Lecture 8

Discourse and Donkey Anaphora
Discourse and Donkey Anaphora

Sentences as the basic units of interpretation

• Compositional semantics takes sentences, as opposed to whole texts, as the smallest autonomous information units in a language.

• Compositional semantics is concerned with the ways in which the meanings of sentences are built up from the meanings of their parts, and it presupposes

• **The principle of compositionality or Frege’s principle:**
  The meaning of the whole is a function of the meaning of the parts and their mode of combination.
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• The principle of compositionality or Frege’s principle: The meaning of the whole is a function of the meaning of the parts and their mode of combination.

• The principle of compositionality requires a theory of
  (i) the meanings of the smallest parts (often words),
  (ii) how the parts are put together, i.e., syntax, and
  (iii) the rules and principles of semantic composition.
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• The theory of compositional semantics leads us to look for a theory that characterizes the meaning of a word in terms of its contribution to the meaning of larger expressions.

• Frege: *Only in the context of a sentence does an expression have a reference.*
  
  (German: Nur im Zusammenhang eines Satzes bedeuten die Wörter etwas).
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• Frege: *Only in the context of a sentence does an expression have a reference.*

• Example: Whatever semantic relation a syntactic subject like *Tom* bears to its predicate *liked bubbly and warm interns*, the syntactic subjects *interns and Tom, interns* and also *bubbly and warm interns* will bear in the parallel constructions below:

  *Tom* liked bubbly and warm interns
  *Interns and Tom* liked warm bubbly (i.e., warm sparkly wine, champagne)
  *Interns* liked warm and bubbly *Tom*
  *Bubbly and warm interns* liked *Tom*
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• What each word contributes to the truth conditions of sentences is regarded as its meaning.

• There are some words like and and of that have meaning only because they contribute to the meaning of sentences in which they appear as parts. These are syncategorematic words (as we have already seen).
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We are dealing with a **two-way dependence**:

- the interpretation a sentence depends on the interpretation of the words in that sentence, and
- an explanation of the interpretation of those words is an account of how they contribute to the interpretation of sentences in which they occur.

_Circularity?_
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• There is no circularity, because the meaning of a sentence is given an independent characterization: a specification of the interpretation that a sentence has is a specification of the conditions necessary and sufficient for the truth of that sentence.

Recall that

• to know the meaning of a (declarative) sentence is to know what the world would have to be like for that sentence to be true.
• We specify what the world would have to be like for a sentence to be true by specifying its truth conditions, i.e., necessary and sufficient conditions for the truth of that sentence.
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But what about

*John kicked the bucket* (= died) ?

Natural languages contain idiomatic phrases and sentences in which lexical meaning (meanings of words) and sentential meaning are not transparently related.

*Should we not abandon the principle of compositionality?*
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• **Idioms** in and of themselves are not an argument to abandon the principle of compositionality; they represent an important part of language data to be accounted for in a systematic way by a linguistic theory, but arguably they do not represent a general way in which the meanings of words and sentences are related.

• If there were no direct relation between lexical and sentential meaning, the meaning of each sentence in language would have to be listed.

• Since the number of sentences that make up a language is infinite, this would mean that no human being would be able to determine the meanings of all the sentences of any language due to the finite resources of the brain.
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• Discourse as the basic unit of interpretation

The meaning of a sentence is not determined in isolation, but often with respect to the preceding discourse. We can illustrate this point with cross-sentential anaphora.

\[ \text{Tom}_i \text{ entered the room. } \text{He}_i \text{ took off his coat.} \]
\[ \text{enter-the-room}(t) \wedge \text{took-off-his-coat}(x) \]
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Tom\textsubscript{j} entered the room. He\textsubscript{j} took off his coat.

\text{enter-the-room}(t) \land \text{took-off-his-coat}(x)

Assumptions:

(1) The sequence of two independent sentences is interpreted as a conjunction ‘\land’ of the two propositions they express.

Recall that the English \textit{and} is often understood as conversationally implicating ‘and then’.
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Tom \textsubscript{i} entered the room. He \textsubscript{i} took off his coat.

enter-the-room(t) \land took-off-his-coat(x)

Assumptions:

(2) *He* in the second sentence is co-referential with *Tom* in the first sentence. This particular resolution of the pronominal reference is indicated by **co-indexing**.

