Integrating compositional semantics and event semantics

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Preface

It is sometimes said that the marriage of (Neo-)Davidsonian event semantics and compositional semantics is an uneasy one. And indeed, in many implementations of event semantics, standard treatments of scope-taking elements such as quantifiers, negation, conjunctions, modals, the adverb *only*, etc. need to be complicated as compared to the simple accounts they get in semantics textbooks. A typical graduate Semantics I course will introduce students to the main idea and motivation of event semantics (say, adverbial modification, by reading Davidson (1967)), and will then go on to describe phenomena like quantification and negation in an event-free framework (say, by using the Heim and Kratzer (1998) textbook).

While specialists who wish to combine the two frameworks will know where to look for ideas (e.g. Krifka, 1989a; Landman, 2000; Beaver and Condoravdi, 2007), there are currently no published easy-to-use, off-the-shelf systems that put the two together, textbook-style. An aspiring semanticist might be discouraged by this situation, particularly when a given language or phenomenon that seems to be well-suited to event semantics also involves scope-taking elements that need to be analyzed in some way. For example, event semantics is a natural choice for a fieldworker who wishes to sketch a semantic analysis of a language without making commitments as to the relative hierarchical order of arguments or the argument-adjunct distinction. Yet the same fieldworker would face significant technical challenges before being able to also use such standard tools as generalized quantifier theory or classical negation when encountering quantifiers and negation.

This course aims to remedy this situation by presenting an implementation of Neo-Davidsonian event semantics that combines with standard treatments of scope-taking elements in a well-behaved way.

Course outline

- **Day 1** Introduction to event semantics, based on Davidson (1967), and of the classical compositional implementation, based on Carlson (1984) and Parsons (1990).

- **Day 2** Presentation of the system described in Champollion (2015), which focuses on scopal (as opposed to scopeless) interactions of quantifiers of arbitrary monotonicity. Detailed comparison of derivations of "John kissed every girl" in that system and in the classical compositional implementation.

- **Day 3** Other scope-taking elements in Champollion (2015): negation, aspectual adverbials, and conjunction.

- **Day 4** Review of algebraic semantics and mereology. Algebraic event semantics in Krifka (1989a).

- **Day 5** *Only* in standard event semantics: Bonomi and Casalegno (1993) and Beaver and Clark (2008). Lexically non-predetermined material posing problems for (Neo-)Davidsonian accounts of *only*. Treatment of *only* in Esipova and Champollion (2017).

Acknowledgments

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The content of Lecture 5 was presented at NELS 2018 in Iceland as Esipova and Champollion (2017), and we thank the audience there for helpful feedback.

Other important influences for these lecture notes include the work of Fred Landman, particularly Landman (1996, 2000); Godehard Link, particularly the collected papers in Link (1998); Manfred Krifka, particularly Krifka (1989a,b, 1992, 1998); and Bonomi and Casalegno (1993) and Beaver and Clark (2008).

Thanks to Maribel Romero, Josh Tauberer, and Dylan Bumford for their work on the Lambda Calculator (Champollion, Tauberer, and Romero, 2007), which was used to check the derivations and generate the LATEX code for the trees in these notes. The calculator is available at `http://www.lambdacalculator.com`.

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None of the people mentioned should be taken to necessarily agree with the content of these lecture notes. All errors are ours, and if you spot any, please drop us a line at `champollion@nyu.edu` and `masha.esipova@nyu.edu`.

These lecture notes are subject to change. Comments welcome!

Lucas Champollion and Masha Esipova, New York, June 18th, 2018

Note: These lecture notes are for the NASSLLI 2018 course and have been substantially extended and reworked since they were last used in 2014. For the ESSLLI 2014 lecture notes, see `http://ling.auf.net/lingbuzz/002143`.

Day 1

Introduction to event semantics

Today: Introduction to event semantics, based on Davidson (1967), and of the classical compositional implementation, based on Carlson (1984) and Parsons (1990).

1.1 Introduction

- Classical work in formal semantics, such as Montague (1974), represents the meaning of a verb with n syntactic arguments as an n-ary relation

- Davidson (1967) argued that verbs denote relations between events and their arguments; syntactic arguments are also arguments of the semantic predicate

- The neo-Davidsonian position (e.g. Castañeda, 1967; Carlson, 1984; Parsons, 1990; Krifka, 1992) relates the relationship between events and their arguments by thematic roles; syntactic arguments as well as modifiers are combined with the event via thematic roles

- There are also intermediate positions. Landman (1996) assumes that the lexical entry of a verb consists of an event predicate conjoined with one or more thematic roles. Kratzer (2000) argues that verbs denote relations between events and their themes.

Table 1.1: Approaches to verbal denotations

Position	Verbal denotation	Example: Brutus stabbed Caesar
Traditional	$\lambda y \lambda x[\mathbf{stab}(x,y)]$	$\mathbf{stab}(b,c)$
Classical Davidsonian	$\lambda y \lambda x \lambda e[\mathbf{stab}(e,x,y)]$	$\exists e[\mathbf{stab}(e,b,c)]$
Neo-Davidsonian	$\lambda e[\mathbf{stab}(e)]$	$\exists e[\mathbf{stab}(e) \wedge \mathbf{ag}(e,b) \wedge \mathbf{th}(e,c)]$
Landman (1996)	$\lambda y \lambda x \lambda e[\mathbf{stab}(e) \wedge \mathbf{ag}(e,x) \wedge \mathbf{th}(e,y)]$	$\exists e[\mathbf{stab}(e,b,c)]$
Kratzer (2000)	$\lambda y \lambda e[\mathbf{stab}(e,y)]$	$\exists e[\mathbf{ag}(e,b) \wedge \mathbf{stab}(e,c)]$

1.2 Events: Some ontological assumptions

- Events are things like Jones' buttering of the toast, Brutus' stabbing of Caesar.

- Events may be taken to form a mereology, so they include plural events (Bach, 1986; Krifka, 1998). This will be the topic of Day 2.

- An event can have both a temporal extent and a spatial extent, so it can be multi-dimensional, unlike intervals, which by definition are always one-dimensional.

- Events are usually thought to have temporal parts (subevents which occupy less time). It is controversial whether individuals also do (e.g. John doesn't exist at time t, only John's-time-slice-at-t does) or whether they are always wholly present at each moment in time (Markosian, 2009). Most semanticists seem to assume the latter.

- Some authors treat events as built from atoms (Landman, 2000), others distinguish between count and mass events (Mourelatos, 1978). With mereology, we need not decide (Krifka, 1998).

- Some authors also include states (e.g. John's being asleep) as events. Others use *event* more narrowly as opposed to states.

  - Do stative sentences have an underlying event (Parsons, 1990, ch. 10)? Maybe individual-level predicates don't (Kratzer, 1995)?

1.3   Event semantics and verbal modifiers

- Verbs have an implicit event argument

(1) $[\![\text{stab}]\!] = \lambda y \lambda x \lambda e[\textbf{stab}(e, x, y)]$

- Verbal modifiers apply to the same event variable

(2)   a. $[\![\text{at noon}]\!] = \lambda e[\textbf{time}(e, \textbf{noon})]$
         b. $[\![\text{in the forum}]\!] = \lambda e[\textbf{loc}(e, \iota x.\textbf{forum}(x))]$

- The event argument is bound by existential closure

(3) $[\![\text{Brutus stabbed Caesar}]\!] = \exists e[\textbf{stab}(e, \textbf{brutus}, \textbf{caesar})]$

- (Arguments and) modifiers are additional conjuncts

(4) $[\![\text{Brutus stabbed Caesar at noon}]\!] = \exists e[\textbf{stab}(e, \textbf{brutus}, \textbf{caesar}) \wedge \textbf{time}(e, \textbf{noon})]$

1.4   Thematic roles

- Thematic roles represent ways entities take part in events (Parsons, 1990; Dowty, 1991)

- Two common views:

    - Traditional view: thematic roles encapsulate generalizations over shared entailments of argument positions in different predicates (e.g. Gruber, 1965)
        * *agent* (initiates the event, or is responsible for the event)
        * *theme* (undergoes the event)
        * *instrument* (used to perform an event)
        * sometimes also *location* and *time*

    - Alternative view: thematic roles as verb-specific relations: Brutus is not the agent of the stabbing event but the stabber (Marantz, 1984).

- No consensus on the inventory of thematic roles, but see Levin (1993) and Kipper-Schuler (2005) for a wide-coverage role lists of English verbs

Questions:

- Do thematic roles have syntactic counterparts, the theta roles (something like silent prepositions)? Generative syntax says yes at least for the external argument: the "little v" head (Chomsky, 1995). See also the applicative heads of Pylkkänen (2008).

- Does each verbal argument correspond to exactly one role (Chomsky, 1981) or is the subject of a verb like *fall* both its agent and its theme (Parsons, 1990)?

- Thematic uniqueness / Unique Role Requirement: Does each event have at most one agent, at most one theme etc. (widely accepted in semantics, see Carlson (1984, 1998), Parsons (1990), and Landman (2000)) or no (Krifka (1992): one can touch both a man and his shoulder in the same event)?

1.5   Advantages of the Neo-Davidsonian approach

Davidson (1967), Castañeda (1967), Carlson (1984), Parsons (1990), and Landman (2000)

- Makes it easier to state generalizations across the categories of nouns and verbs, and to place constraints on thematic roles

- Good for formulating analyses without committing to an argument/adjunct distinction

- Lends itself to a natural compositional process in terms of intersection with an existential quantifier at the end (Carlson, 1984). Similarly in Parsons (1990, 1995).

