Introduction to Semantic Theory
Definite descriptions and modification

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Class: June 8, 2016

Connecting back to the previous lecture

Central result: extension to multi-step derivations; introduction of the central strategy of semantic research

Strategy to analyze a new expression α:

- Given an LF that contains α as the only unknown expression, determine the type that α should have.
- Think about the intuitive semantic contribution of α in that sentence (and other examples). This step cannot be done mechanically – it requires sprachgefühl, which can only be trained by thinking about the meaning of words.
- Does the proposed type fit with the intuitive meaning? If yes, great! If not, there's troublesome work ahead.
- Assuming that the type is okay, formulate a proposal for the extension of α that is of the required type.

Aim for today

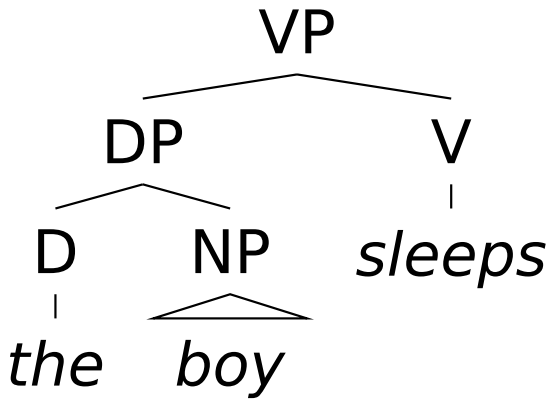
The aim for today: to derive the extension of *the* and to introduce a first empirical problem for our system – nominal modification

- ⇒ While the definite article can still be analyzed with our system, a closer look at attributive (and predicative) adjectives reveals an empirical problem.
- ⇒ We will see: the problem posed by simple adjective-noun combinations can be solved in two different ways, which will put us in the position to choose one or the other.
- ⇒ Consequence: After comparing the two proposals, we will be in the position to choose to adopt a new derivation rule – predicate modification (PM).

The type of the definite article

Use the methodological strategy outlined in the recap to derive a proposal for the extension of the definite article!

Step 1: Determine which type *the* should have given a sentence in which only *the* is an unknown expression in terms of semantic types.



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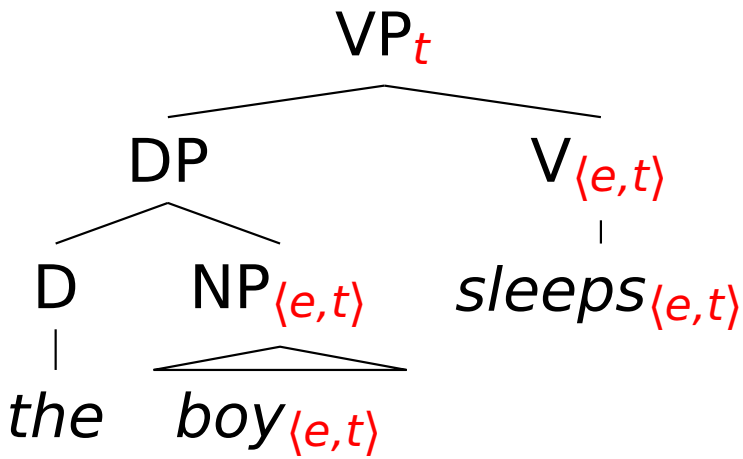

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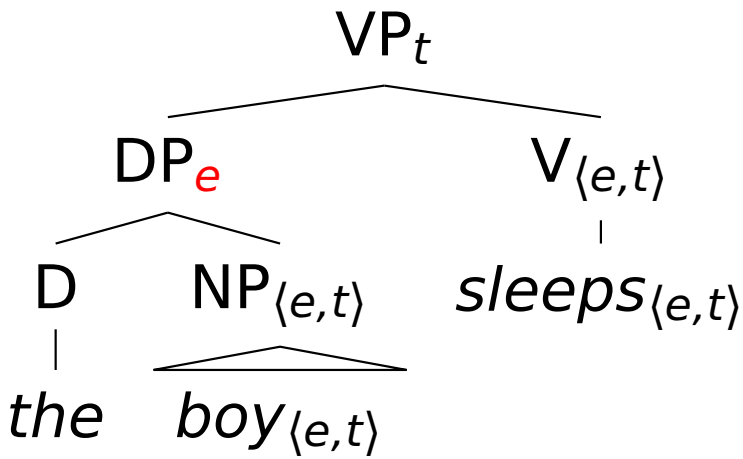