A different interpretation in which *he* in the second sentence is NOT co-referential with *Tom*, but rather is deictic, is also possible, of course.
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Tom entered the room. He took off his coat.
enter-the-room(t) \& took-off-his-coat(x)

Assumptions:

(3) Proper names like Tom are translated as individual constants in first order predicate logic: here t.
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Tom, entered the room. He took off his coat.

Assumptions:

(4) Pronouns are translated as **individual variables**: here *x*.

The interpretation of an individual variable is dependent on the assignment function *g*, which assigns values (individuals) to variables.
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Tom$_i$ entered the room. He$_i$ took off his coat.
enter-the-room(t) $\land$ took-off-his-coat(x)

Given that coindexing in the syntax gives us instructions about the identification of the unique individual the pronoun is supposed to pick out, we may take it to mean that the value assigned to the variable $x$ is $t$:

Tom$_i$ entered the room. He$_i$ took off his coat.
enter-the-room(t) $\land$ took-off-his-coat(x)

Assume: $g(x) = t$
Therefore, we get
enter-the-room(t) $\land$ took-off-his-coat(t)

Coindexing constrains the assignment function $g$, which assigns values (individuals) to variables.
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- Interpretation of discourses that involve
  - cross-sentential anaphora like the one just given, and
  - certain puzzles related to the interpretation of
  - cross-sentential anaphora with indefinite NPs as antecedents

- prompted a shift of focus from isolated sentences to discourse analysis, i.e., to texts that consist of two or more sentences.

- From this shift of focus arose ‘DYNAMIC THEORIES OF MEANING’, which take a text or a piece of discourse as the primary syntactic and semantic unit.
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- In this connection, we will introduce the ‘classical’ Discourse Representation Theory, abbreviated as DRT.

- In dynamic theories of meaning, (informally) each proposition, which is added to a discourse, narrows down the range of possible worlds with which the discourse is compatible.

- Recall that we assume that the reference of a sentence is its truth value (or, we say that a sentence denotes its truth value). Sentences are also taken to express propositions, and propositions are construed as sets of possible worlds (intensional semantics).

- From the point of view of dynamic theories of meaning, the meaning of a sentence consists of the change it makes to the set of possible worlds defined by the discourse.
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- Discourse anaphora with indefinite NPs as antecedents

Compare the following sentences:

(1)  
  a. A dog\textsubscript{i} was happy, because he\textsubscript{i} was in the yard.
  b. Some dogs\textsubscript{i} were happy, because they\textsubscript{i} were in the yard.

(2)  
  a. A dog\textsubscript{i} was in the yard. He\textsubscript{i} found a bone.
  b. I saw some dogs\textsubscript{i} in the yard. Ivan was playing with them\textsubscript{i}.
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*A dog*

*Some dogs*

- are indefinite noun phrases
- indefinite NPs are not referential: Traditionally, they are treated as existentially quantified NPs (Russell 1919).

*A dog was in the yard.*

*Some dogs were in the yard.*

\[ \exists x [ \text{dog}(x) \land \text{be-in-the-yard}(x)] \]
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• If indefinite NPs are treated as existentially quantified NPs, then they are not referential
• Therefore, we cannot interpret the coindexing in (1) and (2) as coreference, instead it indicates binding relations.

(1) a. A dog_i was happy, because he_i was in the yard.
   b. Some dogs_i were happy, because they_i were in the yard.

(2) a. A dog_i was in the yard. He_j found a bone.
   b. I saw some dogs_j in the yard. Ivan was playing with them_j.

• The interpretation/value of the pronoun he, they, them covaries with the interpretation/value of the variable introduced by the quantified subject NP a dog and some dogs.
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If we interpret the coindexing in (1) and (2) as binding relations, then

• **Problem**: Only in (1), but not in (2), the individual variable $x$ introduced by the pronouns *he* and *they* can be bound by the existential quantifier, because only in (1), but not in (2) it is in the scope of the existential quantifier.

