COMP5450M

Knowledge Representation and Reasoning MSc

Assignment 3 — Autumn 2020

KRR Challenges and Potential

Brandon Bennett

Due 10am, Friday 4th December, 2020

General Instructions

Task Overview

The task for this assignment is to write a report investigating the potential of KRR as a means to provide capabilities for AI systems. You will consider in particular the issues that arise when using KRR techniques to model the types of inference that underlie common-sense reasoning that is expressed in natural languages. To provide evidence and illustrations you will investigate certain challenge problems that have been proposed for testing KRR approaches to AI.

Focus on KRR

Note that your focus should be on **KRR** aspects ***not*** on the related problem of *natural language processing*. It is certainly difficult to translate from natural language into a logical representation, and you should consider this as one aspect of the problem. However, your main focus should be on what kinds of logical representation and inference system should be used, and what kinds of knowledge need to be represented.

Number of People and Choices of Challenge Problem(s)

Because the assignment can be done by 1, 2 or 3 people, the requirements are a little different depending on the number. The minimum (and maximum) length requirements for the introductory and concluding sections vary according to the number people. Also, for the middle section you need to present ***one detailed example for each person doing the project***. It is expected that each person choose and do most of the work on their own example, but you may, and are encouraged to, exchange ideas on all the examples and work together on the presentation and clarity of the whole report. You will see the exact details in the section below that specifies the structure and requirements for your report.

You also have a choice of studying **either or both** of the two well-known challenge problems (the Winograd Schema Challenge and the COPA dataset, about which further information and links are given below). Probably for a 1-person project it is best to consider only one of these, and in a 3-person project it may be easier to consider both of them, as you will have a wider range of possibilities to explore. However, this is your choice depending on whether you want your report to have more variety or more depth.

Note that for your examples in the middle section, you should only pick ones from the challenge or challenges you considered in the introduction. So, if you only considered one of Winograd and COPA in your introduction, you should pick examples from that challenge. But if you considered both of them you can pick examples from either or both of the challenges.

Background on KRR Challenges

In preparation for writing the report, you should find out about the Winograd Schema Challenge and COPA Challenge.

The Winograd Schema Challenge

The Windograd Schema Challenge is based on an example that was given by pioneering AI researcher and computational linguist Terry Winograd of a kind of problem that arises in the interpretation of certain natural language sentences. The problem concerns the identification of the reference of *pronoun* words (such as 'he', 'she', 'it'), which in some cases appears to require a deep understanding of the meaning of the sentence in which it occurs. A 'Winograd Schema' is a pair of sentences that are the same apart from some key word or phrase, such that the two sentences require different interpretation of the pronoun. Hence, the pair demonstrates that determining the pronoun reference requires 'understanding' of the meaning of the key word/phrase and how this interacts with the meaning of the whole sentence.

Winograd Schema Sentences have been revisited and promoted in the form of an AI challenge by Hector Levesque, a well-known exponent of logic-based AI techniques, and Ernie Davis, a specialist in logical formulations of commonsense reasoning.

For further information, take a look at Ernie Davis' web page at:

- http://www.cs.nyu.edu/davise/papers/WinogradSchemas/WS.html
  Web page all about the *Winograd Schema Challenge* with links to schema sets and other relevant information.
- https://cs.nyu.edu/faculty/davise/papers/WinogradSchemas/WSCollection.html
  This is Ernie Davis' original collection of 150 Winograd schemas. (For some reason it says 146 at the top of the page, but there are actually 150.)

  I shall use the numbering that is used on this web pages to refer to the schemas.
- https://cs.nyu.edu/faculty/davise/papers/WinogradSchemas/WSCollection.xml
  This is an XML version of the original Winograd schemas, which is less densely formatted than the previous version and may be a bit easier to read.

There is also more information on my projects web-page at: https://teaching.bb-ai.net/Student-Projects/Natural-Language-and-Winograd-Schema-Challenge.html

The COPA Dataset

The *Choice of Plausible Alternatives* (COPA) dataset is a resource devised by Andrew Gordon of the University of Southern California. It contains examples an important kind of commonsense reasoning that can be used to guide the design of automated KRR systems and evaluate their performance. Information about COPA, as well as the actual dataset, can be found at:

https://people.ict.usc.edu/gordon/public_html/copa.html

Requirements for your Report

(a) **The Winograd/COPA KRR Challenge Problem(s) (20 Marks):** In this section you should describe either the **Winograd Schema Challenge** or the **COPA** dataset challenge **or both**. You may also mention other challenges but these should be described in less detail.

For the problems you consider, you should explain form of the test's input, the nature of the test, and why it is a significant test for AI and particularly for KRR systems.

Required length:
1 person: 500-1000 words, 2 people: 800-1200 words, 3 people: 1000-1500 words.[1]

Marks will be awarded for: Coherence (8), Content/Detail (12)

(b) **Specific KRR Problem Examples (60 Marks):** Each person doing the project should pick an example instance taken from the challenge problem or problems that you have considered in part (a). So each example will be either a particular Winograd Schema pair or a specific COPA sentence with its two alternative explanations.[2]

Your examination of each example should be around 1 page (∼500 words) in length and should include the following:

- A statement of the problem and an explanation in English of what knowledge and/or reasoning principles you believe to be required for deducing the answer.
  (Marks per example: 1 person: 24, 2 people: 12, 3 people: 8)
- Logical formulas representing the sentences of the problem and giving axioms or general facts that would enable the answer to be deduced. To answer this you do not need a full solution. or an explanation of why the reasoning is difficult to capture in a logical representation.
  (Marks per example: 1 person: 36, 2 people: 18, 3 People: 12)

(Note: the total for this section adds up to 60 however many people are working on the report.)

(c) **Conclusion: Will KRR Succeed or Fail? (15 Marks)** Give your opinion, with justification, of whether you believe that KRR techniques are likely to be able to solve the reasoning challenge problems you have considered (Winograd and/or COPA) with a high degree of accuracy. Consider the advantages of using a KRR approach to this problem and the difficulties that are likely to arise.

Required length:
1 person: 400-600 words, 2 people: 500-800 words, 3 people: 600-900 words.[1]

(d) **Bibliography (5 Marks):** The previous sections should contain appropriate references to relevant publications and resources (e.g. web-sites, datasets). At the end of your report should be a properly formatted bibliography. It will be marked for Accuracy, Scope and Relevance. It is expected you have at least 5 references for each person doing the project.

Summary of report length requirements

Number of People	*Intro (a)*	*Examples (b)*	*Conclusion (c)*	*Total*	*Bib. References*
1 person	500+ w.	1×500+ w.	400+ w.	1400+ w.	5+
2 people	800+ w.	2×500+ w.	500+ w.	2300+ w.	10+
3 people	1000+ w.	3×500+ w.	600+ w.	3100+ w.	15+

[1] You should state the number of words in this section at the beginning of the section. You will lose some marks if the section is less than the minimum word length specified for the number of people doing the project.

[2] ***Note the following restrictions:*** Do ***not*** pick any of the first 9 Winograd Schemas (as referenced in `WSCollection.html`, see previous page) or any of the 3 COPA examples presented on the main page of the COPA website (`copa.html`). I will be using these as examples in lectures.