as the corresponding concepts and the appropriate relations between the concepts are concerned?

2. Paradigm and language games

Before going on to the main points, I would like to comment on the origin of my thoughts. It was ten years ago that I first heard of the new fashion of "cognitive theory". At that time scientists working in the field of educational psychology and research in teaching began to doubt the behavioristic paradigm[1]. I was surprised. I have never been a behaviorist myself. I have always opposed behaviorism, positivism and physicalism in psychology – on the background of traditional gestalt psychology, psychology of thinking and structure and systems theories. I have followed the ideas expressed in the later philosophy of WITTGENSTEIN and in KUHN's theory of science which stands in the tradition founded by WITTGENSTEIN (6)–(8). What does following the philosophy of WITTGENSTEIN mean in this context? It shall be explained briefly, because it is important for the understanding of what follows. Each paradigm – no matter whether it stems from behaviorism, systems theory, structuralism, or the psychology of thinking – functions as an orientation mark in a language game. With its help the rules, the calculation, and the metaphysics of a given language game are reduced to the basic contents of its pragmatic function, thus giving it a meaning, that is an objective, semantic relation to world. In this context, we owe WITTGENSTEIN a lot, because he has shown that just in this function the paradigmatic example cannot be substituted by anything else, that the meaning of the language game is ruled transcendentally by it.

Postulating the paradigm as a very important factor, WITTGENSTEIN at the same time reduces its importance. It only has a function in the respective language game. In other languages games those facts which provide the paradigmatic rules may only be one empirical fact among others. Therefore we must say: What is a principle in one language game, turns out to be a mere fact in the other one[2].

Here I would like to go back to my starting point: what functions as a principle in the language game of behaviorism, is only a contingent fact in the language game of structuralism, and in the language game of systems theory this is true for both and so on. The fact that I critizised behaviorism at that time was not based on my belief that it was completely wrong, but on the fact that it claimed dogmatically to be the only genuine perspective. That this is not true is shown by WITTGENSTEIN's theory of language games, and in its spirit it is today's task to defend behaviorism against the dogma of subjective theories. This strategic relativity follows the correctly understood cognitive paradigm, which can be verified by research in the field of AI.

3. Marc DeMey's "Cognitive Paradigm"

Like all fashions, the cognitive theory in educational psychology and research in teaching looked very simple at the beginning. Input-operation-output has been and still is the main catchword. But this catchword fails to define the law of the cognitive view, it only formulates the automatic control system of an automat[3]. It proclaims cybernation in its plainest form (central heating) to be the model of cognitive processes. This catchword of the automatic control system not only fails to show the problem of the cognitive view but also of the core of AI. I found this view confirmed in Marc DeMey's excellent book "The Cognitive Paradigm" (11). Following his

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analysis, I should like to develop my ideas, which will show that all I said before has a substantial core.

In his book, Marc DeMEY tries to give a general view of the various scientific tendencies (in different disciplines and specialities) which all follow this new paradigm – the "cognitive view". The sense and meaning of what is called cognition, cognitive theory, cognitive paradigm does not result from the simple addition of singular definitions, but rather from the sequence of representation in his book. This makes it impossible to give a standard definition. But it is just this feature which characterizes the paradigmatic view. De MEY does not give a definition, but a description. Right at the beginning, he exemplifies this paradigm by referring it to research in Artificial Intelligence, thus determining – I think for the first time explicitely – the arising of the cognitive paradigm in the course of scientific development in connection with the invention of the first intelligent tool, the computer.

This idea marks the central point of his book. This becomes obvious from the author's use of a systematic framework in writing the book, taken from experience and solutions in the development of AI. This systematic framework consists of four different stages as described by D. MICHIE[4].

1) A monadic stage deals with collecting and handling elements which are regarded separately and independent of each other, as if they were single, self-contained entities. An example from AI research is the word-to-word translation in mechanical translation.

2) A structural stage deals with the perception and distinguishing of more holistic and complex structures as relations defined on sets of elements. Syntactical analysis is the corresponding example from mechanical translation.

3) A contextual stage deals with the examination of the context or the environment in which structures emerge and thus attain definition at the same time indicating the context. Examples from AI research are the context analysis and the analysis of indexical expressions in language processing.

4) A cognitive stage deals with world views and world models that regulate the relationship between structure and environment in various respects. From a subjective viewpoint, these models and examples regulate the selection of the context, which is only hinted at in the corresponding structure. From an objective point of view, world models guarantee the asymmetric relation between structure and context, thus constituting the difference between the system and its environment. They determine what belongs to the world and what is outside it. These world models have a task- or problem-orientated nature and transcend the traditionally strict difference between subject and object. According to De MEY, the corresponding example in AI research is analysis by synthesis, in which – starting from world models or potential worlds – expectation selectively generates language processing and controls understanding by means of sense and meaning by reducing the complexity of possibilities as far as necessary.

