

Fred Feldman, "Logic and Ethics," in Lawrence C. Becker and Charlotte B. Becker, eds. *Encyclopedia of Ethics*, 2nd edition (New York: Routledge, 2001), pp. 1011-1017.

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If we understand 'logic' broadly, then we may want to say that many of the central questions of ethics are "logical questions." Thus, for example, consider the question (based on HUME's [1711-1776] remarks in the *Treatise* [1737], III.i.1) whether it is possible to derive an evaluative conclusion from premises that are entirely factual. That is a question in ethics, but it is also a question about whether in-

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ferences of certain kinds are valid; hence it is (in a broad sense of the term) a "logical" question.

Another example—this one involving UNIVERSALIZABILITY—illustrates the same point. Suppose a person recognizes that two possible situations would be alike with respect to all their universal characteristics. Suppose he recognizes that person A plays a certain role in the first situation, whereas B plays the corresponding role in the second situation. It has been alleged (by R. M. HARE, in 1981) that if the person maintains that A has a certain obligation, but B does not have a corresponding obligation, then that person "contradicts himself." It has furthermore been maintained that this is a matter of "the logic of the moral words." If understood in anything like this way, the question whether moral judgments are universalizable thus becomes a question of logic, broadly construed.

Many other topics are also at the intersection of logic and ethics. Consider, for example, JOHN STUART MILL's (1806–1873) notorious "Proof of the Principle of Utility" and MOORE's (1873–1958) claim that every form of NATURALISM involves the "Naturalistic Fallacy."

Logic Narrowly Construed

However, it is also possible to construe 'logic' more narrowly, so that such questions as these are excluded. On this narrower interpretation, we think of a logic as a formal language whose syntax, axioms, and rules of inference are sufficiently well determined to allow uncontroversial conclusions about what is, and what is not, a theorem in the language. This narrower conception would exclude quite a lot of research in ethics, but would not exclude everything. It would include work such as von Wright's on the logic of preference, as well as Roderick Chisholm's (1916–1999) and Ernest Sosa's attempt to formulate a logic of intrinsic betterness. However, the most obvious body of work in ethics that may also be described as "logical," in this narrower conception of logic, is deontic logic.

Definition of Deontic Logic

Deontic logic is the study of the logical properties of obligation, permission, and forbiddenness. For simplicity in preliminary exposition, let us assume that obligation is a relation between a person and a

state of affairs. Then we are interested in the logical features of the concept expressed by, "person *s* is obligated to see to it that state of affairs *p* occurs." We are also, by extension, interested in the logical features of other, related normative concepts.

The study of deontic logic might be motivated by an interest in such questions as these:

- Q1: Is it possible for a person to have a moral obligation to bring about a certain state of affairs *p*, but also at the same time to have another obligation to bring about the negation of *p*?
- Q2: If a person has an obligation to bring about a certain state of affairs *p*, and *p* entails another state of affairs *q*, then does the person have an obligation to bring about *q* as well?
- Q3: If a person has an obligation to bring about a certain state of affairs *p*, and the same person also has an obligation to bring about another state of affairs *q*, does it follow that this person also has an obligation to bring about the conjunction of *p* and *q*?
- Q4: If a person has an obligation to bring about a certain state of affairs *p*, on the condition that *q* obtains; and *q* does obtain, then does it follow that the person has an obligation to bring about *p*?

While it would be possible (and might be useful) to discuss such questions independently and in a strictly intuitive way, without appeal to an all-inclusive formal system, any such approach is likely to be problematic. One difficulty arises from the fact that the relevant expressions might have a multitude of senses in ordinary language, and these different senses might have different logical features. Keeping them distinct in ordinary language might be hopelessly confusing. Researchers are therefore inclined to pursue their studies within the context of various systems of deontic logic. In these systems, some operator (usually 'O') is intended to be the formal analogue of 'ought' in one of its ordinary language senses. The systematic logical features of the operator are precisely determined. We then consider the extent to which the logical features of the formal operator correspond to those we intuitively suppose

belong to 'ought' in ordinary discourse. It has seemed to many practitioners that proceeding in this way is advantageous, since the plausibility of any logical claim is enhanced if it can be seen to cohere with an overarching conception of the logic of obligation. Thus, deontic logic has attracted considerable attention.

