Composition as saturation and modification

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1 Today

- Summing up what we've learned in previous weeks:
  1. Meanings are either functions, or arguments to functions.
  2. For example, we take it that proper names denote individuals, transitive verbs denote Curry'd functions from two individuals into a truth values, and VPs denote functions from an individual into a truth value (i.e. the characteristic function of some set).
  3. Binary composition happens by applying the functional denotation of one sister to the argumental denotation of the other.
- Our formal rule for interpretation:

  If α is a binary-branching node with daughters β_α and $\gamma_{\langle\alpha,\gamma\rangle}$, $[\![\alpha]\!] = [\![\gamma]\!]([\![\beta]\!])$.

  Notice that this rule is general in that it allows the function-denoting thing γ to either occur on the right or the left.
- Today, expanding our fragment:
  1. Adjectives, nouns, prepositions and prepositional phrases
  2. The *determiners* a and the.
  3. A toy treatment of relative clauses
- We'll explore a variety of options for folding these into our semantics, looking at options that involve expanding our inventory of basic operations for combination and options that do not.
- We'll end with a puzzle: object relative clauses.

2 Nonverbal predicates

- Some other candidates for set-denoting things:
  1. Common nouns (e.g. cat, book, train).
  2. (At least some) adjectives (e.g. orange, friendly, visible).
  3. Prepositional phrases (e.g. out, in the yard, near Bill).

2.1 Some properties

- Parallels to verbs. We have intransitive uses...

  (1) Buddy is a cat.

  (2) Uni is white.

  (3) Billy is out.

- ...as well as transitive uses:

  (4) New Brunswick is a part of New Jersey.

  (5) Billy is near Providence.

  (6) Uni is fond of Porky.

- PPs and APs (though not nouns) can be used in *small clauses*. Bolsters the idea that these things, like intransitive and transitive VPs, have room for a "subject" argument.

  (7) With John happy, things are looking up.

  (8) With John in New Brunswick, things are looking up.

  (9) *With John man, things are looking up.

- PPs and APs (but, again, not nouns) can be used in predicative positions

  (10) John is in New Brunswick.

  (11) John is happy.

  (12) *New Brunswick is city.

- That nominals can't be used in this way doesn't necessarily show that our semantic analysis is wrong, only that something *syntactically distinguishes* nouns from other sorts of property-denoting things.
- Apparent exceptions (which you should be aware of, but which we won't have an analysis for):

  (13) a. Obama is president.
  b. Simon is professor.

  (14) a. With Obama president, our use of drones increased.
  b. With Simon professor, we can expect to enjoy semantics.

2.2 Analysis

- Our analysis is entirely parallel to how we composed up transitive and intransitive VPs. As there, we will rely on properties (i.e. characteristic functions on sets) and Curry'd relations.
- Intransitive nouns/adjective/prepositions denote properties, the characteristic function on some set. E.g. for any x:

  (15) $[\![\mathsf{cat}]\!] = \lambda x.\, x \in \{x : x \text{ is a cat}\}$

  (16) $[\![\mathsf{happy}]\!] = \lambda x.\, x \in \{x : x \text{ is happy}\}$

  (17) $[\![\mathsf{out}]\!] = \lambda x.\, x \in \{x : x \text{ isn't home}\}$

- Transitive nouns/adjectives/prepositions denote Curry'd relations. E.g. for any x and any y:

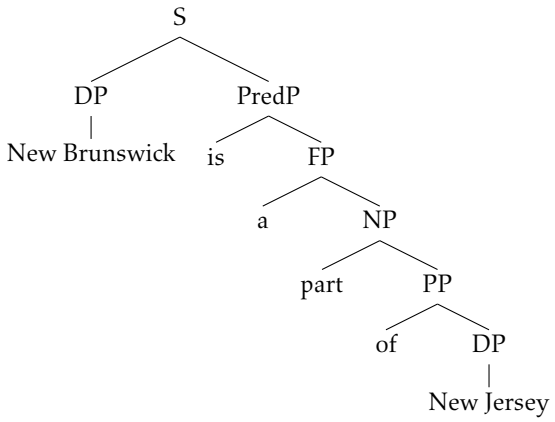
  (18) $[\![\textsf{part}]\!] = \lambda y.\, \lambda x.\, \langle x, y\rangle \in \{\langle x, y\rangle : x \text{ is a part of } y\}$

  (19) $[\![\textsf{fond}]\!] = \lambda y.\, \lambda x.\, \langle x, y\rangle \in \{\langle x, y\rangle : x \text{ is fond of } y\}$

  (20) $[\![\textsf{near}]\!] = \lambda y.\, \lambda x.\, \langle x, y\rangle \in \{\langle x, y\rangle : x \text{ is near } y\}$

- Vacuous words?

