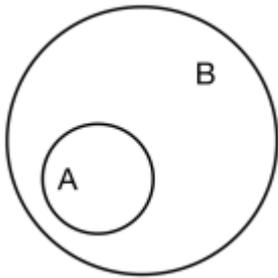


Inside out logic

Description

If you live in Edinburgh, and Edinburgh is in Scotland, then you live in Scotland. This reasoning draws on the containment metaphor, and the transitivity of containment. It is easy to represent as a diagram, eg, as a Venn diagram. If something is in A then it is also in B.



The diagram also applies to "all As are B." Draw a small circle or a dot in A and label it C. This is the basic representation of the logical syllogism. You can see at a glance (even without drawing it) that C must be a B. The diagram demonstrates the following

All As are B; C is an A; therefore C is a B.

If a cat is an animal, and I own a cat, then I own an animal. The classical example of the syllogism reads

All men are mortal
Socrates is a man
Therefore Socrates is mortal.

In minimally abstract terms

A implies B
A
therefore B.

C.S. Peirce worked with Venn diagrams (such as the one above) and even developed a means of extending their scope to include variables. But he also developed his own system of logical diagrams that look superficially like Venn diagrams.

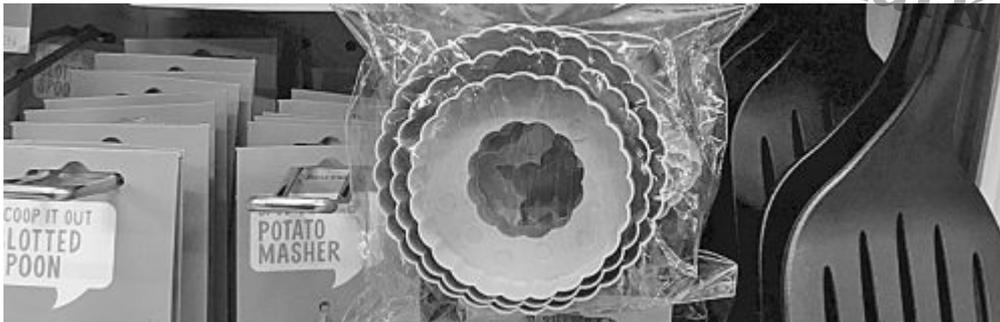
Because I am so wedded to the idea that nested shapes indicate containment, I find it difficult to interpret enclosing shapes to be read in any other way. But in his existential graph system, Peirce's enclosing shapes indicate *exclusion*.

Negation

Peirce proposed a method for representing logical propositions diagrammatically, and in such a way that you can transform that diagram (through a series of rules) to demonstrate a logical proof.

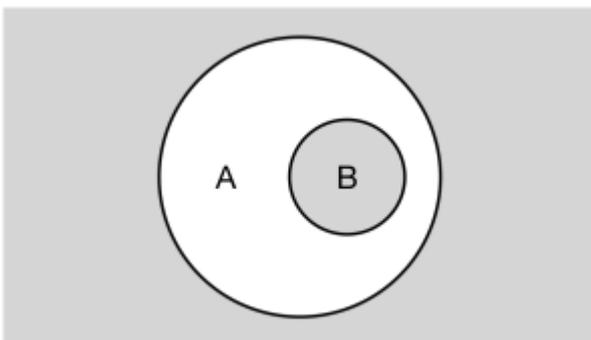
Instead of thinking of bounding lines (the circles in the Venn diagram) as including what is in them, think of the lines as demarcating *exclusion*, i.e. as "untruths," or more precisely, propositions that are not the case in the domain of discussion.

Peirce thought of a line bounding a space as a "cut." A continuous (circular) cut line excludes a certain part of the set/world it is in. (I think of one of those crenelated circular pastry cutters, or groups of activists corralled by police in a demonstration.)



The grey rectangle in the diagram below is the domain of discourse. It is the page on which we construct the drawings. Peirce called this the "sheet of assertions." (He did not use shading, but some commentators think this helps in reading the diagrams.)

Whatever is contained in the outer circle below is excluded from consideration. It is untrue, i.e. not the case. The diagram asserts simply that there is nothing that is A and not B. Peirce called this kind of diagram an "existential graph."



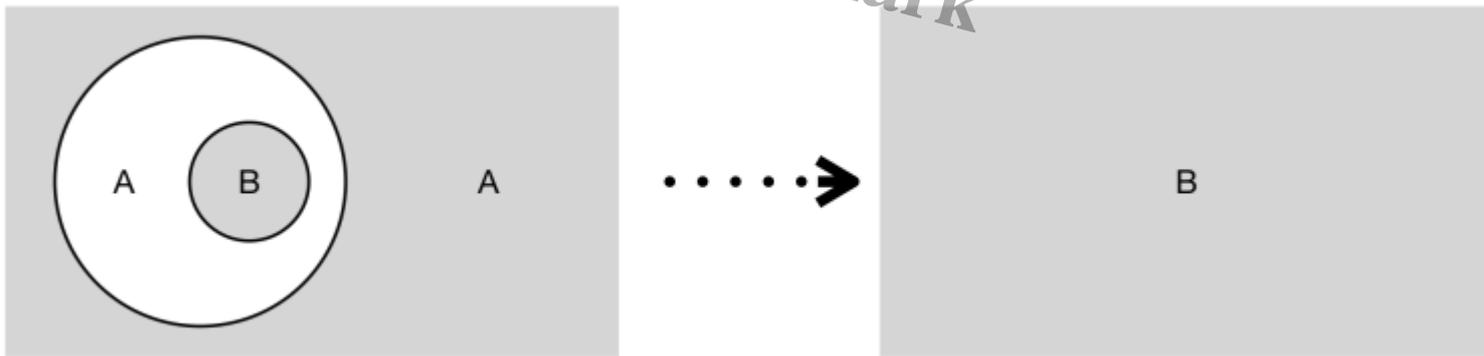
Here's how to read the diagram. If two or more entities are enclosed in the same shape then link them with "and". When you see a boundary line say "not". Start from the outermost boundary. In other words the circles are brackets prefaced by "not".

