CSCI-UA 9472 - Assignment 2 (Part II)
Logic and artificial intelligence

Given date: October 12
Due date: October 29

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In this second assignment, we consider the paper of Nilsson, *Logic and artificial intelligence*. Some of the questions below are slightly more involved and as a result will be weighted on 2 (in which case those will be indicated with a single *) or 3 (in which case those will be indicated with two **) points instead of 1.

- What are the three theses of Nilsson ?
- How does Nilsson make the distinction between declarative and procedural knowledge ? How does he suggest to improve the first simpler distinction that he introduces ?
- According to McCarthy and Smolensky, what are some advantages of declarative knowledge? What is your opinion on those?
- Why is English not a good declarative language candidate? and what language does Nilsson adovocate as a good declarative language?
- What should be, according to Nilsson, the key elements of a machine interacting with the world?
- In what sense is the machine designer comparable to a scientist ?
- How does Nilsson describes the construction of first order predicate calculus ? and the sentences in this language ? Within the framework of first order predicate calculus, how can one summarize the task of the designer?
- What is the difference between state and interpretation?
- How does Nilsson describe *reasoning* (in particular the *reasoning* aspect of the function *mem*)? What does he describe as *sentence manipulation*?
- What is the approach suggested by Nilsson as an alternative to the (expensive) verification that all models of Δ are also models of the new sentence ϕ (explain in your own words)
- What rule can be considered *sound* according to Nilsson ? In particular, what is the difference between a *rule of inference* and a *sound rule of inference*? Explain the difference between the symbols $\Vdash$ and $\vdash$

- How do we call a set of inference rules that will ultimately be able to prove any entailed sentence ϕ?
- Is it always good to limit an agent to sound inferences? (try to be as exhaustive as possible)
- To describe the connection between the real environment and the representation of this environment through the knowledge base, Nilsson cites the American essayist Edward Abbey. What is Abbey's point ?
- According to Nilsson, what is the problem with logical inference as the main source of deduction and reasoning? In particular, what is the difference between induction and deduction? Give an example of a inductive inference. How does Nilsson argue one might sometimes rewrite an unsound inference (or induction) as a sound one (or deduction)?
- How does Nilsson define the term *reification*? Can you give an illustration? When and why could *reification* be useful? What is a metatheory in this framework?
- What does Nilsson mean by *qualifications* and what example does he use to illustate a problem that can arise due to the inifinite number of those qualifications?
- What is a *theory that is not inaccurate*? How can inference be performed in the framework of a theory that is not inaccurate according to Nilsson? In particular, explain the notion of *defasible inference* and *non monotic reasoning*.
- ** In his paper *Applications of Circumscription to Formalizing Common-Sense Knowledge*, John McCarthy uses the following example to illustrate the use of circumscription to tackle the qualification problem. We consider a world with at least 3 blocks, A, B and C. This information is stored in the first order predicate sentence

$$is\ block(A) \wedge is\ block(B) \wedge is\ block(C) \tag{1}$$

From this we may want to express that unless something abnormal happens, if an object is a block, then it must necessarily be A, B or C. This can be done by circumscription. Circumscription relies on (1) replacing an original predicate P (from a sentence S such as (1)) with a second more restrictive predicate $\Phi(x)$ and then (2) applying the circumscription rule

$$S(\Phi) \vee \forall x\,(\Phi(x) \Rightarrow P(x)) \Rightarrow \forall y\,(P(y) \Rightarrow \Phi(y)) \tag{2}$$

In the case of the block world, we can thus take the predicate $\Phi(x)$ to be given (for example) by

$$\Phi(x) \equiv (x = A \vee x = B \vee x = C) \tag{3}$$

Applying the circumscription rule to $\Phi(x)$, we get the implication

$$\Phi(A) \wedge \Phi(B) \wedge \Phi(C) \wedge \forall x.\,(\Phi(x) \Rightarrow is\ block\ x) \Rightarrow \forall x.(is\ block\ x \Rightarrow \Phi(x)) \tag{4}$$

which, given that the predicates are true, provides the conclusion

$$\forall x.(is\ block\ x \Rightarrow (x = A \vee x = B \vee x = C)) \tag{5}$$

If we then learn that $is; block\ D$, the proposition (1) becomes

$$is\ block(A) \wedge is\ block(B) \wedge is\ block(C) \wedge is\ block(D) \tag{6}$$

which invalidates the conclusion (5) (1) Describe in words, and through the example provided above, how circumscription provides a solution to the qualification problem? (2) Is circumsription sound or unsound?

- How does Nilsson describe the frame problem?
- How can the notion of *abnormality* be used to tackle the qualification problem? (limit yourself to Nilsson's paper. No need to read the references that appear in the bibliography)