Early History of Deontic Logic

Philosophers have attempted to formulate principles of deontic logic at least since the fourteenth century. (For details, see Knuuttila.) It has long been recognized that there is an interesting analogy between the logic of (a) necessity/possibility/impossibility and the logic of (b) obligation/permission/forbiddenness. At a minimum, it appears that just as '*p* is possible' seems to be equivalent to 'it is not the case that $\sim p$ is necessary', so also '*p* is permitted' seems to be equivalent to 'it is not the case that $\sim p$ is obligatory'. One striking difference is that, whereas '*p* is necessary' entails '*p* is true', it is not the case that '*p* is obligatory' entails '*p* is true'. The nature and extent of the analogies and disanalogies were investigated by a number of relatively early modern philosophers, including LEIBNIZ (1646–1716) and BENTHAM (1748–1832).

Ernst Mally (1879–1944). The modern history of deontic logic is generally said to have begun with Ernst Mally, whose "*Deontik*" was presented in 1926. Mally recognized that his system had a number of strange consequences, not least of which was the fact that it validated the principle '*Op* if *p*', which in effect makes it a truth of logic that everything is precisely as it ought to be.

Von Wright's "old system." Recent work can to a remarkable degree be traced back to G. H. von Wright's "*Deontic Logic*." In that paper, von Wright attempted to identify a deontic system by specifying a syntax for a formal language and then introducing some definitions, a small set of axioms, and some rules of inference. Instead of using '*O*' as his primitive deontic operator, von Wright used '*P*', representing permission. He noted that the operators are interdefinable as follows: $Op = \text{df. } \sim P\sim p$.

Von Wright's early system was unusual in several ways. One way concerns the proposed interpretation of the items upon which the deontic operators operate. In von Wright's system, the atomic propositional variables ('*p*', '*q*', etc.) are apparently not to

be understood as standard sentence letters. They are supposed to be "names of acts." Hence, it appears that '*O*' is not a sentence operator, but a predicate of acts. One result is that it would be hard to understand iterated deontic operators; von Wright ruled them out as ill-formed. Furthermore, and for similar reasons, von Wright rejected "mixed" formulae, such as $p \rightarrow Oq$. Another unusual feature was that von Wright explicitly decided against including any axiom or rule that would guarantee that all theorems are obligatory. Apparently, von Wright did not want to make the existence of obligations a matter of logical necessity.

The standard system. Within a few years, as the result of efforts of several philosophers, a "standard system of deontic logic" (or SDL), based firmly on von Wright's old system, had emerged. This is more typical in that we start with propositional calculus, where '*p*', '*q*', etc. are sentence letters, and '*O*' and '*P*' are sentence operators. This allows for iterated deontic operators, and for mixed formulae.

SDL may be characterized in a number of equivalent ways. Assume that we start with a suitable formulation of propositional calculus consisting of axioms and the rules *modus ponens* and *uniform substitution*. SDL is the system that results by adding two axioms and one rule:

$$A1: O(p \rightarrow q) \rightarrow (Op \rightarrow Oq).$$

$$A2: Op \rightarrow \sim O\sim p.$$

R: If *A* is a theorem, then so is *OA*.

Weaknesses of SDL. Some of the fundamental weaknesses of SDL have to do with the expression of conditionality. The only conditional is the material conditional, $p \rightarrow q$, defined in the usual way as $\sim p \vee q$. As a result, "iffy" formulas of SDL don't have the logical features of their ordinary language counterparts. This is especially striking if we take either $O(p \rightarrow q)$ or $p \rightarrow Oq$ as our formal language counterpart for statements of conditional obligation, or commitment ('doing *p* commits you to doing *q*'; 'if *p* occurs, then you ought to see to *q*'; etc.). Some of the difficulties were illustrated by Arthur Prior in "*The Paradoxes of Derived Obligation*." For example, consider the following formulae of SDL:

$$1. O\sim p \rightarrow O(p \rightarrow q).$$

$$2. p \rightarrow (\sim p \rightarrow Oq).$$

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Each of these is a theorem of SDL, and yet their ordinary language counterparts seem absurd:

- 1a. If you ought to avoid doing something, then doing it commits you to doing anything whatever.
- 2a. If something happens, then its failure to happen commits you to doing anything whatever.

Chisholm's paradox. But the difficulties concerning conditionality run even deeper. This was brought out by Chisholm's "Contrary to Duty Imperatives and Deontic Logic." Chisholm introduces four ordinary language sentences:

1. Jones ought to go to the aid of his neighbors.
2. It ought to be that if Jones goes to the aid of his neighbors, he tells them in advance that he is coming.
3. If Jones does not go to the aid of his neighbors, then he ought not to tell them in advance that he is coming.
4. Jones does not go to the aid of his neighbors.