4. World Models and Cognition

According to De MEY, the four stages can be transferred to the history of empirical sciences and to their specific theory of science. They first of all correspond to Positivism and Behaviorism (13) (14) with its monadic Elementarism, secondly to logical Empirism (15) in its basic structural features, thirdly to the science of science and to systems theory (16) with its contextual procedure, and fourthly to the cognitive theories resp. paradigm theories[5], which themselves represent the cognitive stage.

Marc De MEY thus describes history as the changing dominance of the afore mentioned language games which appear as stages in problem-solving strategies. He therefore sees a correspondence between the graded structure of AI and the history of human knowledge and its theory of science. This allows us to look upon the concept of AI as a temporarily final point in the development described. It is an interesting and characteristic point of view to look upon the cognitive theory as a paradigmatic theory. This historical phenomenon demonstrates implicitly the ambiguity of the cognitive paradigm. As a result of this development, the cognitive paradigm is itself a subject and an aspect of consideration. But it is at the same time the viewpoint of consideration and its basis of distinction in the four-stages-model. This circle implicitly exposes the cognitive view in a paradigmatic way. It is also a topic in AI research and is dealt with as a circular procedure of problem-solving. The ambiguity of the circle lies in the fact that the cognitive stage as a paradigm forms the fourth stage, but is also as the stage of world models the model for the arrangement of the four stages as a whole.

An example – an almost classic one – shall help to illustrate this. The problem in the understanding of the sentence: "Time flies like an arrow!" The most simple and ostensible translation is: Die Zeit fliegt (davon) wie ein Pfeil (i.e. time vanishes very quickly). It is derived from a simple syntactical structure and a word-to-word translation. But you can also understand "time flies" as a compound noun and "like" as a verb, then the sentence could be translated as follows: "Zeitfliegen lieben den Pfeil (oder die Pfeilspitze)". Here the syntax analysis is influenced by the word analysis. A third possible translation could be the imperative: time, i.e. measure the time of, flies like an arrow (messe die Zeit von Fliegen wie einen Pfeil), and this can mean: 1) measure the time of flies like you measure the time of an arrow; or 2) measure the time of flies as quickly as an arrow. This classical example from translation theory given by OETTINGER[6] shows that a) a word-to-word translation is not unambigious and that b) you therefore need an analysis of the sentence structure. But also the syntax is not unambigious so you need c) an analysis of the context in order to decide what the sentence wants to say. But even when you have decided that it is an imperative – as in the third possible translation – you need d) a model to find out what the comparison "like an arrow" really means. This could be an example, which directs the use of the comparison, thus determining the "world view". This example of a translation problem is used by De MEY paradigmatically to explain what he calls cognition. And it is indeed plausible as, generally, any intelligent human being can understand this sentence at once, because he combines all four kinds of view. He combines the elementary semantic analysis, the structural analysis of the syntax, the indicators for the context and the paradigmatic world views. Modern computer science tries to copy this human procedure with parallel-working Not-VON-NEUMANN-Machines.

5. Network theory and expert systems

De MEY also chooses the theoretical concept of a network to describe the structures of cognition. Although this concept is not explicitly unfolded thematically, it has to be considered as the theoretical complement of the paradigmatic view. As far as the cognitive view reckons with a multitude of world models as a factor of its own constitution, the connection of this multiplicity cannot exist in ONE system, but only in a loosely-joined network that is functionally centered and condensed in cores. At this point it would be helpful to add under a systematical viewpoint a discussion of systems theory (22) (23), which would be useful to clarify the question what the cognitive paradigm is. It would also help to realize the evolutionary character of the cognitive more strictly and plausibly.

