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MODALITY AND FOLK PSYCHOLOGY

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Abstract. The connection of the modern psychology and formal systems remains an important direction of research. This paper is centered on philosophical problems surrounding relations between mental and logic. Main attention is given to philosophy of logic but certain ideas are introduced that can be incorporated into the practical philosophical logic.

The definition and properties of basic modal logic and descending ones which are used in study of mental activity are in view. The defining role of philosophical interpretation of modality for the particular formal system used for research in the field of psychological states of agents is postulated. Different semantics of modal logic are studied. The hypothesis about the connection of research in cognitive psychology (semantics of brain activity) and formal systems connected to research of psychological states is stated.

Keywords: folk psychology, mental, modal logic, possible world, mental state, modality, modal formalisms.

МОДАЛЬНІСТЬ І НАРОДНА ПСИХОЛОГІЯ

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Анотація. Зв'язок сучасної психології та формальних систем залишається важливим та актуальним напрямом досліджень у сучасній когнітивній психології та формальній логіці. Дану статтю сконцентровано на філософських проблемах, які оточують відносини між ментальним та логікою. Основну увагу приділено філософії логіки, але наведено певні ідеї, які можна застосувати у практичній філософській логіці.

Розглянуто визначення та властивості базової модальної логіки та похідних логік, які так чи інакше використовуються для дослідження психологічних станів індивіда. Постульовано визначальну роль філософської інтерпретації модальності для конкретної формальної системи, задіяної в дослідженні психологічних станів агентів. Досліджено різноманітні семантики модальної логіки. Висловлено гіпотезу про зв'язок досліджень у галузі когнітивної психології (семантика мозкової активності) та формальних систем, пов'язаних із дослідженням психологічних станів.

Ключові слова: народна психологія, ментальне, модальна логіка, можливий світ, ментальний стан, модальність, модальні формалізми.

1. Introduction

Paper centers on the exploring the general theoretical relation between the possible worlds model and mental states, both in the scope of the presented formal systems and philosophical interpretations of these systems. The final aim of the work is to conceptualize possibility of precise relation between modal formalism and mental world. It can be viewed as the preparatory exploring the philosophical difficulties of building a formal system devoted to modeling mental as such in general and mental processes more particularly. Thus it will involve logic, philosophy of mind and cognitive science. Folk psychology and similar theories are widely discussing in philosophy of mind and cognitive science and are, of course, an important detail for the study of connection of formal languages and mental world.

Possible worlds are dealt within the special part of logical semantics; it has a specific relation with objects it models which is completely different from the methods for formalizing deduction strategies used, for example, by doxastic and non-monotonic logic. The research of the paper is devoted not to particular formal systems but rather to the general logical semantics in its mentalistic interpretation. That is why only certain types of modal logic and not all non-classical calculi that relate to mental will be considered in the paper.

2. Interpreting modality

There is a certain history of relations between formal logic and cognitive studies before the emergence of systematic study of modality. It is obvious that deductive processes

as one of the regions of human intellectual activity should be closely affiliated with general mental processes in human brains. Traditionally in the logical elaborations there is no place for psychologism and subjectivity.

From the very beginning in psychology there is a lack of the tools for proving the correlation between such subtle material as forms of logical deduction and corresponding psychological phenomenon. Existing empirical methods and self introspection could not answer the questions about underlying informational structure of the human cognitive apparatus which were required to establish that correlation.

The last is partially confirmed by the fact that the rise of interest for logic among psychologists started together with the beginning of the cognitive psychology and new advanced methods for studying brain activity. The one of the first to use logical methods in psychology and psychological data for formal logic was Jean Piaget [15, c. 378]. He studied the psychology of the human intellect and formal logic as the guiding structure of the cognitive processes. There is also a series of the famous psychological experiments [14, p. 533; 1, p. 160] aimed at studying whether untrained in logical science people can reason logically.

The mentioned illustrates that the research on the connection of classical logic and human psychology is relatively recent; and I emphasize that it refers to classical logic – mostly to syllogisms. This part of the logical science does not include the new approaches like possible worlds semantics. Syllogisms as forms of thinking were criticized [11] even by logicians themselves both in psychologistic and formalistic way. Psychological experiments show that syllogisms are not always appropriate in the human thinking, people do not think in this way; even more formal logicians themselves use methods that are far from the reasoning by these rules.

The completely separate domain of scientific activity, tightly connected to practical application of modal logic, is artificial intelligence. Different modal and multimodal systems are used for very wide area of knowledge representation and intelligent behavior modeling. Artificial intelligence researchers in general are not interested particularly in mental states but rather use them as an obligatory items for purposes of modeling action-oriented behavior. And the scope of this paper broadly involves philosophical logical accounts of mentality, human psychology, artificial intelligence.

