The link between Mental Representation and Diagram

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Diagrams are powerful tools of communication

- Inscription
- Advertisement
- Maps and charts
- Stone curving
- Stelae
- Dream

Inscription


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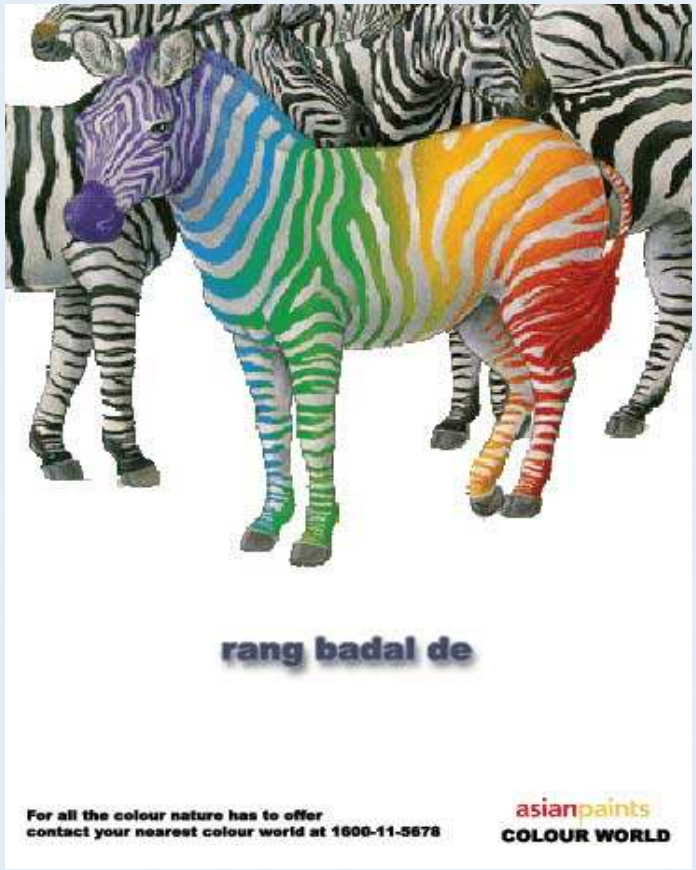
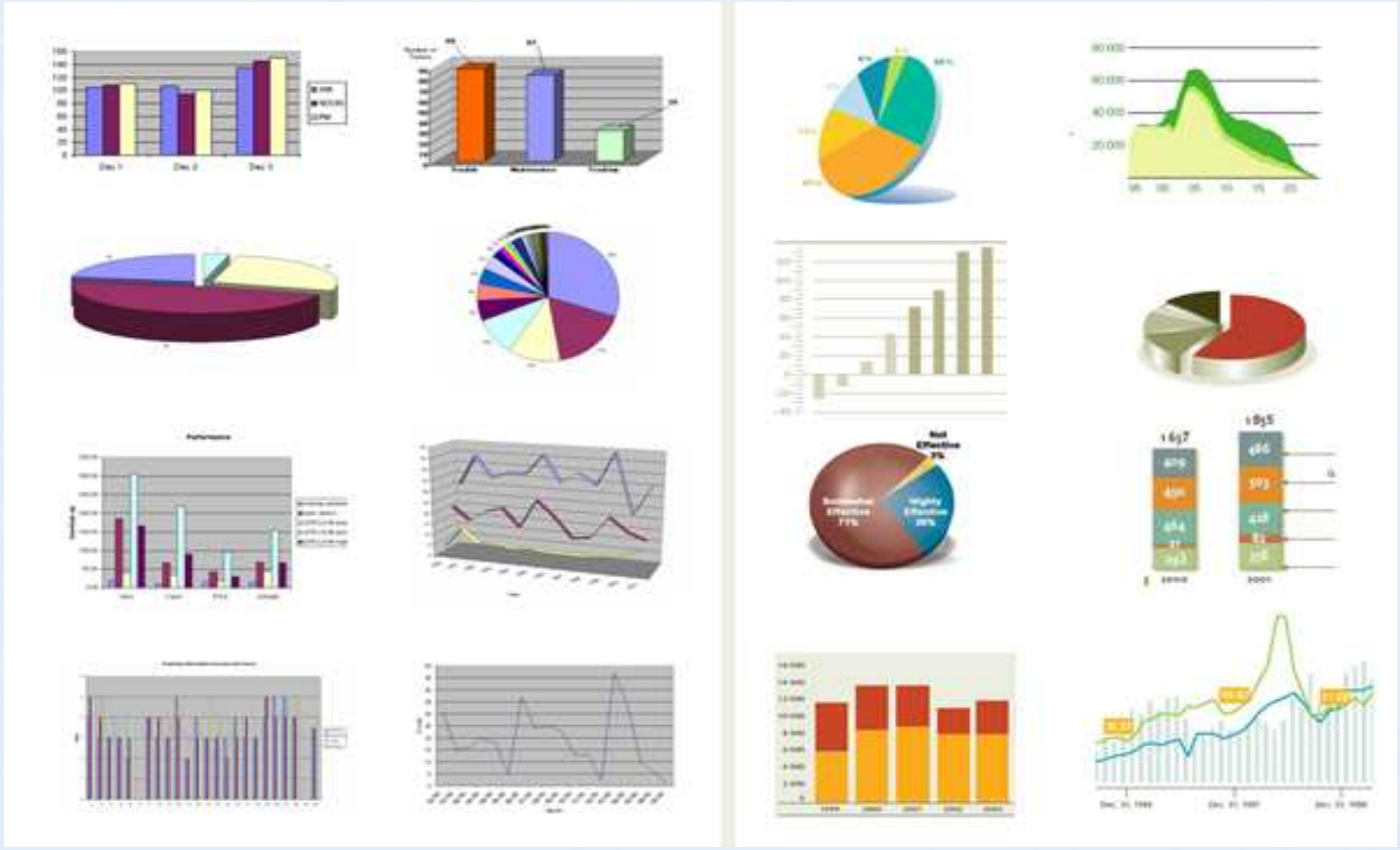