Giving the example of the psychology of attention and perception De MEY shows the network-like procedure of problem-solving. In this case, too, the paradigm of the network is the expert model from AI research. I will stick to my example. If the set of words is not adequately decoded on one level of view – analogous to the four stages – the problem is delivered to another procedure which uses another level. Each level has a corresponding expert automaton which is able to solve only the problem of this level. The final solution results from the interaction among the experts. It is unimportant whether the method employed to solve the problem goes forward from the elements to the models or vice versa. A circular interaction is also possible. In any case, the problem-solving can be thought of as a dynamic path through a network whose knots are the expert subsystems. In general, problem-solving follows the rules of a cognitive structure whose main law is the arbitrary change of the system references. The system-subsystem-relation can be constantly changed. That means that in cognition the contextual dimension can be a subsystem of the monadic dimension and furthermore the monadic dimension can be a subsystem of the structural dimension. In this way a circular, paradox network of inherences appears as the law of the dynamics in which the expert systems interact. That means that the subsystem that has just been subordinated can be the higher system in the following step of problem-solving procedure. It is easy to see that this law represents Russel's antinomy of the set which contains itself as an element, although the stage structure is constructed in a type-theoretical manner[7]. The inherence of "all in all" enforces unfolding. It enforces a process creating situatively the formation of hierarchy that is of a problem-oriented, unstable nature. The hierarchy must be unstable in such a way that it can collapse at any time in order to give way to a new process development. Instability is thus the main feature of cognition. That has been and will always be one of the main tasks of research in AI: to translate such a form of instability into adequate algorithms of computer programmes.

6. Demand for dynamic classification

That means, in order to grasp theoretically the nature of the process in which thinking and knowledge develop, one has to focus on the law of instability. Stability – as it is expressed by the classification systems of traditional classification, as for example the arbor porphyriana (26) – has a teleological tinge and is prone to a harmonizing tendency. Harmony denotes the state of rest of intelligence, that means the stage in which intelligence becomes exhausted on its way through the world. This concept is not able to grasp theoretically the dynamics of intelligence. It fails to mark the basic restlessness that becomes dynamic by jumping to a higher level, on which "super-signs" are formed if there is too much quantitative complexity on one stage – for example from the monadic to the structural stage, from alphabet to meaning – and thus cognition continually reduces complexity. Instability in overstrain forms the actual motor of development of cognitive activity.

7. Models of cognitive classification

What relevancy has all this to the problem of using AI to classify our knowledge? At this point I will not say more about the classification of our knowledge, because it is evident that the traditional classification models are not able to express all aspects of the network of subsystems. I would like to summarize once more the results of the problem analysis of AI.

1) AI and correspondingly cognition cannot be grasped by the simple automaton model, but only by the model of a network of automatons.

2) The system of these automatons does not form a super automaton, which functions like a closed system according to strict rules, but forms a loose network. If we look upon an automaton as a language game, it refers to the position of WITTGENSTEIN, according to which different language games are not connected in a sort of super language game. The understanding of computers as language games results from the fact that they are controlled by programmes, i.e. texts and therefore language.

3) According to WITTGENSTEIN the loose network combining the language games is made by family resemblances. Family resemblance is illustrated by examples. Its particular determination is revealed in examples. This shows that the paradigmatic is of foremost importance.

4) The paradigmatic example is the intensive, i.e. the semantic form of the world model, which, for its part, represents the structural-schematic form of the example. This shows the ambiguity of the cognitive view. As a structural model it is the externally extensive horizon-marking boundaries – the heuristics of a cognitive map, but being an example it is the internally connecting, concrete principle, which, in its concreteness, is contingent in itself. The example is the core, the orientation mark (viewpoint) in the cognitive map; this mark may vary but is nevertheless that point which defines areas in the cognitive map. Therefore you can say that the fourth cognitive stage of MICHIE's concept also regulates the interaction between all stages. So the four-stages-model as a whole can be called the cognitive view, though the cognitive view is only a part of the whole model.

5) The network of automatons or, to put it shortly, the network of the cognitive, is necessarily a loose one. This follows on the one hand from the Janus-faced nature of the paradigmatic as a contingent principle. Moreover, it becomes plausible when you take into consideration that cognition should be understood as a dynamic principle. On the automaton level this means that the given expert system should be able to "learn". For classificational systems of knowledge this means that the classification should be a dynamic one. This seems to be a contradiction in itself, but it is always included where any problems of AI are concerned[8].

6) The loosely coupled network of the cognitive is combined by family resemblances. That implies a variety of relations of resemblance as they always occur, for example, in a family. That is the reason why WITTGENSTEIN used just this term. The schematic, but not excluding, core of family resemblances is analogy, which represents a kind of resemblance of resemblance: grandfather resembles mother in the shape of face, just as my uncle resembles me in physique[9]. Analogy means the resemblance of proportions and is therefore a suitable instrument for building up a network. Analogy does not only denote the resemblance between elements, but at the same time refers to the resemblance of other elements. Referring to other elements, an open universality is expressed, that is in the case of analogy you can combine everything without having to give up classifying differences. The Middle Ages with their tradition of working with analogy could therefore say that analogy combines the principles of sympathy and antipathy, as FOUCAULT has shown in his book "The Order of Things"[10].

