Topics in the Lexical Semantics–Morphosyntax Interface

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Polysemy and "co-composition", I:
Verb complementation

Outline for Part 3

- Polysemy in event description: some more data (**Warning!** Only some will be analyzed)
- Alternatives to multiplying verb/complement denotations:
  - **Indexicality:** Add a contextual parameter to the verb denotation (Bosch 1995)
  - Change the composition rule to allow for the argument to **co-compose** with the verb semantics (Pustejovsky 1995)
  - Make the verb denotation "**polymorphic**" (Asher 2011)
  - **Overspecify** the verb denotation and **filter** using **vector-based semantics** (Erk and Padó 2008, a.m.o.; see Lenci 2018 for a review, now standard in computational semantics)

Polysemy in event description

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- Manifestations of this fact:
  - Hard to distinguish precise senses for verbs.
  - A verb's interpretation seems to be influenced by the interpretation of its arguments.
  - "Conceptual" components of meaning intervene in the syntax/semantics interface, even if they are not strictly entailed – especially visible in cross-linguistic data.

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  - "Conceptual" components of meaning intervene in the syntax/semantics interface, even if they are not strictly entailed – especially visible in cross-linguistic data.
- How to best analyze verb-argument interaction and the effects of "conceptual" content at the syntax/semantics interface?

Distinguishing verb senses

Apresjan (1974); Fillmore and Atkins (2000); Hanks (2006); Pustejovsky and Rumshisky (2010); Spalek (2015), a.m.o.

(1) Cris baked the flan / the potatoes.

(2)
a. Cris **rompió** el vaso.
b. Cris **rompió** la cámara.
c. El viento **rompió** el toldo.
d. Cris **rompió** la ley.
e. El vaso / la cámara / el toldo / la ley **se rompió**.
f. El grupo **se rompió** en dos partes.
g. España **rompió** relaciones con Argentina.
h. Una avería **rompió** la circulación de los trenes.

Verb semantics and alternations

Fillmore (1986); Levin (1993); Rappaport Hovav and Levin (2024), a.m.o.

- Verb polysemy interacts in surprising ways with syntactic alternations.
- This includes the interpretation of null arguments.

Example: "Broom-*sweep*" vs. "Basic-*sweep*":

(3) a. The waiter swept the floor (with a broom).
b. The waiter swept his hair ??(with a brush).
c. The waiter swept. [strongly "broom"]
d. The waiter swept a broom across/over the floor. [$\not\equiv$ 3a]
e. The waiter swept a brush across/over his hair. [$\equiv$ 3b]

Cross-linguistic patterns

Fillmore and Atkins (2000); McNally and Spalek (2022); Spalek and McNally (2024)

- Verb polysemy builds on both event structure and "conceptual" content.
- Evident in similarities and differences in polysemy.
- A first hint that lexical semantics is not homogeneous.

Example: *Winning* as *sweeping*:

(4) a. sweep the Oscars
b. barrer los oros
c. The FCB women swept the Copa / ??the Madrid
d. El FCB Feminino barrió (en) la Copa / el Madrid

Complement coercion

Pustejovsky (1995); Asher (2011); Piñango and Deo (2016); Spalek and Sæbø (2019), a.m.o.

- Many verbs take DP complements whose interpretations are "coerced."
- How does coercion work?
- How to explain the variation across verbs (and across languages)?

Example: Aspectual verbs

(5) a. The novelist finished the book.
b. The goat finished the book.
c. The novelist ended the book.
d. ??The goat ended the book.

Two* general strategies to analyze polysemy

- **Underspecification:** A single core denotation for all words senses
  - Keep compositional rules classical; use pragmatics to differentiate word senses.
  - Offload some pragmatics to new composition rules that allow arguments to contribute to functor disambiguation.

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- Two perspectives on the same problem, but the details matter!
- For some analyses, **representations** become important, and new kinds of them are needed.

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Analysis 1: Indexical analyses

Bosch (1995)

- Verbs denote functions from contexts to denotations, similar to indexical pronouns (Kaplan 1989).
- A contextual variable fixes the denotation; cannot vary under quantification.

(6) a. The waiter swept the floor, and so did the chef after she stepped in a puddle of oil and fell.
⇒ Waiter and chef did the same kind of sweeping.

b. Every waiter swept the floor.
⇒ Every waiter did the same kind of sweeping.

(7) $\lambda c \lambda y \lambda x . \mathbf{sweep}_c(x, y)$

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- **Advantage:** Keeps semantics otherwise classical.
- **Limitation:** No insights into patterns/generalizations.

