

Lexical meaning in context: an introduction

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Lexical semantics in 1979

- typed lambda calculus to calculate logical forms for disambiguated sentences.
- two basic types E and T
- Church Montague of interpretation of types as sets:
 $\alpha \Rightarrow \beta$ is the set $\{f \mid f: D_\beta \rightarrow D_\alpha\}$,
- standard intensional logic interpretations.

General problem

- interactions between word meaning and the predicational context (and discourse context)
- (1) All the children were drawing fish. Suzie's salmon was blue.
 - (2)
 - a. Julie began with the kitchen, proceeded to the living room and finished up with the bedrooms.
 - b. Yesterday Julie cleaned her house. Julie began with the kitchen, proceeded to the living room and finished up with the bedrooms.
 - c. Last week, Julie painted her house. Julie began with the kitchen, proceeded to the living room and finished up with the bedrooms.

5 problems that a theory of lexical meaning should solve

- types and selectional restrictions
- subtyping
- If types don't have the Church-Montague interpretation, what are they?
- copredication and counting with dual aspect terms
- coercions and interactions with discourse context

Types and selectional restrictions

- (3) The number 2 is soft.
 - (4) Is the number 2 soft?
 - (5) The number 2 is not soft.
 - (6) If numbers could have colors, the number 2 would be blue.
- selectional restrictions are presuppositions about the types of arguments.
 - There are a variety of ways that arguments can meet the selectional restrictions of predicates.

More on type presuppositions

Distinguish between necessary falsity and semantic anomaly (type presupposition failure)

- (7)
- a. Tigers are animals.
 - b. Tigers are robots.
 - c. #Tigers are financial institutions.
 - d. #Tigers are Zermelo-Frankel sets.
- Many philosophers take (7a) to be necessarily true and (7b) to be necessarily false
 - Nevertheless, according to most people's intuitions, a competent speaker could entertain or even believe that tigers are robots.
 - Much harder to make sense of a competent speaker's even entertaining that tigers are literally financial institutions, or ZF style sets.

The subtyping problem

- a lot of linguistic evidence for a rich system of subtypes of **E** (eventualities vs. physical objects vs. informational or abstract objects vs. animate objects vs. locations vs. kinds. vs. masses vs. ...)
- Most linguists working on lexical meaning assume these distinctions in more or less formalized form
- First order physical properties are intuitively a subtype of first order properties—
 $(\mathbf{P} \rightarrow \mathbf{T}) \sqsubseteq (\mathbf{E} \rightarrow \mathbf{T})$
- Not so on the Church/Montague set theoretic model of types.
- In fact the type of first order physical properties and the type of first order properties are disjoint according to Church/Montague

Fine grained intensionality for types

- (8) Look! the trees are speaking (*Lord of the Rings*)
- (9) These trees are really speaking to me. I'm going to paint the living room green.
- types corresponding to fictional objects and the absurd type have the same extension or the same set of inhabitants, namely the empty set.
 - But types of fictional objects are intuitively distinct from \perp .

Upshot

- types are not identified with sets of their inhabitants
- proof objects (concepts) with rules of application
- subtypes for higher order types then can be interpreted as proof objects:
- If $\alpha \sqsubseteq \beta$, then a proof that something is α furnishes a proof that that thing is also β
- First order properties defined as $\Sigma x \subseteq \mathbf{E} (x \Rightarrow \mathbf{T})$, where Σ is an existential quantifier over types.

Distinguish between type presuppositions and fine grained types

- predicates presuppose general types for their arguments (INFORMATIONAL OBJECTS vs. PHYSICAL OBJECTS vs. EVENTUALITIES)
- lexical items have finegrained types.
- finegrained types yield finegrained shifts in meaning.
 - adjectives: *flat tire, flat country, flat beer*
 - verbs: *load the hay on the wagon, load the wagon with hay*
 - verbal modification:

Dual aspect nouns

- (10) Ducks lay eggs and are common to most of Europe. [*individual* and *kind*]
- (11) Snow is common this time of year and all over my back yard. [*kind* and *mass*]
- (12) Mary picked up and mastered three books on mathematics. [*physical object* and *informational content*]
- (13) Je ne suis qu'un roseau mais je suis un roseau pensant. (Pascal) [*physical object* and *thinking agent*]
- (14) That is a lump of bronze but also Bernini's most famous famous statue [*portion of matter* and *artifact*]
- (15) Le prix Goncourt is 10000 euros and a great honor not accorded every year. [*amount of money* and *prize*]
- (16) The lecture (interview, speech) lasted an hour and was very interesting. (*event* and *information*)
- (17) The bank is just around the corner and specializes in sub prime loans. (*physical object/location* and *institution*).

