# DOWNLOAD PDF FORMALIZING REASONING WITH VISUAL DIAGRAMMATIC REPRESENTATIONS

## Chapter 1 : HCIRN > Diagrams: International Conference on the Theory and Application of Diagrams

*The formalization of reasoning with visual representations is an extremely difficult task, requiring a synthesis of complex representational and computational aspects as well as cognitive aspects. It can therefore serve as a touchstone for our understanding of visual representations.*

Introduction Diagrams or pictures probably rank among the oldest forms of human communication. They are not only used for representation but can also be used to carry out certain types of reasoning, and hence play a particular role in logic and mathematics. However, sentential representation systems e. Diagrams are usually adopted as a heuristic tool in exploring a proof, but not as part of a proof. Challenging a long-standing prejudice against diagrammatic representation, those working on multi-modal reasoning have taken different kinds of approaches which we may categorize into three distinct groups. One branch of research can be found in philosophy of mind and cognitive science. Since the limits of linguistic forms are clear to those who have been working on mental representation and reasoning, some philosophers and cognitive scientists have embraced this new direction of multi-modal reasoning with enthusiasm and have explored human reasoning and mental representation involving non-linguistic forms Cummins ; Chandrasekaran et al. Another strand of work on diagrammatic reasoning shows that there is no intrinsic difference between symbolic and diagrammatic systems as far as their logical status goes. Some logicians have presented case studies to prove that diagrammatic systems can be sound and complete in the same sense as symbolic systems. This type of result directly refuted a widely-held assumption that diagrams are inherently misleading, and abolished theoretical objections to diagrams being used in proofs Shin ; Hammer a. A third direction in multi-modal reasoning has been taken by computer scientists, whose interest is much more practical than those of the other groups. We have the following goals for this entry. First of all, we would like to acquaint the reader with the details of some specific diagrammatic systems. At the same time, the entry will address theoretical issues, by exploring the nature of diagrammatic representation and reasoning in terms of expressive power and correctness. The case study of the second section will not only satisfy our first goal but also provide us with solid material for the more theoretical and general discussion in the third section. As mentioned above, the topic of diagrams has attracted much attention with important results from many different research areas. Hence, our fifth section aims to introduce various approaches to diagrammatic reasoning taken in different areas. The following quotation from Chandrasekaran et al. These are constructed by the agent in a medium in the external world paper, etc , but are meant as representations by the agent. Internal diagrams or images: These comprise the controversial internal representations that are posited to have some pictorial properties. As we will see below, logicians focus on external diagrammatic systems, the imagery debate among philosophers of mind and cognitive scientists is mainly about internal diagrams, and research on the cognitive role of diagrams touches on both forms. Diagrams as Representational Systems The dominance of sentential representation systems in the history of modern logic has obscured several important facts about diagrammatic systems. One of them is that several well-known diagrammatic systems were available as a heuristic tool before the era of modern logic. Another interesting, but neglected, story is that a founder of modern symbolic logic, Charles Peirce, not only revised Venn diagrams but also invented a graphical system, Existential Graphs, which has been proven to be equivalent to a predicate language Peirce ; Roberts ; Zeman  These existing diagrams have inspired those researchers who have recently drawn our attention to multi-modal representation. Logicians who participate in the project have explored the subject in two distinct ways. First, their interest has focused exclusively on externally-drawn representation systems, as opposed to internal mental representations. Second, their aim has been to establish the logical status of a system, rather than to explain its heuristic power, by testing the correctness and the expressive power of selective representation systems. In this section, we examine the historical development of Euler and Venn diagrams as a case study to illustrate the following aspects: Second, we will observe different emphases given to different stages of extension and modification of a diagrammatic system. Thirdly and relatedly, this historical development illustrates an interesting tension and trade-off between the expressive power and visual clarity of diagrammatic systems. Most importantly, the reader will witness logicians tackle the issue of whether there is any intrinsic reason that sentential systems, but not diagrammatic systems, could provide us with rigorous proofs, and their success in answering this question in the negative. Hence, the reader will not be surprised by the following conclusion drawn by Barwise and Etchemendy, the first logicians to launch an inquiry into diagrammatic proofs in logic, there is no principled distinction between inference formalisms that use text and those that use diagrams. One can have rigorous, logically sound and complete formal systems based on diagrams. Leonhard Euler, an 18th century mathematician, adopted closed curves to illustrate syllogistic reasoning Euler  The four kinds of categorical sentences are represented by him as shown in Figure 1. Euler Diagrams For the two universal statements, the system adopts spatial relations among circles in an intuitive way: If there is no overlapping part between two circles, then the diagram conveys the information that no A is B. This representation is governed by the following convention: The power of this representation lies in the fact that an object being a member of a set is easily conceptualized as the object falling inside