CS 786G *Cognitive Modeling*
Week 2 Discussion Paper
Natural inference and Classical Predicate Logic as representation

Steve Woods
89800462

May 26, 1995

Rips (1994) discusses both the appropriateness and effectiveness of classical predicate logic (CPL) as a means of modelling or duplicating human representation and reasoning methods. The essential features of successful applications of CPL in relatively complex domains are shown to surround heuristic application of rules and control of the process of inference or rule production of new "facts" into the base of knowledge. In this short paper, we will *very briefly* discuss the motivation of heuristic control selection preferred in Rips (1994) and an example of inadequate representational ability of CPL for a human expression of a rule for reasoning.

The understanding of the essentials of human cognition is a task in progress, with many *key* aspects of the process entirely unknown. In many Artificial Intelligence (AI) papers, these "gaps" of knowledge remain persistent points of disagreement between researchers, with argument on these points relying primarily on points of purely personal opinion or intuition. Many researchers fill in these gaps by resorting to claiming this or that method is more *natural* than its predecessor or counterparts. In this vein, Rips (1994) re-iterates earlier criticism of some partially successful methods of search control in CPL automatic reasoners, such as *resolution*, seeking to replace such strategies with less "machine-oriented" or "psychologically inscrutable" ones that more adequate reflect "natural deduction". While the appeal that more obvious human-intuitive approaches must be an important aspect of systems that interact directly with human reasoning systems (people) is seductive, it does not entail that other approaches are inappropriate for at least two reasons. First, (and Rips makes this point indirectly), determining human use of *resolution* to be unnatural or awkward may be an artifact of the way in which people are taught to express their reasoning process and not indicative of the process itself; and second, an effective reasoner might make use of "non-intuitive" methods within the black box of its own operations, and simply map these methods to some appropriate related set of human-intuitive methods in order to facilitate human communication. It would appear then, that without more specific appeal[1] to actual specific substantiated research into human cognition, it remains precarious to eliminate reasoning methods due to *unnaturalness*.

Rips (1994) makes use of an example in which the sentence "The richer the country, the more powerful one of its officials" is translated into a quantifier-free form of predicate logic as "IF (Country(X) AND Country(Y) AND Richer-than(X,Y)) THEN (Official(b_X) AND Official(b_Y) AND More-powerful-than(b_X,b_Y)). The intended meaning is translated by Rips (1994) as "there is some mapping from each country to an official of that country such that if country X is richer than country Y, then the indicated official of X is more powerful than the official of Y". In the actual written rule, the implication in the word *one* is that the official in question in Country X fulfills some type of function related to one corresponding official in Country Y. Therefore, official b_X in fact shares not only a relationship with Country X, and b_Y with Y, but also a role-relationship with official b_Y. This relation is in fact a similarity statement between two relations, that of b_X to X and b_Y to Y. Therefore, the individuals b_X and b_Y chosen in any instantiation of the predicate logic form *should* be constrained to those that demonstrate this relation, however, it would appear that this constraint is missed in the predicate logic representation of this rule. It would be easy at this point to claim that clearly this logical representation is "unnatural" since it does not seem to readily encapsulate all of the important information inherent in the English "equivalent". Further thought suggests that what actually is missing in this case is a representation of understood context between the writer and the reader, specifically that information about role sharing that is in some fashion implicit in the text.

In this paper I have briefly outlined two objections to a criticism of the use of "unnatural" control mechanisms in automated reasoning as part of a method of modeling human cognition, and I have pointed out one example where the encapsulation of a written textual rule for reasoning has been mis-translated into a form of predicate logic as a result of missing or ignoring shared-context between reader and writer.

References

Rips, L. (1994), *The psychology of proof: Deductive reasoning in human thinking*, MIT Press, chapter 2, pp. 63–99. ISBN 0-262-18153-3.

Thagard, P. (1994), Introduction to cognitive science, Manuscript in preparation.

[1] Of course, this appeal quite possibly occurs in later Chapters of Rips (1994), however, this discussion is based solely on Chapter 2.