- (18) The canvas is immense, and, as an example of a bygone school, interesting to all art lovers. (*New York Times* March 24, 1894) [*physical object* and *informational object*]
- (19) The promise was made but impossible to keep. [*speech act* (event) and *proposition*]
- (20) The belief that all non Christians are immoral is false but persists in many parts of America. [*informational content* and *state*]
- (21) Mary's testimony concerning the matter occurred yesterday and is riddled with factual errors and inconsistencies [*event* and *information content*]
- (22) The very same thought that caused Mary to shudder amused Kim. [*event* and *information content*]
- (23) The house contains some lovely furniture and is just around the corner. [*physical object* and *location*]
- (24) Most cities that vote democratic passed anti-smoking legislation last year. [*population* and *legislative entity*]
- (25) Lunch was delicious but took forever. [*food* and *event*]
- (26) The temperature is 90 and rising. *function* and *value*

Copredication, counting and quantificational shift with dual aspect nouns

- dual aspect nouns (book, lunch, city)—shifts in quantificational domains (quantificational puzzles)
- mass nouns, bare plurals (at the level of determiners)

- (27) John has read every math book in the library.
- (28) John has mastered every math book in the library.
- (29) John has stolen every math book in the library
- (30) John answered every question.
- (31) John repeated every question.

- a simple ambiguity (lots of ambiguities don't support copredication)

(32) The bank is slippery from the recent rains and specializes in IPOs.

- copredications are ellipses; copy the DP with the dual aspect noun into the second predication and disambiguate. (predicts false readings for quantified sentences like *Mary carried home and then mastered 3 books on semantics*)
- dual aspect nouns have a product or conjunctive type: $\text{BOOK} \sqsubseteq \text{I} \sqcap \text{P}$.
(but no object is both an individual instance of a kind and a kind...)
- dual aspect nouns have a product type: $\text{BOOK} \sqsubseteq (\text{I}, \text{P})$
Problems with counting arguments.

Counting arguments

- a there are exactly two copies of *War and Peace*, two copies of *Ulysses*, and six copies of the *Bible* on a shelf .
- b Pat has read *War and Peace* and *Ulysses*, and no other book
- c Sandy has read the *Bible*, and no other book.

Now, consider the questions:

- (Q1) How many books are there on the shelf?
- (Q2) How many books has Pat read?
- (Q3) How many books has Sandy read?
- (Q4) Who has read more books, Pat or Sandy?

My guess is that most people would answer:

- ten to (Q1)
- two to (Q2)
- one to (Q3)
- Pat to (Q4)

Pairing approach gives us too many objects

The pairing approach gives us 10 pair objects consisting of a physical object represented by a number of the physical copy and an information content represented by the title of the book or an abbreviation thereof:

- (1, W&P), (2, W&P), (3, U), (4, U), (5, Bible), (6, Bible), (7, Bible), (7, Bible), (8, Bible), (9, Bible), (10, Bible),

Upshot: dual aspect nouns require a special type

- $\text{BOOK} \sqsubseteq \text{I} \bullet \text{P}$
- model this type categorially using a fibre product, which says, roughly, that given a maps from one aspect to another, there exists an object that has these two aspects.
- the categorial model is well adapted to conceiving of types as proof objects
- copredication involves a type justification in which an aspect type is selected, and this may affect the domain.
- the selection of an aspect type will determine counting and individuation principles.