the set, just as locations on the page are thought of as falling inside or outside drawn circles. Moving on to two existential statements, this clarity is not preserved. Obviously, Euler himself believed that the same kind of visual containment relation among areas can be used in this case as well as in the case of universal statements. In this diagram, not only is part of circle A contained in area B as Euler describes , but the following are true: All A are B. All C are A. Therefore, all C are B. All C are B. Therefore, no C is A. In both examples, the reader can easily infer the conclusion, and this illustrates visually powerful features of Euler diagrams. However, when existential statements are represented, things become more complicated, as explained above. Some C is A. Therefore, Some C is not B. No single diagram can represent the two premises, since the relationship between sets B and C cannot be fully specified in one single diagram. Instead, Euler suggests the following three possible cases: Hence, the representation of existential statements not only obscures the visual clarity of Euler Circles but also raises serious interpretational problems for the system. However, a more serious drawback is found when this system fails to represent certain compatible that is, consistent pieces of information in a single diagram. Suppose we drew an Euler diagram for the former proposition and try to add a new compatible piece of information, i. The weak point in this [Euler diagrams], and in all similar schemes, consists in the fact that they only illustrate in strictness the actual relation of classes to each other, rather than the imperfect knowledge of these relations which we may possess, or may wish to convey by means of the proposition. A primary diagram represents all the possible set-theoretic relations between a number of sets, without making any existential commitments about them. For example, Figure 2 shows the primary diagram about sets A and B. This is the major difference between Euler and Venn diagrams. By using this syntactic device, we obtain diagrams for universal statements as shown in Figure 3. However, it should be noted that a shading is a new syntactic device which Euler did not use. This revision gave flexibility to the system so that certain compatible pieces of information may be represented in a single diagram. In fact, using primary diagrams also avoids some other expressivity problems to do with spatial properties of diagram objects discussed below, in Section 3. Surprisingly, Venn was silent about the representation of existential statements, which was another difficulty of Euler diagrams. We can only imagine that Venn might have introduced another kind of a syntactic object representing existential commitment. This is what Charles Peirce did about twenty years later. This extension was completed by means of the following three devices. In this way, Peirce increased the expressive power of the system, but this change was not without its costs. Another important contribution Peirce made to the study of diagrams starts with the following remark: In the same way that the rules of algebra tell us which transformations of symbols are permitted and which are not, so should the rules of diagram manipulation. However, more importantly, Peirce did not have any theoretical toolâ€”a clear distinction between syntax and semanticsâ€”to convince the reader that each rule is correct or to determine whether more rules are needed. That is, his important intuition that there could be transformation rules for diagrams remained to be justified. This revision is made in two stages: This system, which is proven to be logically equivalent to monadic predicate logic, is the same as Venn-I except that a connecting line between diagrams is newly introduced to display disjunctive information. Euler admits that no single Euler diagram can be drawn to represent the premises, but that three possible cases must be drawn. However, Venn-I cannot express disjunctive information between universal statements or between universal and existential statements. In addition to this revision, Shin presented each of these two systems as a standard formal representation system equipped with its own syntax and semantics. The syntax tells us which diagrams are acceptable, that is, which are well-formed, and which manipulations are permissible in each system. The semantics defines logical consequences among diagrams. Using these tools, it is proven that the systems are sound and complete, in the same sense that some symbolic logics are. This approach has posed a fundamental challenge to some of the assumptions held about representation systems. Since the development of modern logic, important concepts, e. However, none of these turned out to be intrinsic to these traditional symbolic logics only. For any representation system, whether it is sentential or diagrammatic, we can discuss two levels, a syntactic and a semantic level. What inference rules tell us is how to manipulate a given unit, whether symbolic or diagrammatic, to another. The definition of logical consequence is also free from any specific form of a representation system. The same argument goes for the soundness and the completeness proofs. When a system is proven to be sound, we should be able to adopt it in proofs. The main revision from Euler to Venn diagrams, introducing primary diagrams, allows us to represent partial knowledge about relations between sets. The extension from Venn to Peirce diagrams is made so that existential and disjunctive information may be represented more effectively. Both Venn and Peirce adopted the same kind of solution in order to achieve these improvements: However, on the negative side, these revised systems suffer from a loss of visual clarity, as seen above, mainly because of the introduction of more arbitrary conventions. The modifications from Peirce to Shin diagrams concentrate on restoring visual clarity, but without loss of expressive power. Hammer and Shin take a different path from these revisions: On the other hand, this revised Euler system is not a self-sufficient tool for syllogistic reasoning, since it cannot represent existential statements. This case study raises an interesting question for further research on diagrammatic reasoning.