The diagram above reads not(A and not B). This is Boolean terminology familiar to anyone who has searched a database using the standard query language (SQL).

Substitute *Edinburgh* for A and *Scotland* for B. Then the diagram reads: you can't live in Edinburgh and not live in Scotland. It is equivalent to saying that living in Edinburgh implies you live in Scotland A implies B.

From what I can gather, there is nothing particularly two-dimensional about such diagrams. The circles cannot overlap. What they represent could be laid out as a single string with nested brackets. The advantage of the 2D shapes is that there's room to introduce other symbols, such as points and lines indicating qualities. (I'll ignore that feature here.)

Peirce also devised a series of rules to operate on such diagrams to convert one set of propositions into another. The diagram below demonstrates the working of the syllogism: A implies B, A, therefore B. I have left out the transformations demonstrating how the final proposition is derived. But here is the starting diagram and what it looks like at the end of the demonstration (proof).



In Boolean calculus that's

not(A and not B) and A
therefore B

As he worked in threes, Peirce described the kinds of graphs indicated above as *alpha* graphs, with further developments designated as *beta* and *gamma* graphs. (The examples he and his commentators use extend beyond the simple demonstration I have given here.)

The 5 rules Peirce devised for translating a diagram so as to demonstrate a proof include removing double cuts, i.e. not(not(A)) is simplified to A. There's no need to iterate these rules here, and I think they are similar to basic Boolean calculus, but in graphical form.

Possibility

How does this diagrammatic method cope with *abduction*, i.e. the proposition that if someone lives in Scotland then thereâ??s the *possibility* that they live in Edinburgh, but no logical certainty that they do?

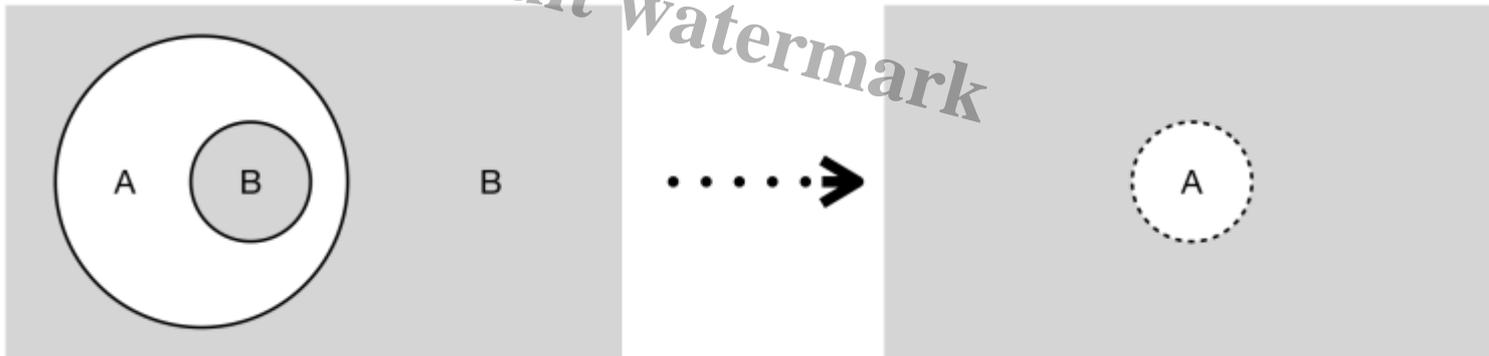
A implies B
B
therefore *perhaps* A

As we would expect, the formulation

not(A and not B) and B
therefore A

does not hold according to the transformation rules.

Such speculative propositions that someone might live in Edinburgh if we know they live in Scotland are supported by Peirceâ??s *gamma* graphs and the idea of the â??broken cutâ?? (a dashed boundary) meaning the â??possibility of,â?? requiring 2 extra rules to process. The start and end points of the demonstration (proof) would look like this.



Proving that something is a *possibility* is easy, and the method supports such a demonstration. But to ascertain how likely it is requires extra evidence, as well as some extra-logical processing. See post [Calculating belief](#).

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- Sowa, John F. 2011. Peirceâ??s tutorial on existential graphs. *Semiotica vol 186, issue 1-4, pp 345-394*. Available online: <http://www.jfsowa.com/pubs/egtut.pdf> (accessed 25 January 2018).

Note

- See Graham Shawcrossâ?? extended description of existential graphs: <https://grahamshawcross.com/2012/12/12/visual-thinking/>

Category

1. Artificial Intelligence

Tags

1. diagram
2. existential graph
3. logic
4. Peirce

Date Created

January 27, 2018

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