What do diagrams teach? Reasoning and perception

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Abstract: My paper concerns Peirce’s Existential Graph Theory (EGs) and its basic units that are diagrams or graphs. This theory is a logical algebraic system demonstrated in geometrical order. It is divided into several parts, which roughly correspond to propositional logic, first-order logic, and modal logic. I will discuss the philosophical peculiarities of the theory rather than the technical ones. Philosophical ideas of this diagrammatic approach and its graphical syntax open new prospects for looking at the objective of logic. Graph philosophy will be scrutinized through the lens of information exchange and the growth of new knowledge. Special attention will be paid to logic teaching. I think that diagram construction and perception can develop students’ logical skills. The existential graph theory realizes Peirce’s claim that logic is another name for semiotic. It deals with iconical signs that admit several ways of interpretation (Tarski style semantics, game-theory semantics, etc.). Work with graphs is a graphical equivalent of scientific experiments. These experiments let us observe the processes of information exchange, discover new knowledge and fruitfully operate with necessary conclusions. In short, graph theory allows us to perceive the nature of propositions, concepts and reasoning. The latter is treated as graph transformations that are regulated with the rules.

Keywords: existential graph theory, diagrams, Peirce, icon, iconicity, logic and information

Peirce’s theory of Existential Graphs (EGs) stays away from the main Frege-Russell’s vector of logic development. Today, however, it does not look like an outsider as it did in the previous century. This logical system is extremely original, but it should be scrutinized as a specific development of algebra of logic that includes several further theories, such as the Alpha, the Beta, and the Gamma parts, which roughly correspond to propositional logic, first-order logic
and modal logic, respectively. The basic units of EGs are graphs that remind Euler or Venn’s diagrams. They reproduce logical relations within propositions and consist of various ovals, thick lines and dots. Graphs are placed on the sheet of assertions. Two graphs on the same sheet are juxtaposed. If we want to read a graph, we have to admit that the juxtaposition corresponds to conjunction while an oval expresses the negation.

The sheet is the basic tautology, and, as a consequence, everything that is scribed on it is accepted to be true. In other words, we admit that our premises are true. These premises can be transformed to get a conclusion. There is a set of rules that regulates these transformations. Existential graphs theory is open for various semantic interpretations (for instance, it can be understood as a model theory or game-theoretic approach). Finally, which is the central issue of the talk, it is worth being studied within the frames of the philosophy of logic since it lets analyze logical consequence or laws, solve the problems of decidability or compositionality, etc.

I intentionally leave technical peculiarities of EGs aside (see [Pietarinen, 2006] for details) and focus on philosophical ideas that lead to the debates on information exchange and new knowledge discovery. These ideas introduce a new way of thinking about the subject of logic and its goals. Besides, they can answer some questions regarding logical courses. The philosophical foundation of the existential graphs theory, as well as its relative technical simplicity, transforms it into a comfortable tool that meets pedagogical demands [Paolucci, 2017; Sowa, 2001]. The points of my talk are enumerated below.

1. **Logic as Another Name for Semiotics**

   The graph theory can be scrutinized as a technical realization of Peirce’s idea that logic is another name for semiotics (the study of signs and sign processes). We live in a world of signs that are used for thoughts transitions. Signs appear to be a useful instrument for operations with thoughts (not thinking) relations. Peirce’s position enlarges the logic horizons. It should not be reduced to Frege’s project about the universal language or Gilbert’s style calculation but can be seen as a kind of thoughts calculation.

2. **Iconic Style of Representations**

   Various sings present our thoughts, but icons serve a particular function [Shin, 2002; Stjernfelt, 2007]. Although diagrams are symbols, they have an iconic core. Thus, Peirce ruins a long-lasting tradition of the Modern Period, due to which thoughts are always expressed with symbols. Iconic essence of diagrams demonstrates non-linear nature of knowledge discovery or information flow and confirms that thoughts are not obligatory given verbally or linguistically [Hull, 2017]. Graphs deal with informative processes development, but they do not concentrate on the verbal or linguistic sides of propositions.
3. Methodeutic of Deductive Reasoning

In EGs, graphs transformation introduces reasoning or an inference (the distinction is not essential at this level of analysis) as a series of insertions and omissions. The original graph is iconically turned into another one until the conclusion is reached. Such transformations let us conduct experiments and treat deduction broader than we usually do. Peirce offers two types of deductions that he calls corollarial and theorematic. The former takes place if we need only to imagine a situation in which the premises are true to perceive immediately that the conclusion follows (i.e., ordinary syllogisms). The latter demands an experiment in the imagination upon the image of the premises to get a conclusion. Moreover, the philosopher stresses that diagrams deal with both formal (signs formaliter) and material (signs materialiter) sided of deduction [Stjernfelt, 2011]. Deduction features result in Peirce’s crucial insight of methodetic of deductive reasoning [Peirce, 1931–1958 CP 4.613], which shows the nature of new knowledge discovery and information flow [Hoffmann, 2010, Hoffmann, 2011, Pechlivandis, 2017].