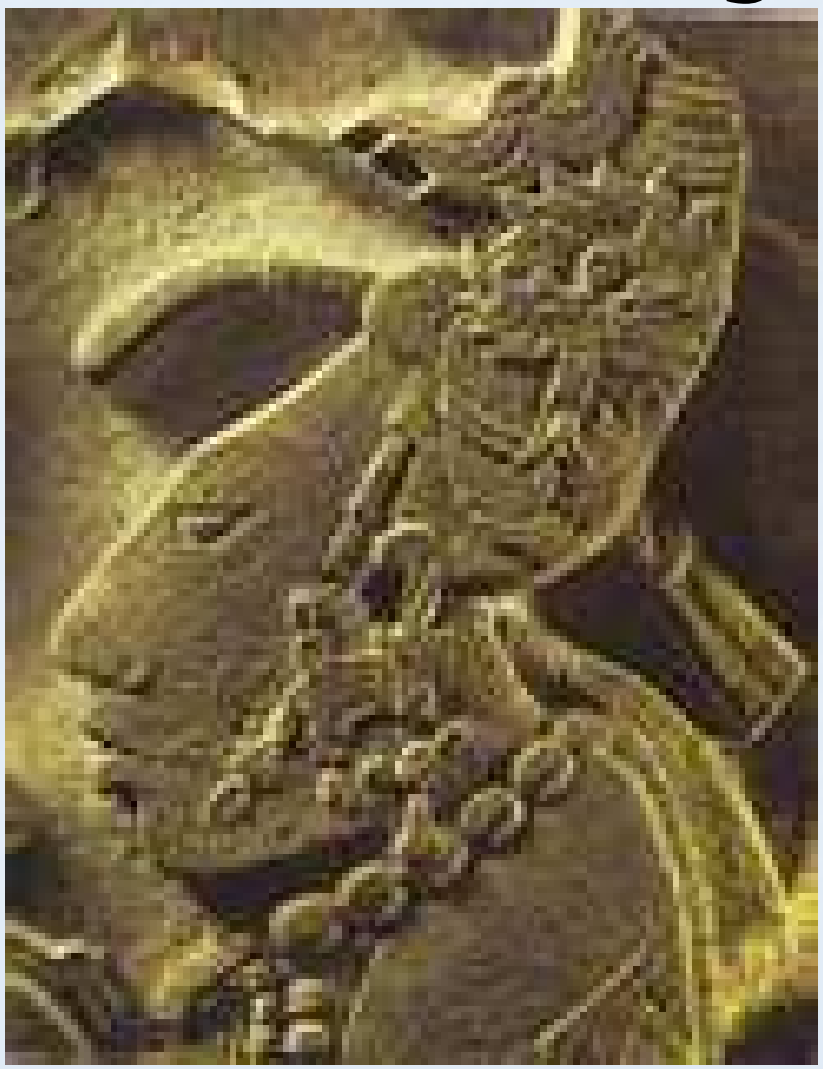
Maps

Charts



Stone curving

Stone curving



Stelae

Dream

Diagrams

- Peirce[9] in his analysis of sign in the context of thought or communication talks about the status of diagrams in the world.
- According to Ittelson[6] diagrams provide non-visual information in a visual form. Diagrams *resemble* writing in depending on agreed conventions, *differ* from writing in that the overall form affects the interpretation.
- Goodman [5] places diagrams in the class of models which are analogue (semantically dense) in some dimensions, but digital (syntactically disjoint) in others.

Diagrams

- Goodman holds that denotation, the core of representation, does not rely on resemblance. Because, in that case, it would not be able to depict things that do not exist.

Chandrashekharan et al[3]

- Internal diagrams or images are posited to have some pictorial properties
- External diagrammatic representation are constructed in the external world in the medium of paper, wood, stone etc.

Issues on diagrams

Logicians focus on External diagrammatic systems

Imagery debate about philosophers of mind and cognitive scientists is about Internal diagrams

Imagery debate

The *image* refers to the internal representation that is used in information processing, not the experience itself. The experience of imagery is a sign that the underlying brain events are taking place.

- The imagery debate centers around the problem of what can be viewed as the primitives of cognition. The central question related to the imagery debate then is: Do images form the basis of all our higher cognition? If not, what does? Could propositions serve that function? Or both images and propositions? Or something altogether different?

Imagery debate

Debate:

Stage 1. The focus was constrained by concepts of alternative types of mental representations that underlie imagery. A phase of philosophical exchange and empirical research.

Stage2. The focus shifted to the empirical results collected during the first phase. Arguments involved methodological problems with the experiment.

Stage3. Researchers have responded to the possible methodological and conceptual problem with the earlier purely behavioural research by turning to the facts about brain function.

Multimodal reasoning

Challenge prejudice against diagrammatic representation under three broad groups:

Philosophy of Mind and Cognitive Science explored human reasoning and mental representation involving non-linguistic forms.

Depictive representation

- A depictive representation is a type of picture which specifies the locations and values of configurations of a point in a space. In depictive representation each point of an object is represented by a pattern of points and spatial relations among the parts themselves. Depictive representation convey meaning via their resemblance to an object with part of representation corresponding to parts of an object.

Propositional representation

- A propositional representation is a mental sentence that specifies unambiguously the meaning of an assertion. Such representation contain a relation popularly known as predicate. A propositional representation is not a statement in natural language but an abstract way of specifying unambiguously the meaning of assertion. The basic elements of a propositional representation are symbols.

Diagrammatic reasoning shows there is no intrinsic difference between symbolic and diagrammatic systems as far as their logical status is concerned. It has been proved that diagrammatic systems can be sound and complete in the sense of a symbolic system.

Multimodal reasoning

The computer scientists consider the third direction for

- knowledge representation
- System design
- Visual programming

Diagrams and language

Herbert Simon[10]

The role of reasoning in language and diagram is different.