We are interested in the particular part of the semantics of modal logics which are possible worlds. In these aspects we need to explicate both the technical structure of them and their philosophical interpretation. With the problem of applying modal logic to world of mental these two items come in a close connection.

So what are the possible worlds in logic? Most logical textbooks would say neutrally that these are the scenarios for states of affairs. Researchers tend to separate themselves from metaphysics. «There are many interpretations for “possible worlds” , ranging from metaphysical worlds to worlds in science-fiction, states of a computer, board positions in chess, or deals in a card game» [2, p. 15; 3].

There is a state of affairs described by number of logical statements which is our world. Modal logics emerged from the need of studying the necessity and possibility by formal methods and it was only possible while representing the alternative states of affairs. So the other worlds which we call possible emerged.

So we have our world that is described by the list of propositional statements like p – «Sun is shining», q – «Bob is happy» and so on. And then there is that another world which we can name a possible world where something went wrong and sun is still shining but Bob is unhappy so it is described by p and not- q .

The worlds are connected with each other with the special accessibility relation which defines the status of this or that statement in relation to its modal property. So let us assume that the world where Bob is unhappy is accessible from ours. Then the statement q cannot be necessary because in the accessible alternative $\text{not-}q$ is true.

Semantically modality is not represented by worlds but rather by the relation between these worlds. This makes all the worlds interdependent because all the properties, important for the formal system, are external properties that influence worlds' relations. To define this externalism in other words – there is nothing in the content inside the world which can be changed and influence the general picture at least without changing the relation that connects this possible world with other worlds.

I emphasize this global detail of the semantics of modality which in my opinion is an important property for understanding inner structure of modal logic especially if we are speaking about non classical calculi connected to the problem of human psychology. Such calculi change an original rules a lot in order to get formal properties they need. This is precisely the place where philosophy of logic and philosophical interpretation of the formal system go together and really matter.

Inner content of the possible world alone – the statements – relates to the mental states as defined by classical logic. And these are the vague definitions of the “forms of reasoning” as the object of logic. There are also philosophical problems when there is no possibility to tie the reasoning and forms of reasoning to the brain activity. The closest conception for the logic as part of psychology may be found in the mentioned psychological discussions and in philosophy of logic. But even in these discussions as well a proposition may be considered as a content of the thought, but there is no way further out from the formal logic, these discussions only influence our understanding of the foundations of the formal systems.

The technical part of the classical logic cannot be influenced by admitting the fact that formal systems are connected to mental states. The main rules and laws of traditional logic were defined in ancient times. The philosopher may believe, like psychologist Mill, that mental states are in the basis of logical reconstructions; while another philosopher can be a formalist, but their calculations and inferences will be the same as if they both were done by Aristotle. Changes are not possible due to the very nature of the classical science of logic and we can talk about such changes only for non classical formal and informal systems. Mill's and his successors' position concerns mostly metaphysics as we can see from the next quote: «The notion that truths external to the mind may be known by intuition or consciousness, independently of observation and experience, is, I am persuaded, in these times, the great intellectual support of false doctrines and bad institutions. By the aid of this theory, every inveterate belief and every intense feeling, of which the origin is not remembered, is enabled to dispense with the obligation of justifying itself by reason, and is erected into its own all-sufficient voucher and justification» [13, p. 233].

Some of the new logical systems break classical axioms like non monotonic and some introduce new elements like modal. New elements often mean the more strict axiomatic system; but sometimes they do not narrow the scope of logic but to the contrary – enlarge it. We need the last to apply (or even “project”) logical foundations to mentality in general and to mental processes and states in particular and vice versa. Modal logic provides a wide potential to represent and formally analyze mental states and processes and in the following passages author will try to show it with examples.

3. Possible worlds semantics

Possible worlds semantics is itself the case when new for a formal system semantic object (possible world) actually enlarges the domain of the formal system. Though it of course sounds paradoxical and the analogy with the Frege's invention of first order predicate logic [7] appears. In both examples it only takes some properties of the natural language and incorporates them into formal structure (enlarges it) leaving less for the content. New axioms which necessary appear in the case of introducing new notions always make logic more specific. But formal system is interesting to the extent it can formalize the natural phenomenon and calculate. That is why it is more useful and interesting to explore certain regions of thought with the help of first order predicate logic than propositional one. And there are even more regions that are accessible only for the modal logic like necessity and possibility, knowledge, deontic normativity etc.

The classical logic has strict boundaries. Formalization of some complex statements in terms of propositions is senseless as the core properties are not caught by the formulas. The best examples are mostly from the philosophically oriented modal logics. Deontic statement will be neutral simple statement in the propositional calculus and there will be no way to present its normative status and ties to the other such statements in the system of law for example. Showing only general logical properties is senseless as they can be very primitive and relatively irrelevant for the content of the given deontic statement.