(5)   a. $[\![\text{agent}]\!] = \lambda x \lambda e[\mathbf{ag}(e) = x]$
       b. $[\![\text{theme}]\!] = \lambda x \lambda e[\mathbf{th}(e) = x]$
       c. $[\![\text{stab}]\!] = \lambda e[\mathbf{stab}(e)]$

    d. $[\![$[ag] Brutus$]\!]$ = $\lambda e[\mathbf{ag}(e) = \mathbf{brutus}]$

    e. $[\![$[th] Caesar$]\!]$ = $\lambda e[\mathbf{ag}(e) = \mathbf{caesar}]$

    f. $[\![$Brutus stab Caesar$]\!]$ = (5c) $\cap$ (5d) $\cap$ (5e)   (sentence radical)

    g. $[\![$Brutus stabbed Caesar$]\!]$ = $\exists e. e \in$ (5c) $\cap$ (5d) $\cap$ (5e)   (full sentence)

- This has been elevated to a principle, *conjunctivism*, in Pietroski (2005, 2006).

1.6   Diamond entailments

- Diamond entailments are perhaps the strongest argument for event semantics.

(6)   a.   Brutus stabbed Caesar on the forum at noon.

        b.   Brutus stabbed Caesar on the forum.

        c.   Brutus stabbed Caesar at noon.

        d.   Brutus stabbed Caesar.

Exercise 1.1 What are the entailment relations between these sentences? Why do you think this is called a diamond entailment? □

- Capturing diamond entailments, classical Davidsonian style:

(8)   Brutus stabbed Caesar on the forum at noon
    $\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar}) \wedge \mathbf{loc}(e) = \mathbf{forum} \wedge \mathbf{time}(e) = \mathbf{noon}]$

(9)   Brutus stabbed Caesar on the forum
    $\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar}) \wedge \mathbf{loc}(e) = \mathbf{forum}]$

(10)   Brutus stabbed Caesar at noon
    $\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar}) \wedge \mathbf{time}(e) = \mathbf{noon}]$

(11)   Brutus stabbed Caesar
    $\exists e[\mathbf{stabbing}(e, \mathbf{brutus}, \mathbf{caesar})]$

- Capturing the same entailments, Neo-Davidsonian style:

(12)   Brutus stabbed Caesar on the forum at noon
    $\exists e[\mathbf{ag}(e) = \mathbf{brutus} \wedge \mathbf{stabbing}(e) \wedge \mathbf{th}(e) = \mathbf{caesar} \wedge \mathbf{loc}(e) = \mathbf{forum} \wedge \mathbf{time}(e) = \mathbf{noon}]$

(13)   Brutus stabbed Caesar on the forum
    $\exists e[\mathbf{ag}(e) = \mathbf{brutus} \wedge \mathbf{stabbing}(e) \wedge \mathbf{th}(e) = \mathbf{caesar} \wedge \mathbf{loc}(e) = \mathbf{forum}]$

(14)   Brutus stabbed Caesar at noon
    $\exists e[\mathbf{ag}(e) = \mathbf{brutus} \wedge \mathbf{stabbing}(e) \wedge \mathbf{th}(e) = \mathbf{caesar} \wedge \mathbf{time}(e) = \mathbf{noon}]$

(15)   Brutus stabbed Caesar
        $\exists e[\mathbf{ag}(e) = \mathbf{brutus} \land \mathbf{stabbing}(e) \land \mathbf{th}(e) = \mathbf{caesar}]$

- Diamond entailments in downward entailing environments:

(16)   a.   Nobody stabbed Caesar on the forum at noon.
        b.   Nobody stabbed Caesar on the forum.
        c.   Nobody stabbed Caesar at noon.
        d.   Nobody stabbed Caesar.

(17)   a.   Brutus did not stab Caesar on the forum at noon.
        b.   Brutus did not stab Caesar on the forum.
        c.   Brutus did not stab Caesar at noon.
        d.   Brutus did not stab Caesar.

Exercise 1.2 What are the entailment relations between the sentences in (16)? What are the entailment relations between the sentences in (17)? How can they be represented using logical formulas like the ones above? □

1.7   Other applications of event semantics

- Antecedents for anaphoric expressions like pronouns, and referents for definite descriptions and the like:

(22)   a.   Jones did it slowly, deliberately, in the bathroom, with a knife, at midnight. What he did was butter a piece of toast. (Davidson, 1967)
        b.   After the singing of the Marseillaise they saluted the flag. (Parsons, 1990)

- Explicit quantification over events (Parsons, 1990):

(23)   a.   In every burning, oxygen is consumed.
        b.   Agatha burned the wood.
        c.   Therefore, oxygen was consumed.

- Perceptual reports (Higginbotham, 1983), as an alternative to situation semantics:

(24)   John saw Mary leave.

- The semantic relation between adjectives (*violent*) and adverbs (*violently*) (Parsons, 1990):

(25)   a.   Brutus stabbed Caesar violently.
        b.   There was something violent.

- The semantic relation between gerunds and verbs (Parsons, 1990)

(26)   a.   They sang the song.
        b.   the singing of the song

- Various semantic relations between causatives and their intransitive counterparts (Parsons, 1990)

(27)   a.   Mary felled the tree.
        b.   The tree fell.

(28)   a.   Mary opened the door.
        b.   The door opened.

- Aspectual phenomena and measurement (Krifka, 1998; Champollion, 2010, 2017)

(29)   a.   three liters of water
        b.   three hours of running
        c.   run for three hours

1.8   Recommended background reading

All recommended readings are available via the shared folder.

- Davidson (1967), Parsons (1990), Carlson (1984), and Landman (2000, lecture 1)

- Overview articles for event semantics: Eckardt (2002) and Maienborn (2011)

- For the next lecture: Champollion (2015).

Exploring the derivations interactively

From Day 2 on, all derivations will be available for interactive viewing in the Lambda Calculator (Champollion, Tauberer, and Romero, 2007), a pedagogical software application that allows step-by-step viewing and computing of semantic derivations in the typed λ calculus in a user-friendly, graphics-based environment that provides interactive feedback. All derivations in this document have been checked for correctness with the help of this program, and the figures have been generated with it. The calculator can be downloaded at `http://www.lambdacalculator.com`. A file that implements the semantic fragment described in this proposal is available at `http://www.nyu.edu/projects/champollion/events-calculatorfile.txt`. Readers who would like to experiment with the fragment can easily edit this file with a regular text editor. Instructors who would like to view the fragment are recommended to use the "teacher edition" of the calculator, which allows the user to step through derivations automatically. Please send requests to `champollion@nyu.edu`.

Day 2

Quantification and event semantics

Today: A closer look at how quantification interacts with event semantics. Presentation of the system described in Champollion (2011, 2015), which focuses on scopal interactions of quantifiers.

2.1   Introduction

- Quantifiers + event semantics = a happy marriage?

- Beaver and Condoravdi (2007): NO
  "In Davidsonian Event Semantics the analysis of quantification is problematic: either quantifiers are treated externally to the event system and quantified in (cf. Landman, 2000), or else the definitions of the quantifiers must be greatly (and non-uniformly) complicated (cf. Krifka, 1989a)"

- Note: Landman (2000) is an extended version of Landman (1996), which we have seen on Day 2. The "external treatment" refers to the NQI and SQI operations, which B & C consider problematic. We'll take a closer look at Krifka (1989a) on Day 5.

- Eckardt (2010): NO
  "The semantic composition of even a simple sentence like *John likes most Fellini movies* requires quantifier raising, interpreted traces, coindexing, and lambda abstraction."

- Champollion (2011, 2015): YES!

- If you're a syntactician, or if you're a semanticist who is used to covert movement, and if you're working on a language where there's independent evidence for covert syntactic movement, none of these assumptions might seem particularly bothersome. But if for whatever reason you want to avoid quantifier raising, interpreted traces, coindexing, lambda abstraction, or partial reconstruction, there is a simple way to do so. This is the topic of today's lecture.

- Previous implementations of the Neo-Davidsonian program, including those we have seen so far, require a syntactic treatment of quantifier scope, i.e. covert movement such as quantifying-in or quantifier raising.

- Situating this analysis:

	No Events	Events
Syntactic Quantifier Scope	e.g. May (1985)	e.g. Landman (2000)
Semantic Quantifier Scope	e.g. Hendriks (1993)	*this presentation*

- Syntactic approaches to QR are widespread, but they are sometimes seen as problematic:

  - Some authors view QR per se as complex and cumbersome (e.g. Eckardt, 2010)

  - QR entails the presence of a representational level (Logical Form) because quantifier movement happens covertly. As such, it is not directly compositional (Jacobson, 1999; Barker, 2002). Simply put, "direct compositionality" means WYSIWYG—the syntax and the semantics work in tandem, and there is no mapping of syntactic derivations to a distinguished level of Logical Form.

  - Positing quantifier raising is problematic for languages in which surface scope determines semantic scope completely: additional stipulations are then needed to explain why quantifiers conspire to keep their relative order after they are raised.

- **Problem:** Can we keep the advantages of event semantics without committing ourselves to a representational view?

- **Solution:** This account relies on type shifting and will not require any covert movement.

2.2   Combining event semantics and quantification

- **Generalization:** The event quantifier always takes lowest possible scope with respect to other quantifiers

(1)   No dog barks.

(2)   a. $\neg\exists x[\mathbf{dog}(x) \wedge \exists e[\mathbf{bark}(e) \wedge \mathbf{ag}(e, x)]]$ No $>> \exists e$
               "There is no barking event that is done by a dog"
         b.   *$\exists e[\neg\exists x[\mathbf{dog}(x) \wedge \mathbf{bark}(e) \wedge \mathbf{ag}(e, x)]]$ *$\exists e >>$ No
               "There is an event that is not a barking by a dog"

- Perhaps (2b) is ruled out because it is trivial. That still leaves us with accounting for the possibility of (2a).