(1) a. **A** dog$_i$ was happy, because **he$_i$** was in the yard.
    b. Some dogs$_i$ were happy, because **they$_i$** were in the yard.
    $\exists x[\text{dog}(x) \land \text{happy}(x) \land \text{be-in-the-yard}(x)]$

(2) a. **A** dog$_i$ was in the yard. **He$_i$** found a bone.
    b. Some dogs$_i$ were in the yard. **They$_i$** found a bone.
    $\exists x[\text{dog}(x) \land \text{be-in-the-yard}(x)]$
    $\exists x \exists y[\text{dog}(x) \land \text{bone}(y) \land \text{find}(x,y)]$
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(2) a. A dog\(_i\) was in the yard. He\(_i\) found a bone.
   
   b. Some dogs\(_i\) were in the yard. They\(_i\) found a bone.

\[
\begin{align*}
\exists x & \, [\text{dog}(x) \land \text{be-in-the-yard}(x)] \\
\exists x \exists y & \, [\text{dog}(x) \land \text{bone}(y) \land \text{find}(x,y)]
\end{align*}
\]

(2a,b) involve cross-sentential, discourse anaphorical, relations.

- Therefore, the individual variable introduced by the pronouns he and they remains free, unbound.
- For an individual variable \(x\) to be free means that \(x\) could be assigned any salient individual in the domain of discourse as its value.
- However, under the most natural interpretation of (2a,b), (2a,b) does not mean that just any salient dog(s) found a bone, but instead the dog or the dogs introduced in the previous sentence.
- In order to get this interpretation, the individual variables introduced by the pronouns he and them ought to be in the scope of the existential quantifier.
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We would like to assign sentences in (2) the logical representations given below them:

(2) a. \(A \text{ dog}_i \) was in the yard. \(H_{e_i} \) found a bone.
    b. \(\text{Some dogs}_i \) were in the yard. \(T_{h_i} \) found a bone.
    \(\exists x \exists y [\text{dog}(x) \land \text{be-in-the-yard}(x) \land \text{bone}(y) \land \text{find}(x,y)]\)

• Problem: Given the assumptions about the scope and binding made so far, we cannot get the logical representations given above, which properly represent our intuitions about what the English sentences mean.
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Questions:

How do we establish anaphoric relations between an indefinite NP and an anaphoric pronoun outside the (traditional) scope domain of the indefinite NP?

How do we generally establish anaphoric relations beyond the (traditional) scope of the quantifier?
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• One possible solution: Reduce the conjoined sentences to a single sentence which contains a VP-conjunction:

(2) a. A \text{dog}_{i} \text{ was in the yard. } H_{e,ij} \text{ found a bone.}
   a’. A \text{dog}_{i} \text{ was in the yard and } H_{e,ij} \text{ found a bone.}
   \forall x \exists y [\text{dog}(x) \land \text{be-in-the-yard}(x) \land \text{bone}(y) \land \text{find}(x,y)]

(2a) and (2a’) can be considered paraphrases.
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Problem for the proposed solution:

• It cannot be generalized to all binding relations across two or more sentences.

• One counterexample: (3a) and (3b) can be true in different circumstances, that is, they are not always satisfied in the same situation.

(3) a. Exactly one student called me. She asked about the exam.
   True in a situation in which exactly 1 student called me.

   b. Exactly one student called me and asked about the exam.
      – There is exactly 1 student who both called and asked about the exam
      – True in a situation in which several students called me, but only one called and also asked about the exam. In this situation, (3a) is false, because (3a) excludes the possibility of more than one student calling.
Discourse and Donkey Anaphora

• Conclusion:
The cross-sentential, discourse anaphorical, relations in sentences like (2a) cannot involve a reduction to a single sentence, because this solution cannot be generalized to all such relations.

(2) a. A dog\textsubscript{i} was in the yard. He\textsubscript{i} found a bone.
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• Donkey anaphora

(1) a. *Every farmer who owns every donkey \(_i\) beats it\(_i\).

    b. Every farmer who owns a donkey \(_i\) beats it\(_i\).