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## Chapter 2 : Diagrams (Stanford Encyclopedia of Philosophy)

*The theory of inter-diagrammatic reasoning is extended to include the use of color values in diagrams. The syntax of this more general theory, its subsumption of the original theory, and the.*

Diagram[ edit ] A diagram is a 2D geometric symbolic representation of information according to some visualization technique. Sometimes, the technique uses a 3D visualization which is then projected onto the 2D surface. The term diagram in common sense can have two meanings. Sample flowchart representing the decision process to add a new article to Wikipedia. Like the term " illustration " the diagram is used as a collective term standing for the whole class of technical genres, including graphs , technical drawings and tables. This is only the genre, that shows qualitative data with shapes that are connected by lines, arrows, or other visual links. In science the term is used in both ways. Or as Bert S. Hall wrote, "diagrams are simplified figures, caricatures in a way, intended to convey essential meaning". White "the characteristics of a good diagram are elegance, clarity, ease, pattern, simplicity, and validity". In his papers on qualitative logic , entitative graphs , and existential graphs , Peirce developed several versions of a graphical formalism , or a graph-theoretic formal language , designed to be interpreted for logic. In the century since Peirce initiated this line of development, a variety of formal systems have branched out from what is abstractly the same formal base of graph-theoretic structures. Conceptual graph[ edit ] A conceptual graph CG is a notation for logic based on the existential graphs of Charles Sanders Peirce and the semantic networks of artificial intelligence. In the first published paper on conceptual graphs, John F. Sowa used them to represent the conceptual schemas used in database systems. His first book [6] applied them to a wide range of topics in artificial intelligence, computer science, and cognitive science. Elsie the cat is sitting on a mat The diagram on the right is an example of the display form for a conceptual graph. Each box is called a concept node, and each oval is called a relation node. The letters x and y, which are called coreference labels, show how the concept and relation nodes are connected. Entitative graph[ edit ] An entitative graph is an element of the graphical syntax for logic that Charles Sanders Peirce developed under the name of qualitative logic beginning in the s, taking the coverage of the formalism only as far as the propositional or sentential aspects of logic are concerned.

## Chapter 3 : visual reasoning with diagrams | Download eBook PDF/EPUB

*Formalizing Reasoning With Visual & Diagrammatic Representations: Papers from the Aaai Fall Symposium [Gerard Allwein] on calendrierdelascience.com *FREE* shipping on qualifying offers.*

## Chapter 4 : Diagrams > Notes (Stanford Encyclopedia of Philosophy)

*Diagrammatic reasoning is %he understanding of concepts and ideas by the use of diagrams and imagery, as opposed to linguistic or algebraic representations" [GCN95, on back cover].*

## Chapter 5 : CiteSeerX â€” A Logic-based Formalism for Reasoning about Visual Representations

*reasoning in textual versus diagrammatic, and diagramÂ- matic versus diagrammatic, representations. The paper concludes with a summary of the major issues which.*

## Chapter 6 : Using Diagrammatic Reasoning for Theorem Proving in a Continuous Domain - CORE

*Diagrammatic)Reasoning)! WilliamBechtel!! Summary! Diagrams!figure!prominently!in!human!reasoning,calendrierdelascience.comivescience research!has!provided!important.*

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## Chapter 7 : Formalizing Reasoning with Visual and Diagrammatic Representations

*C. GurrTheories of visual and diagrammatic reasoning: foundational issues G. Allwein, K. Marriot, B. Meyer (Eds.), AAAI Fall Symposium: Formalizing Reasoning with Visual and Diagrammatic Representations, AAAI Press ().*

## Chapter 8 : Diagrammatic reasoning - Wikipedia

*DIAMOND: Diagrammatic Reasoning System Demonstration* grammatic Representations II. Formalizing Reasoning with Visual and Diagrammatic Representations.*