Empirically Motivated Logical Representations in Lexical Semantics

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Session 1

Project Description

- Logic & Language project, with an experimental flavour.
- The right project if you are interested in the meaning of natural language words and like to combine analytic thinking with empirical, quantitative research.
- **Goals:**
  - (i) To get acquainted with current research in lexical semantics, in particular with issues related to the semantics of gradable predicates, focusing on scalar adjectives, multidimensional adjectives and nouns, antonyms, and vague predicates.
  - (ii) To develop skills to formulate research hypotheses that can be supported empirically, with quantitative evidence.

Second part: individual research projects

- Individual work with meetings for questions and supervision upon request.
- Group meetings once a week - presentations of proposed research project
- Project report to be submitted on February 1 (max. 15 pages)
- For instance:
  - an extension of an existing or original semantic proposal;
  - a critical analysis of existing theoretical proposals of some phenomenon related to the topics under discussion;
  - a corpus-based empirical study providing evidence supporting or refuting an existing or original proposal;
  - an experiment design, describing the hypothesis, the thinking behind the hypothesis, the testing methodology, and the expected outcome given the hypothesis.
  - ...

Plan for today

Gradable Predicates

- Gradable adjectives (e.g. tall, expensive, cold, heavy, small) are adjectives whose meaning involves reference to a scalar concept or dimension, such as height, cost, temperature, weight, size,. . .
- An adjective is considered gradable if it can be used in combination with degree morphology, and with other degree constructions

positive	**comparative**	**superlative**
tall	tall-er	tall-est
expensive	more expensive	most expensive
former	?more former	?most former
pregnant	?more pregnant	?most pregnant

- Can the distinction between gradable and non-gradable adjectives be supported with quantitative distributional evidence?

Gradability and Vagueness

Gradable adjectives are prototypical examples of vague predicates.

- They give rise to *borderline cases*: there is always a set of entitites for which we are uncertain about whether they are tall or not, expensive or not, etc.
- They give rise to the *Sorites Paradox*:

P1 `A 5 EUR cup of coffee is expensive.`
P2 `Any cup of coffee that costs 1 cent less than an expensive cup of coffee is expensive.`

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- Is premise **P2** true? If not, why are we so willing to accept it as true?

Gradable Adjectives

To account for the meaning of gradable adjectives, we need formal semantic analyses that can (at least) explain the aforementioned aspects:

- their distribution with respect to degree constructions – i.e. the fact that they can appear in comparative constructions
- their vagueness – i.e. the fact that they give rise to borderline cases and the Sorites paradox

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There are several proposals in the literature. We'll sketch two main approaches:

- Degree-based semantics (Cresswell 1977, Kennedy 2007, ...)
- Supervaluationist approaches (Kamp 1975, Klein 1980, ...)

Degree-based Analyses

- In degree-based analyses, GAs are modelled as measure functions, mapping their arguments to *degrees* ($\sim$ abstract representations of measurement) on an appropriate scale.

$[\![\texttt{tall}]\!] = \lambda x.\mathbf{tall}(x) : \langle e, \delta\rangle$ `tall(Anna) = 1.72m`
`tall(Berno) = 1.83m`

- Degree morphology combines with adjectival measure functions to yield a truth value: *Berno is tall-er than Anna*

$[\![\texttt{more/-er}]\!] = \lambda G \lambda x \lambda y. G(x) \succ G(y) : \langle\langle e, \delta\rangle, t\rangle$

$\texttt{more(tall,Berno,Anna) = tall(Berno)} \succ \texttt{tall(Anna) = 1.83m} \succ \texttt{1.72 = true}$

Degree-based Analyses

- What do we do with the positive form (e.g. *Anna is tall*)? We need a mechanism to convert measure funtions into truth values

$[\![\emptyset_{pos}]\!] = \lambda G \lambda x. G(x) \succ \mathbf{d} : \langle\langle e, \delta\rangle, t\rangle$ (or else, a type-shifting rule)

$\mathbf{d}$ is a *standard of comparison* threshold

$\emptyset_{pos}$(tall,Anna) = tall(Anna) $\succ \mathbf{d}$ = 1.72m $\succ$ 1.70m = true

- Where does the threshold $\mathbf{d}$ come from? The standard is computed relative to a context-dependent *comparison class* C. We can substitute $\mathbf{d}$ for a *standard fixing function* $\mathbf{s}$:

$[\![\emptyset_{pos}]\!] = \lambda G \lambda x. G(x) \succ \mathbf{s}(G)(C) : \langle\langle e, \delta\rangle, t\rangle$

$C_1 = \{x | basketball\_player(x) = 1\}$; $C_2 = \{x | 12\_year\_old(x) = 1\}$

$\emptyset_{pos}$(tall,Anna) = tall(Anna) $\succ$ s(tall)(C) = 1.72m $\succ$? = ?

