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Knowledge, chance, and change

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Chapter 1

Introduction

This thesis is about the logic of knowledge, chance and change. In logic one is engaged with inferences and one tries to answer the question whether an inference is correct. One does this by looking at the abstract form of inferences. Logical languages are often tailored to inferences where a certain concept is paramount. All sorts of logics have been developed, each with their own application areas. In this thesis three logics are studied: epistemic logic, dynamic logic, and probabilistic logic. A chapter is dedicated to each of them. There is a chapter on the combination of dynamic logic and epistemic logic. The central chapter of this thesis is dedicated to the combination of all three of these logics. With this logic one can study inferences about probabilistic information change.

In epistemic logic one focuses on inferences where knowledge (or more generally information) plays a crucial role. Reasoning about knowledge is particularly interesting in situation involving more than one individual. In that case someone can know whether someone else knows something or does not know something. Chapter 2 provides a short introduction to epistemic logic, without any new results. Readers familiar with epistemic logic can skip this chapter, or skim through it to get acquainted with my notation.

Dynamic logic is the logic of change. It is mostly applied to changes that occur due to the execution of computer programs. In chapter 3 some technical results about propositional dynamic logic are presented. Propositional dynamic logic is not compact, and therefore a finitary proof system can never be strongly complete. In chapter 3 a strongly complete proof system is presented and a straightforward completeness proof is provided. A curious property of the canonical model, called disharmony, is also examined. This chapter is the result of joint work with Gerard Renardel and Rineke Verbrugge, which has already resulted in a publication (see Renardel de Lavalette, Kooi, and Verbrugge (2002)).

Epistemic logic and dynamic logic can be combined to study inferences about information change. The main part of chapter 4 is dedicated to providing an overview of all dynamic epistemic logics, but a new system is also presented.

These logics differ from other approaches to information change in that higher-order information is explicitly taken into account.

In probabilistic logic inferences about probability are studied. There are many different philosophies about the nature of probability. In chapter 5 I investigate the relationship between two probabilistic logics, that have arisen from two different notions of probability.

In chapter 6 I develop a probabilistic dynamic epistemic logic, which combines the logics that were treated in the earlier chapters. It is suited to analyze inferences about the probabilistic information change, especially when higher-order probabilities play a role. The paper on which this article is based will appear later this year (see Kooi (2003)).

Once these logics are presented some problems in the area of knowledge, chance and change are explicitly discussed: the Monty Hall dilemma is analyzed in chapter 7, the game Mastermind is examined in chapter 8, and the two envelope paradox discussed in chapter 9.

Finally in chapter 10 I draw some conclusions.