Foundations of Semantics and Pragmatics - Homework 3

Please submit answers to the following exercises on paper to the course pigeon hole, not later than 10.12.2012. You can discuss the exercises with other students, but your work must be personal. If you have questions, please contact Assaf at least one day before the deadline.

1. Give informal descriptions of the following functions, which are described as lambda terms. For example, \( \lambda x.e.\lambda y.e.y \) is a function of type \( e(e) \). It sends every entity of type \( e \) to a function that sends every entity of type \( e \) to itself.

1. \( \lambda x.e.\lambda f.et.f(x) \)
2. \( \lambda f(et).\lambda y.f(\lambda z.e.y) \)
3. \( \lambda f(e).\lambda x.e(f(x)) \)
4. \( \lambda f(e).\lambda g(\lambda z.e.g(\lambda y.e.f(x))) \)
5. \( \lambda f(e).\lambda x.e.\lambda y.e.(f(x))(y) \land (f(y))(x) \)

remark: \( \land \) is standard propositional conjunction.

2. Write down the lambda terms corresponding to the following informal descriptions.

1. The function of type \( (e(e))((ee)t)(et) \) that sends a function \( f \) of type \( e(e) \) to a function that takes a function \( g \) of type \( ee \) as an input and returns the composition of \( f \) and \( g \). Recall that the composition of a function \( f : A \to B \) and a function \( g : B \to C \) is the function \( h : A \to C \) s.t. for every \( x \in A \), \( h(x) = g(f(x)) \).

2. The function of type \( (e(et))(e(et)) \) that sends every (char. function of a) binary relation \( R \) to the (char. function of the) symmetric closure of \( R \). Recall that \( R' \) is the symmetric closure of \( R \) if for all pairs \( \langle x,y \rangle \) in \( R \), \( R' \) contains both \( \langle x,y \rangle \) and \( \langle y,x \rangle \).

3. In the last tutorial class we analyzed the sentence It is not the case that Obama lost to Romney (a) and gave semantics to it is not the case that. We noticed that there is a sentence with equivalent truth conditions - Obama did not lose to Romney (b).

1. Analyze sentence (b) by drawing a tree and decorating it with types and denotations. Assume that did denotes an identity function of type \( (et)et \).

2. Write down the types and denotations of it is not the case that from sentence (a) and not from sentence (b).

3. Show that the denotations of the sentences are the same by comparing the denotation computed to the head of their trees.
4. Consider the following sentence: “The killer of the cat escaped”.
Answer the questions below:

1. Analyze the sentences by drawing a tree and decorating it with types. Assume that \( \text{of} \) denotes an identity function of type \( ee \).

2. For each predicate - \( \text{cat} \) and \( \text{killer} \), give a denotation (as a function or a set) of the predicate such that the sentence has a truth value and a denotation such that it has not.

3. Consider the following entailment pattern:
   - John killed the cat
   - The killer of the cat escaped

   \[ \Rightarrow \]
   - John escaped

   (a) What should be the relation between the denotation of \( \text{killed} \) and \( \text{killer} \) for the entailment to follow?
   (b) Give a model in which the consequent has a truth value, and show that the TCC holds for this model.

5. Consider the following equivalence:

1. Jan \([\text{is} \ [\text{running} \ [\text{in Utrecht}]]]\]

2. [Jan \([\text{is} \ [\text{running}]]\) \[\text{and} \ [\text{Jan} \ [\text{is} \ [\text{in Utrecht}]]]\]]

Assume the following types and denotations:

<table>
<thead>
<tr>
<th>Word</th>
<th>Type</th>
<th>Denotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>( e )</td>
<td>arbitrary denotation ( \text{jan} )</td>
</tr>
<tr>
<td>Utrecht</td>
<td>( e )</td>
<td>arbitrary denotation ( \text{utrecht} )</td>
</tr>
<tr>
<td>is</td>
<td>((et)(et))</td>
<td>identity function IS</td>
</tr>
<tr>
<td>running</td>
<td>( et )</td>
<td>arbitrary denotation ( \text{run} )</td>
</tr>
<tr>
<td>in</td>
<td>in (1)</td>
<td>(e(et)(et)) denotation ( \text{in}_1 )</td>
</tr>
<tr>
<td></td>
<td>in (2)</td>
<td>??? denotation ( \text{in}_2 )</td>
</tr>
</tbody>
</table>

a. Determine the semantic type of \( \text{in}_2 \).

b. Specify the denotation of \( \text{in}_1 \) as a lambda term such that the equivalence follows.
   Hint: Make use of the denotation \( \text{in}_2 \).