Degree-based Analyses

- Since the comparative does not make use of a standard threshold, this accounts nicely for the fact that the comparative does not entail the positive:

```
Berno is taller than Anna
⊭ Berno is tall & ⊭ Anna is tall
```

- But it does not account for the exitence of borderline cases... Once we find a property for the comparison class variable, there doesn't seem to be room for uncertainty. Some possibilities:
  - Epistemic uncertainty: we are uncertain about the precise location of $\mathbf{s}(G)(C)$ (but there is such a location; hence P2 is false)
  - We are unwilling to reject P2 because of some sort of *similarity contraint*: "When x and y differ in G by a small degree, we are unable or unwilling to judge 'x is G' true and 'y is G' false"

Supervaluationist Analyses

- Degree-based approaches define the meaning of the positive form in terms of a comparison relation ($\succ$)
- Thus they seem to violate the principle of compositionality, according to which the meaning of the comparative should be a a function of the meaning of the positive form
- In the supervaluationist approaches put forward by Kamp (1975) and Klein (1980) the comparative is derived from the positive.
- A sketch of the approach. . .

Supervaluationist Analyses

- According to supervaluationist analyses *à la* Klein (1980), gradable adjectives denote properties of individuals, i.e. functions of type $\langle e, t \rangle$.
- Crutially, they are *partial* functions, defining a positive extension, a negative extension, and an *extension gap*.
- Every context determines a comparison class that provides the functional domain.

$[\![\texttt{tall}]\!]_C = \lambda x.\mathbf{tall}(x) : \langle e, t \rangle$ `partial function`

$\texttt{tall}^+ = \{x : [\![\texttt{tall}(x)]\!]_C = 1\}$
$\texttt{tall}^- = \{x : [\![\texttt{tall}(x)]\!]_C = 0\}$

- To account for the meaning of the comparative, and to preserve classical logic generalisations such as the law of excluded middle ($p \vee \neg p = 1$), supervaluationists introduce the notion of *super-truth*

Supervaluationist Analyses

- Let s be a function that assigns to each adjectival partial function adj a set of total functions consistent with adj that "*close the extension gap defined by* adj"
- The functions $f \in s(adj)$ are called *precisifications* or *completions*.
- *Berno is tall-er than Anna* is true iff there is a total function $f \in s(\texttt{tall})$ such that Berno belongs to $\texttt{tall}^+$ and Anna to $\texttt{tall}^-$.
- Super-truth: $[\![\text{tall}(x)]\!]_C$ is *super-true* iff $[\![\text{tall}(x)]\!]_C = 1$ in all $f \in s(\texttt{tall})$. Thus, $p \vee \neg p =$ *super-true*.
-

Supervaluationist analyses: getting by w/o degrees

- borderline cases: indeterminacy is a consequence of the structure of the models wrt which linguistic expressions receive their interpretations (model-theoretic)
- Preserve classical logic: with the notions of super truth, they preserve generalisations like the law of excluded middle ($p \vee \neg p$)
- Eliminate the Sorites by rendering the 2nd premise super false
- semantics for gradable predicates that does not require adding new, abstract ontological object like degrees

predictions about vague expressions and gradability: are all vague expressions gradable? are all gradable expressions vague?
point to parts of Klein and Kamp papers

Relative vs. Absolute gradable adjectives

- Are all gradable adjective vague (contet-dependent, with borderline cases, and giving rise to the Sorites)?
- So-called *absolute adjectives* are gradable – can be used in comparative constructions and with degree morphology (unlike non-gradable adjectives s.a. *'prime'* *'wooden'*, *'geological'*
- But they exhibit different entailment patterns:
- Minimum standard: require their arguments to possess a minimal degree of the property. Maximum stardard require a maximal degree.

(1) The rod is bent / straight.

(2) The table is wet / dry.

(3) The roof is wetter than the terrace $\Rightarrow$ the garden is wett

(4) The roof is dryer than the terrace $\Rightarrow$ the terrace is not dry

Relative vs. Absolute gradable adjectives

- Absolute adjectives don't seem to give rise to the Sorites. Premise 2 is judged false:

  (5) Water

Relative vs. Absolute gradable adjectives

- Instead of being interpreted wrt a contextually determined standard of comparison, absolute adjectives take maximal and minimal degrees on a scale as reference point.
- They are not contextually determined, can be computed on the basis of the function expressed by the adjective.
- Why do different adjectives have different standards? Scale structure

  According to degree-based analyses, gradable adjectives denote functions that map objects onto scales. Variation then can be explained wrt properties of the scalar representations they make use of.

Scale structure

- Kennedy & McNally (2005) argue that one parameter of scalar variation is the open/close distinction, whether a scales has minimal or maximal elements.
- Typology of scale structures from the distribution of degree modifiers:
  (totally) open $\circ$——$\circ$
  lower closed upper closed (totally) closed