No animals were harmed in the analyses of these sentences.
Discourse and Donkey Anaphora

• Donkey anaphora
The difference between indefinite NPs and other quantificational NPs is manifested in other contexts:

(1)  a. *Every farmer who owns every donkey$_i$ beats it$_i$.
    \[ \forall x \forall y [ \text{farmer}(x) \land \text{donkey}(y)] \rightarrow \text{own}(x,y) \rightarrow \text{beat}(x,y) \]

    b. Every farmer who owns a donkey$_i$ beats it$_i$.

• (1a) is excluded as ungrammatical by the fact that the pronoun it corresponds to a free variable, a variable outside the scope of the universal quantifier. This is because the phrase every donkey in (1a) cannot bind the pronoun in beats it:
• logic: prohibited by the rules of the first order predicate logic
• syntax: prohibited by the rules of syntax, the phrase every donkey does not C-command the pronoun.
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Preliminary conclusion:
The rules governing the scope and binding relations that predicate logic (and syntax) provide make the right predictions about the ungrammaticality of the English sentence (1a).

To put it differently, the logical formula given for (1a) predicts that the co-indexing in (1a) is not licensed (assuming that anaphoric relations in natural language can be taken as constrained by the rules of predicate logic).
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- **Problem:**
The same rules of syntax and logic would also exclude the well-formed English sentence (1b) as ungrammatical.
The pronoun *it* corresponds to a free variable in the translation of (1b):

(1) b. Every farmer who owns a donkey\(_i\) beats it\(_i\).

\[ \forall x [ [\text{farmer}(x) \land \exists y [\text{donkey}(y) \land \text{own}(x,y) ] ] \rightarrow \text{beat}(x,y)] \]

Chierchia & McConnell-Ginet 1990.p.133

- The existential quantifier is assigned narrow scope with respect to the implication ‘\(\rightarrow\)’.
- This means that the last occurrence of *y*, the variable that represents the pronoun *it*, is **not bound by** \(\exists y\).
- This in turn means that its value is referentially independent of the NP *a donkey*, hence (1b’) does not give us the reading we want for (1b).
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• **Another possibility (Chierchia & McConnell-Ginet 1990, p.133):**

\[ \forall x \exists y [ \text{farmer}(x) \land [\text{donkey}(y) \land \text{own}(x,y)] ] \rightarrow \text{beat}(x,y) \]

• Here the existential quantifier \( \exists y \) is assigned wide scope over the implication ‘\( \rightarrow \)’, and so the last occurrence of \( y \) is bound.

• But this still gives us the wrong truth conditions:
  – Even if a *donkey* -- assuming it is an existential quantifier -- could bind the individual variable \( y \) introduced by *it*, we still would not get the right intuitive truth conditions of (1b), which require that every farmer beats *every* donkey he owns.
  – Sentence (1b) is also true whenever there is anything that makes the antecedent false.
  – Take a situation were a farmer owns a donkey and a pig, but does not beat any of them. The above formula will be true in that situation, because for each farmer we need to find at least one object that either is not a donkey owned by this farmer, or is beaten by the farmer. Hence, if this object denotes the pig, the sentence will be true in that situation.
Discourse and Donkey Anaphora

Another solution:

(1) b. Every farmer who owns a donkey \(_i\) beats it\(_i\).

\[ \forall x \forall y [ \text{farmer}(x) \land \text{donkey}(y) \land \text{own}(x,y)] \rightarrow \text{beat}(x,y) \]

- This representation is a well-formed formula in predicate logic.
- It seems to represent fairly well the truth conditions associated with the English sentences in (1b).
- But we interpret the indefinite NP *a donkey* (in the relative clause of a universally quantified NP) in terms of a **universal quantifier** (taking wide-scope over the whole sentence) rather than an existential quantifier.
- **Problem:** This means that indefinites must sometimes be interpreted as existential quantifiers, and sometimes as universal quantifiers, without any apparent systematicity.
Discourse and Donkey Anaphora

Summary so far:

• The compositional existential interpretation of the indefinite NP (see Russell 1919) gives us the wrong results.