These seem to be both consistent and independent (none is entailed by any combination of others). Yet it appears impossible to represent the logical structure of these sentences in SDL. Using intuitive abbreviations ('A' for 'aid'; 'N' for 'notify'), we might try:

- 1a. OA.
- 2a. $O(A \rightarrow N)$.
- 3a. $\sim A \rightarrow O\sim N$.
- 4a. $\sim A$.

However, (1a)–(4a) yield a contradiction in SDL. From (1a) and (2a) we can derive ON; from (3a) and (4a) we can derive $O\sim N$. Conjoining these yields ON and $O\sim N$, which contradicts A2, which can be understood as ruling out such conflicts of obligation.

We might try altering the scope of the deontic operator in (2) and (3) and using instead:

- 2b. $A \rightarrow ON$.
- 3b. $O(\sim A \rightarrow \sim N)$.

However, the resulting quartet violates the independence condition. (1a) entails (3b); (4a) entails (2b). Various other combinations might be proposed, but none adequately represents the logical features of the original sentences.

Recent Developments in Deontic Logic

Since the publication of Chisholm's paper, a multitude of divergent systems of deontic logic have been formulated. It might even be said that the field has become fragmented, with different researchers pursuing apparently incompatible approaches. Two of the most striking developments are (a) the introduction of dyadic systems, in which conditional obligation ('given that p occurs, q is obligatory') is the fundamental logical primitive; and (b) the rise of the semantic research tradition, in which operators are analyzed by appeal to formal semantics.

Possible world semantics for deontic logic. Kripke's pioneering work in alethic modal logic had shown the fecundity of the old (Leibnizian?) idea that necessity and possibility may be understood respectively as truth in all and some possible worlds. A number of people attempted to adapt the intuition to the interpretation of obligation. Thus we have semantical interpretations of deontic logic. This idea was pursued in two main ways.

Deontic semantics for deontic logic. Some attempted to formulate the semantics on the basis of this intuition: what ought to be the case is what is the case at all worlds in which everyone does what he ought. We may call these "deontic semantics for deontic logic." This is pursued in, for example, Hintikka's "Some Main Problems of Deontic Logic." There the idea is this: certain worlds are "deontic alternatives" to others. Whatever is obligatory at the base world is also obligatory at these deontic alternatives; whatever is obligatory at a deontic alternative is there done. Then we say that '*Op*' is true at *w* iff *p* is true at all deontic alternatives to *w*.

Axiological semantics. Others attempted to formulate the semantics on the basis of an axiological intuition: what ought to be the case is what is the case at all worlds in which everything turns out as well as it can. We may call these "axiological semantics for deontic logic." These have clear affinities to UTILITARIANISM, since obligation is explained by appeal to the goodness of the outcome. This is pursued

in, for example, David Lewis's *Counterfactuals*. A simplified version of the idea is this: for every world there is a ranking of other possible worlds in terms of some unspecified value. Op is true at w iff p is true at all the "bests" from w ; Pp is true at w iff p is true at at least one of the "bests" from w . Lewis wanted to provide for the case in which there is no upper limit to the values of the relevant worlds, and so his actual semantics is based on a somewhat more complex idea: Op is true iff p is true at some possible world, and as we consider worlds better and better than that one, we never find p false.

Dyadic deontic logics. Another major development was the introduction of a primitive dyadic deontic operator: Op/q , to be understood as meaning roughly that p ought to be done, given that q occurs. Some had attempted to introduce the dyadic operator axiomatically, but such attempts ran into difficulties. Perhaps the problems arose because the ordinary language construction 'If . . . , then it ought to be the case that . . . ' is used in several easily confused senses. It appears that these may have different logical features. Axiomatic systems were likely to contain axioms reflecting more than one of these uses. It was only when the semantic approach and the dyadic approach merged (in, for example, the work of David Lewis) that the basis for a more satisfactory solution to Chisholm's puzzle was at hand.

Using the abbreviations introduced above, the Chisholm sentences may be represented as follows:

- 1c. OA .
- 2c. $O(N/A)$.
- 3c. $O(\sim N/\sim A)$.
- 4c. $\sim A$.

When represented in this way in the context of a typical dyadic system, the sentences seem to have the appropriate logical features.