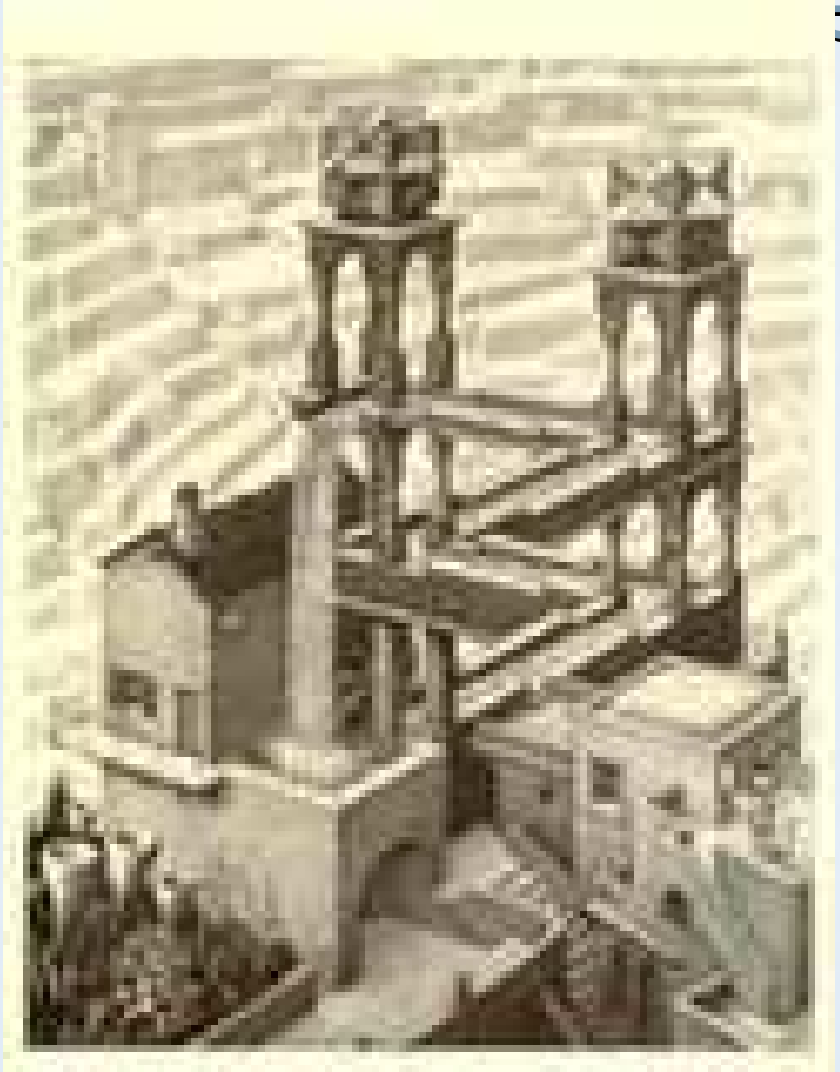
The irrational numbers could not be expressed through language. Due to this ability of diagrams Euclid developed his scheme of geometric reasoning.

Linguistic (algebraic) and diagrammatic representations found common ground during Descartes' invention of analytic geometry.

threats

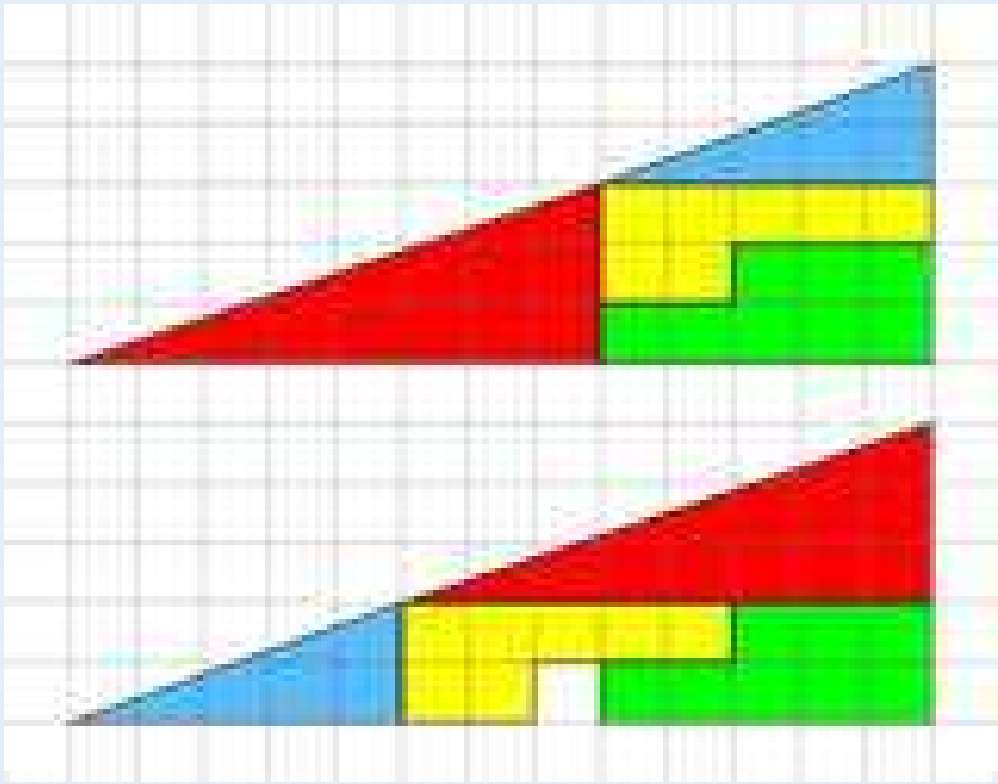
- With the legitimation of irrational numbers in 19th century by Dedikind, symbolic mathematics posed a threat to geometric diagrams.