- Even with respect to fixed scope operators like negation, the event quantifier always seems to take low scope:

(3)   Spot didn't bark.
         a.   ="There is no event in which Spot barks"

  b. $\neq$"There is an event in which Spot did not bark"

- Independent motivation for the Scope Domain Principle:

- Unique Role Requirement: if a thematic role is specified for an event, it is uniquely specified. Thematic roles are partial functions from events to individuals.

(4) Every dog barks.

(5) a. $\forall x[\mathbf{dog}(x) \to \exists e[\mathbf{bark}(e) \wedge \mathbf{ag}(e) = x]]$ Every $>> \exists e$
      "For every dog there is a barking event that it did"
  b. *$\exists e \forall x[\mathbf{dog}(x) \to [\mathbf{bark}(e) \wedge \mathbf{ag}(e) = x]]$ *$\exists e >>$ Every
      "There is a barking event that was done by every dog"

- Example (5b) violates the Scope Domain Principle. It also violates the Unique Role Requirement as long as there is more than one dog.

- An event semantic derivation is shown in Fig. 2.1. (This follows Kratzer (1996) and would look similar in Landman (2000).)

IP
$\exists e.\mathbf{bark}(e) \wedge \mathbf{ag}(e, \mathbf{spot})$

[existential closure]
$\lambda V.\exists e[V(e)]$

VoiceP
$\lambda e.\mathbf{bark}(e) \wedge \mathbf{ag}(e, \mathbf{spot})$

DP
|
Spot
spot

Voice'
$\lambda x \lambda e.\mathbf{bark}(e) \wedge \mathbf{ag}(e, x)$

[agent]
$\lambda x \lambda e.\mathbf{ag}(e, x)$

VP
|
barks
$\lambda e.\mathbf{bark}(e)$
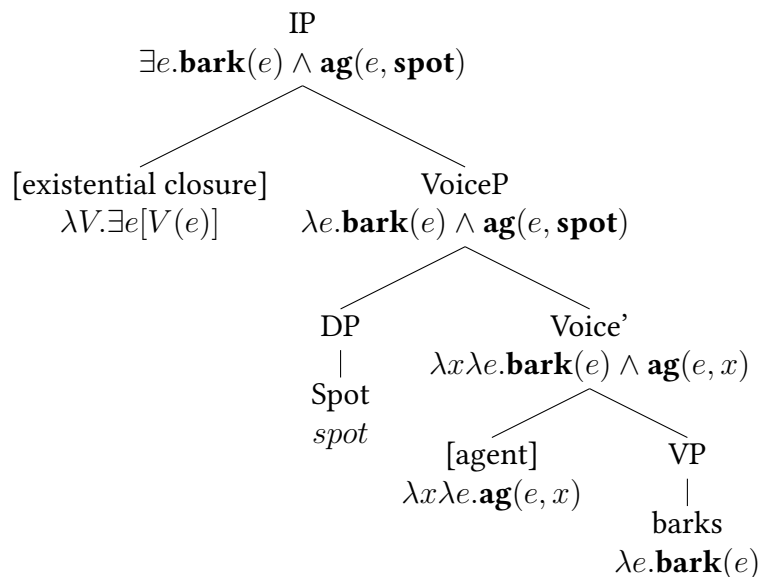
Figure 2.1: "Spot barks"

- Functional heads introduce thematic roles (for Kratzer (1996) only the agent role)

- Kratzer (1996) invents an "event identification" rule that combines the Voice head (*agent*) with the VP.

(6) f: $\langle e, vt \rangle$ g: $\langle vt \rangle$ $\Rightarrow$ h : $\langle e, vt \rangle$
      $\lambda x \lambda e.\mathbf{ag}(e, x)$ $\lambda e.\mathbf{bark}(e)$ $\lambda x \lambda e.\mathbf{ag}(e, x) \wedge \mathbf{bark}(e)$
      (Kratzer's event identification rule)

- This rule can of course also be expressed as a silent operator:

(7) $[\![\text{EVENT-ID}]\!] = \lambda f_{\langle e,vt\rangle}.\lambda g_{\langle vt\rangle}.\lambda x.\lambda e.[g(e) \wedge f(x)(e)]$

- I won't go this route, and instead stay with Kratzer (1996) (or alternatively, suppress the presence of this operator in the trees). Nothing essential depends on this.

- Existential closure binds the event variable at the end.

- Problem: To give quantificational arguments scope above the event quantifier, the standard analysis requires quantifier raising and therefore a syntactic level of representation (LF) distinct from surface order. So no WYSIWYG, no direct compositionality.

- This is shown in Fig. 2.2: the quantifier is displaced compared with surface order.

$\neg\exists x[\textbf{dog}(x) \wedge \exists e[\textbf{bark}(e) \wedge \textbf{ag}(e,x)]$

DP $\lambda x\exists e.\textbf{bark}(e) \wedge \textbf{ag}(e,x)$

no dog   1   IP
$\lambda P.\neg\exists x[\textbf{dog}(x) \wedge P(x)]$ $\exists e.\textbf{bark}(e) \wedge \textbf{ag}(e,g(1))$

[existential closure]   VoiceP
$\lambda V.\exists e[V(e)]$ $\lambda e.\textbf{bark}(e) \wedge \textbf{ag}(e,g(1))$

DP   Voice'
| $\lambda x\lambda e.$
t_1 $\textbf{bark}(e)$
$\wedge\, \textbf{ag}(e,x)$

[agent]   VP
$\lambda x\lambda e.\textbf{ag}(e,x)$ |
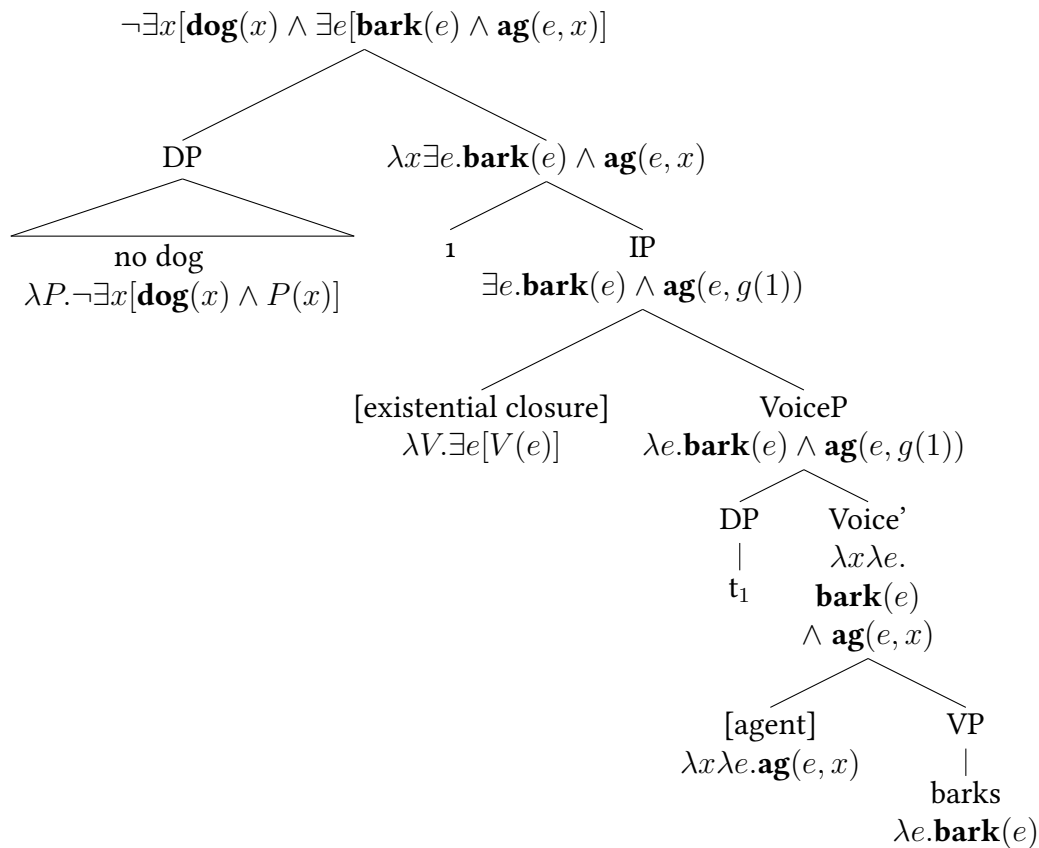barks
$\lambda e.\textbf{bark}(e)$

Figure 2.2: "No dog barks", with quantifier raising

2.3   The framework in Champollion (2014)

- **Shift (in typing/thinking):** Think of a verb V as being true of any set that contains a Ving event (instead of denoting the set of all Ving events). Not only verbs but all their projections

hold of sets of events. So a VP like "kiss Mary" is true of any set that contains a kissing event whose theme is Mary, and so on up the sentence.

(8)   a.   Old Neo-Davidsonian approach: $[\![\text{kiss}]\!] = \lambda e.\textbf{kiss}(e)$

       b.   This approach: $[\![\text{kiss}]\!] = \lambda f_{\langle vt \rangle}.\exists e.\textbf{kiss}(e) \wedge f(e)$

           (derivable from (8a) by Partee (1987)'s type-shifting principle A; other inspirations: existential closure, bare plurals, continuation semantics)

(9) $[\![\text{kiss Mary}]\!] = \lambda f.\exists e.\textbf{kiss}(e) \wedge f(e) \wedge \textbf{th}(e) = \textbf{mary}$

- Start with a verb and successively apply its arguments and adjuncts to it, as in event semantics. But the verb is now of type $\langle vt, t \rangle$ (where v is the type of events)

- Compared to syntactic approaches, putting existential closure into the lexical entry of the verb will automatically derive the fact that all other quantifiers always have to take scope above existential closure.