Various other researchers pursued a variety of other approaches, including mixtures of deontic and tense logic; deontic logic with subjunctive conditionals; deontic logic for *prima facie* obligation; deontic logics with operators relativized to persons, times, normative systems, etc.

Remaining Areas of Controversy

While there is a modest amount of consensus on some issues, profound disagreement and confusion

reign with respect to very many fundamental questions. I here list just a few of the most basic.

Moral dilemmas. Let us say that a moral dilemma occurs when a certain person has an absolute moral obligation to bring about a certain state of affairs, p , and the same person also has an absolute moral obligation to bring about the negation of p . Moral philosophers and deontic logicians are divided on the question of whether MORAL DILEMMAS are possible. The standard axiological semantics mentioned above seems to rule out such dilemmas, since, if p is true at some world and never false at a better world, then it cannot also be the case that $\sim p$ is true at some world and never false at a better world.

Bas van Fraassen and others have argued that such cases are possible, and that the standard semantics must therefore be rejected. One line of argument for this conclusion is this: a person might promise one person that he will bring about p , and promise another that he will bring about $\sim p$. If the promises were made in suitable circumstances, he might be in a moral dilemma. Another line of argument (suggested by Ruth Marcus) is based on the possibility of situations in which a person must choose between saving the life of one endangered twin or saving the life of the other (saving both is impossible).

A number of commentators have suggested that this apparent clash of intuitions might be the result of the fact that different philosophers have focused on different concepts of obligation. Perhaps those who advocate dilemmas have focused on what we may call (following Ross) "*prima facie* obligation"; those who have denied dilemmas have focused on "all-in obligation." If so, it is no wonder that they have different views about the possibility of conflicts of obligation. Loewer and Belzer have attempted self-consciously to formulate a deontic system in which the 'O' operator expresses *prima facie* obligation.

The Good Samaritan paradox. If we understand Op to be true iff p is true at all best worlds, then we seem to be committed to the validity of this formula: $(Op \text{ and } p \rightarrow q) \rightarrow Oq$. Indeed, some version of the formula is a theorem in virtually all systems. Nevertheless, it generates strange looking sentences in some cases, as described by Lennart Aqvist. For example, consider the case in which p is 'Jones is punished because he in fact murdered Smith,' and q is

'Jones murdered Smith.' Here p entails q ; Op might be true; but it seems doubtful that Oq is true.

Problems about truth values. From its very inception (or modern reincarnation) deontic logic has been perplexed about the very deepest question about deontic sentences: do these things have truth values? Some have been impressed by the facts (a) that it is hard to see how anyone might have empirical evidence for one of them; and (b) that their fundamental linguistic role seems to be action-guidance rather than mere expression of fact. Thus, it might be better to view deontic sentences as more like imperatives than indicatives. Thus arises a puzzle sometimes known as "Jorgensen's Paradox." If deontic sentences do not have truth values, and logic concerns itself exclusively with things that do have truth values, then how can there be any such thing as deontic logic? On the other hand, if deontic sentences do have truth values, how can they be action-guiding and "imperative"?

The neutrality problem. It might appear that a viable system of deontic logic would have to be neutral with respect to normative ethics—that is, that any viable system would have to display some minimal set of formal characteristics that would be acceptable to advocates of all (plausible) systems of normative ethics. This corresponds to the idea that (for example) standard propositional calculus is compatible with virtually any view about American history. Logic should tell us what entails what; it should not tell us what is true. However, it is hard to see how deontic logic can be neutral with respect to normative theory, when the semantical interpretation of the obligation operator immediately generates truth conditions for sentences of the form Op .

Thus, for example, if we adopt an axiological semantics for deontic logic, we seem to be committed to some form of CONSEQUENTIALISM in normative ethics. We seem to be saying that Op is true if p would be true if things turned out in the best way possible. Those who reject the idea that our moral obligations are in this way linked to the values of outcomes (however assessed) will surely want to reject the proposed semantical interpretation of deontic logic.

See also: BENTHAM; CATEGORICAL AND HYPOTHETICAL IMPERATIVES; CONSEQUENTIALISM; DEONTOLOGY; DUTY AND OBLIGATION; FORMALISM; HARE; HUME; INTUITIONISM; MOORE; MORAL DILEMMAS;

MORAL REASONING; MORAL TERMS; OUGHT IMPLIES CAN; POSSIBILISM; PRACTICAL REASON[ING]; PRESCRIPTIVISM; ROSS; UNIVERSALIZABILITY.

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