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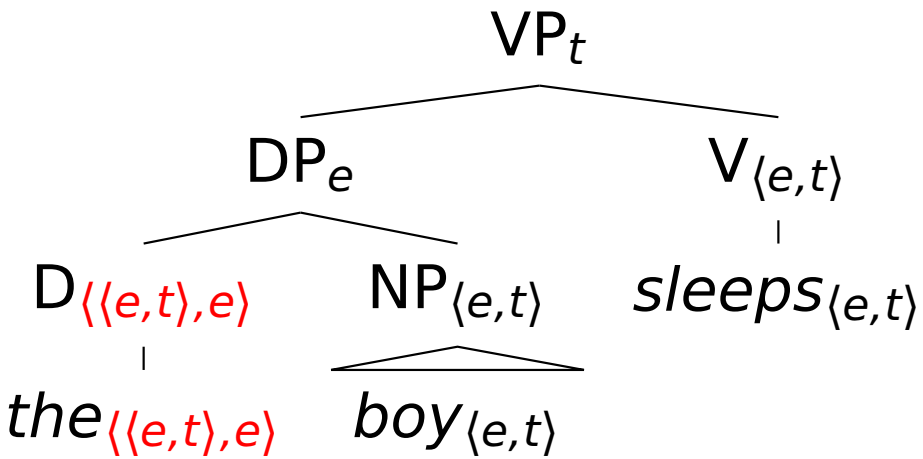


Intuitively: the contribution of *the*

Step 2: Think about, intuitively, what the contribution of the definite article is. Compare the following pairs:

(1) a. *dog – the dog* (*The dog barks.*)
b. *boy – the boy* (*The boy sleeps.*)

What is the extension of the bare nouns? What is the extension of the full DP? What does this mean for *the*?

Check: proposed type vs. intuition

Step 3: Does you intuition fit with the proposed type?

- Proposed type: $\langle\langle e, t\rangle, e\rangle$; a function that takes something that is a one-place predicate and returnes something that is an individual
- Intuitive contribution: Definite descriptions (i.e., '*the* + NP') denote an individual that can be correctly described with the noun and that is unique. Everything that is not contributed by the noun, must be contributed by the definite article (because of compositionality).

$\Rightarrow$ The intuitive contribution and the types fit.

Proposal for the extension of *the*

A proposal for the extension of *the* based on the semantic type that was derived – $\langle\langle e, t\rangle, e\rangle$:

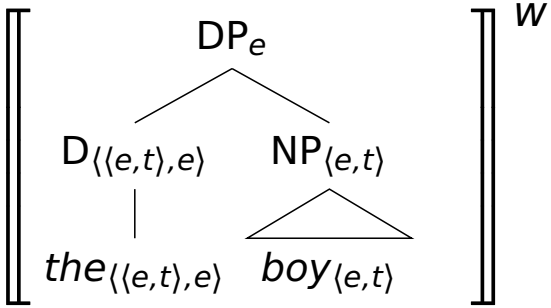
(2) $[\![the]\!]^w = \lambda P_{\langle e,t\rangle}.\iota x[P(x) = 1]$

- The ι-operator stands for "the unique".
- The formula $\iota x[P(x) = 1]$ therefore means "the unique individual x for which $P(x) = 1$.

Which type does $\iota x[P(x) = 1]$ have?

The extension of definite descriptions

The extension of definite descriptions, like *the boy*, can now be computed by 2 × (NN) and (FA) from the DP tree given before:



$$\llbracket \quad \rrbracket^w \overset{2\times(NN)+(FA)}{=} [\![the]\!]^w([\![boy]\!]^w)$$

$$= \lambda P_{\langle e,t\rangle}.\iota x[P(x) = 1]([\![boy]\!]^w)$$

$$\overset{\lambda}{=} \iota x[[\![boy]\!]^w(x) = 1]$$

$$= \iota x[[\lambda y_e.\ \text{boy'}(y)(w)](x) = 1]$$

$$\overset{\lambda}{=} \iota x[\ \text{boy'}(x)(w) = 1]$$

The problem of attributive adjectives – I

We have hypotheses for the types and extensions of nouns and adjectives: both have type $\langle e, t \rangle$. Hence, we should be able to derive the extension of nouns modified by attributive adjectives.

