The Role of Automated Deduction in Intellectics

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The observation that humans often appear to use a more sophisticated logic than the classical one has sometimes served as an argument against the fundamental role of Automated Deduction in Intellectics. In response to this challenge, a variety of non-classical logics have been developed over the last decade, in order to provide adequate formalisms that cover different aspects of commonsense reasoning. In our talk, we will argue that both classical logic and non-classical derivatives, though different in the details, are based on common grounds. This insight gives rise to the question whether and how calculi originally designed for classical deduction can be adjusted to the various kinds of non-classical logic. We will illustrate such adjusting modifications on the grounds of the connection method [3, 2]. As the two fundamental concepts we will elaborate the one of a *connection*, which represents the application of the *modus ponens* rule, and the one of a *path*, which represents the current assumptions made in the course of a single deductive sequence. For two exemplary aspects of topical interest related to non-classical deduction, namely *resource-sensitivity* and *non-monotonicity*, we will point out the refinements and restrictions required for connections and paths in order to cope with these aspects adequately; yet both concepts do remain fundamental.

Resource-sensitivity is an important aspect of reasoning about actions and change [9, 10]. A straightforward use of classical logic lacks the essential property that facts describing a world state may change in the course of time. To overcome this problem, the truth value of a particular fact has to be associated with a particular state. This solution brings on the famous technical frame problem [11]. In [1, 4, 5, 6] we have developed the *linear* connection method for solving the problem *without* the need of any so-called frame axioms [11, 8, 7]. Literals here are treated as resources which can be consumed during a deductive sequence. More specifically, in contrast to classical logic a literal on the path has to be removed immediately after it has been engaged in some connection.

The treatment of incomplete information constitutes one of the central problems for complex information systems. This issue was brought to the attention of the Artificial Intelligence community by Minsky [12], who prompted the creation of an area known as non-monotonic reasoning. In our talk, we will consider one of the best known and most-widely used formalisms for default reasoning, namely Reiter's Default Logic [13], and put it in the context of the connection method. We will discuss an approach which relies on the idea that a default rule can be decomposed into a classical implication along with two qualifying conditions—one accounting for the character of an inference rule and another one enforcing the respective consistency conditions. To this end, we have modified the standard criterion defining a valid proof in the connection method. More specifically, in contrast to classical logic the possibility of connecting two literals is restricted by additional criteria, namely *admissibility* (to ensure explicit provability of the prerequisite of each applied default) and *compatibility* (to ensure consistency of the justification of each applied default) [14]. Furthermore, we employ the *stability* criterion (to ensure validity in every extension) for the case of drawing skeptical conclusions [16, 15].

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