Some counting pictures

On the shelf is a copy of Jane Austen's collected works and 3 copies of *The Bible*:

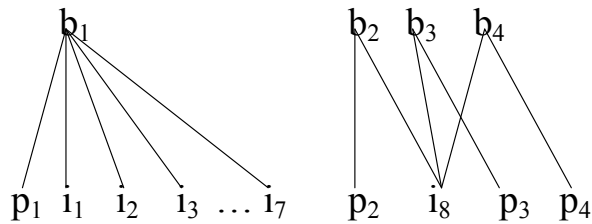


Figure 1: Books individuated physically

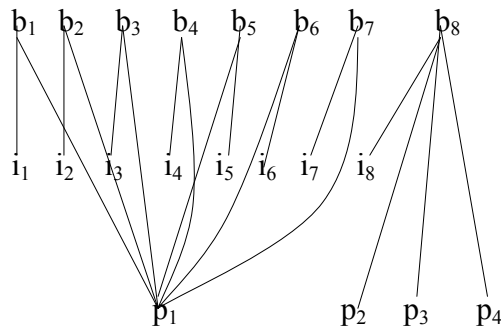


Figure 2: Books individuated informationally

An aside on relative predication

- (33) John as a banker is a mean SOB, but as a father
he's a sweetheart.

The *as* construction can introduce an aspect of the noun it modifies.

Coercion

- aspectual verbs *begin a novel, enjoy a cigarette*
- consummables *drink a bottle, have a beer*
- aspectual coercion *John is being silly*
- representations *The elephant in the living room should go in the bedroom, Chris sketched his hand, the garden with the flowers, the dress with the flowers*
- freezing (containers, containants)
- evaluative adjectives *good mathematician job*
→ activity

Coercion depends on the predicate

- (34) Sam enjoyed (started, finished) the zibzab.
- (35) a. Mary finished eating the apple.
b. Mary finished the apple.
c. Mary stopped eating the apple.
d. Mary stopped the apple.
- (36) a. The reading of the book started at 10 am.
b. #The book started at 10 am.
c. John started the book.
d. John started the reading of the book.
e. John started at 10am (started to run, to bicycle, to climb, ...)

But coercion may depend on other factors as well

- (37)
- a. #Smith has begun the kitchen.
 - b. The janitor has begun (with) the kitchen.
 - c. The cleaners have started the suits
 - d. The exterminator has begun (with) the bedroom.
 - e. The painters have finished the windows.

as well as on discourse context.

(38) George enjoyed many books that covered difficult topics

- No quantificational domain shift. *Many* continues to quantify over books
- A different sort of presupposition type justification from that of aspect selection.

What a coercing predicate demands

- an underspecified dependent type that takes the actual type of the argument and returns a type demanded by the predicate.
- Other arguments of the predicate or discourse context can specify this type.

The basic picture

- the data calls for a complexification of the type system, even for its reinterpretation.
- types seem to act very much as presuppositions. The selectional restrictions of predicates are presuppositions that have to be justified by their arguments.
- add a parameter to λ terms to carry type presuppositions, and allow processes of justification (outside the lambda calculus) to manage these type presuppositions.
- accommodations of presuppositions may lead to modifications of content in logical form (a move familiar from SDRT with discourse relations).

- rich system of basic types (including \mathbf{E} and \mathbf{T})
- **Presuppositional Type:** Π , another base type that carries the type presuppositions of terms.
- **Disjunctive Types:** If σ and τ are types, then so is $(\sigma \vee \tau)$
- **Functional Types:** If σ and τ are types, then so is $(\sigma \Rightarrow \tau)$
- **Quantificational Types:** If σ and τ are types and X is a variable ranging over types, then $\exists X \sqsubseteq \sigma \tau$ is a type.
- **Bullet Types:** A finite set of types of the form $\sigma \bullet \tau$ where σ, τ are types

Lexical entries

$$(39) \quad \lambda x: \mathbf{P} \text{ tree}(x)$$

$$(40) \quad \lambda \mathcal{P} \lambda x \lambda \pi \mathcal{P}(\pi * \text{arg}_1^{\text{tree}}: \mathbf{P})(x)(\lambda v \lambda \pi' \text{tree}(v, \pi'))$$

Verbs:

$$(41) \quad \lambda \Phi \lambda \pi \Phi(\pi * \text{ARG}_1^{\text{fall}}: \mathbf{P})[\lambda y: \mathbf{P} \lambda \pi' \text{fall}(y, \pi')].$$

DPs: $(\exists X \sqsubseteq \mathbf{E}(X \Rightarrow (\Pi \Rightarrow \mathbf{T})) \Rightarrow (\Pi \Rightarrow \mathbf{T})).$

Other types change in predictable ways.