  1. For any f, $[\![\textsf{is}]\!] = \lambda f.\, f$
  2. For any x, $[\![\textsf{of}]\!] = \lambda x.\, x$
  3. For any f, $[\![\textsf{a}]\!] = \lambda f.\, f$



- Node-by-node:

  1. $[\![\text{PP}]\!] =$
  2. $[\![\text{NP}]\!] =$
  3. $[\![\text{FP}]\!] =$
  4. $[\![\text{PredP}]\!] =$
  5. $[\![\text{S}]\!] =$

3 Composing complex predicates

- Examples of complex predicates:

  (21) Uni is a white cat.

  (22) A dilapidated house near New Brunswick collapsed.

  (23) Kaline is a gray cat in Texas fond of Joe.

- A natural thing to suppose is an alternative mode of combination called **predicate modification**. Combines two properties by intersecting them:

$$[\![\text{X Y}]\!] = [\![\text{X}]\!] \cap [\![\text{Y}]\!], \text{ when defined}$$

- Or, more precisely, given that we're working with characteristic functions rather than sets per se:

$$[\![X\ Y]\!] = \lambda x.\ [\![X]\!]\ x \wedge [\![Y]\!]\ x, \text{ when defined}$$

  Here, I use the propositional-logical wedge $\wedge$ in the meta-language, to simply indicate that the result is 1/True iff $[\![X]\!]\ x$ and $[\![Y]\!]\ x$ are both 1/True.

- Gives a notion of **type-driven interpretation**
  1. Which rule applies is determined by semantic considerations, i.e. we go with whichever option yields a well-defined interpretation.
  2. There is never any uncertainty about which rule will apply.
  3. Our previous semantics was in fact already type-driven in the sense that which operation applied (forward or backward functional application) was determined by which of the daughter nodes was typed as the function, and which was typed as the argument.
- We could keep functional application as our sole method of combination in a few different ways:
  1. Positing more complicated meanings for e.g. adjectives.
  2. Positing silent elements in the syntax which do the heavy lifting for us by **coercing** meanings into things with the right type. Difficult to imagine how we might decide between this and enriching possibilities for combination.

3.1 Example

- Example analysis of a grey cat in Texas fond of Joe in Figure 1.
- Notice that the order in which the modifiers combine **makes no difference**. We could have grouped cat in Texas or in Texas fond of Joe as constituents and gotten the same meaning. (Earlier we saw reasons to suppose that order matters.)
- Thus, order effects not accounted for:

(24) The visible stars include Capella, Betelgeuse, and Sirius.
≠ The stars visible include Capella, Betelgeuse, and Sirius.

3.2 Interlude: predicate conjunction

- We saw some potentially problematic instances of conjunction on the last homework (i.e. grammatical, meaningful conjunctions of predicates, transitive verbs, and DPs).
- We now have a way to to think about at least some of these case. Perhaps *and* is ambiguous between "boolean" conjunction and predicate conjunction:

(25) Uni is happy and orange.

(26) Uni is orange and in the garage.

(27) Uni meowed and purred.

- But how about coordinating transitives?

(28) Uni saw and devoured her food.

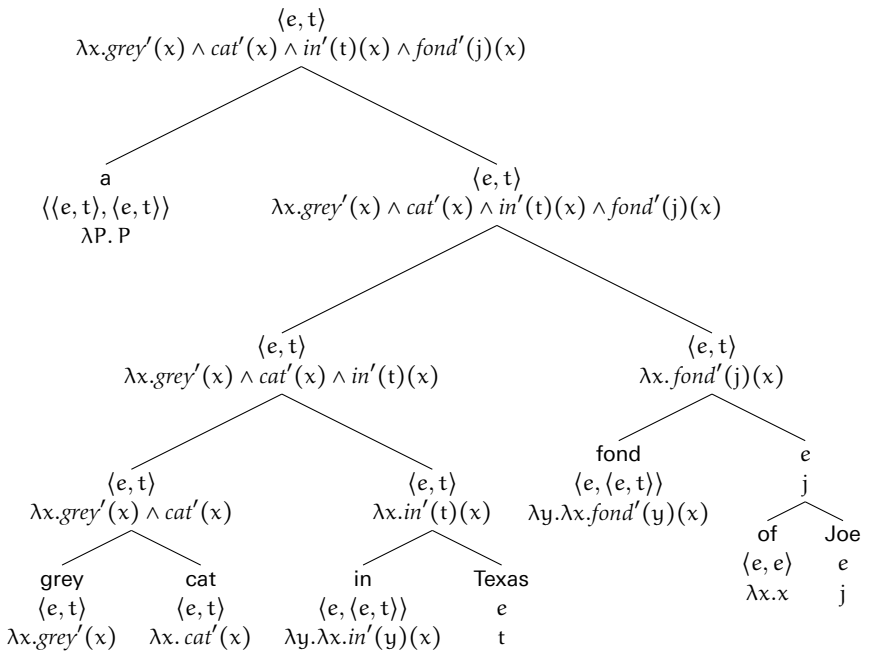


Figure 1: a grey cat in Texas fond of Joe

- Hm. There seems to be a clear generalization that we do not yet know how to state.
- In addition, DP coordination:

