Logics of communication and knowledge
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The goal of this dissertation is to give a logical representation of the knowledge dynamics that takes place during communication. I present a number of different logical frameworks for a number of different scenarios, ranging from an email conversation where all information that is sent is considered to be true, to a game of Liar’s Dice where lying is expected of the players.

In Chapter 3, I present a framework for modeling the knowledge of agents who exchange messages, using Dynamic Epistemic Logic. This framework uses Kripke models to represent the agents’ knowledge in a static situation, and action models to update these Kripke models when the situation changes. Because the models are supposed to be finite, and all messages are represented explicitly in the model, the messages that are considered possible by the agents are limited to a finite set. This framework is useful in a situation in which there is a number of rounds in each of which a finite set of new messages becomes available to the agents. These messages can gradually be added to the model.

The framework presented in Chapter 4 is of a more general nature. It models a setting where agents communicate with messages over a specific network in accordance to a certain protocol. This framework is very flexible because the nature of communicative events and the observational power of the agents can be adapted to the situation at hand. It combines properties of the Dynamic Epistemic Logic approach with the perspective of Interpreted Systems.

In Chapter 5 and 6 I focus on email communication specifically. I first study the existence of common knowledge in a group of agents who communicate via emails. Unlike the approach presented in Chapter 3, all possible emails are represented in the model, which is therefore of infinite size. I prove a number of properties of finite states in this infinite model, and show that common knowledge of an email with BCC recipients is rare.

Apart from common knowledge, I consider two new kinds of knowledge: potential and definitive knowledge. These two types of knowledge make a distinction between the assumption that every agent immediately reads every email he re-
ceives, or that every agent has only read the emails he replied to or forwarded. I also present a method to do model checking, even though the model is of infinite size.

Chapter 7 is a study of the properties of action models, which are used to model communicative events. I define a notion of action emulation that signifies when two canonical action models are equivalent. Because every action model has an equivalent canonical action model which can be computed, this gives a general method to determine action model equivalence.

In Chapter 8 I move from knowledge to belief. I use the same Kripke models as for knowledge, only without the assumption that all relations are equivalence relations. I propose a different assumption, namely that the relations are linked. I also give a number of updates of these models that preserve this property, representing communicative events.

Finally, Chapter 9 gives different perspectives on the issue of lying. It includes a complete logic of manipulative updating, which can be used to represent the effects of lying in a group of agents. I also analyze a game of Liar’s Dice and implement this scenario in the model checker DEMO. Furthermore, I show that in a game where lying is considered normal, a lie is no longer a lie: because the agents who hear the lie do not believe it, no false belief is created.