It is interesting to consider this point because there are many other cases when philosophical interpretation of the formalism influences a structure of an argument and even directs it, while usually logicians do not pay much attention to the interpretation, considering it of second importance. In the case of the philosophical logics the later is not quite right. In these logics philosophical interpretation works complexly in both ways – structure of the formal system reflects the aims and problems posed by theory, and theory should consider the implications it will have from the constructed formal system.

The latter is quite important for mentalistic logic because the aim of constructing such formal system lies completely in the field of its philosophical interpretation. The very notion of mental and mental worlds are themselves hard philosophical problems. There is a huge discussion around what mental states exactly are and there is a number of philosophers that deny the existing or adequacy of these notions providing quite strong arguments. From the other point of view philosophy and philosophical discussions are not just sources of problems for our presumed new formal system but also the field where we can acquire new grasping. It of course means that we have to admit some particular theory of mental and follow this model in our formal constructions. Many calculi are built basing on the existing philosophical conception. Take for example connection between the philosophy of action and action based logics.

The axioms of the classical logic are provided mostly by common sense. Some of the later non classical logics appeared as the result of the further philosophical theoretical investigation and sometimes creative doubt. But in the case of mentalistic logic we have to construct a system basing on how we understand the role of mental in the general ontology and its relations to the cognitive work of our brain. Logical system based on the laws of psychology would be an interesting project.

The problematical question of philosophy of logic is content of a term, one or another philosophical concept that appear difficult for understanding, analyzing and competitive interpretations (sometimes contradictory) are equally valid. New logics still focus on the form of the arguments but they appear due to the philosophical reconsideration

of the role of content. When we frame the ontology of everyday world into subjectivity of mental states we insist that we are narrowing down the content but also rely on psychological and logical tools for working with it.

So what are the special features of the logical modality which will help us to model the mental world of a human and acquire a deeper understanding of the content of corresponding logical propositions? The conception of the world presents a philosophical frame for the list of statements it consists of. It is the method of formalizing a vast area of content details. The world can represent an epistemic status of the propositions or rational planning element etc. The theoretical flexibility of this model was demonstrated by number of different non classical logics [12, p. 5] where possible worlds, sometimes even few connected sets of them, were used for entirely different purposes than presenting necessity and possibility. Possible worlds present reasoning about rational actions and knowledge about the environment and sometimes more complex recursive structure like knowledge about knowledge and reflections on one's behavior.

The same statement being framed by worlds and in connection with the system of the sets got new specific form. We conclude that possible worlds can serve as a tool for representing subtle peculiarities of the contents of the statements inaccessible for other methods. Yet the worlds were used very straightforwardly – like in the case of the action based logic for example [5; 8, p. 508; 10]. Different possible worlds represented different knowledge bases connected within the system of the information processing. The good example of how this tool can be used in a better way is actual mentalistic logic. There are a number of psychological notions that are hard to explicate like imagination, emotions, feelings, perceptions and memory. Knowledge bases can represent different mechanisms of memory and separate worlds of propositions – specific judgments about these memories. With the help of the system of sets we can model not only reasoning but also reflections on reasoning and even the cooperation of logical thinking and imagination. The varieties of mental processes that can be represented by systems of possible worlds prove that we have an advanced tool of formal representing of content. The Bratman's theory of the action based logics admits this approach: «...we make progress in understanding aspects of mind by articulating characteristic functions or roles together with associated norms» [4, p. 43].

So now we consider the change in the worlds' model instead of dealing with propositions that fill those worlds. For example, it would be the shift from the classical logic to the doxastic one. The statements are the same – the sun is shining and Bob is happy – but due to the system of possible worlds (for example, the world of knowing which is then the background) these are not the statements about facts from the actual world but statements about what someone knows i.e. epistemological facts. There is nothing new in the content of information which these statements bear but due to the new form, specific attitude of these statements, they mean differently.

4. Folk psychology and semantics of brain activity

The idea of possible world semantics as the system of frames for propositions is obvious. What is not obvious is how modality can be applied to brain activity. We are used to idea to view mind and brain dualistically not in metaphysical sense but in functional as well. I refer first of all to the notion of the folk psychology. We admit that brain is a set of the neurons and use special mathematics to describe its work. In the meantime we use folk psychology as a special apparatus to describe brain's work of the different more global level. Folk psychology is not even formalized notion while neural networks theorists use precise mathematics to describe neural processes.

These two levels seem to be conceptually contradictory. Some theorists like Churchland [6] try to persuade that one level should be reduced to another while others state that it is impossible in principle. But both methods are used with a certain practical success. Folk psychology is strongly connected to the cognitive science as it is not just one of the modules of the mind but rather the language with the help of which we describe the work of mind on the global level. This bridge was already built in the vast philosophy of mind literature [5, p. 121; 16].