- Every argument/adjunct is a function from $\langle vt, t \rangle$ to $\langle vt, t \rangle$.

(10) $[\![\text{Mary [th]}]\!] = \lambda V.\lambda f.V(\lambda e.f(e) \wedge \textbf{th}(e) = \textbf{mary})$

- On the old approach, a verb phrase had to apply to an event, but there was no single event to which a verb phrase like "kiss every girl" could apply. Now, "kiss every girl" applies to any set of events that contains a potentially different kissing event for every girl. Noun phrases can retain their usual analysis as quantifiers over individuals.

(11) $[\![\text{kiss every girl}]\!] = \lambda f.\forall x.\textbf{girl}(x) \rightarrow \exists e.\textbf{kiss}(e) \wedge f(e) \wedge \textbf{th}(e) = x$

- Noun phrases can retain their usual analysis as quantifiers over individuals. I assume that proper names are Montague-lifted to that type.

(12)   a. $[\![\text{every girl}]\!] = \lambda P.\forall x.\textbf{girl}(x) \rightarrow P(x)$

       b. $[\![\text{John}]\!] = \lambda P.P(\textbf{john})$

- For a basic illustration, see Figure 2.3 ("John kissed every girl").

- We can handle scopal ambiguities in situ by type shifting the thematic roles (Figures 2.4 and 2.5)

- Every argument/adjunct filters out those event types that don't conform to its denotation (as in event semantics)

  - This also includes quantifiers: no QR, only in-situ application

- At the end you apply (13) to get a truth value.

(13) $[\![\text{closure}]\!] = \lambda e.\text{true}$ Alternative: $[\![\text{closure}]\!] = \lambda e.e \in s_{topic}$

This is different from existential closure: it asserts that the predicate is true of the set of all events. (Intuitively, one might think of the world as the set of all events that exist. The operator asserts that the sentence is true of the world.) Or we could use quantifier domain restriction to events in the topic situation.

2.4   Recommended background reading

- For the system presented today: Champollion (2015). See also Coppock and Champollion (2017), Section 10.3.2 and onwards, for an easy introduction.

- For the next lecture: Champollion (2015), continued.

IP : t
$\forall x[\mathbf{girl}(x) \rightarrow$
$\exists e[\mathbf{kiss}(e) \wedge \mathbf{ag}(e) = \mathbf{john} \wedge \mathbf{th}(e) = x]]$

[closure] : vt
$\lambda e.\mathbf{true}$

IP : $\langle vt, t\rangle$
$\lambda f.\forall x[\mathbf{girl}(x) \rightarrow$
$\exists e[\mathbf{kiss}(e) \wedge f(e) \wedge \mathbf{ag}(e) = \mathbf{john} \wedge \mathbf{th}(e) = x]]$

DP : $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$
$\lambda V.\lambda f.V(\lambda e.[f(e) \wedge \mathbf{ag}(e) = \mathbf{john}])$

VP : $\langle vt, t\rangle$
$\lambda f.\forall x[\mathbf{girl}(x) \rightarrow$
$\exists e[\mathbf{kiss}(e) \wedge f(e) \wedge \mathbf{th}(e) = x]]$

john : $\langle et, t\rangle$
$\lambda P.P(\mathbf{john})$

[ag] : $\langle\langle et, t\rangle,$
$\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle\rangle$
$\lambda Q.\lambda V.\lambda f.$
$Q(\lambda x.V(\lambda e.[f(e)$
$\wedge\mathbf{ag}(e) = x]))$

kissed : $\langle vt, t\rangle$
$\lambda f.\exists e[\mathbf{kiss}(e) \wedge f(e)]$

DP : $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$
$\lambda V.\lambda f.\forall x[\mathbf{girl}(x) \rightarrow$
$V(\lambda e.[f(e) \wedge \mathbf{th}(e) = x])]$

every girl :
$\lambda P.\forall x[\mathbf{girl}(x) \rightarrow P(x)]$

[th] : $\langle\langle et, t\rangle,$
$\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle\rangle$
$\lambda Q.\lambda V.\lambda f.$
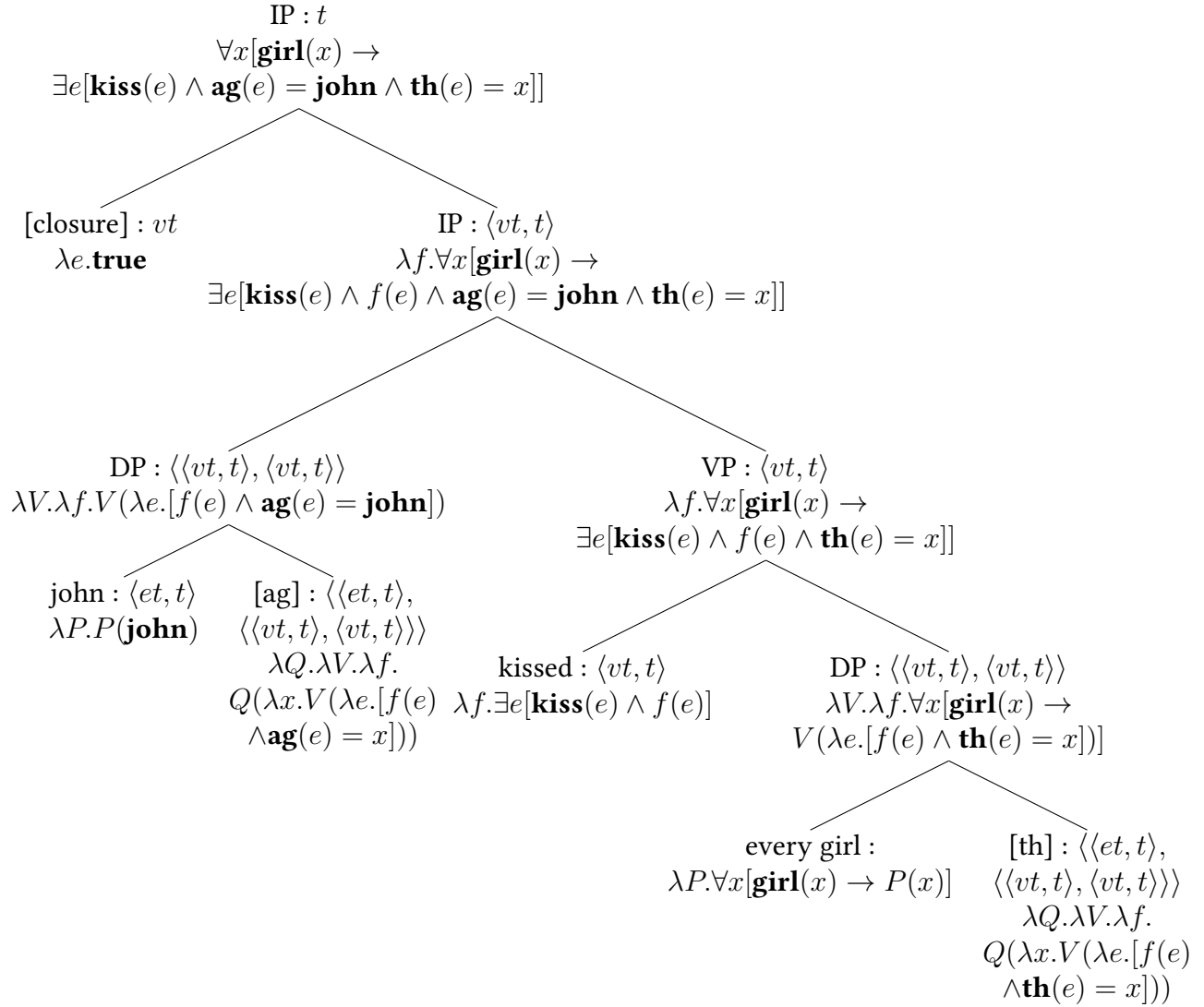$Q(\lambda x.V(\lambda e.[f(e)$
$\wedge\mathbf{th}(e) = x]))$

Figure 2.3: Illustration of the framework in Champollion (2011, 2015), using the sentence "John kissed every girl."

