Homework Assignments for Computational NL Semantics (320541) Spring 2015

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For Course Purposes Only

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Contents

Assignment 1 (Fragment 1) Given Feb 17, Due Feb. 24

Problem 1.1 (Fragment Interpretations)
Consider the following sentences: 50pt

1. *Prudence was the golfer*.
2. *Fiona liked the golfer and Ethel poisoned Prudence*.
3. *It was not the case that Fiona sang*.

For all three of them:

1. Give a parse + translation tree for each of the sentences above.
2. Make a model for $\mathrm{PL_{NQ}}$ and calculate the truth value of each sentence relative that model. Show each step in the calculation. (Yes, this is tedious. We won't keep making you do it. But you have to do it a few times to be sure that you know how.)
3. Give a semantic proof showing that sentences (1) and (1) together entail the sentence: *Fiona liked Prudence.*.
4. Give a semantic proof showing that the sentence *Fiona liked Prudence* does **not** entail sentence (1). (You don't have to repeat calculations you already did for the previous proof.)
5. Now give syntactic versions of the two previous proofs.

Problem 1.2 The following sentence can be parsed in two different ways: 20pt

1. *It is not the case that Jo laughed and Fiona sang.*

Give the two parse + translation trees, and show using a semantic or syntactic proof that the interpretations assigned to the two parses are not equivalent.

Problem 1.3 15pt

1. What is the simplest thing you can think of that is allowable in English but that we cannot do with syntax of Fragment 1?
2. What is the simplest thing you can think of that the syntax of Fragment 1 can generate but which we cannot translate into $\mathrm{PL_{NQ}}$?
3. What are the simplest deductions which we can perform intuitively on the basis of Fragment 1, which we cannot represent in our logic?

Problem 1.4 (Model Generation)

15pt

1. Construct a model generation tableau to represent the following discourse:
   Fido is the dog and Mimi is the cat. Jane owns the dog or Jane owns the cat. Jane does not own Fido.
2. Now show, using the model generation calculus, that adding the sentence *Jane does not own Mimi* to the discourse above leads to a contradiction.

Clarification: Fragment 1 was a little vague here, saying that all NPs are mapped to individual constants. We assume that "the dog" is mapped to a constant d, where the information $dog(d)$ is in the world knowledge.

Assignment 2 (Extending Fragment 1: Worksheet) Given Feb 25, Due Mar 1.

Problem 2.1 Modify the syntax of Fragment 1 so that it will generate sentences like the following ones: 15pt

1. *Ethel howled and screamed.*
2. *The dog howled or barked.*
3. *Ethel kicked the dog and poisoned the cat.*
4. *Fiona liked Jo and loathed Ethel and tolerated Prudence.*
5. *Fiona laughed and kicked the cat.*
6. *Fiona kicked the cat and laughed.*
7. *Prudence kicked and scratched Ethel.*

Make sure that the syntax can deal with the possibility of recursion.

Note: *and* and *or* are interchangeable in all of these constructions. Your syntax should allow for both possibilities.

Problem 2.2 Use your new syntax from Problem 2.1 to give parses for sentences from Fragment 1, i.e. 15pt

- *Ethel liked Jo.*
- *Ethel laughed.*
- *Bertie is the teacher.*

Problem 2.3 Now try to adapt $\mathrm{PL_{NQ}}$ and the $\mathcal{F}_1$ translation rules so that, applied to the new parses for the sentences in Problem 2.1, you derive the old results. How to proceed: 15pt

- For any new category that you introduced, figure out what kind of object its translation should be.
- Enrich $\mathrm{PL_{NQ}}$ with objects of that kind. You may introduce any notation you like to do this.
- Provide a semantic rule for the new elements of $\mathrm{PL_{NQ}}$. (I.e. extend the definition of the valuation function so that it applies to the new elements.)
- Write translation rules that handle whatever the old fragment could handle.
- Work through the examples in Problem 2.2 to test the new rules.

Try to provide adequate translations for *and* and *or* as they occur in the sentences in Problem 2.1. Do all the steps above with the full system. Make sure that your rules can still handle ordinary sentential conjunction and disjunction.

Now you can try to use the same tools to deal with negation compositionally.

Problem 2.4 Revise the grammar from Problem 2.1 so that it will generate the following sentences 15pt

1. *Bertie didn't laugh.*
2. *Bertie didn't laugh and didn't scream.*
3. *Bertie didn't laugh or scream.*
4. *Bertie didn't laugh or kick the dog.*

Note: You can treat *didn't* as a single unanalysed unit.

