

# Deontic reasoning and deontic logic

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# Overview

- 1 A myth about formal logic
- 2 logic and psychology
- 3 Reasoning systems
- 4 An empirical study of deontic reasoning
- 5 Discussion

## The universal language of mathematics

It is a rather common belief that formal logic as part of the more precise language of mathematics is suitable for getting to the true meaning or logical form of everyday language statements which are themselves often ambiguous.

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- A logical analysis of a sentence can somehow reveal, or at least approximate, this supposed logical form.
- There is a special connection between the logical form and the 'real meaning' of the sentence, somehow the true form reveals the true content.
- This idea of logic as an "ideal language" suitable for revising or reforming natural language goes at least back to Frege and Russell, see (Frege, 1879), (Russell, 1905), (Russell, 1916).

Although, this idea and its philosophical assumptions have been criticized extensively, its proponents are still common; for a well-argued defence of logical forms, see (Stanley, 2000); for criticism of the idea, see (Stokhof, 2007). In opposition to this view, I would like to argue for the following two points.

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- 2 Rather, formal logics are artificial languages which are more predictable in some ways than natural languages.
- 3 However, logics also suffer from some of the same flaws as natural languages.
- 4 In some ways formal logics are vastly inferior to natural languages.

## An imprecise sentence

This sort of thing is familiar from logic courses. An imprecise sentence such as the following is presented.

*'One American dies of melanoma almost every hour.'*

To a mathematician, such a claim inevitably raises a chuckle, and occasionally a sigh.' (Devlin, 2012, p. 10).

Supposedly, this sentence *literally* means that one specific American dies almost every hour, which we know to be physically unlikely.

## Rewriting the sentence

Devlin first suggests that the sentence is rewritten as follows to get to the *intended* meaning.

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Let us briefly consider what Devlin actually does.

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- The adverbial phrase 'almost every hour' has been moved to the front of the sentence.
- The rewritten sentence supposedly literally means what it is intended to mean.

# Doubts

I have some doubts about this distinction between literal and intended meaning.

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- However, obtaining alignment between 'literal meaning' and 'intended meaning' requires knowledge of grammar, not mathematics.
- Further, the skills required have little to do with formal logic as we understand this - we are here in the area of hermeneutics, interpreting (and correcting) text.

## The logical form of the sentences

Enter first order classical logic. Devlin suggests the following formalization of the two sentences.

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- However, there is no such thing as the logical form of a sentence.
- Formalization is more like translating into another language, although this is also not a very good analogy.

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  - The second sentence is one where for every hour we pick out, we can find an American who dies of melanoma.
  - However, this is all a trick. What I have done is that I have translated back into English Devlin’s intended meaning with these two (formal) sentences.

## Sceptical remarks

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- For instance, a lot more than one American could die on average and still the second sentence could be true. There could be only one hour in the universe or even no hours and one of the sentences could still be satisfied. Clearly, that is not what is intended in the natural language sentence.
- Finally, the translation introduces a telling mistake, since the word “almost” has disappeared in the translation. It is not that easy to translate a “fuzzy” word such as “almost” into first order classical logic, its ideal model domain is that of discrete, countable, self-identical objects. This is not the world we live in.

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  - Are these aspects less essential than the ones captured by the formalization? I do not see why.
  - There are emotional aspects and so on.

## And some general sceptical remarks

There are many more presuppositions (e.g. existential import) and implications (e.g. at most countable models), that make it clear that first order logic is (also) restricted to certain contexts.

- We should give up the fundamentalist idea that first order logic is somehow closer to the language of thought or reality than other systems. Perhaps we should even begin to look to psychology?

## Logic and psychology

There is a strong bias against psychology in logic that dates back to Frege's conception of logic. He famously wrote the following.

*'What if beings were. . . found whose laws of thought flatly contradicted ours and therefore frequently led to contrary results even in practice? The psychological logician could simply recognize this and say: these laws are valid for them, whereas others are valid for us. I would say: here we have a hitherto unknown form of insanity.'*

(Frege, G., *Grundgesetze der Arithmetik*. Band I. Jena: Verlag Hermann Pohle, 1893)

## Dissent

However, there is some opposition to this restrictive dismissal of psychology in the logic community.

- Johan van Benthem has claimed there has been a *cognitive turn* in logic ( van Benthem, J. F. A. K. (2008). Logic and reasoning: Do the facts matter? *Studia Logica*, 88, pp. 67–84).

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- On the other hand, cognitive psychology could perhaps learn from logic (van Lambalgen, M. and Coughlan, M. (2008). Formal models for real people. *Journal of Logic Language and Information*, 17, 385–389).
- I will here use deontic reasoning as an example of the relationship between logic and actual reasoning.



## A crash course in deontic logic

Deontic logic is a branch of logic named by von Wright, where inferences concerning obligations and permissions are studied.

- Typically conceived as a part of modal logic, although there are many other kinds of deontic systems on the market. Standard deontic logic (SDL) is the normal modal logic D.

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- There are also other problems, e.g. should deontic operators operate on action terms or on propositions?
- I now briefly review some experimental work done in psychology about deontic reasoning.

## Psychological work in deontic reasoning - the deontic selection task

*'If a person is drinking beer, then that person must be over 19 years of age.'*

( Cox, R. J., and Griggs, R. A. (1982). The effect of experience on performance in Wason's selection task. *Memory and Cognition*, 10, pp. 496-502.)