Geometric paradoxes



Geometric paradoxes

Geometric paradoxes



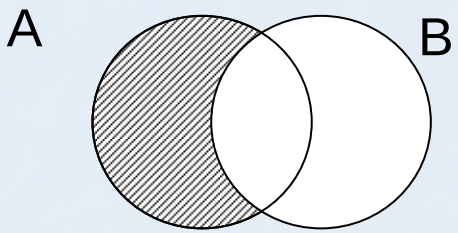
Diagrams as heuristic tools

- Lewis Carroll square
- Peirce diagrams
- Venn diagrams

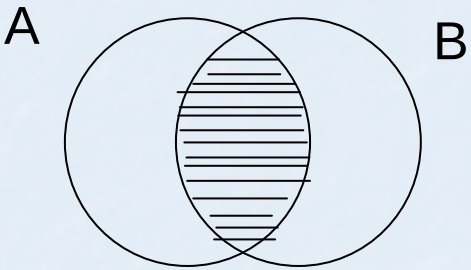
Lewis Carroll square

I	often	wondered	when	I	cursed ,
Often	feared	where	I	would	be-
Wondered	where	she'd	yield	her	love
When	I	yield,	so	will	she.
I	would	her	will	be	pitied!
Cursed	be	love!	She	pitied	me...