Analysis 2: Co-composition

The Generative Lexicon (Pustejovsky 1995)

- Rich feature structures as lexical representations: **A**rgument **S**tructure, **E**vent **S**tructure, **Q**ualia **S**tructure.
- 4 "quale": **F**ormal, **C**onstitutive, **T**elic, **A**gentive

$$\lambda y \lambda x \lambda e \left[\begin{array}{l} \textbf{bake} \\ \text{AS} = \left[\begin{array}{l} \text{A1} = x : phys \\ \text{A2} = y : phys \end{array} \right] \text{ES} = \left[\text{E1} = e : process \right] \\ \text{QS} = \left[\text{A} = bake\_act(e, x, y) \right] \end{array} \right]$$

$$\lambda x \exists y \left[\begin{array}{l} \textbf{cake} \\ \text{AS} = \left[\begin{array}{l} \text{ARG1} = x : phys \\ \text{D-ARG1} = y : mass \end{array} \right] \text{QS} = \left[\begin{array}{l} \text{F} = cake(x) \\ \text{C} = made\_of(x, y) \\ \text{T} = \lambda z, e[eat(e, z, x)] \\ \text{A} = \exists w, e[bake(e, w, y)] \end{array} \right] \end{array} \right]$$

Analysis 2: Co-composition

The Generative Lexicon (Pustejovsky 1995)

A complex "co-composition" rule allows the representation of *cake* to add to that for *bake*. *Bake a cake* is enriched as follows:

- Argument structure: A2 = y : *phys* specified to be an artefact.
- Event Structure: Subevent E2 added to follow E1, the state of the cake existing.
- Qualia Structure: Licenses the *bake_act* as means for E2.

$$\lambda y \lambda x \lambda e \begin{bmatrix} \textbf{bake} \\ \text{AS} = \begin{bmatrix} \text{A1} = x : phys \\ \text{A2} = y : phys \end{bmatrix} \text{ES} = \begin{bmatrix} \text{E1} = e : process \end{bmatrix} \\ \text{QS} = \begin{bmatrix} \text{A} = bake\_act(e, x, y) \end{bmatrix} \end{bmatrix}$$

Analysis 2: Co-composition

The Generative Lexicon (Pustejovsky 1995)

- **Advantages:**
  - The basic insight seems on the right track.
  - Prospect of capturing within-language generalizations related to verb alternations.
- **Limitations:**
  - Representations too rigid, heavily criticized (e.g., Fodor and Lepore 1998).
  - Composition rules never really worked (see e.g., Asher 2011).

Rich types and type polymorphism

Cooper (2023); Asher (2011); Chatzikyriakidis and Luo (2017); Sutton (2022), a.m.o.

- Types in classic formal semantics build on entities, sets, and relations between combinations of these in different possible worlds: e, t, $\langle e, t \rangle$, etc.
  - Known limitations, e.g., for attitude verbs (*believe*, *know*, etc.)
- Different, much richer type systems are used in logic and computer science.
  - Developed for other purposes but extended to lexical polysemy.

Rich types and type polymorphism

Cooper (2023); Asher (2011); Chatzikyriakidis and Luo (2017); Sutton (2022), a.m.o.

- Assume a type hierarchy $\approx$ a huge ontology of categories.
- Content words denote unique types in this type hierarchy.
- Types combine by function application to create subtypes.*
  - [[bake]]: $\lambda\tau_i\lambda\tau_j.\textsc{bake}(\tau_i, \tau_j)$, [[flan]]: $\textsc{flan}$, [[potato]]: $\textsc{potato}$ etc.
  - [[bake a flan]]: a subtype of $\textsc{bake}$ (τ_j: artefact)
  - [[bake a potato]]: a distinct subtype of $\textsc{bake}$ (τ_j: phys. object)
- $\textsc{bake}$ is a type **polymorphic** function: It can take many *different* types as arguments.
- Each instance of the function $\approx$ a different sense.

*Various versions exist, many technical details omitted.

Remark: Rich types and Carlsonian kinds

Rich type analyses resemble the use Carlson's (1977) kinds to form complex event-kind descriptions (Carlson 2003; Gehrke and McNally 2015; McNally 2017).

(10) a. The occasional sailor strolled by.

b. $\exists e_k[\textbf{strolled-by}(e_k, \iota x_k[(\textbf{occasional}(\textbf{sailor}))(x_k)])]$

Just as Carlsonian kinds can be realized by tokens, rich types can be related to sets (Cooper 2005; Asher 2011).

Rich types and type polymorphism

Cooper (2023); Asher (2011); Chatzikyriakidis and Luo (2017); Sutton (2022), a.m.o.

- **Advantages:**
  - Can serve as a bridge between classical referential semantics and vector-based semantics (more on this later).
  - Offers indirect way for complement to influence verb senses through presuppositions on the types of verb arguments.
  - Can be extended to metaphorical uses, adjective-noun composition.
- **Limitations:**
  - Some implementations are technically messy.
  - Unless more is said, just turns the problem of understanding verb polysemy into the problem of understanding type polymorphism.

