Connections between Natural Language Processing and Automated Reasoning

Chris Mellish
Department of Computing Science
University of Aberdeen
King's College
Aberdeen AB24 3UE, UK
cmellish@csd.abdn.ac.uk

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1 Introduction

I studied for a PhD at Edinburgh under Alan Bundy's supervision from 1976 to 1981 (including spending two years as an RA). In fact, I was his first research student to get a PhD. My work was (and is) in natural language processing (NLP), but Alan's focus is on aspects of automated reasoning (AR) to do with Mathematics. So how did I end up with Alan as supervisor? It was really a series of lucky accidents, including me applying for a non-existent course at Edinburgh and Yorick Wilks (now Professor of NLP at Sheffield) leaving shortly before I arrived. When I arrived in Edinburgh, there *was* NLP work going on, in the form of Martha Palmer's work on Alan's MECHO system. So that's where I ended up.

Studying NLP with Alan in the context of MECHO was a great introduction, because (unlike a lot of other NLP work going on at the time) it was NLP in the context of a real and plausible task. At a deeper level, it meant that we were looking at both language understanding and reasoning in the context of the same system. It turned out that search control was a serious issue for both areas, and we had some success in devising mechanisms that were useful for both [Byrd et al 82, Bundy et al 79].

2 Connections between AR and NLP

AR and NLP in fact have an honourable history of working together, mainly in two distinct ways:

NLP in the service of AR - particularly NLP (in fact, natural language *generation*) being used to explain complex proofs in a way that can be understood by a human. This work goes back at least to [Chester 76] and is still actively pursued (see e.g. [Horacek 99])

AR in the service of NLP - particularly AR being used to automate aspects of natural language *understanding*. There are many proposals in formal semantics to model language understanding in terms of constructing logical representations of some kind [van Benthem and ter Meulen 97]. There is, unfortunately, rather less work that actually considers the computational problems of organising or controlling inference in these formalisms. The advent of logic programming and Prolog (which originated from Colmerauer's work on machine translation) and the viewing of parsing as deduction [Pereira and Warren 83] meant that NLP tasks could be viewed as the same kinds of problems considered by AR. There have also been specific proposals that distinctive kinds of inference may be needed by NLP, e.g. abduction [Hobbs et al 93] and model generation [Konrad 04, Mellish 02]. And yet the above work carried out in the MECHO project still stands out as one of the few examples that try to address inference *control* for NLP tasks.

3 AR in NLG

Since 1984, my main work has been focussed on natural language *generation* (NLG) rather than *understanding*. Just recently, I have been concerned with the problem of *content determination*: given some information expressed as a set of logical axioms and the desire to present some of this information in natural language, how can one derive appropriate pieces to send to an NLG system? In particular, one requires content that is of appropriate complexity for linguistic realisation, is linguistically coherent with what has just been said, does not lead the reader to make false implicatures, etc. I have come to believe that content determination is a kind of inference from the input material, but an inference that needs to be guided by linguistic criteria that have no simple expression in the logic [Mellish and Sun 05]. Standard (e.g. refutation-based) approaches to inference seem to be inappropriate for a task like this. What ideas are there in AR that might inform the implementation of such a "natural language directed inference" system? I am still trying to answer this question, but my initial starting point is to look at meta-level control of inference in general. And of course Alan has one of the key publications in this area [Bundy and Welham 81]...

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