Venn diagram

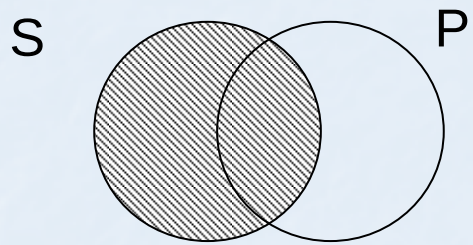


All A is B



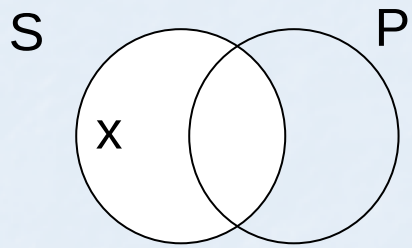
No A is B

Venn diagram

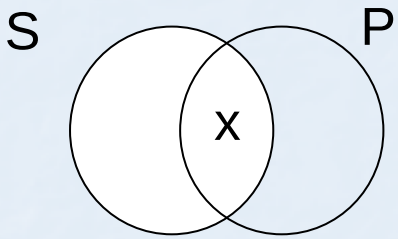


All A is B and No A is B

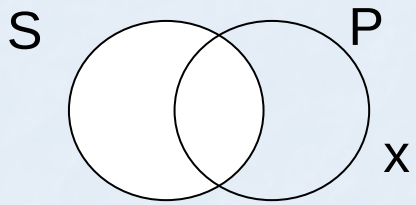
Peirce diagram



Some S is not P

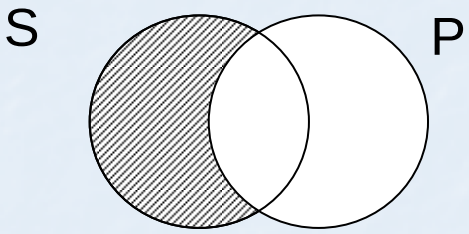


Some S is P

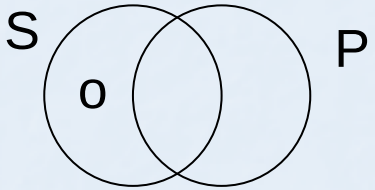


There is something besides S and P

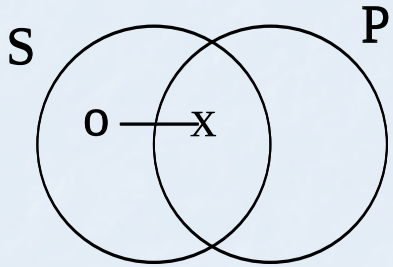
Venn-Peirce diagrams



Venn



Peirce

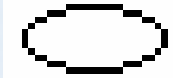


either All S is P or Some S is P

Syntax: Venn-i^{o}

Venn-i^{o} is a modification on Venn-i[2] with respect to the open universe. Following are the primitive symbols of Venn-i^{o}:

[ ] Open rectangle: the open universe.

 closed curve: monadic predicates.

Shading: indicating emptiness.

x cross: indicating non-emptyness.

$a_1 \ldots\ldots a_n$: names of individuals.

Syntax: Venn-i^{o}

- $\bar{a}$: absence of individual named a.
- $A_1,\ldots,A_m$: names of closed curves.
- — : line connecting crosses (x's)lcc.
- --- : line connecting individuals (a's) lci (in the degenerate case lci contains just one individual symbol, say a).

Syntax: Venn-i^{o}

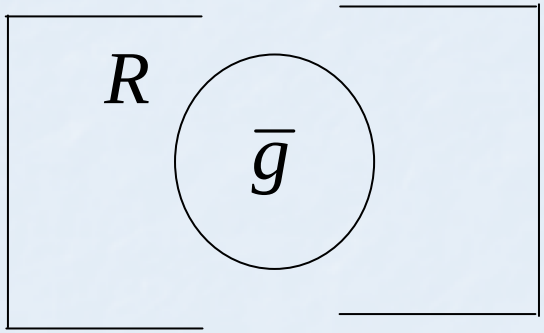
- The notion of *well-formed diagram* with respect to open universe.

- Type I: One closed curve containing some of the above mentioned objects within '[ ]'.
- Type II: More than one intersecting closed curves as is done in Venn I within ' [ ]'.
- Type III: These diagrams are formed by joining type I or Type II diagrams by lines.

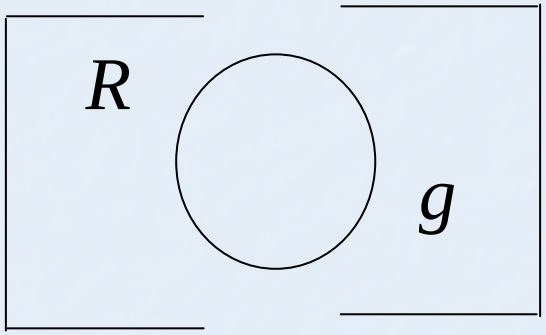
$\bar{g}$

Venn-i^o

- The representation of 'Gandhi is not in this room' in Venn-i^o is:



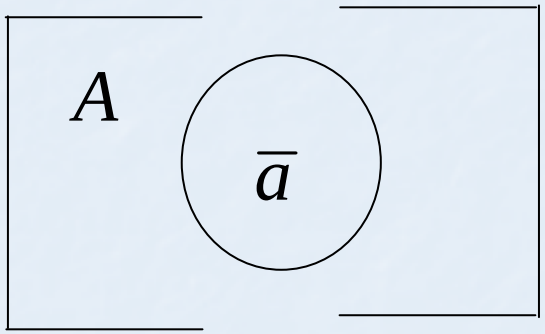
From this the inference



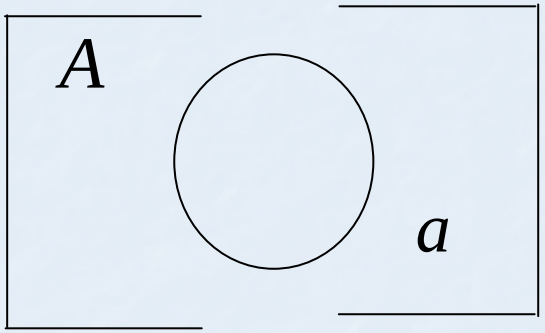
- will not be allowed in Venn-i^o which involves existential commitment.

Venn-i^{o}

In general, inferences from



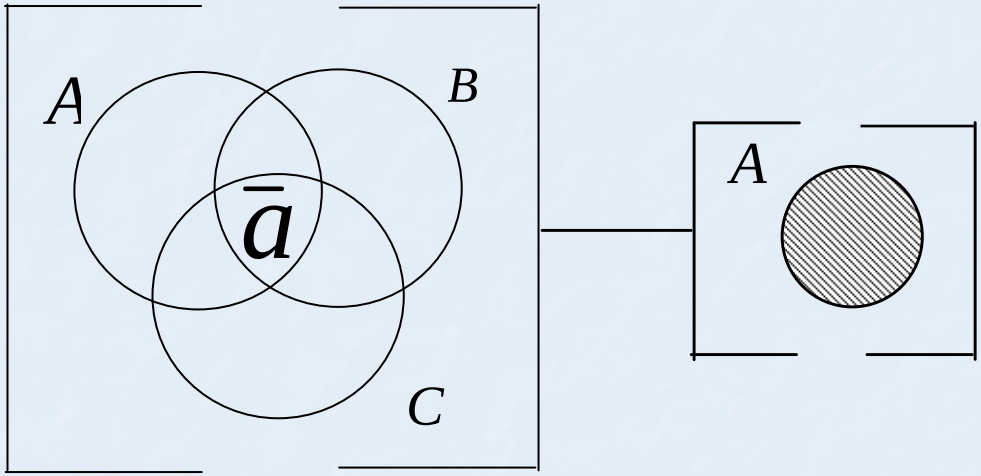
to



will not be available in Venn-i^{o} .

Venn-i^{o}

Following is an example of a type III diagram in Venn-i^{o}



Venn-i^{o}

The depiction of the open universe in terms of

'[ ]'is helpful in grouping of diagrams and in representing disjunctions.

Any Venn-i diagram with open universe will be a Venn-i^{o} diagram.

Advantage of diagrams: its relation with imagery

- Diagrams deepen our understanding about ourselves and the ways in which we think.
- Diagrams provide an essential scientific base for constructing representations of different diagrammatic information that can be stored and processed by the computer.

Conclusion

The investigation into the relation between external and internal representation on the one hand and diagrams on the other, need to be investigated at length.

Alan Blackwell[2] considers that dimensions of notational framework provides an *analytic approach* to understanding the way that diagrams are used in real tasks.

Cabris and Kosslyn[4] suggests that *Visual thinking* operates mostly on sketchy cartoon like representations of the physical world. The sensory input is translated into efficient codes before storing and manipulating it.

Conclusion

- A cleverly organized display minimizes the number of perceptual units which enables a design to pack a lot of information into it.
- The underlying principle that help researchers that speak in favour of diagrams is the *Representational Correspondence Principle* that states, effective diagrams depict information the same way that our internal representation do. This principle is based on the observation that all visual input is translated into internal codes before it is operated on by reasoning process.

Conclusion

- The brain is often in danger of being overwhelmed by too much information and thus a crucial aspect of processing involves stripping down representations to the core, preserving some aspects and discarding others.

Conclusion

- According to Chabris & Kosslyn caricatures make use of the *Representational Correspondence Principle* by matching a stimulus more closely to our internal representation of the represented object and there by facilitate our encoding. Our internal representation is not just a mental photograph. These representations emphasize the most useful aspect of the stimulus and deemphasize those aspects that will not help in the most common tasks involving those stimuli. In other words these internal representations do not include irrelevant details.

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Thank you