From types/kinds to vector-based semantics

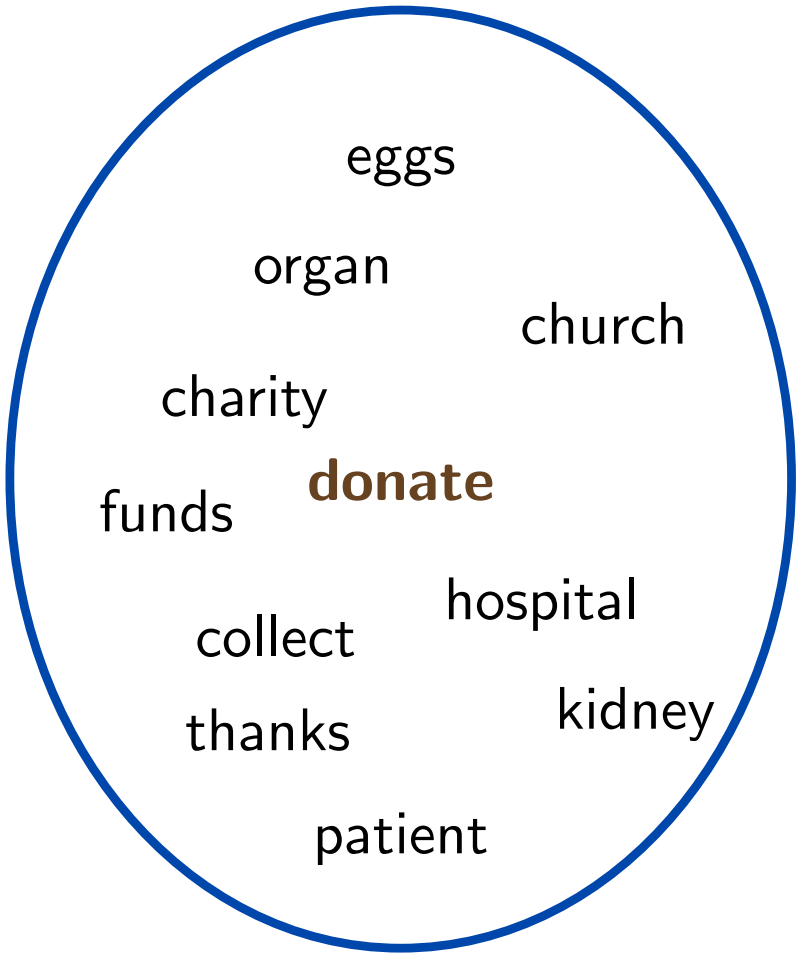
- Type polymorphism and the appeal to Carlsonian kinds are more like *overspecification* than *underspecification* approaches.
- But what is inside that overspecified black box?
- One answer is to view content words as linked to concept representations **in addition to** entities (recall Background, I).
- Representing concepts using (numeric) vectors reflecting distributions in language use is a extremely powerful option: they underlie Large Language Models like ChatGPT.
- More on this in Part 6.

Under- vs. overspecification: The intuition

Underspecification

x **donate** y to z
x causes s
x acts volitionally
$s = z$ has y
s is intended to be permanent
z is intended to benefit from y
⋮

Overspecification



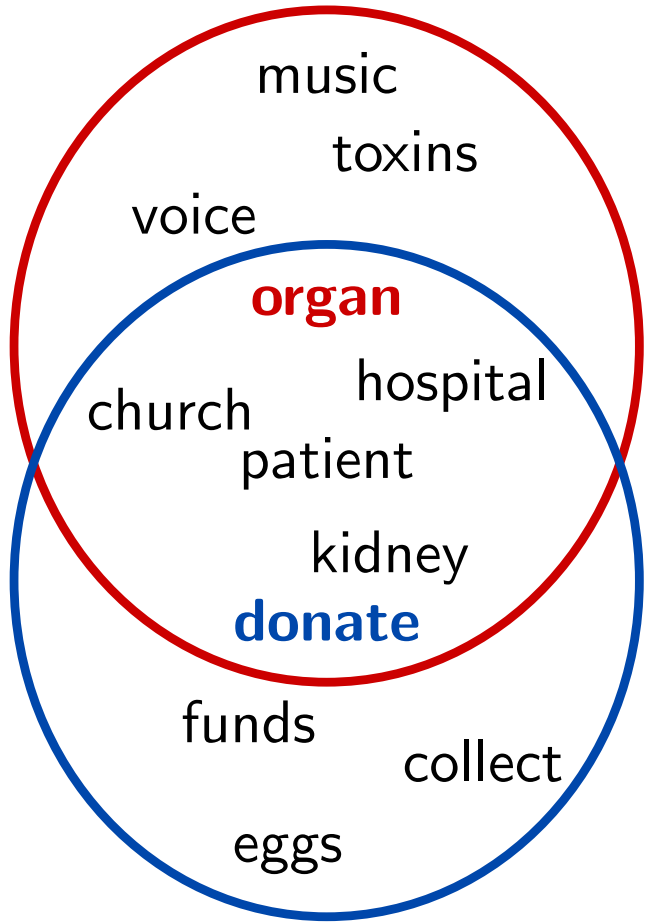
donate

Under- vs. overspecification: The intuition

Underspecification

x **donate** y to z
x causes s
x acts volitionally
$s = z$ has y
s is intended to be permanent
z is intended to benefit from y
y is an **organ**
y is a part of something
y has a designated function
$\vdots$

Overspecification



donate an organ

Summary

- Complex event descriptions built around verbs offer a wealth of interesting empirical data to explore.
- We have barely scratched the surface.
- Different, mostly "non-mainstream" techniques can address basic aspects of the challenges.
- But without some kind of richer concept-like semantic representation, they only go so far.

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