IP : t
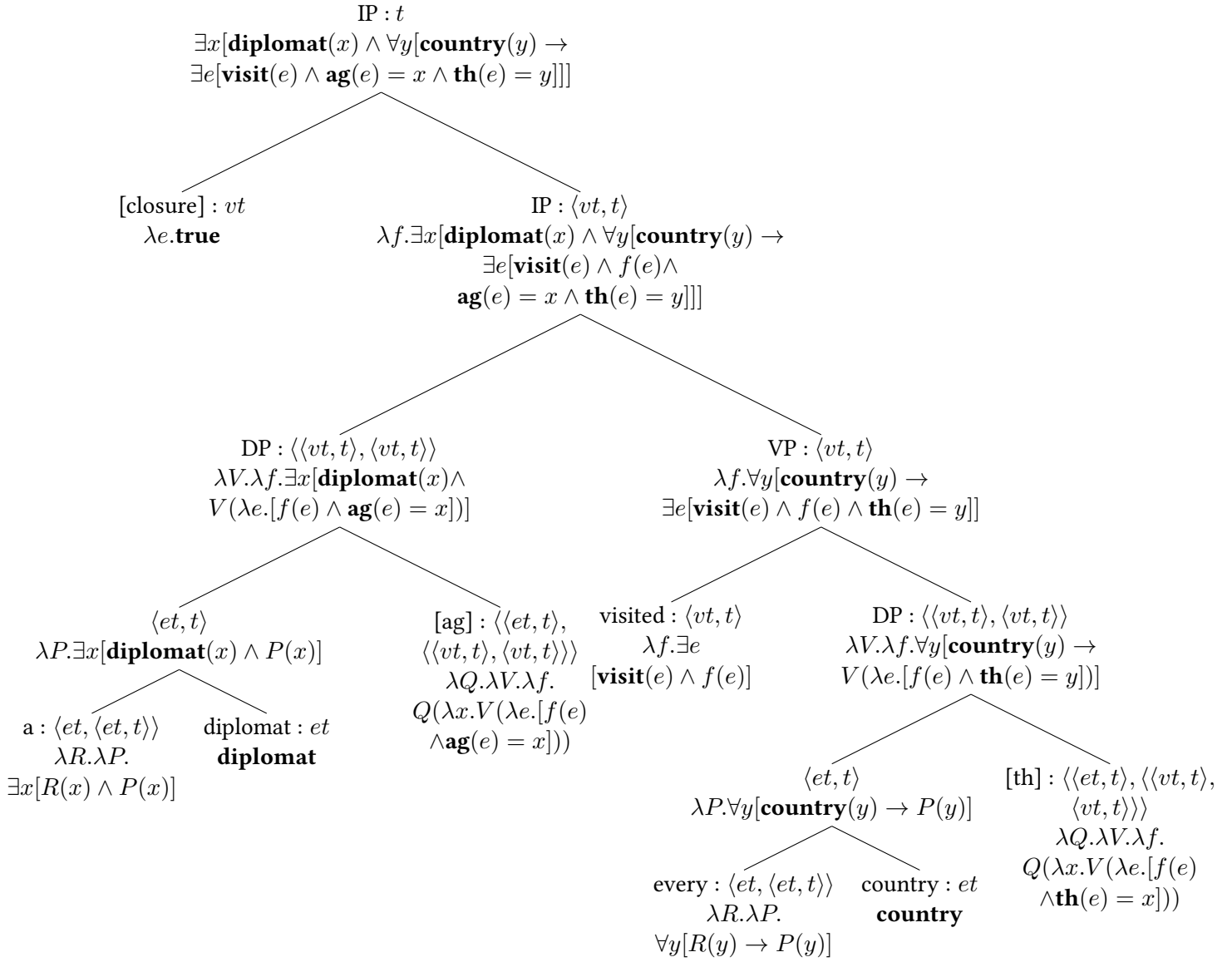$\exists x[\mathbf{diplomat}(x) \wedge \forall y[\mathbf{country}(y) \rightarrow$
$\exists e[\mathbf{visit}(e) \wedge \mathbf{ag}(e) = x \wedge \mathbf{th}(e) = y]]]$

[closure] : vt
$\lambda e.\mathbf{true}$

IP : $\langle vt, t \rangle$
$\lambda f.\exists x[\mathbf{diplomat}(x) \wedge \forall y[\mathbf{country}(y) \rightarrow$
$\exists e[\mathbf{visit}(e) \wedge f(e) \wedge$
$\mathbf{ag}(e) = x \wedge \mathbf{th}(e) = y]]]$

DP : $\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle$
$\lambda V.\lambda f.\exists x[\mathbf{diplomat}(x) \wedge$
$V(\lambda e.[f(e) \wedge \mathbf{ag}(e) = x])]$

VP : $\langle vt, t \rangle$
$\lambda f.\forall y[\mathbf{country}(y) \rightarrow$
$\exists e[\mathbf{visit}(e) \wedge f(e) \wedge \mathbf{th}(e) = y]]$

$\langle et, t \rangle$
$\lambda P.\exists x[\mathbf{diplomat}(x) \wedge P(x)]$

[ag] : $\langle \langle et, t \rangle,$
$\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle \rangle$
$\lambda Q.\lambda V.\lambda f.$
$Q(\lambda x.V(\lambda e.[f(e)$
$\wedge \mathbf{ag}(e) = x]))$

visited : $\langle vt, t \rangle$
$\lambda f.\exists e$
$[\mathbf{visit}(e) \wedge f(e)]$

DP : $\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle$
$\lambda V.\lambda f.\forall y[\mathbf{country}(y) \rightarrow$
$V(\lambda e.[f(e) \wedge \mathbf{th}(e) = y])]$

a : $\langle et, \langle et, t \rangle \rangle$
$\lambda R.\lambda P.$
$\exists x[R(x) \wedge P(x)]$

diplomat : et
$\mathbf{diplomat}$

$\langle et, t \rangle$
$\lambda P.\forall y[\mathbf{country}(y) \rightarrow P(y)]$

[th] : $\langle \langle et, t \rangle, \langle \langle vt, t \rangle,$
$\langle vt, t \rangle \rangle \rangle$
$\lambda Q.\lambda V.\lambda f.$
$Q(\lambda x.V(\lambda e.[f(e)$
$\wedge \mathbf{th}(e) = x]))$

every : $\langle et, \langle et, t \rangle \rangle$
$\lambda R.\lambda P.$
$\forall y[R(y) \rightarrow P(y)]$

country : et
$\mathbf{country}$

Figure 2.4: A diplomat visited every country (surface scope)

IP : t
$\forall y[\textbf{country}(y) \rightarrow \exists x[\textbf{diplomat}(x) \land$
$\exists e[\textbf{visit}(e) \land \textbf{th}(e) = y \land \textbf{ag}(e) = x]]]$

[closure] : vt
$\lambda e.\textbf{true}$

IP : $\langle vt, t\rangle$
$\lambda f.\forall y[\textbf{country}(y) \rightarrow$
$\exists x[\textbf{diplomat}(x) \land$
$\exists e[\textbf{visit}(e) \land f(e) \land \textbf{th}(e) = y$
$\land\textbf{ag}(e) = x]]]$

DP : $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$
$\lambda V.\lambda f.$
$\exists x[\textbf{diplomat}(x) \land$
$V(\lambda e.[f(e) \land \textbf{ag}(e) = x])]$

VP : $\langle\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle, \langle vt, t\rangle\rangle$
$\lambda M.\lambda f.\forall y[\textbf{country}(y) \rightarrow$
$(M(\lambda f.\exists e[\textbf{visit}(e) \land f(e)])$
$(\lambda e.[f(e) \land \textbf{th}(e) = y]))]$

$\langle et, t\rangle$
$\lambda P.\exists x$
$[\textbf{diplomat}(x) \land P(x)]$

[ag] : $\langle\langle et, t\rangle,$
$\langle\langle vt, t\rangle,$
$\langle vt, t\rangle\rangle\rangle$
$\lambda Q.\lambda V.\lambda f.$
$Q(\lambda x.V(\lambda e.[f(e)$
$\land\textbf{ag}(e) = x]))$

visited : $\langle vt, t\rangle$
$\lambda f.\exists e[\textbf{visit}(e)$
$\land f(e)]$

DP : $\langle\langle vt, t\rangle, \langle\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle, \langle vt, t\rangle\rangle\rangle$
$\lambda V.\lambda M.\lambda f.$
$\forall y[\textbf{country}(y) \rightarrow$
$(M(V)(\lambda e.[f(e) \land \textbf{th}(e) = y]))]$

a :
$\langle et, \langle et, t\rangle\rangle$
$\lambda R.\lambda P.$
$\exists x[R(x)$
$\land P(x)]$

diplomat : et
$\textbf{diplomat}$

$\langle et, t\rangle$
$\lambda P.\forall x$
$[\textbf{country}(y) \rightarrow P(y)]$

[th-lift] : $\langle\langle et, t\rangle, \langle\langle vt, t\rangle,$
$\langle\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle, \langle vt, t\rangle\rangle\rangle\rangle$
$\lambda Q.\lambda V.\lambda M.\lambda f.$
$Q(\lambda x.[M(V)$
$(\lambda e.[f(e) \land \textbf{th}(e) = x])])$

every : $\langle et, \langle et, t\rangle\rangle$
$\lambda R.\lambda P.$
$\forall x[R(y) \rightarrow P(y)]$

country : et
$\textbf{country}$

Figure 2.5: A diplomat visited every country (inverse scope)

Day 3

Negation and conjunction in event semantics

Today: Other scope-taking elements in Champollion (2011, 2015): negation, aspectual adverbials, and coordination.

3.1 Negation

- Like other verbal modifiers, we can give negation the semantic type $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$.

- Negation has been considered particularly difficult for event semantics because it leads to apparent scope paradoxes (Krifka, 1989a).

- *For*-adverbials can take scope both above negation and below it (Smith, 1975):

  (1)   John didn't laugh for two hours.
         a.   For two hours, it was not the case that John laughed.
         b.   It was not the case that John laughed for two hours.

- We have seen earlier that negation always takes scope above the event quantifier.

  (2)   No dog barks.

  (3)   a. $\neg\exists x[\mathbf{dog}(x) \wedge \exists e[\mathbf{bark}(e) \wedge \mathbf{ag}(e) = x]]$ No $>> \exists e$
               "There is no barking event that is done by a dog"
         b.   *$\exists e[\neg\exists x[\mathbf{dog}(x) \wedge \mathbf{bark}(e) \wedge \mathbf{ag}(e) = x]]$ *$\exists e >>$ No
               "There is an event that is not a barking by a dog"

- So in (1a), the *for*-adverbial must take scope above the event quantifier.

- So if the event quantifier is introduced at the sentential level, the *for*-adverbial must be able to take scope there.

- But this is a controversial assumption, and there is no consensus on whether *for*-adverbials attach above or below the subject (Rathert, 2004).