## Remarks

- Studies conclude that people are better at the deontic reasoning task than at the alethic version.
- People are better at tasks with a specific content than at a more abstract task where some sentences have been replaced with letters.
- A limitation is the somewhat odd focus only on conditionals.
- What about the normative aspect of logic?

## Other empirical work in deontic reasoning

Several other empirical studies have also been conducted in deontic reasoning, see (Beller, 2010) for a review of the literature until then. Particularly interesting among them is the study of so-called illusory inferences. These are inferences “that seem highly plausible but that are in fact invalid” (Bucciarellia and Johnson-Laird, 2005).

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### Example (illusory inference)

Suppose only one action is permitted: Either “Take A or B, or both” or “Take C or B, or both”. Are you permitted to take B?  
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- Most people erroneously answer “Yes”.



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- Most people erroneously answer “Yes”.
- However, if you take B, then you are both performing the first and the second action, violating the constraint that you may only perform one of them.

What is interesting about this study, from my point of view, is not so much that people fail to perform the reasoning task correctly, but rather the role played by free-choice inferences in the study.

- The free choice inference is the inference from the disjunctive imperative sentence (e.g. “Take A or B, or both”) to the conjunctive permission of every disjunct (“you may take A and you may take B and you may take both”).

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- The study presupposes this inference to be correct although it is not valid in most formal deontic logics.
- One reason why people fail to perform the test correctly is probably also the dominance of the principle that a disjunctive imperative implies free choice, which is here overridden by a (higher-level) constraint on the performance of the action prescribed by the imperative.

## Interesting implications of the study

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- Free choice inferences are generally perceived to be correct (both by the informants and the designers of the study)
- However, it can be overridden in specific situations.

## Psychology vs. logic

The purpose of the psychological studies of deontic logic is to produce psychologically plausible models of how people reason deontically.

- These models are related to reasoning in a descriptive sense, but they do not in themselves provide us with the means to justify inferences as correct or reject them as incorrect.

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- Getting there requires the tools of formal logic. However, this does not mean that logic cannot be informed by empirical studies. I would go so far as to claim that empirical studies can be used to find the boundaries of our theoretical models and to assess in which social domains they are likely to yield correct reasoning (most of the time).



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- What I propose is the testing of our reasoning systems in much the same way as other theoretical models are tested.

## Traditional answers from logic

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- Some delegate the dirty work of getting it all to fit with reality to pragmatics.
- Others confine themselves to dealing with purely technical matters.
- I suggest that we need to look at alternative ways of seeing the relation between logic and intuition.

## Wittgenstein quote

Our language can be seen as an ancient city: a maze of little streets and squares, of old and new houses, and of houses with additions from various periods; and this surrounded by a multitude of new boroughs with straight regular streets and uniform houses. (Wittgenstein, 1958, Section 19).



## A characterization of reasoning systems

A reasoning system is a fixed arrangement of components (a symbol system) that most of the time will give rise to correct patterns of reasoning when there is the right sort of fit between the model domain and the social domain in which the reasoning system is used.

## Inspiration from Cartwright's nomological machines

*It is a fixed (enough) arrangement of components, or factors, with stable (enough) capacities that in the right sort of stable (enough) environment will, with repeated operation give rise to the kind of regular behavior that we represent in our scientific laws.*

(Cartwright, N. (1999). *The Dappled World*, Cambridge University Press.)

## Characterization of the elements of a reasoning system

What I propose is that perceived logical correctness is dependent on three elements.

- E1 A symbolic system and rules for its manipulation (basically the formulas of the system) .

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- E2 An idealized model domain characterizing some inferences as logical (formal semantics or theorems or rules).
- E3 A social or psychological domain (the cognitive processes of a human being, the domain of discourse).

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## Implications of the characterization

- The correctness of the inferences of a reasoning system is only *ceteris paribus*. If the social domain is changed the reasoning system might not give us correct reasoning patterns any longer.

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- As the social domain is itself to a certain degree a human construct, one might both consider changing the social domain, e.g. teaching people the right way to think, develop the concepts, and changing the logic when meeting inconsistencies between linguistic intuitions and formal logics.

## Implications of the characterization

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- As the social domain is itself to a certain degree a human construct, one might both consider changing the social domain, e.g. teaching people the right way to think, develop the concepts, and changing the logic when meeting inconsistencies between linguistic intuitions and formal logics.
- Social domains may have many different sizes, from the big domains of discourse, deontic, epistemic, and so on, to a highly shielded micro-worlds with lots of special assumptions being made.



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- Time to get more specific.

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- Further they were allowed to comment on their response, which some did in some cases.



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- Conjecture: Many people will affirm the following inference: 'you may run or you may hide. Therefore: you may hide.'
- Here the disjunction is not within the scope of the deontic operator.
- It seems like the scope of operators does not only go inwards but also outwards into a wider context.

## Discussion of pragmatics

Could we not leave all of this to pragmatics and concentrate on correct reasoning in the old sense? I don't think that we can, and for several reasons.

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- Further, pragmatics is about what actually does follow but should perhaps not be said, but when it comes to Ross' paradox the majority of the informants denied that the inference follows at all, in other words they deny that the conclusion is true. These points tend towards the conclusion that these phenomena must be explained as genuine semantic intuitions, not pragmatic conventions in a Grice's sense.

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