The rules

Definition 1 *Binding Presuppositions:*

$$\frac{\gamma \sqsubseteq \alpha, \text{ARG}_i^P : \alpha, \text{ARG}_i^P : \gamma}{\text{ARG}_i^P : \gamma}$$

Sometimes presuppositions can't be bound.

Definition 2

Simple Type Accommodation

$$\frac{\alpha \sqcap \beta \neq \perp, \text{ARG}_i^P : \alpha * \text{ARG}_i^P : \beta}{\text{ARG}_i^P : \alpha \sqcap \beta}$$

(42) I'll have a Chardonnay.

The type presupposition of the determiner is COUNT, but *Chardonnay* is neither MASS nor COUNT (or has a default for mass Borer)

Why bother?

$$(43) \quad \lambda \mathcal{P} \lambda x: E \lambda \pi \mathcal{P}(\pi * \text{ARG}_1^{\text{book}: \mathbf{P} \bullet \mathbf{I}})(x)(\lambda v \lambda \pi' \text{book}(v, \pi'))$$

where \mathcal{P} has the general type of all NP modifiers MOD, or $1 \Rightarrow 1$. This combines via Application with the adjective *heavy*'s entry

$$(44) \quad \lambda P: 1 \lambda u \lambda \pi_1(\text{heavy}(u, \pi_1 * \text{ARG}_1^{\text{HEAVY}: \mathbf{P}}) \wedge P(u, \pi_1))$$

(43) and (44) combine to give us:

$$(45) \quad \lambda x \lambda \pi \lambda P \lambda u[(\text{heavy}(u, \pi * \text{ARG}_1^{\text{book}: \mathbf{P} \bullet \mathbf{I}} * \text{ARG}_1^{\text{heavy}: \mathbf{P}})) \wedge P(\pi * \text{ARG}_1^{\text{book}: \mathbf{P} \bullet \mathbf{I}})(u)](x)(\lambda v \lambda \pi' \text{book}(v, \pi'))$$

Remarks

$\text{ARG}_1^{\text{book}}: \text{P} \bullet \text{I}$ is an instruction that this type must be satisfied by the types assigned to the variables going in for that argument of *book* in the lambda term to which it is an argument. The problem is that u is both the first argument to *heavy* and the first argument of *book*. So it has to obey incompatible typing requirements.

Given that we take aspects seriously, *heavy* should be predicated of the physical aspect of *book*.

How to do this

Shift the predication by applying a functor in logical form so that the presupposition can be justified.

$$(46) \quad \lambda P \lambda w : \mathbf{P} \bullet \mathbf{I} \lambda \pi_3 \exists z : \mathbf{P}(P(\pi_3)(z) \wedge \text{O-elab}(z, w, \pi_3))$$

$$(47) \quad \lambda x \lambda \pi \lambda P \lambda u [(\lambda v \lambda \pi_1 \text{heavy}(v, \pi_1)(\pi * \text{ARG}_1^{\text{book}} : \mathbf{P} \bullet \mathbf{I} * \text{ARG}_1^{\text{heavy}} : \mathbf{P})(u) \\ \wedge P(\pi * \text{ARG}_1^{\text{book}} : \mathbf{P} \bullet \mathbf{I})(u))](x)(\lambda v \lambda \pi' \text{book}(v, \pi'))]$$

The application of the functor in (46) to the term, $\lambda v \lambda \pi_1 \text{heavy}(u, \pi_1)$, yields:

$$(48) \quad \lambda P \lambda w \lambda \pi_3 \exists z (P(\pi_3)(z) \wedge \text{O-elab}(z, w, \pi_3)) \\ [\lambda v \lambda \pi_1 \text{heavy}(v, \pi_1)]$$

which reduces to:

$$(49) \quad \text{a. } \lambda w \lambda \pi_3 \exists z ((\text{heavy}(z, \pi_3) \wedge \text{O-elab}(z, w, \pi_3)))$$

Reintegrating the result in (49d) into the context of (47):

$$(50) \quad \lambda x \lambda \pi \lambda P \lambda u [(\lambda w \lambda \pi_3 \exists z (\text{heavy}(z, \pi_3) \wedge \text{O-elab}(z, w, \pi_3)) \\ (\pi * \text{ARG}_1^{\text{book}} : \mathbf{P} \bullet \mathbf{I} * \text{ARG}_1^{\text{HEAVY}} : \mathbf{P})(u) \wedge \\ P(\pi * \text{ARG}_1^{\text{book}} : \mathbf{P} \bullet \mathbf{I})(u))](x)(\lambda v \lambda \pi' \text{book}(v, \pi'))]$$

Remarks

Substituting the new modifier meaning for the original one there will satisfy the presuppositions of the head noun, since the variable filling the argument of *book*, w , is now of the right type and furthermore the argument to *heavy* is no longer also the argument to *book*.