4. Intuitive and Rational Knowledge

Peirce rethinks Kant’s dichotomy between intuition and concepts. He admits Kant’s position that they both depend on each other but makes a step forward and brings these two sides together. It seems that intuition is organically scribed into (rational) reasoning [Paolucci, 2017]. Once again, we come to the idea that even necessarily reasoning can collect informative truth [Hookway, 1985, Pietarinen, 2007, Pietarinen, 2006, Stjernfelt, 2007]. This controversial consolidation has to be discussed separately. However, it is worth mentioning that intuitive and rational integration can also be found within the frames of cognitive sciences. The general line of this integration is different. If Peirce prefers rational basis and puts intuitive steps into it, cognitive science develops another direction. It often starts with intuition as all inferences are based on it (see [Sperber, Mercier, 2017] for the details).

5. Diagrams Construction and Interpretation

EGs are syntactical structures, but they are highly depended on their interpretation. The theory draws a strict distinction between graphs construction and their reading. EGs introduce the logical core of dialogs [Pietarinen, 2006] that turns it into a pragmatically oriented conception. Indeed, dialogical shifts are tightly tied with agents’ presuppositions that are regulated with habits, laws and conventions admitted in a representational system [Peirce, 1931–1958 CP 4.418]. The latter provides another angle for information flow studies.

To conclude, Peirce’s theory contributes to the debates on information dissemination and sharing, new knowledge discovery, etc. In the long run, it prompts reflection on cognitive turn in logic that is being discussed during the
last decades [Benthem, 2011; Pietarinen, 2014]. Finally, EGs techniques could help to adjust logical courses to the contemporary era of information. I am not insisting on the priority of this theory. There are many other profitable approaches. Nevertheless, it seems that EGs could say something to students that are lost in the formal conceptions of contemporary logic.


References


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Чему учат диаграммы? Рассуждения и восприятие*

Аннотация: В статье речь пойдет о теории экзистенциальных графов Ч. Пирса (теории графов) и ее базовых единицах – диаграммах или графах. Теория графов – полноценная логическая система. Перед нами алгебра, построенная геометрическим образом. Теория включает в себя несколько разделов, которые примерно эквивалентны логике высказываний, логике предикатов первого порядка, модальным логикам. В центре его внимания будет обсуждение не только технических особенностей теории, сколько ее философских оснований. Философские идеи, на которых базируется теория графов, равно как и ее диаграмматический синтаксис, позволяют с несколькими иной стороны взглянуть на задачи логики и ее предназначение. В статье графическая система Пирса будет рассмотрена через призму проблемы обмена информации и прироста нового знания. Особое внимание будет уделено вопросу продуктивности использования графического подхода в рамках курсов по логике. Я покажу, каким образом построение и восприятие диаграмм могут способствовать развитию у студентов базовых логических навыков. Теория экзистенциальных графов представляет собой реализацию утверждения, что логика является лишь иным названием для семиотики. Ее ключевыми знаками оказываются знаки-иконы. Именно иконой логических отношений и являются диаграммы, которые сами по себе остаются синтаксическими структурами. Их восприятие же определяется процедурами означивания и интерпретации (семантика экзистенциальных графов может задаваться в духе Тарского, теоретико-игрового подхода и т. д.). Работу с графами стоит рассматривать как эксперименты, напоминающие те, с которыми мы сталкиваемся в естественных науках. В ходе таких экспериментов мы способны не только выявлять необходимые следствия, имплицитно или эксплицитно заключенные в диаграммах, но и открывать новые знания, наблюдать за процессами обмена информации. Одним словом, работа с графами позволяет перцептивно воспринимать природу высказываний, понятий, а также рассуждений. Последние задаются через представление о трансформации графа, то есть его видоизменения, регламентированного правилами.

Ключевые слова: теория экзистенциальных графов, диаграммы, Пирс, знак-икона, иконичность, логика и информация


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