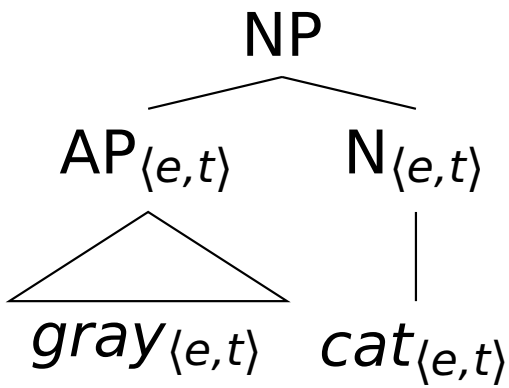
(3) a. *gray cat*
b. *small child*

However: There seems to be a problem with combining the extensions of nouns with those of adjectives, given the rules (NN) and (FA).

The problem of attributive adjectives – II

Since both are of type $\langle e, t \rangle$, they cannot be combined by using (FA)!

PROBLEM!



What can be done in this situation?

The problem of attributive adjectives – III

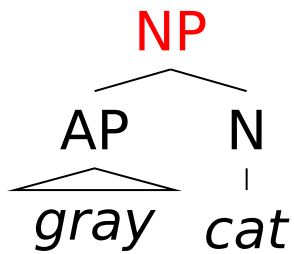
There are two options – apart from discarding the entire system and calling it quits:

- Adapt the types of (one of) the expressions so that (FA) can be applied.
- Introduce a new derivation rule that applies in this situation (i.e., when two expressions of type $\langle e, t \rangle$ need to be combined).

Why do we even have to do anything? Because phrases like '*gray cat*' are grammatical and interpretable. Hence, our system better be able to derive their extensions!

Before starting out: consulting intuitions

Since we need to change our assumptions regarding (at least) one of the lexical items that make up the modified NP, we need to determine what the desired outcome should be to be able to reverse engineer the types and extensions for the noun and adjective.



Intuitively: what is the extension of the modified NP *gray cat*? An individual? A set? A relation?

The type and extension of a modified NP – I

Modified NPs cannot be used to refer to a single individual, so they cannot be of type *e*. They are also not relations (similar to (di)transitive verbs) – they do not relate two or more individuals.

⇒ They denote sets of individuals.

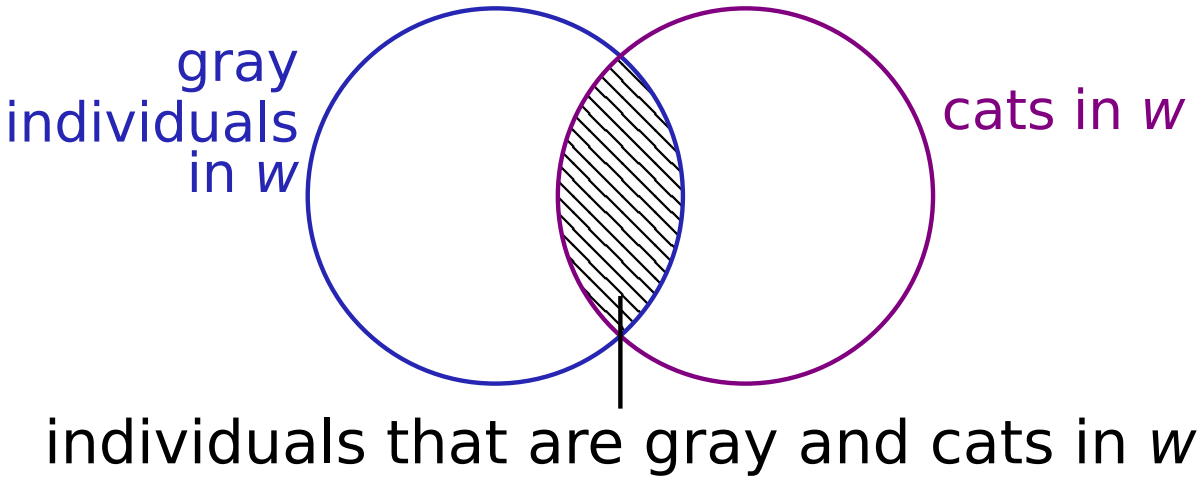
Hence, they are of type $\langle e, t \rangle$.

Which set does *gray cat* denote?

The type and extension of a modified NP – II

The set denoted by *gray cat* is the set of individuals that are gray and a cat in *w*.

Mathematically, this is the intersection of the sets of gray individuals with the set of cats in *w*:



Formalizing the conceptual analysis

How can we formalize “the set of individuals that are gray and cats in w” in set notation and function notation?