So there is a big gap between neural processes and global brain's decisions as folk psychological notions are. We hardly can deal with the individual neuron – what can be said about billions of them with extremely complex connections? In other words there is no clear conceptual bridge between the mathematics of the neural networks and folk psychology. Why then insert here the third problem – modality?

The thing is that the modality is not a third level or the third problem – on the contrary it may be the decision to this gap problem. By extending the analogy with metaphysical problems we can introduce the notion of supervenience here. Supervenience is a term which came to philosophy of mind from philosophy of science. A part from that it is quite popular in analytic philosophy in general. It is used to describe the relation between different levels of ontology – chemistry and physics in science or material brain and mind in philosophy of mind for example. Supervenience is based on the properties of the objects on both levels. This term makes possible introducing more complex relations between ontological regions than those which are usual for common sense (which is exactly the case for the folk psychology and neural network mathematics).

There is an obvious causal dependence between work of the brain on the cellular level and general mind. But there are two big problems surrounding it – first of all the complexity of the neural network computing processes secondly the conceptual imprecision of the notion of phenomenal experience and following impossibility to connect it to the mathematics. So the problem has two sides – theoretical and practical. Neurons and global parts of the brain and mathematical models of neurons together with the notions of folk psychology are two distinct though connected problems. While the practical side can be resolved only in the process of the scientific elaboration the theoretical problem is a target for the profound philosophical analysis.

So where is the place of modality here? In the previous text it was hypothesized that modal logic can be used not only for action-oriented logics but also for analysis of the underpinning mental processes. In the formal sense modal logic is a compromise between the precise mathematics of the neural networks and vague notions of natural language which are the folk psychological terms. So if the modal logic indeed can be placed for studying the mental world it can be a valuable tool for closing the mentioned theoretical gap.

It is a common fact that logic does not deal with the content of the statements which it operates with but only works with the formal side of the information – something that can be calculated. And now this newly opened difference between statements concerning mental attitudes – something we can call the frame of the mental state – can be formalized and studied using semantics of the possible worlds.

This point needs a more explicit explanation in relation to the notion of mental. In many theories of mental there is one common place – the idea that a defining property of the mental state is its content. A thought or a mental image or an abstract fantasy are always about something. The problem is not about notion of intentionality though it is tempting to insert this analogy here. We are not talking about general property of the consciousness but about properties of mental states which are the elements of conscious experience. And

unlike vague and eluding notion of general conscious experience these elements form something similar to the complex formal language which can be analyzed with the methods we have for other formal languages.

What is even more important is that the content of a thought may be another thought – like when we reflect on our experience or introspect ourselves. Such many leveled structures were always a problem for the cognitive science. But there is already designed mechanism for modeling such phenomenon methods in modal logic [16]. We can also recall the problem with the more than double negation for the intuitionistic logics. Accessibility relation for the possible worlds semantics being enough modified can represent many-leveled cognitive structures like mentioned reflections.

The relation between possible worlds is often modified also syntactically for the needs of different formal systems other than classical necessity and possibility. A number of different non classical logics appeared. Formal characteristics of possible worlds may change in different degrees but what is more important the philosophical interpretation of these structures changes radically. In doxastic logics for example the possible worlds are not alternative states of affairs but rather knowledge bases – special objects that emulate particular cognitive resource of human mind [5, c. 121; 12]. Knowledge can still be about particular state of affairs. But while simple modality is an alternative ontology, doxastic logic represents epistemology. Formally it is still the list of propositions with slight changes in relations between these lists. It still can bear much resemblance to S4 of classical modal logic but the difference in application is gigantic.

5. Conclusion

This work is just an attempt to explore the possibility of interpretation of modal logics for specific context of formalizing human mental activity. In the first chapter of the paper the importance of the philosophical interpretation of the particular modal logic is emphasized. Then the comparative analysis of different modal semantics is introduced. In the last chapter of the work the central idea of the paper is given – the hypothesis of the connection of the research in fields of the formal systems that formalize psychological states of the agent and certain aspect of the cognitive psychology. The formal study of folk psychology is compared to study of semantics of brain activity.

To conclude, there exist a vast variety of logics that are used specifically to emulate human mental states. Among them we can name doxastic logics, epistemic logics, logics of action, belief-desire-intention logics, some of the non-monotonic logics etc. Some of them do not state mental states as their target explicitly or rather state formalizing mental attitudes as a tool for enabling formal study of certain types of behavior. Nevertheless, these formal systems have much to do with modeling human mental states. However, the proper mentalistic logic – the system that will be completely devoted to the underpinning processes of the inner mental life of a human being is still missing. Exploring the philosophical problems surrounding the subject may clarify the need and whether and how it is possible to complete that task.

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