We can get something appropriate for the NP *heavy book* now using standard λ calculus + Binding

$$(51) \quad \lambda x: \mathbf{P} \bullet \mathbf{I} \lambda \pi \exists z: \mathbf{P} (\text{heavy}(z, \pi) \wedge (\text{O-elab}(z, x, \pi) \wedge \text{book}(x, \pi)))$$

The meaning of *a heavy book*:

$$(52) \quad \lambda Q \lambda \pi \exists u: \mathbf{P} \bullet \mathbf{I} \sqcap \text{COUNT} \exists z: \mathbf{P} (\text{heavy}(z, \pi) \wedge (\text{O-elab}(z, u, \pi) \wedge \text{book}(u, \pi))) \wedge Q(\pi)(x)$$

- Coordination Rule for *and*:

- Given a λ term of the following form

$$[\lambda\Phi\lambda\Psi\lambda\pi \Psi(\text{Pre}_{\phi_1}(\pi))(\lambda u\lambda\pi_1 \Phi(\text{Pre}_{\phi_2}(\pi))(\phi))]$$

and

$$[\lambda\Phi\lambda\Psi\lambda\pi \Psi(\text{Pre}_{\psi_1}(\pi))(\lambda u\lambda\pi_1 \Phi(\text{Pre}_{\psi_2}(\pi))(\psi))],$$

- one may rewrite the construction as the following λ term:

$$\lambda\Psi\lambda\Phi\lambda\pi \Psi(\text{Pre}_{\psi_1}(\text{Pre}_{\phi_1}(\pi))) (\lambda u\lambda\pi_1 \Phi(\text{Pre}_{\psi_2}(\text{Pre}_{\phi_2}(\pi)))) \\ (\lambda x\lambda\pi_2(\phi(\pi_2)(x)(u) \wedge \psi(\pi_2)(x)(u)))$$

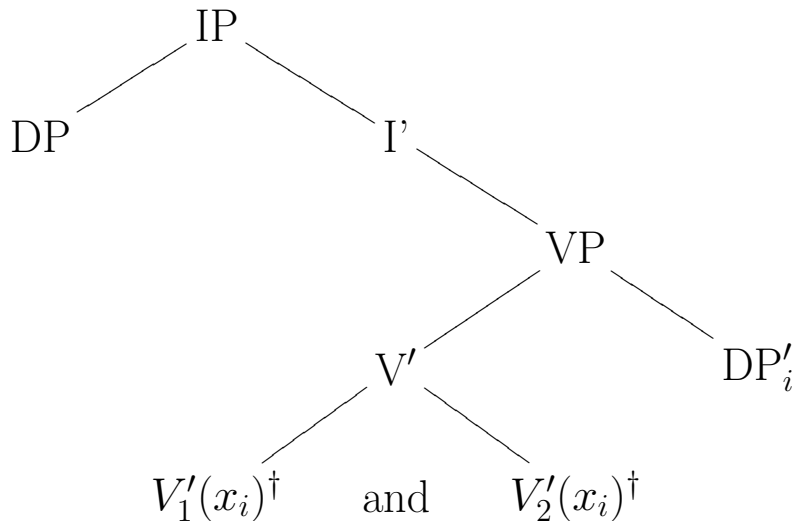
Local Justification

The Copredication Rule provides for two more local predications —when ϕ and ψ are each applied to the variable x introduced by the argument of the coordinated predicates.

- Local Presupposition Justification in Coordinated Predicative Constructions:

Suppose $\text{Pre}_\psi(\text{Pre}_\phi(\pi))$ is unsatisfiable. Then:

$$\frac{\Phi(\text{Pre}_\psi(\text{Pre}_\phi(\pi)))(\lambda x \lambda \pi_1 (\phi(\pi_1)(x) \wedge \psi(\pi_1)(x)))}{\Phi(\pi)(\lambda x \lambda \pi_1 (\phi(\text{Pre}_\phi(\pi_1))(x) \wedge \psi(\text{Pre}_\psi(\pi_1))(x)))}$$



example

(53) John picked up and mastered three books.