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How can we formalize "the set of individuals that are gray and cats in *w*" in set notation and function notation?

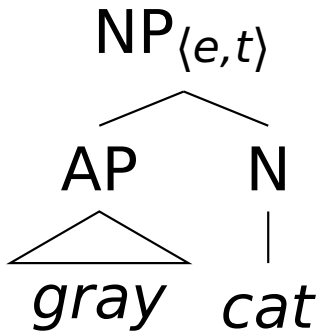
(4) a. $[\![gray\ cat]\!]^w = \{x : x \text{ is gray and a cat in } w\}$
b. $[\![gray\ cat]\!]^w = \lambda x_e.\ x \text{ is gray and a cat in } w$

Since we want the extension of *gray cat* to be composed of *gray* and *cat*, the abbreviated notation should reflect that:

(5) $[\![gray\ cat]\!]^w = \lambda x_e.\ \text{gray'}(x)(w)\ \&\ \text{cat'}(x)(w)$

Proposal 1: Adapting the types

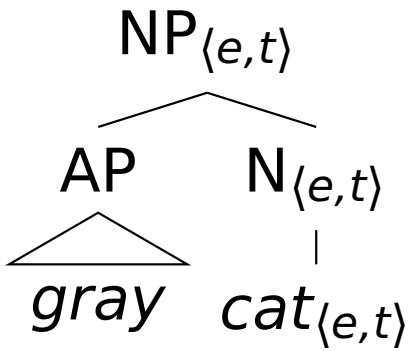
Since we have a proposal for the type and extension of the entire modified NP, we can start to worry about the change in type and extension for the adjective or noun for Proposal 1:



Should we adapt the type of the noun, that of the adjective, or both?

Adapting the type of the modifier

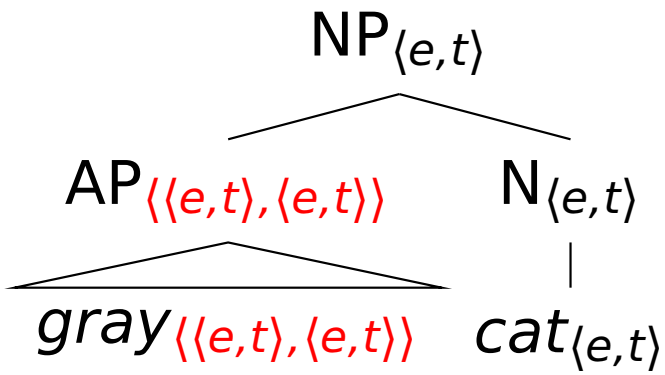
Since it is easiest to keep one of the original types constant, we should only adapt one of the types. Our assumptions for the extension of nouns did not turn out to be problematic (and was used to determine the extension for *the*). Hence, it is best to adapt the type of the attributive adjective.



What does the type for the adjective have to be – given (FA) and (NN)?

The adapted type for the adjective

There is only one possibility for the type of the adjective:



What does this type mean? What kind of extension does the adjective *gray* have?

Inferring the new extension of *gray*

If we have proposals for the extensions for two out of three nodes of a branching node, we can infer the last one:

$$\lambda x_e.\ \text{gray'}(x)(w)\ \&\ \text{cat'}(x)(w)$$

$$?\qquad \lambda y_e.\ \text{cat'}(y)(w)$$

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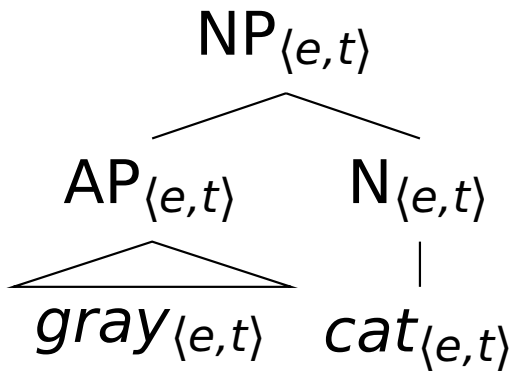
(6) $$[\![gray]\!]^w = \lambda P_{\langle e,t\rangle}.\lambda \underline{x}_e.\ \text{gray'}(\underline{x})(w)\ \&\ P(\underline{x})$$

Proposal 2: A new derivation rule

The second option to solve the empirical problem provided by attributive adjectives is to keep the types and extensions of the adjective and noun as they are, and to devise a new rule to combine them.