- Krifka (1989a) wants the *for*-adverbial to be able to attach below the subject. We have seen that the *for*-adverbial can take scope above negation.

- Given that the event quantifier is introduced above the subject, Krifka concludes that negation takes scope under the event quantifier.

- Given the background assumption that *for*-adverbials do not take scope at the sentential level, this is necessary in order to explain why *for*-adverbials take scope both above and below negation.

- One of the premises of the scope dilemma—the assumption that the event quantifier takes scope at the sentential level—is missing from our system.

- Even if the *for*-adverbial never takes scope at the sentential level, we are not forced to conclude that negation takes scope under the event quantifier.

- We can formulate the meaning of *not* in terms of logical negation, without fusions.

(4) $[\![\text{not}]\!] = \lambda V \lambda f \neg V(\lambda e[f(e)])$

(5)   John did not laugh.
    a. $[_{\text{CP}}$ [closure] $[[_{\text{DP}}$ john [ag]] $[_{\text{VP}}$ did not laugh]]]
    b. $\neg \exists e[\textbf{laugh}(e) \wedge \textbf{ag}(e) = \textbf{john}]$

- Let us now add an anaphoric treatment of tense to restrict the translation to the reference time (written $t_\textbf{r}$), as Krifka does.

(6) $[\![[\text{past-closure}]]\!]$
        $= \lambda V[t_\textbf{r} \ll \textbf{now} \ \wedge \ V(\lambda e[\tau(e) \subseteq t_\textbf{r}])]$

- Note that $t_\textbf{r} \ll \textbf{now}$ is not in the scope of V, so tense always has widest scope.

- The following translation generates the desired readings for (1).

(7) $[\![\text{for two hours}]\!]$
        $= \lambda V \lambda f \exists t[\textbf{hours}(t) = 2 \wedge t \subseteq t_\textbf{r}$
        $\wedge \forall t'[t' \subseteq t \to V(\lambda e[f(e) \wedge \tau(e) = t'])]]$

- My analyses of (1a) and (1b) are shown in (8) and (9) respectively. Figures 3.1 and 3.2 show these derivations in detail.

- In both sentences, the *for*-adverbial takes scope at VP level.

(8)   a.   For two hours, it was not the case that John laughed.

b. $[_{\text{CP}} [[_{\text{DP}} \text{john [ag]}] [_{\text{VP}} [_{\text{VP}} \text{did not laugh }] [_{\text{PP}} \text{for 2 hours}]]]]$

c. $t_{\mathbf{r}} \ll \mathbf{now} \wedge \exists t[\mathbf{hours}(t) = 2 \wedge t \subseteq t_{\mathbf{r}} \wedge \forall t'[t' \subseteq t \rightarrow \neg \exists e[\mathbf{laugh}(e) \wedge \mathbf{ag}(e) = \mathbf{john} \wedge \tau(e) = t' \subseteq t_{\mathbf{r}}]]]$

(9)   a.   It was not the case that John laughed for two hours.

b. $[_{\text{CP}} [[_{\text{DP}} \text{john [ag]}] [_{\text{VP}} \text{did not} [_{\text{VP}} \text{laugh} [_{\text{PP}} \text{for 2 hours}]]]]]$

c. $t_{\mathbf{r}} \ll \mathbf{now} \wedge \neg \exists t[\mathbf{hours}(t) = 2 \wedge t \subseteq t_{\mathbf{r}} \wedge \forall t'[t' \subseteq t \rightarrow \exists e[\mathbf{laugh}(e) \wedge \mathbf{ag}(e) = \mathbf{john} \wedge \tau(e) = t' \subseteq t_{\mathbf{r}}]]]$

3.2   Conjunction

- The word *and* can be used both intersectively and collectively:

(10)   a.   John lies and cheats.

       b.   John and Mary met.

- On the intersective or "boolean" theory, the basic meaning of *and* is intersective (Winter, 2001; Champollion, 2016).

- On the collective or "non-boolean" theory, the basic meaning of *and* are collective (Krifka, 1990; Lasersohn, 1995; Heycock and Zamparelli, 2005)

- Lasersohn (1995, ch. 14) claims that event semantics favors the collective theory.

- A closer look reveals that event semantics is also compatible with the intersective theory. See Champollion (2015) for the full argument. Here I give the upshot.

- Lasersohn translates sentence radicals as event predicates.

(11)   a. $[\![\text{and}]\!]_{Lasersohn} = \lambda P_1.\lambda P_2.\lambda e.\exists e_1 \exists e_2.P_1(e_1) \wedge P_2(e_2) \wedge e = \{e_1, e_2\}$

       b. $[\![\text{sing and dance}]\!]_{Lasersohn} = \lambda e.\exists e_1 \exists e_2.\mathbf{sing}(e_1) \wedge \mathbf{dance}(e_2) \wedge e = \{e_1, e_2\}$

- The intersective theory identifies *and* with the following rule (e.g. Partee and Rooth, 1983). Here τ ranges over types that end in t, and σ_1 and σ_2 range over any type.

(12) $\sqcap_{\langle \tau, \tau\tau \rangle} =_{def} \begin{cases} \wedge_{\langle t,tt \rangle} & \text{if } \tau = t \\ \lambda X_\tau \lambda Y_\tau \lambda Z_{\sigma_1}.X(Z) \sqcap_{\langle \sigma_2, \sigma_2 \sigma_2 \rangle} Y(Z) & \text{if } \tau = \langle \sigma_1, \sigma_2 \rangle \end{cases}$

- Applied to event predicates and event quantifiers:

(13)   **Conjunction of event predicates:** (no event quantifier!)
$[\lambda e.F_{vt}(e)] \sqcap_{\langle vt, \langle vt, vt \rangle \rangle} [\lambda e.G_{vt}(e)]$
$= [\lambda e.F_{vt}(e) \wedge G_{vt}(e)]$

IP : t
$\exists t[\mathbf{hours}(t) = 2$
$\wedge t \subseteq t_{\mathbf{r}}$
$\wedge \forall t'.t' \subseteq t \rightarrow$
$[t_{\mathbf{r}} \ll \mathbf{now}$
$\wedge \neg \exists e[\mathbf{laugh}(e)$
$\wedge \mathbf{ag}(e) = \mathbf{john}$
$\wedge \tau(e) = t' \subseteq t_{\mathbf{r}}]]]$

closure : vt
$\lambda e.\mathbf{true}$

$\langle vt, t \rangle$
$\lambda f \exists t[\mathbf{hours}(t) = 2$
$\wedge t \subseteq t_{\mathbf{r}}$
$\wedge \forall t'.t' \subseteq t \rightarrow$
$[t_{\mathbf{r}} \ll \mathbf{now}$
$\wedge \neg \exists e[\mathbf{laugh}(e) \wedge f(e)$
$\wedge \mathbf{ag}(e) = \mathbf{john}$
$\wedge \tau(e) = t' \subseteq t_{\mathbf{r}}]]]$

DP
$\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle$
$\lambda V \lambda f.V(\lambda e[f(e) \wedge$
$\mathbf{ag}(e) = \mathbf{john}])$

VP : $\langle vt, t \rangle$
$\lambda f \exists t[\mathbf{hours}(t) = 2$
$\wedge t \subseteq t_{\mathbf{r}}$
$\wedge \forall t'.t' \subseteq t \rightarrow$
$[t_{\mathbf{r}} \ll \mathbf{now}$
$\wedge \neg \exists e[\mathbf{laugh}(e) \wedge f(e)$
$\wedge \tau(e) = t' \subseteq t_{\mathbf{r}}]]]$

john
$\langle et, t \rangle$
$\lambda P.P(\mathbf{john})$

[ag]
$\langle \langle et, t \rangle, \langle \langle vt, t \rangle, \langle vt, t \rangle \rangle \rangle$
$\lambda Q \lambda V \lambda f.$
$Q(\lambda x.V(\lambda e[f(e)$
$\wedge \mathbf{ag}(e) = x]))$

VP : $\langle vt, t \rangle$
$\lambda f.[t_{\mathbf{r}} \ll \mathbf{now}$
$\wedge \neg \exists e[\mathbf{laugh}(e) \wedge f(e)$
$\wedge \tau(e) \subseteq t_{\mathbf{r}}]]$

PP
for two hours : $\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle$
$\lambda V \lambda f.$
$\exists t[\mathbf{hours}(t) = 2 \wedge t \subseteq t_{\mathbf{r}}$
$\wedge \forall t'[t' \subseteq t \rightarrow$
$V(\lambda e[f(e) \wedge \tau(e) = t'])]]$

did : $\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle$
$\lambda V \lambda f.[t_{\mathbf{r}} \ll \mathbf{now}$
$\wedge V(\lambda e.f(e)$
$\wedge \tau(e) \subseteq t_{\mathbf{r}}])]$

VP : $\langle vt, t \rangle$
$\lambda f. \neg \exists e[\mathbf{laugh}(e) \wedge f(e)]$

not: $\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle$
$\lambda V \lambda f.$
$\neg V(\lambda e.f(e))$

laugh : $\langle vt, t \rangle$
$\lambda f \exists e[\mathbf{laugh}(e)$
$\wedge f(e)]$

