MODAL LOGIC AND ITS APPLICATIONS – course outline – Marcello Di Bello – July 2007

OVERVIEW: The aim of the course is to illustrate the applications of modal logic to metaphysics, epistemology, formal semantics and artificial intelligence. The course also offers a basic introduction to logic. No previous knowledge of logic or philosophy is expected.

REQUIREMENTS: Regular attendance and weekly homework assignments.

COURSE SCHEDULE:

Introduction to Modal Logic (meetings 1, 2, 3). Syntax and semantics of classical and modal logic (propositional and predicate) are presented. Special attention is paid to single out analogies and differences between classical and modal logic.

References:

Blackburn, P. et al. (2001), *Modal Logic*, Cambridge University Press.

On the Nature of Possible Worlds (meeting 4). The notion of a possible world is central in modal logic, but controversies exist about the nature and ontological status of possible worlds. This lecture surveys the different ways one can conceive of a possible world. Within the philosophical community, the debate is between metaphysical and epistemic readings. The mathematical community prefers to think of possible worlds as points, so that possible world semantics becomes nothing else than a graph-like semantics. Computer scientists like to think of possible worlds as transition states of a system executing an algorithm.

References: Blackburn, P. et al. (2001), *Modal Logic*, Cambridge University Press.

Kripke, S. (1972), *Naming and Necessity*.

Lewis, D. (1983), Possible worlds, in *Philosophical Papers*, Oxford University Press.

Stalnaker, R. (1976), Possible Worlds, *Nous*, 10, pp. 65-75.

Doing Metaphysics with Modal Logic (meeting 5). We will see modal logic tackling some nasty metaphysical problems. Since its beginnings, philosophy has distinguished between an immutable, meta-emprical, God-like world, and a changeable and empirical world. Contingency and necessity are a pair of concepts that can discriminate these two worlds. But what does it mean to be necessary or contingent? The alethic and metaphysical interpretation of modal logic can help us give an answer to this question.

References:

Aristotle, *De Interpretatione*.

Leibniz (1686), *Discourse on Metaphysics*.

Lewis, D. (1986), *On the Plurality of Possible Worlds*.

Plantinga, A. (1989), *The nature of Necessity*.

Doing Epistemology with Modal Logic (meeting 6). This lecture brings us from the realm of metaphysics to realm of epistemology, from the investigation of being to the investigation of knowledge. What is knowledge and what features characterize it? We will appeal to the epistemic interpretation of modal logic for answering this question.

References:

Hintikka, J. (1962) , *Knowledge and Belief*.

Relevance Logic (meeting 7). Lectures 6 and 7 are about modal logics which give particular accounts of the connective $\rightarrow$. One is relevance logic. In this logic, implications are such that the truth of the antecedent is connected with the truth of the consequent. A sentence of the form" *If the moon is made of cheddar cheese, then I am Marilyn Monroe*" may count as true in classical logic, but not so in relevance logic.

References:

Anderson & Belnap (1975), *Entailment: The logic of Relevance & Necessity*, Princeton UP.

Conditional Logic (meeting 8). There is another way we can use the phrase *if ...then*, namely when we reason hypothetically: If the moon were made of cheddar cheese, then it would have been eaten up by aliens. This reasoning is called counterfactual reasoning, and we use it all the time in our every day life. If we were to formalize this sort of reasoning in classical logic, by using material implication, we would run into trouble (that's counterfactual reasoning!). However, another variant of modal logic provides an interesting solution, conditional logic, which is the topic of this lecture.

References:

Lewis, D. (1973), *Counterfactuals*, Blackwell.

Conditional Logic and Belief Revision (meeting 9). Sometimes it is surprising how one formalism can account for more than one phenomenon. This might tell us that the formalism is very powerful, or that the there is a commonality between seemingly different phenomena. Conditional logic (used to model counterfactual reasoning) turned out to be adequate for modelling belief revision as well. The connection between conditional logic and belief revision is the topic of this lecture.

References:

Grove, A. (1988), Two Modellings for Theory Change, *Journal of Philosophical Logic*, vol. 17.

A logic for Belief Revision DDL (meetings 10 and 11). The connection between conditional logic and belief revision is a strong one. Until this connection was discovered, there was no work in modal logic that attempted to model belief revision. The research was entirely conducted by the computer science community, mostly interested in building intelligent systems for belief revision. Once the connection was discovered, a new modal logic was invented, Dynamic Doxastic Logic, designed to model belief revision from the point of view of modal logic. The final two lectures introduce this logic.

References:

Segerberg, K. (1988), Irrevocable Belief Revision in Dynamic Doxastic Logic, *Notre Dame Journal of Formal Logic*, 39:3, pp. 287-306.