⇒ We know the types and extensions of all the parts; we need a rule that produces this output from the input!

Inferring the new rule

Since we know all the parts of the branching node, we can abstract away from the input to get the new derivation rule:

$$\lambda x_e.\ \text{gray'}(x)(w)\ \&\ \text{cat'}(x)(w)$$

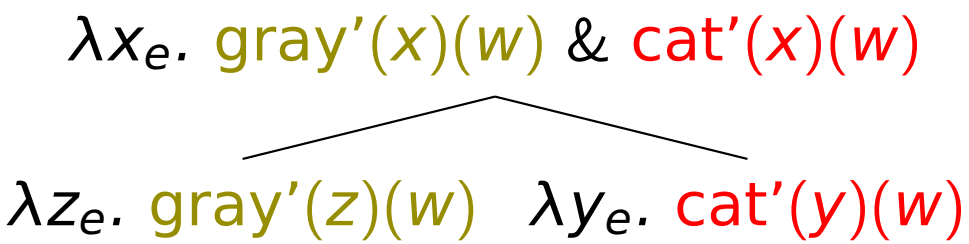
$$\lambda z_e.\ \text{gray'}(z)(w) \qquad \lambda y_e.\ \text{cat'}(y)(w)$$

$\Rightarrow$ The new rule conjoins the descriptive parts of the two predicates and expresses that they both need to hold of an individual if it is in the resulting set.

The new rule: predicate modification (PM)

(7) **Predicate Modification (PM):**
For a branching node α with the set of daughters $\{\beta, \gamma\}$, where β and γ are of type $\langle e, t\rangle$, then $[\![\alpha]\!]^w = \lambda x_e.[\![\beta]\!]^w(x)$ & $[\![\gamma]\!]^w(x)$

Compare the proposed input and output of the rule to the situation in our tree:



Intermediate summary

We have seen two possible solutions to the empirical problem provided by attributive adjectives:

- Proposal 1: adapting the type and consequently the extension of the adjective

  (8) $[\![gray]\!]^w = \lambda P_{\langle e,t\rangle}.\lambda x_e.$ gray'$(x)(w)$ & $P(x)$

- Proposal 2: introducing a new derivation rule

  (9) Predicate Modification (PM):
  For a branching node α with the set of daughters $\{\beta, \gamma\}$, where α and β are of type $\langle e, t\rangle$, then $[\![\alpha]\!]^w = \lambda x_e.[\![\beta]\!]^w(x)$ & $[\![\gamma]\!]^w(x)$

Which proposal is "better"? How can we decide?

What are the consequences?

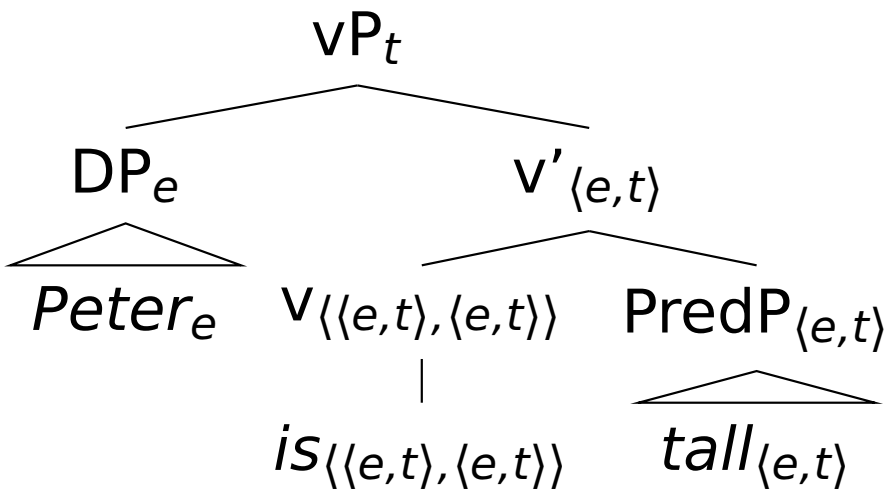
The two proposals have different consequences for the system and previously analyzed lexical items: the proposal with the more desireable/less undesirable consequences wins.

- Proposal 1: The change in type and extension of the adjective has an impact on all analyses which were made presupposing $\langle e, t \rangle$ as the type of the adjective.
- Proposal 2: The addition of a new derivation rule has no impact on previous analyses; it is, however, methodologically dispreferred.