Figure 3.1: Derivation for Example (8): John [didn't laugh] for two hours

IP : t
$t_{\mathbf{r}} \ll \mathbf{now} \wedge \neg\exists t[\mathbf{hours}(t) = 2 \wedge t \subseteq t_{\mathbf{r}}$
$\wedge\forall t'[t' \subseteq t \rightarrow$
$\exists e[\mathbf{laugh}(e) \wedge \mathbf{ag}(e) = \mathbf{john} \wedge \tau(e) = t' \subseteq t_{\mathbf{r}}]]]$

closure : vt
$\lambda e.\mathbf{true}$

IP : $\langle vt, t\rangle$
$\lambda f.t_{\mathbf{r}} \ll \mathbf{now}$
$\wedge\neg\exists t[\mathbf{hours}(t) = 2 \wedge t \subseteq t_{\mathbf{r}}$
$\wedge[\forall t'[t' \subseteq t \rightarrow$
$[\exists e[\mathbf{laugh}(e) \wedge f(e)$
$\wedge\mathbf{ag}(e) = \mathbf{john} \wedge \tau(e) = t' \subseteq t_{\mathbf{r}}]]]]]$

DP : $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$
$\lambda V.\lambda f.V(\lambda e[f(e)\wedge$
$\mathbf{ag}(e) = \mathbf{john}])$

VP : $\langle vt, t\rangle$
$\lambda f.t_{\mathbf{r}} \ll \mathbf{now}$
$\wedge\neg\exists t[\mathbf{hours}(t) = 2 \wedge t \subseteq t_{\mathbf{r}}$
$\wedge[\forall t'[t' \subseteq t \rightarrow$
$\exists e[\mathbf{laugh}(e) \wedge f(e)$
$\wedge\tau(e) \subseteq t_{\mathbf{r}} \wedge \tau(e) = t']]]]$

john : $\langle et, t\rangle$
$\lambda P.P(\mathbf{john})$

[ag]
$\langle\langle et, t\rangle, \langle\langle vt, t\rangle, \langle vt, t\rangle\rangle\rangle$
$\lambda Q.\lambda V.\lambda f.$
$Q(\lambda x.V(\lambda e[f(e)$
$\wedge \mathbf{ag}(e) = x]))$

did
$\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$
$\lambda V.\lambda f.$
$t_{\mathbf{r}} \ll \mathbf{now}\wedge$
$V(\lambda e.f(e) \wedge \tau(e) \subseteq t_{\mathbf{r}})$

VP : $\langle vt, t\rangle$
$\lambda f.\neg\exists t[\mathbf{hours}(t) = 2 \wedge t \subseteq t_{\mathbf{r}}$
$\wedge\forall t'[t' \subseteq t \rightarrow$
$\exists e[\mathbf{laugh}(e)$
$\wedge f(e) \wedge \tau(e) = t']]]$

not : $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$
$\lambda V.\lambda f.$
$\neg V(\lambda e.f(e))$

VP : $\langle vt, t\rangle$
$\lambda f.\exists t[\mathbf{hours}(t) = 2 \wedge t \subseteq t_{\mathbf{r}}$
$\wedge\forall t'[t' \subseteq t \rightarrow$
$\exists e[\mathbf{laugh}(e)\wedge$
$f(e) \wedge \tau(e) = t']]]$

laugh : $\langle vt, t\rangle$
$\lambda f.\exists e[\mathbf{laugh}(e)$
$\wedge f(e)]$

PP: $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$
for two hours
$\lambda V.\lambda f.\exists t[\mathbf{hours}(t) = 2 \wedge t \subseteq t_{\mathbf{r}}$
$\wedge\forall t'[t' \subseteq t \rightarrow$
$V(\lambda e[f(e) \wedge \tau(e) = t'])]]$

Figure 3.2: Derivation for Example (9): John didn't [laugh for two hours]

(14)   **Conjunction of event quantifiers:** (two event quantifiers!)
        $[\lambda f.\exists e.F_{vt}(e) \wedge f(e)] \sqcap_{\langle\langle vt,t\rangle,\langle\langle vt,t\rangle,\langle vt,t\rangle\rangle\rangle} [\lambda f.\exists e.G_{vt}(e) \wedge f(e)]$
        $= [\lambda f.[\exists e.F_{vt}(e) \wedge f(e)] \wedge [\exists e'.G_{vt}(e') \wedge f(e')]]$

- The one-event view in (13) doesn't work well because it forces both verbal predicates to apply to the same event.

Exercise 3.1 Take Davidson's example of a ball that is at once rotating quickly and heating up slowly (Davidson, 1969). This example is generally taken to show that there must be two events involved, since one and the same event cannot be both quick and slow. Why is this an argument against (13)? How would you model the meaning of a sentence like (15) on the two-event view in (14)?

(15)   The ball rotated quickly and heated up slowly.

□

- Let's have a look at the interaction of conjunction and indefinites.

- Sentence (20) is a classic (Rooth and Partee, 1982; Partee and Rooth, 1983).

(20)   John caught and ate a fish.

- Rooth and Partee (1982) claim that this sentence only has a "one fish" reading (where the existential takes scope over the indefinite, i.e. John ate the fish he caught), and lacks a "two fish" reading (i.e. John caught a fish and ate a fish).

- The "one fish" reading is predicted by the intersective theory if transitive verbs are assumed to have type $\langle e, et\rangle$. The rule in (12) generates the following entry for *and* in this case:

(21) $\sqcap_{\langle\langle vt,t\rangle,\langle\langle vt,t\rangle,\langle vt,t\rangle\rangle\rangle} = \lambda V'.\lambda V.\lambda f.[V(f) \wedge V'(f)]$

- Hendriks (1993) argues that the "two fish" reading is dispreferred for pragmatic reasons but that it is available with the right continuation:

(22)   John caught and ate a fish. The fish he caught was inedible, and the fish he ate caught his eye.

- Judgments on this kind of sentence vary (Hendriks, 1993; Bittner, 1994; Winter, 1995). See for yourselves:

(23)   a.   John bought and sold a car.
        b.   John sold and bought a car.

- Additional question: What are the thematic roles assigned by the various verbs involved? In (20), are there two themes, or are there two different relations (*prey* and *food*)?

- What about conjunctions of unaccusative and unergative verbs:

(24)   John walked and fell.

Exercise 3.2 Suppose that there are only *agent* and *theme*. How is the "one-fish" reading of (20) represented? How is the "two-fish" reading represented? □

- Here is how the verb phrase is derived. We conjoin the verbs directly, and apply the thematic role head to the object before the result is applied to the conjunction.

(28)   a. $[\![$ catch and eat $]\!] = \lambda f.[\exists e.\mathbf{catch}(e) \wedge f(e)] \wedge [\exists e'.\mathbf{eat}(e') \wedge f(e')]$
         b. $[\![\text{th}]\!] = \lambda Q \lambda V \lambda f[Q(\lambda x[V(\lambda e[f(e) \wedge \mathbf{th}(e) = x])])]$
         c. $[\![\text{a fish}]\!] = \lambda P \exists x.\mathbf{fish}(x) \wedge P(x)$
         d. $[\![\text{th}]\!]([\text{a fish}])] = \lambda V \lambda f[\exists x[\mathbf{fish}(x) \wedge [V(\lambda e[f(e) \wedge \mathbf{th}(e) = x])]]]$
         e. $[\![\text{th}]\!]([\text{a fish}])]([\![$ catch and eat $]\!]) = \lambda f[\exists x.\mathbf{fish}(x) \wedge [\exists e.\mathbf{catch}(e) \wedge f(e) \wedge \mathbf{th}(e) = x] \wedge [\exists e'.\mathbf{eat}(e') \wedge f(e') \wedge \mathbf{th}(e') = x]]$

- As for the "two-fish" reading, for those speakers that have it, we can generate it by adding an additional lexical entry for our silent theme head into the grammar—call it [th2].

- This entry combines first with the verb and then with the object. First attach [th2] to each of the verbs, then intersect, and finally apply the conjunction to the object.

- Intersection is done by an application of the rule in (12), which in this case gives the following result (don't try this at home! :))

(29) $\sqcap_{\langle\langle\langle et,t\rangle,\langle vt,t\rangle\rangle,\langle\langle\langle et,t\rangle,\langle vt,t\rangle\rangle,\langle\langle et,t\rangle,\langle vt,t\rangle\rangle\rangle\rangle} = \lambda C.\lambda C'.\lambda Q.\lambda f.[(C'(Q)(f)) \wedge (C(Q)(f))]$

- Here, we exploit the fact that our theme heads expect their arguments to be of type $\langle et, t\rangle$, similarly to the transitive verbs in Montague (1973).

(30)   a. $[\![\text{th2}]\!] = \lambda V \lambda Q \lambda f[Q(\lambda x[V(\lambda e[f(e) \wedge \mathbf{th}(e) = x])])]$
         b. $[\![\text{catch}]\!] = \lambda f.\exists e.\mathbf{catch}(e) \wedge f(e)$
         c. $[\![\text{th2}]\text{ catch}]\!] = \lambda Q \lambda f[Q(\lambda x[\exists e.\mathbf{catch}(e) \wedge [f(e) \wedge \mathbf{th}(e) = x]])]$
         d. $[\![\text{th2}]\text{ eat}]\!] = \lambda Q \lambda f[Q(\lambda y[\exists e'.\mathbf{eat}(e') \wedge [f(e') \wedge \mathbf{th}(e') = y]])]$
         e. $[\![\text{th2}]\text{ catch}]\text{ and }[\![\text{th2}]\text{ eat}]\!] = \lambda Q \lambda f[Q(\lambda x[\exists e.\mathbf{catch}(e) \wedge [f(e) \wedge \mathbf{th}(e) = x]])] \sqcap \lambda Q \lambda f[Q(\lambda y[\exists e'.\mathbf{eat}(e') \wedge [f(e') \wedge \mathbf{th}(e') = y]])]$
                 $= \lambda Q.\lambda f.[Q(\lambda x[\exists e.\mathbf{catch}(e) \wedge [f(e) \wedge \mathbf{th}(e) = x]])$
                 $\wedge Q(\lambda y[\exists e'.\mathbf{eat}(e') \wedge [f(e') \wedge \mathbf{th}(e') = y]])]$
         f. $[\![\text{a fish}]\!] = \lambda P \exists x.\mathbf{fish}(x) \wedge P(x)$
         g. $[\![(30e)]\!]([\![(30f)]\!]) = \lambda f.$
                 $[\exists x.\mathbf{fish}(x) \wedge \exists e.\mathbf{catch}(e) \wedge f(e) \wedge \mathbf{th}(e) = x]$
                 $\wedge[\exists y.\mathbf{fish}(y) \wedge \exists e'.\mathbf{eat}(e') \wedge f(e') \wedge \mathbf{th}(e') = y]$

- We can make [th2] available on a per-speaker basis.