Provide a translation for *didn't* that ensures that a sentence like *Bertie didn't laugh* is a paraphrase of *It is not the case that Bertie laughed*.

Assignment 3 (Working with Verb Phrases and Imagining Nominal Phrases) Given Mar 6., Due Mar10.

Problem 3.1 (Translation for adverbs)
In the previous assignment, you worked out the type of VP adverbs such as *slowly* in: 15pt

1. *John ate the sandwich slowly.*

Now that you know the type of this expression, you can give a translation for it. Work out a translation by:

- Deciding what you think the translation of sentence 1 should be.
- Working backwards from this translation using linguists' β-expansion to get a translation for *slowly*.

Problem 3.2 (A Grammar for Fragment 4)
Extend (and possibly modify) the grammar of Fragment 3 with a treatment of noun phrases, so that the following sentences can be covered without the "the-NP" trick. 15pt

1. *Peter loved the cat.*
2. but not **Peter loved the the cat.*
3. *John killed a cat with a hammer.*
4. *Peter loves every cat.*
5. *Every man loves a woman.*

You should come up with a solution that covers the determiners *the*, *a*, and *every* in a general way. Give the type of all new syntactical categories you introduce.

Problem 3.3 (Translating Fragment 4)
25pt

1. Give translation rules for the grammar you defined in Problem 3.2
2. Give logical expressions for the determiners *a* and *every* (you can use first-order connectives and quantifiers). Can you interpret these as set operators?
3. Describe how the translation ι[1] of the determiner *the* behaves as a function and mathematically define the interpretation $\mathcal{I}(\iota) \in \mathcal{D}_\alpha$ in the logical semantics.

The translations you give should predict the observations about appropriate usage of the determiners.

[1]Unfortunately, the traditional symbol used for this is iota, just as for the type of individuals; but they are easy to distinguish by the context

Assignment 4 (Working with Nominal Phrases) Given Mar 11., Due Mar17.

Problem 4.1 (Adverbs again: to think about and discuss)
Consider adverbs such as *slowly*, which combine with a VP to return a VP. At first sight, it would seem that these could be treated analagously to predicative adjectives. Consider Version 1 and Version 2 of our treatment of these adjectives and determine which approach, if either, seems correct for the treatment of adverbs. If you think either approach is correct, give a translation and denotation for *slowly*. If you think neither approach will yield an appropriate treatment for this type of adverb, explain why. 15pt

Note: Don't write a doctoral thesis in answer to this question. A paragraph will be plenty.

Problem 4.2 Here we have another intuitively acceptable discourse which our system predicts to be unacceptable. Again, provide the tableau which is generated, and explain why our rules are inadequate for this case and what is needed to improve the system. 15pt

Jane didn't hear the telephone. The baby was crying.

Problem 4.3 Construct a model generation tableau for the following intuitively acceptable discourse, adding whatever plausible world knowledge is needed. 15pt

Jane bought an old car. The steering wheel fell off.

Note: Treat *steering wheel* as an unanalyzed CN, and *fell off* as an unanalyzed intransitive verb.

Now do the same for the following discourse, which is *not* intuitively acceptable, showing that our current system predicts its unacceptability. Again, add world knowledge as needed.

Jane bought an old car. The wheel fell off.

Problem 4.4 (Generalized quantifiers)
Provide generalized quantifier interpretations for the determiners: 15pt

1. *No* (as in *No student likes homework.*) and
2. *At most five* (as in *At most five people laughed.*)

Problem 4.5 The following discourse is intuitively acceptable, but our system cannot provide a model for it. Give the tableau which is generated by our rules. What is it about our rules which makes them inadequate for this example, and what kind of improvement is needed to make the system a better model of actual interpretation processes? 15pt

Jane owns a dog. She brought home another dog. The dog growled at her dog.

Translation notes:

1. Treat *brought home* as an unanalyzed transitive verb.
2. For the final sentence, assume that *her dog* is equivalent to *the dog that Jane owns*, i.e. translate as: $\iota(\lambda x.\mathrm{dog}(x) \wedge \ni \mathrm{jane} x)$

Problem 4.6 (Practice with semantic rules)

15pt

1. Using semantic proofs, show that our current translation rules predict that:
   (a) The sentence *Every boy runs* entails *Some boy runs*.
   (b) The sentence *It is not the case that every boy runs* entails *Some boy doesn't run.* (Note: Treat *it is not the case that* as an unanalyzed item translated by $\neg$, as we did in the previous fragment.)