$\Rightarrow$ Take a closer look at the consequences of Proposal 1.

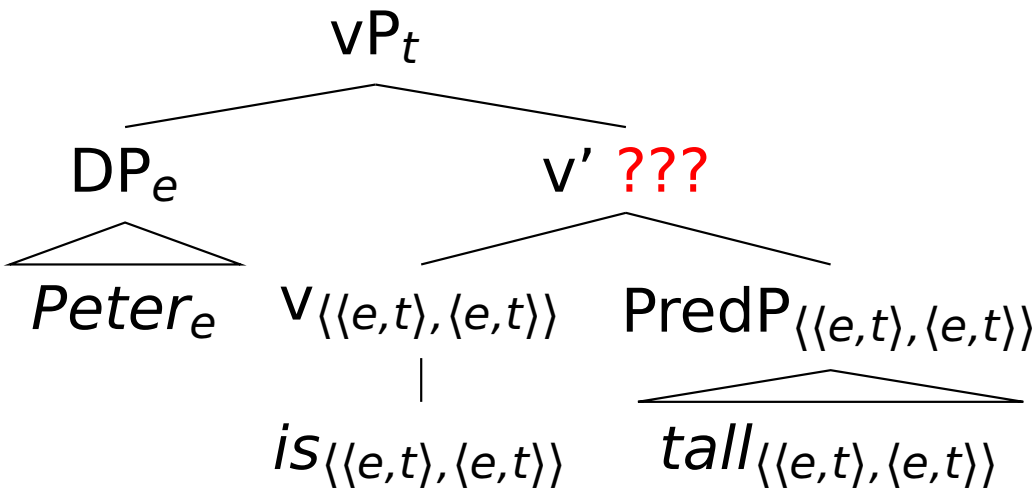
Proposal 1 and predicative adjectives – I

This was the tree for predicative adjectives (annotated with semantic types) that we had the last time:



Proposal 1 and predicative adjectives – II

Assuming that predicatively and attributively used adjectives have the same extensions – if we change the type of the adjective from $\langle e, t\rangle$ to $\langle\langle e, t\rangle, \langle e, t\rangle\rangle$, we run into a problem:



What can we do in this situation to solve this problem?

Consequences of Proposal 1

To model predicative adjectives, we would need to either...

- change the type of the copula from $\langle\langle e,t\rangle,\langle e,t\rangle\rangle$ to $\langle\langle e,t\rangle,\langle\langle e,t\rangle,\langle e,t\rangle\rangle\rangle$, which in turn would have an impact on predicatively used DPs like '*a man*' in '*Peter is a man*' – etc.
  This means trouble/a complete overhaul of our analyses!
- assume that adjectives can have two different types and extensions: one kind ($\langle e,t\rangle$) for the predicative use, and one ($\langle\langle e,t\rangle,\langle e,t\rangle\rangle$) for the attributive use.
  This is less problematic and has indeed been proposed.

Back to comparing the consequences – I

- Proposal 1 – ambiguous adjectives: The assumption that adjectives have different contributions depending on their syntactic position is uneconomical from a lexical point of view – all possible interpretations of a lexical item are stored in the lexicon: we would have multiple entries for ALL adjectives.

  Fortunately, the entries are systematically related; hence, the polysemy could be modelled by lexical derivation rules!

- Proposal 2: The addition of a new derivation rule is methodologically dispreferred since it is – in some sense – cheating. From a methodological point of view, adding a new rule whenever we run into trouble is not good science.

  Fortunately, the (PM) rule would have many more areas of application than just modified nouns!

Back to comparing the consequences – II

The two proposals are pretty evenly matched for attractiveness. The choice boils down to preference.

For some reason, Proposal 2 prevailed as the standard solution to the problem of attributive adjectives.

We will follow this decision; we add (PM) to our derivation rules and keep the type and extension of adjectives unchanged.

Summary

- We used the inference method that we have also employed in the previous lecture to derive a proposal for the extension of the definite article *the*.
- We discussed the empirical problem presented by attributive adjectives and two possible solutions for it.
- We chose Proposal 2 to follow in this course; this means we add the rule (PM) to our original rules (NN) and (FA).

(10) Predicate Modification (PM):
For a branching node α with the set of daughters $\{\beta, \gamma\}$, where α and β are of type $\langle e, t\rangle$, then $[\![\alpha]\!]^w = \lambda x_e.[\![\beta]\!]^w(x)$ & $[\![\gamma]\!]^w(x)$