MSc AI and HMC thesis project:
Reading experiments on higher-order reasoning

Background. It is commonly assumed in reading research that comprehension unfolds in real time as a reader understands the text. The goal of the self-paced reading method is to monitor that process. It is widely believed that longer processing times reflect a greater processing load (see Haberlandt, 1994). The reading process can be experimentally studied in moving window design: the text appears on the screen and the readers expose successive segments of the text, the windows, by pressing a space bar. The intervals between presses indicate the reading time for the window. Even better, one can use eye-tracking to more precisely monitor the eye-fixations of subjects reading normal text (see Just et al. 1982).

Project. People can understand complicated stories containing higher-order social information. They can also draw conclusions from a written text containing this sort of information. For example:

Imagine that you are a member of the Fellowship of the Ring. Your company is forced to take the path through the ancient mines of Moria. During the battle that ensues, Gandalf fights Balrog, and both fall into an abyss. The remaining eight members of the Fellowship escape from Moria but a little while later the fellowship is broken. Frodo and Sam depart secretly to Mordor on their own and on the way they don't talk to anyone. Some days later, together with Merry and Pippin, you meet Gandalf again. It's hard to believe but Gandalf survived the fall in Moria.

Based on the information provided above you are able to decide whether the following sentences are true:

(1.) Pippin knows that you know that Gandalf is alive. (2nd-order) Answer: True
(2.) Frodo knows that Pippin knows that Gandalf is alive. (2nd-order) Answer: False
(3.) Merry knows that Gandalf is alive. (1st-order) Answer: True
(4.) Gandalf is dead. (0th-order) Answer: False

The goal of the project is to study the processing of higher-order epistemic sentences (see, e.g., Verbrugge 2009, Apperly 2010, and the website of our project: http://www.ai.rug.nl/SocialCognition/)
What are the factors influencing the complexity of higher-order sentences? The obvious hypothesis is that the order of the sentence plays a crucial role. The higher the order the more grammatically complex is the sentence. But does the grammatical complexity explain all? There might be other important factors responsible for difficulties with comprehension. First of all, epistemic content of the sentences may play a role. Are the grammatically equivalent sentences equally difficult, no matter whether they differ in epistemic involvement? Furthermore, it might be necessary to take into account other factors as well, for example, the use of personal pronouns, the truth-value of the sentence or the form of embeddings. One hypothesis might be that sentence (5.) is easier to comprehend than sentence (6.) as it contains self-referentiality that requires a form of introspection on my side.

(5.) I know that Bob knows that Cecilia knows who won a poker game yesterday.
(6.) I know that Bob knows that I know who won a poker game yesterday.

Finally, we may want to take into account various complexity measures. The self-paced reading experiments contain at least 2 stages. You need to read (parse) sentences and as you go, incrementally, build an understanding (comprehension) of the text. Next, based on your comprehension model you need to reason to answer the experimenter's questions (make a decision). For instance, the time you spend reading a given sentence is influenced both by parsing and comprehension difficulty. The time you need to reach a decision together with its correctness is dependent on the decision complexity.

Student. We are looking for one or two MSc student in HMC or AI familiar with experimentation with adult subjects and statistical methods or/and logical or cognitive modeling. The project could involve experimental and/or theoretical work. This research project will be jointly supervised by Ben Meijering (http://www.ai.rug.nl/~meijering/), Jakub Szymanik (http://www.jakubszymanik.com/), and Rineke Verbrugge (http://www.rinekeverbrugge.nl/) (all in Multi-Agent Systems Group here at ALICE).

References

I. Apperly. 2010. Mind Readers: The Cognitive Basis of "Theory of Mind", Psychology Press.

Just, M.A., Patricia A.C., and J.D. Wooley. 1982. Paradigms and processes in reading comprehension. Journal of Experimental Psychology@: General, Vol 111 (2), Jun 1982, 228-238. To be downloaded through RuG viahttp://scholar.google.nl/scholar?cluster=12384934461399084449&hl=nl&as_sdt=0,5

K. Haberlandt. 1994. Methods in reading research. In: M.A. Gernsbacher (ed.), Handbook of Psycholinguistics. San Diego, CA: Academic Press, pp. 1-31.

R. Verbrugge. 2010. Logic and social cognition: The facts matter, and so do computational models. Journal of Philosophical Logic 38 (6), 2009, pp. 649-680. To be downloaded from: http://www.rinekeverbrugge.nl/PDF/Articles%20in%20refereed%20journal/Logicsocial-JPL09.pdf