  (29) John and Bill excel at semantics.

- Not obvious how to fold this in. All we know how to do is boolean conjunction and (generalized) predicate conjunction. Perhaps there is a way to view a DP as a function??
- Apparently cases of **non-boolean conjunction** exist. The following does not entail that John lifted the piano together, and Bill lifted the piano together:

  (30) John and Bill lifted the piano together.

3.3 Issues remain

- Our semantics seems to license the following inference:

  (31) Tiny is a small elephant.
  ⇏ Tiny is an elephant, and Tiny is small.

- Make sure you see why.
- Subsective adjectives? For any f, x:

  (32) $[\![\text{small}]\!] \approx \lambda f.\, \lambda x.\, x$ is small for an f

- Comparison classes offer another option. For any x:

$$[\![\text{small}]\!] = \lambda x.\ x \text{ is small relative to the contextually specified standard } c$$

- How far does this get us?
  1. Someone is a beautiful dancer (at least on one reading) only if they *dance* beautifully. In other words, the noun can *dimension* of comparison can be regulated by the noun.
  2. Superlatives: John read the fewest books.
  3. Privatives: This is a fake gun / John is a former senator.
- Order effects not accounted for:

(33) The visible stars include Capella, Betelgeuse, and Sirius.

(34) The stars visible include Capella, Betelgeuse, and Sirius.

4 Extension 1: definite descriptions, partial functions

- Basic cases:

(35) The queen of England is bald.
Judgment: False

(36) The king of France is bald.
Judgment: ???

- A couple data points:
  1. Definite descriptions seem to denote individuals, i.e. they go all the places individual-denoting DPs like **Uni** do.
  2. Definite descriptions come with something like a *felicity condition* on their use. As a first pass, only ok to use when there is a unique individual in the denotation of the complement noun phrase.
- A semantics for the. For any property f:

$$[\![\text{the}]\!] = \lambda f. \begin{cases} \text{if there is exactly one } x \text{ such that } f\,x, \text{ then that } x \\ \text{undefined otherwise} \end{cases}$$

- This semantics is **partial**: it does not assign a meaning to every property f, only those that hold of exactly one individual. In all other cases, the result is undefined.
- Potentially problematic: the following seems to just be False.

(37) The king of France is standing over there

5 Extension 2: subject-headed relative clauses

- Basic data:

  (38) Mary is a student who met John.

  (39) The person who took semantics did well.

  (40) The black cat who purred meowed.

- Each of these cases is no biggie. Works just like previous modification cases. We get a property in the syntax, and that property combines with the noun by predicate modification (one way or another).
- Exercise: try it!

5.1 Syntax

- Interpretability constrains our choice of possible analyses of complex DPs. If we go with the first analysis below, it's hard to see how to fold in the relative clause once we've composed up the black cat.

  (41) [The black cat] who purred

  (42) The [black cat who purred]

- Can also see with PP modifiers:

  (43) [The book] in the corner

  (44) The [book in the corner]

- In addition to issues of interpretability, there is an issue of basic interpretive adequacy. Even if we managed to finagle a rule for the first cases, the black cat would denote the single (salient) black cat (and be undefined if there were more than one [salient] black cat).
- But we can use the black cat who purred in a context where there's multiple black cats, so long as just one of them purred.

5.2 Object relatives

- Subject relatives are easy to compose.
- Object relatives are harder: "gaps" can occur anywhere

  (45) The cat [Bill met _] purred.

  (46) The cat [Bill showed _ Uni] purred.

  (47) The cat [Bill showed Uni _] purred.

- More generally, any time a gap isn't at the left edge of the relative clause:

  (48) The man who [Bill said _ left] was in my class.

- So are subjects also a result of movement? Possibly. Parallel issue with wh movement. Subject constituent questions may not require anything special, but object ones (and internal ones) certainly do.
- How to compose up the subject and verb to give a property? What we require:
    1. A meaning for the extraction gap the functions as a syntactic and semantic placeholder.
    2. A way to use that placeholder to derive a property.