I have reached a point where I can give an answer – at least in principle – to the question whether a cognitive classification is a potential tool of AI. I will leave it to the experts to apply it in practical situations. I'm sure that it will raise a lot of questions. Once again I would like to summarize this in some points.

1) It is the task of cognitive classification to design a network of automatons. According to this, the elementary stage deals with the verbal classification of knowledge into meaningful units and their corresponding synonymous identification. This will produce the lexicon of the automaton. The structural stage could produce an expert automaton which classifies just these relations as "super-signs", that is as abbreviations for chains of meaningful units. The contextual stage could summarize fields which unite meaningful units according to certain relations. The paradigmatic stage would have the task of laying down paradigmatic examples which classify the afore-mentioned fields and also produce a multitude of world views.

2) It would be necessary to define the model character of these examples, so a classification of examples would result in a variety of world views. The activity would be the model and the "I do something" the paradigmatic example for classification of knowledge expressed by BALLMER (30), whereas the genetic, that is the dynamic automaton, would represent the world model scheme of classifications presented by UNGVARY (31) (32). It is possible and might be very fertile to have both models compete in an expert-system. This competition, this multitude of world models, this network of language games, is the main idea of the cognitive paradigm.

3) On the other hand these models, of which I have mentioned only two examples known to me, determine, as we know, those fields in which meaningful units are combined both according to their semantic field features (in a strict sense of the term) and to their structural links. These models can be found in BALLMER's fields of passive or transitive activity or in UNGVARY's genetic automaton of economy or religion, just to mention two.

4) Each of these models follows the intensity of an example. With UNGVARY it is the computer, with BALLMER the "I do something". The second face of the Janus-head results from the given schematization. The scheme of activity is a time feature (the structural figure of time). At the last meeting of our society BALLMER appreciated my proposal. He wanted to discuss my analysis referring to this matter, but his lifespan came to an end (33). UNGVARY's world model is the abstract, mathematically defined automaton. It is so interesting because it is the model of the cognitive itself, but not in the simple form for which I reproached the early cognitive psychologists. As a world model it implies – for UNGVARY – the dynamic self-multiplication of the automata.

5) Both models are contingent. It is not necessary to decide for one of them on the basis of truth. Each of them generates different similarities. They compete in a productive sense. To some extent they describe the same practical net and at other points they differ from one another and multiply world to a network of potential worlds. That is precisely the task a dynamic classification should be able to fulfill. According to the structure of AI it cannot be the aim to unite the two world models in one model alone which might unite. Their strength is their diverging parallelism, which enabled the classification system to "learn" and to build up new models according to the use and the possibly combined results from information retrieval. For each retrieval produces a new example of classification, which can determine a new world model when the path of the retrieval within the network is schematically generalized. Therein lies the strength of intensive and semantic reference.

6) The schematizing model concept results from the relations of similarity emerging when the given classification system is used, that is during information retrieval. It is not possible to say in advance if the analogy, the aemulatio or the convenientia are used in that retrieval. As a substitute for the lack of creativity and of situational invention of possible resemblances, which is characteristic of man's intelligence, the expert system of classification would have to contain a sub-system of potential resemblances, which would have to be at least as rich as that known in the Middle Ages and which – according to FOUCAULT contained fifteen different relations of similarity[10]. This is a field of reconstructing research. It could also be relevant as a field of activity for numeric classificators because their wealth of experience in dealing with similarity statistically could be used for classification by AI. It is this important aspect – that an expert system for classification should be able to learn by concrete information retrieval – which

suggests the implementation of a subsystem, which by using knowledge in retrieval works out empirical clusters and, as far as these clusters can be numerically condensed to ideal cluster cores, leads to new paradigms (34) (35). What is thus done in a mathematical way, was known in the Middle Ages under the name of Convenientia.

Notes:

1 See references (1)–(4). The relationship with AI-research is indicated by Trappl (5), p. 831–838, in particular p. 833.
2 See also Hönigswald (9), p. 65. According to Hönigswald there is no concept of the *one* truth. What the concept of truth means may be shown in a network of variations of this concept in various scientific domains. Wittgenstein calls these domains "language games".
3 See Miller (1) and in particular König (10)
4 See Michie (12). He describes only the first three stages, the fourth stems from DeMey.
5 See Wittgenstein (6) and Kuhn (8). See also Minsky (19) and Piaget (20).
6 See DeMey (11), p. 13 and Oettinger (21) p. 113–130, in particular p. 125–.
7 See also the "language-game-solution" in Wittgenstein (24) and (25).
8 As an example for a more modern and dynamic approach to classification see Judge (27).
9 See Wittgenstein (6), p. 67– (quoted in points).
10 See Foucault (28) and also Thomas de Vio (29).

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