(c) The sentence *Some boy runs* does not entail *Some boy doesn't run*.

2. Intuition tells us that the sentence *Some boy runs* entails *Some boy moves.*. Is this entailment predicted by our current system? If yes, how? If no, why not, and what kind of addition do we need to make to the system to capture this fact?

3. Give a syntactic version of proofs (1a) and (1b) above using model generation tableaux.

Problem 4.7 (Set/function Relations)

15pt

1. Let f be a function in $\mathcal{D}_{\iota\to\iota\to\iota\to o}$. f is the characteristic function of a set. What sorts of entities are the members of this set?

2. Now answer the same question for $f \in \mathcal{D}_{(\iota\to o)\to o}$ and for $f \in \mathcal{D}_{(\iota\to o)\to\iota\to o}$.

3. Give a λ expression which represents the complementation operation on sets of individuals, i.e. the operation which, given a set of individuals, returns the complement of that set.

4. Give a λ expression which represents the complementation operation on the intersection of a pair of sets of individuals, i.e. the operation which, given two sets of individuals, returns the complement of their intersection.

Problem 4.8 (Type raising for NPs)

We have assumed so far that NPs always have translations of type ι. From this, we infer that VPs must have translations of type $\iota \to o$. Given these assumptions, we treat the subject NP as the argument of the VP. The goal of this problem is for you to figure out how to change the type and translation of the NP to make the VP an argument of the subject NP, maintaining the assumption that the VP is of type $\iota \to o$. 15pt

Consider the sentence:

1. *John ran.*

Assume as before that the VP is of type $\iota \to o$.

1. If we wanted the VP to be an argument of the NP, what type would the NP have to be?

2. If the VP is treated as argument of the NP, we might want to write the translation of the sentence as a whole like this: john(run). Assuming this translation for the sentence, what would the translation of the NP itself be?

3. Now suppose that we want to keep the VP of type $\iota \to o$, treat it as argument to the NP, and still translate the sentence as a whole in the familiar way, i.e. as run(john). (The expression john is, as before, a constant of type ι in our logical language.) Provide another higher-typed translation for the NP *John* which will produce this translation for the sentence as a whole.

4. Suppose that we were to assume that NPs were always of this new, higher type. What problem would arise in the case of transitive sentences such as *John saw Jane*?

Assignment 5 (Treatment of Adjectives) Given March 18., Due March 21.

Types and translations for adjectives:

Recall the properties of adjectives like *blue*, *French*, *happy*, *forgetful*: If something is a blue diamond, then it is blue and it is a diamond. If someone is a French journalist, then she is French and she is a journalist. The next task is to give types and translations for adjectives of this kind. However, there is more than one way to do this, so you will get to explore a couple of options. We assume throughout that attributive adjectives combine with CNPs.

Problem 5.1 (Adjectives Version 1)

Assume, as we have so far, that the translation of a branching node is arrived at by function application. Specify the type for attribute adjectives in NPs such as *the blue diamond*. Then give a translation of this type for such adjectives. 10pt

Problem 5.2 (Adjectives Version 2)

Now assume that the type of the translation of attributive adjectives is $\iota \to o$. Try to come up with an alternative way of specifying the translation of the CNP node under this assumption, to give the same results as you obtained in Version 1. 10pt

Problem 5.3 (Predicative adjectives)

Our fragment generates sentences of the form *Jane is happy, The diamond is blue*. Assume that predicative *be* denotes the identity function. (Alternatively, you can say that it is invisible to the translation rules.) Can either of the analyses you have given be extended directly to adjectives in this construction? If not, what modifications need to be made? 20pt

Problem 5.4 (Some more complicated cases)

Not all adjectives behave quite as nicely as the ones you just analyzed. Consider these: *big*, *small*, *tall*, *short*. Note that if something is a big ant, then it must be an ant but is not normally what we call big. However, it must be big for an ant. Similarly, if something is a short skyscraper, it must be a skyscraper, but is probably not something we would normally call short. However, it must still be short for a skyscraper. 20pt

Consider whether these adjectives are best treated along the lines of ?ADJfrag-adj1? or ?ADJfrag-adj1? above. Make a choice, and then offer a translation for *big*. If you don't see a way to translate it which will directly predict its behavior, simply translate it as big and specify the desired denotation for this constant.

Problem 5.5 (And yet more complications)

A fake diamond is not a diamond; an alleged murderer is not necessarily a murderer. Suggest a way of treating either of these adjectives. 10pt