Prolegomenon to continuations

Handout 1

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Contents

1 Reading

- Chapter 1 of (Barker & Shan 2014).
  - If you have any questions, please feel free to send me them in advance of next week's class.
- Additional background: (Barker 2002)

2 Background

"Computational linguistics" is often taken to be a synonym for *NLP*, i.e., teaching computers how to understand and produce natural language.

Although this is a worthy enterprise, this is (arguably) of little direct relevance to theoretical linguistics.

In theoretical linguistics, we're interested in answering the question: *what do we know, when we know a language?*

In the context of formal semantics, this amounts to characterizing knowledge of *the conditions under which a sentence is true.*

In this class, we'll be doing "computational linguistics" in a different sense - we'll be applying insights from computer science (more narrowly, programming language theory) to linguistic phenomena.

Concretely, we'll apply techniques from the *functional programming* paradigm to phenomena in natural language semantics.

In compositional semantics, it is common to use the *Simply Typed Lambda Calculus* (STLC) in order to model composition (Carpenter 1998); see the technical primer.

2.1 Continuations (why bother?)

In the first block of this seminar, we're going to be investigating mechanisms via which meanings "get high".

To put this in a different way, expressions of natural language come with conventionalized meaning components. Often, meaning components end up interpreted in places that don't necessarily correspond to the pronounced position of the expression they're associated with.

Special cases of this include:

- Scope-taking (our focus for the first part of the seminar).
- Presupposition projection.
- Projective non-at-issue content (expressives, supplements, etc.).

We have fairly well-established techniques for dealing with these phenomena, e.g., quantifier raising for scope-taking (May 1977, Heim & Kratzer 1998).

Continuations provide a powerful abstraction for modeling meaning components getting high in a more general, uniform way.

This doesn't automatically make them preferable, but if we can get away with reducing our set of theoretical primitives while maintaining the same empirical coverage, we should at least pursue the possibility.

Continuations were originally developed/discovered by computer scientists in order to account for computations that are delayed until later on (see, e.g., (Danvy & Filinski 1992, Wadler 1994)). As such, they're especially well-suited to modelling meaning components whose evaluation is delayed.

We'll begin by following (Barker & Shan 2014), who develop an account of scope-taking in terms of continuations.

One of the *design features* of continuation semantics that will be of special interest to us is that it has a built in *left-to-right* bias. In other words, the *surface scope* reading of (1) involves a simpler computation than the inverse scope reading.

In other words:

(1) Exactly three philosophers have won every prize.

A related phenomenon that we'll discuss, is that the interaction between scope and anaphora exhibits a *leftness bias.*

(2) Every student^1's mother adores their$_1$ best friend.

(3) *Their$_1$ best friend adores every student^1's mother.

The contrast above is an example of a *weak crossover* violation (Postal 1971).

Roughly, weak crossover can be stated as follows: scope may feed binding *unless* the bound expressions precedes the scope-taker.

Continuation semantics has a fairly unique account of the contrast in (3), which we'll learn about in a couple of weeks time.

2.2 The plan

We're going to start by developing an understanding of the *tower notation* introduced by (Barker & Shan 2014), and its relationship with expressions of the STLC.

We'll get a handle on continuation semantics' built-in linear bias, encoded in the composition principles themselves.

We'll show how to account for scopal ambiguities via a combination of *lowering* and multi-story towers.

We'll also introduce the idea that *scope islands* can be analyzed in terms of obligatory evaluation.

3 From Montague lift to continuation semantics

Arguably, continuation semantics is in a certain sense *already implicit* in the inventory of type-shifters standardly assumed in formal semantics.

(4) $LIFTxk \;\; . \; k \; x$ $\qquad\qquad$ $LIFT : e\text{ß}(e\text{ß}t)\text{ß}t$

References

Barker, Chris. 2002. Continuations and the Nature of Quantification. *Natural Language Semantics* 10(3). 211–242. https://doi.org/10.1023/A:1022183511876 (28 January, 2020).

Barker, Chris & Chung-chieh Shan. 2014. *Continuations and natural language* (Oxford Studies in Theoretical Linguistics 53). Oxford University Press. 228 pp.

Carpenter, Bob. 1998. *Type-logical semantics* (Language, Speech, and Communication). Cambridge, Mass: MIT Press. 575 pp.

Danvy, Oliver & Andrzex Filinski. 1992. Representing Control: A Study of the CPS Transformation. *Mathematical Structures in Computer Science* 2(4). 361–391. https://www.cambridge.org/core/journals/mathematical-structures-in-computer-science/article/representing-control-a-study-of-the-cps-transformation/37193FD94F87443338FC7F519783FF0A (5 February, 2020).

Heim, Irene & Angelika Kratzer. 1998. *Semantics in generative grammar* (Blackwell Textbooks in Linguistics 13). Malden, MA: Blackwell. 324 pp.

May, Robert. 1977. *The grammar of quantification.* Massachussetts Institute of Technology dissertation.

Postal, Paul Martin. 1971. *Cross-over phenomena* (Transatlantic Series in Linguistics). New York: Holt, Rinehart and Winston. 262 pp.

Wadler, Philip. 1994. Monads and composable continuations. *LISP and Symbolic Computation* 7(1). 39–55. https://link.springer.com/article/10.1007/BF01019944.