\( \forall x \exists y [ [\text{farmer}(x) \land [\text{donkey}(y) \land \text{own}(x,y)] ] \rightarrow \text{beat}(x,y)] \)

• The universally quantified formula

\( \forall x \forall y [ [\text{farmer}(x) \land \text{donkey}(y) \land \text{own}(x,y)] \rightarrow \text{beat}(x,y)] \)

seems to give us the right result, but we do not know how to derive it in a compositional way. It clashes with the independent assumption that indefinite NPs are to be represented with existential quantifiers.
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Summary so far:

In the most general terms,

Every farmer who owns a donkey\textsubscript{i} beats it\textsubscript{i}.

poses two main questions:

1. How can pronouns take non-commanding non-referential antecedents?
2. How can indefinites be understood to mean universal?
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This phenomenon is general, and it shows up in other types of constructions, notably in conditional constructions like (2):

(2)  a. *If Bill owns every donkey$_i$, he beats it$_i$.  
b. If Bill owns a donkey$_i$, he beats it$_i$.  
c. $\exists x [\text{donkey}(x) \land \text{own}(b,x)] \rightarrow \text{beat}(b,x)$  
d. $\forall x [ \text{donkey}(x) \land \text{own}(b,x)] \rightarrow \text{beat}(b,x]$  
Geach
Discourse and Donkey Anaphora

• **Summary:**
  • Indefinite NPs appear to undergo what looks like a change in meaning, (which seems to correspond to the meaning associated with universally quantified NPs), when they occur in

  1. the restrictive portion of a universal quantifier
     
     *Every farmer who owns a donkey beats it.*

  2. in the antecedent of a conditional
     
     *If a farmer owns a donkey, he beats it.*

• This behavior of indefinites is known under the name of donkey anaphora due to the examples used to illustrate it by Geach (1962).
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In sum

‘Donkey’ sentences are sentences that contain
- an indefinite NP which is
  - inside an if-clause
    If a farmer owns a donkey, he beats it, or
  - inside a relative clause (modifying a universally quantified DP)
    Every farmer who owns a donkey beats it
AND a pronoun which is outside that if-clause or relative clause, but is anaphorically related to the indefinite NP.

This amounts to the variable introduced by the pronoun being outside of the traditional scope domain of the indefinite NP, represented by means of the existential quantifier
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• The phenomenon illustrated by ‘donkey’ sentences has been known at least since the ancient Stoics, who discussed it in connection with sentences like

If someone/anyone is in Athens, he is not in Rhodes.
∀x[x is in Athens → ¬ x is in Rhodes]

• Since such sentences were first discussed by the Stoic philosopher Chrysippos, some people call them Chrysippos-sentences. (Stoicism, a Greek school of philosophy, founded about 300 BC.)

• ‘Donkey’ sentences were also discussed in the medieval literature (see Geach 1962, Heim 1982, p. 44ff.)
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• The assumption that the truth conditions of such ‘donkey’ sentences amount to the truth conditions of the universally quantified logical formula was challenged.

*If a farmer owns a donkey, he beats it*
*Every farmer who owns a donkey beats it*
∀x∀y[ x is a man ∧ y is a donkey ∧ x owns y] → x beats y

• The logical formula says that every farmer beats all the donkeys every farmer owns
• The logical formula would correspond to what the English sentence means, if we make the additional assumption that there is a presupposition that each farmer owns just one donkey.
Discourse and Donkey Anaphora

*Every person who had a dime put it into the parking meter.*
Schubert and Pelletier 1988

- This sentence can be true even though every person did not put all the dimes every person possessed into the parking meter.

*Every customer who had a credit card paid with it.*
Heim 1982
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• Much work in semantics and pragmatics is devoted to the solution of the mysteries related to such ‘donkey’ sentences.
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We will look at two strategies to provide an account of ‘donkey’ sentences:

• **E-type anaphora**: It assumes that there is *something special about the anaphoric pronoun*, which is outside of its binding operator, that is, outside of the *if*-clause or relative clause which contains its antecedent indefinite NP.

• **Discourse Representation Theory** (and File Change Semantics): It assumes that there is *something special about the indefinite NP* which is inside an *if*-clause or a relative clause.

It does not behave like a quantificational NP at all, and therefore, it should not be translated with the existential quantifier.

Indefinite noun phrases are not existentially quantified (contra Russell 1919), but introduce individual variables into the logical representation.