(54) $\lambda\pi\exists u(u = j(\pi) \wedge \exists_3 w: \mathbf{P} \bullet \mathbf{I}(\text{book}(w, \pi) \wedge$
 $\exists z: \mathbf{P} (\text{pick-up}(u, z, \pi)$
 $\wedge \text{o-elab}(z, w, \pi)) \wedge \exists z': \mathbf{I} (\text{master}(u, z', \pi) \wedge$
 $\text{o-elab}(z', w, \pi))))$

An entry for a coercion predicate

$$(55) \quad \lambda\Psi\lambda\Phi\lambda\pi \Phi(\pi * \text{ARG}_1^{\text{enjoy}} : \text{AG})(\lambda v \Psi(\pi * \text{ARG}_2^{\text{enjoy}} : \text{EVT} - \\ \epsilon(\text{HD}(\Phi), \text{HD}(\Psi)) \\ (\lambda y_1 \lambda \pi_3 (\text{enjoy}(v, y_1, \pi_3) \wedge \text{ag}(y_1) = v(\pi_3))))))$$

$$(56) \quad \text{George enjoyed many books}$$

Using local justification, we get:

$$(57) \quad \lambda\pi \exists y (y = g(\pi) \wedge \text{many}(x) (\text{book}(x)(\pi), \exists z : \text{AG}(\text{enjoy}(y, z, \pi) \wedge \\ \text{ag}(z) = y \wedge \phi_{\epsilon(\text{AG}, \text{BOOK} \sqcap \text{CT})}(z, y, x, \pi))))$$

Specifying underspecified types

- $(\alpha \sqsubseteq \text{HUMAN} \wedge \beta \sqsubseteq \text{P} \bullet \text{I}) > \epsilon(\alpha, \beta) = \text{READ}(\alpha, \beta)$
- $(\alpha \sqsubseteq \text{AUTHOR} \wedge \beta \sqsubseteq \text{P} \bullet \text{I}) > \epsilon(\alpha, \beta) = \text{WRITE}(\alpha, \beta)$
- $(\alpha \sqsubseteq \text{GOAT} \wedge \beta \sqsubseteq \text{P} \bullet \text{I}) > \epsilon(\alpha, \beta) = \text{EAT}(\alpha, \beta)$
- $(\alpha \sqsubseteq \text{JANITOR} \wedge \beta \sqsubseteq \text{P}) > \epsilon(\alpha, \beta) = \text{CLEAN}(\alpha, \beta)$

We can also simply deny certain equalities as in

- $(\alpha \sqsubseteq \text{GOAT} \wedge \beta \sqsubseteq \text{P} \bullet \text{I}) > \neg \epsilon(\alpha, \beta) := \text{READ}(\alpha, \beta)$

The type specification logic allows us to write appropriate axioms for specifying underspecified types.

Remarks

- In TCL type requirements get passed from predicates to arguments.
- For verbal modification, this has consequences. Many modifiers (manner) are like nominal modifiers but some take the verb or VP as an argument (aspect and tense). Predict these will bring about modifications of the type of the verbal complex:

- (58)
- a. John wrote a letter in an hour.
 - b. John wrote a letter for an hour.
 - c. John kissed Mary at 10 in the morning.
 - d. John kissed Mary for an hour.

On the other hand

Treating manner adverbials the way TCL treats nominal modifiers predicts that a verb or a VP can affect the type of the modifier:

(59) paint a miniature with a brush

(60) scrub the floor with a brush

Also predict that we can't pile on modifiers of the same type unless through coordination:

(61) hit the rock with a hammer with a bat

(62) hit the rock with a hammer and a bat

Other applications

- various coercions beyond the event kind
- aspectual coercion *John is being silly*
- loose talk (apparently non subsective modifiers like *wooden nickel*) or noun noun compounds like *sand castle*
- depictives (a sort of aspect introducer)
- resultatives
- nominalisations
- lexically generated, ordinary presuppositions of type T as a special case of type presuppositions