Taaltheorie en Taalverwerking 2017

Homework 4

1. Translate the following sentences into quantified formulae of predicate logic. 3 points

   (a) Angus likes somebody and somebody likes Betty.

   (b) Angus loves a dog who loves him.

   (c) Nobody greets Carl.

   (d) Somebody coughs and sneezes.

   (e) Nobody coughs or sneezes.

   (f) Only one dog barks.

   Hint 1: Use constants a, b, c for the proper names 'Angus', 'Betty', and 'Carl', respectively. Use the predicate $Person(x)$ to translate the words 'somebody', 'nobody', and 'person'. The other predicates should be obvious, but note that the words 'only one' in (f) should not be translated using predicates.

   Hint 2: Sentences (c) and (e) can be translated into two equivalent formulae. Give the two possible options.

2. Consider a question-answering system trying to answer the following questions. 3 points

   (a) Is McDonald's a vegetarian restaurant?

   (b) Can vegetarian persons eat at McDonald's?

   Give a single set of logical facts and inference rules necessary to answer the first question negatively and the second question affirmatively. Your set of facts should state general properties of restaurants, of vegetarian restaurants, of vegetarian persons, and of McDonald's.

   Hint: Use mb as a constant for 'McDonald's' and the predicates $Restaurant(x)$, $Person(x)$, $Vegetarian(x)$, $ServesVeg(x)$, $ServesMeat(x)$, and $CanEatAt(x, y)$ to construct your set of facts. From these facts, you should be able to logically infer the following answers (without these answers being part of the set of facts themselves):

   (a) $\neg(Restaurant(md) \wedge Vegetarian(md))$

   (b) $\forall x[(Person(x) \wedge Vegetarian(x)) \rightarrow CanEatAt(x, md)]$

3. Consider the following context-free grammar.

$S \rightarrow NP\ VP$	$D \rightarrow$ a | every
$NP \rightarrow D\ N$	$N \rightarrow$ restaurant | menu
$NP \rightarrow PN$	$PN \rightarrow$ Albert
$VP \rightarrow V\ NP$	$V \rightarrow$ has | opens

(a) Extend this grammar with a semantic attachment for each syntactic rule. Use λ-expressions for the semantic attachments of the lexical rules. [2 points]

(b) Translate each of the following sentences to predicate logic: [8 points]

i. Albert opens a restaurant.

ii. Every restaurant has a menu.

Then, using the grammar with semantic attachments you have given in (a), show how this logical representation is built up compositionally: derive the parse tree for each sentence; number the nodes in the tree; and then for each number/node, give the corresponding semantic representation before and after β-conversion (including all intermediate steps).

4. Consider again the sentence *Every restaurant has a menu* from Exercise 3(b). [3 points]

(a) Is this sentence ambiguous? If so, what kind of ambiguity does it exhibit?

(b) If it is ambiguous, give the possible predicate logic formulae into which it can be translated.

(c) Is it possible to compute all possible meanings for this sentence using your Python implementation of the previous exercise (or the original CFG)? Explain why.