- There are also other possibilities. Maybe speakers who can get the 'two fish' reading allow a parse of the sentence with ellipsis in the first conjunct. Alternatively, the 'two fish' reading is a Right-Node-Raising construction with both copies being interpreted.

- If different thematic roles are involved in the catching and in the eating, things get a bit more complicated yet. See Champollion (2015) for details.

3.3   Conclusion

- Neo-Davidsonian event semantics does not pose a particular problem when it is combined with standard accounts of quantification, be they syntactic or semantic. This then provides a simple account for the fact that quantifiers always take scope above existential closure, a fact which is difficult to model otherwise. Such a claim would be problematic especially in case of languages where quantifiers otherwise take scope in situ.

- The framework proposed in Champollion (2015) combines the strengths of event semantics and type-shifting accounts of quantifiers. It is therefore well suited for applications to languages where word order is free and quantifier scope is determined by surface order.

- Adopting event semantics does not commit us to choosing one theory of coordination over another. In particular, adopting the intersective theory is compatible with event semantics.

3.4   Recommended background reading

- For this lecture: on negation, Krifka (1989a), and of course Horn (1989). On conjunction, Lasersohn (1995, ch. 14), Winter (2001) and Champollion (2016).

- For the next lecture: Champollion and Krifka (2016)

Day 4

Algebraic event semantics

Today: Review of algebraic semantics and mereology. Algebraic event semantics in Krifka (1989a).

4.1 Algebraic structures for semantics

- **Mereology:** the study of parthood in philosophy and mathematical logic

- Mereology can be axiomatized in a way that gives rise to **algebraic structures** (sets with binary operations defined on them)

Figure 4.1: An algebraic structure
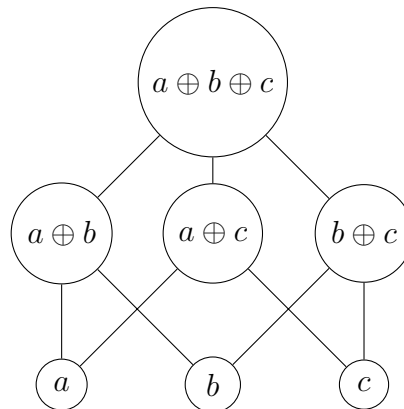
- **Algebraic semantics:** the branch of formal semantics that uses algebraic structures and parthood relations to model various phenomena

4.2 Basic motivation of mereology

- Basic motivation (Link, 1998): entailment relation between collections and their members

(1)   a.   John and Mary sleep. $\Rightarrow$
             John sleeps and Mary sleeps.
       b.   The water in my cup evaporated. $\Rightarrow$
             The water at the bottom of my cup evaporated.

- Basic relation $\leq$ (parthood)—written $\leq$; a partial order

- Sums (also called fusions) are that which you get when you put several parts together

- Fundamental assumption in algebraic semantics: any nonempty set of things of the same sort (e.g. individuals, substances, events) has a sum.

- Two applications of sum in linguistics are conjoined terms and definite descriptions. We will see more of them below.

    – For Sharvy (1980), $[\![\text{the water}]\!]$ = $\bigoplus$ water

    – For Link (1983), $[\![\text{John and Mary}]\!]$ = $j \oplus m$.

- Link (1983) proposes algebraic closure as underlying the meaning of the plural.

(2)   a.   John is a boy.
       b.   Bill is a boy.
       c. $\Rightarrow$ John and Bill are boys.

- Algebraic closure closes any predicate (or set) P under sum formation:

(3)   **Definition: Algebraic closure (Link, 1983)**
       The algebraic closure $^*P$ of a set P is defined as $\{x \mid \exists P' \subseteq P[x = \bigoplus P']\}$.
       (This is the set that contains any sum of things taken from P.)

- Link translates the argument in (2) as follows:

(4) $\text{boy}(j) \wedge \text{boy}(b) \Rightarrow {}^*\text{boy}(j \oplus b)$

- This argument can be proven valid given the axioms of classical extensional mereology.

- Are thematic roles their own algebraic closures (Krifka, 1989b, 1998; Landman, 2000)?

(5)   **Cumulativity assumption for thematic roles**
       For any thematic role θ it holds that $\theta = {}^*\theta$. This entails that
       $\forall e, e', x, y[\theta(e) = x \wedge \theta(e') = y \rightarrow \theta(e \oplus e') = x \oplus y]$

- Example: If John is walking (event e_1) and Mary is walking (event e_2), then John is the agent of e_1 and Mary is the agent of e_2. The sum of e_1 and e_2, intuitively the event of John and Mary walking, is an event—call it e_3. Cumulativity of thematic roles says that the agent of e_3 is (the sum of the individuals) John and Mary.

- Many people assume the answer is yes (makes things easier to formalize)
  - To symbolize this, instead of writing th, I will write *th.

- As a consequence of (5), thematic roles are homomorphisms with respect to the $\oplus$ operation:

  (6) **Fact: Thematic roles are sum homomorphisms**
  For any thematic role θ, it holds that $\theta(e \oplus e') = \theta(e) \oplus \theta(e')$.
  (The θ of the sum of two events is the sum of their θs.)

- Potential challenge to this assumption: the rosebush story (Kratzer, 2003). Suppose there are three events e_1, e_2, e_3 in which Al dug a hole, Bill inserted a rosebush in it, and Carl covered the rosebush with soil. Then there is also an event e_4 in which Al, Bill, and Carl planted a rosebush. Let e_4 be this event. If $e_4 = e_1 \oplus e_2 \oplus e_3$, we have a counterexample to lexical cumulativity.

Exercise 4.1 Why is this a counterexample? How could one respond to this challenge? □

4.3 Lexical cumulativity

- Many authors assume *lexical cumulativity*: whenever two events are in the denotation of a verb, so is their sum (Scha, 1981; Schein, 1986, 1993; Lasersohn, 1989; Krifka, 1989a, 1992; Landman, 1996, 2000; Kratzer, 2008).

  (7) a. John walked.
  b. Mary walked.
  c. ⇒ John and Mary walked.

  (8) a. John saw Bill.
  b. Mary saw Sue.
  c. ⇒ John and Mary saw Bill and Sue.

- This entailment is parallel to the entailment from singular to plural nouns:

  (9) a. John is a boy.
  b. Bill is a boy.
  c. ⇒ John and Bill are boys.

- Verbs have plural denotations: they obey the same equation as plural count nouns on the inclusive view

  (10) $[\![V]\!] = {}^*[\![V]\!]$

  (11) $[\![N_{pl}]\!] = {}^*[\![N_{sg}]\!]$

- It is customary to indicate lexical cumulativity by writing $\lambda e[^*\mathbf{see}(e)]$ for the meaning of the verb *see* instead of $\lambda e[\mathbf{see}(e)]$.

4.4 Krifka (1989): Algebraic event semantics

- The goal of Krifka (1989a) is to combine event semantics with the full range of quantifiers treated by generalized quantifier theory (Barwise and Cooper, 1981)

(12) a. Most girls sang.
      b. Less than three girls sang.

- Van Benthem's Problem: (van Benthem, 1986)

(13) Less than three girls sang.

      a. Wrong paraphrase: "There was an event which contained singing by less than three girls"

Exercise 4.2 What is wrong with this paraphrase? What would be a better one?□

- Krifka introduces the concept of a **maximal** event. Intuitively, an event is maximal iff it contains everything that occurs within a certain stretch of time.

- Given this, Krifka suggests the following paraphrase as an improvement:

(15) *Most / Less than three girls sang* is true iff there is a **maximal** event which contains singing events of more than half / less than three of the girls.

- Formally:

(16) **Definition: MaXimal Event (Krifka, 1989a)**
      $\mathbf{MXE}(e) \stackrel{\text{def}}{=} \exists t[e = \bigoplus(\lambda e'.\tau(e') \leq t)]$
      (An event is maximal iff is the sum of all the events whose runtimes are parts of a given temporal interval.)

- How could we define the meaning of arbitrary quantifiers based on this?

- According to generalized quantifier theory (Barwise and Cooper, 1981)

(17) $[\![\text{less than three girls}]\!] = \lambda P.|\{x|\mathbf{girl}(x)\} \cap \{x|P(x)\}| < 3$

(18) $[\![\text{most girls}]\!] = \lambda P.\frac{|\{x|\mathbf{girl}(x)\} \cap \{x|P(x)\}|}{|\{x|\mathbf{girl}(x)\}|} > 1/2$

- To translate this into event semantics, we need to be able to count the girls in an event.

- Let's introduce the type n of natural numbers, and write n for variables over numbers and N for sets of numbers.

(19) $\mathbf{max}(N) \overset{\text{def}}{=}$ the highest number in N

- The following is a streamlined version of Krifka's proposal, slightly adapted to match the assumptions made in the previous sections of this chapter:

(20) $[\![[\text{less than three girls}]_{ag}]\!]$
$= \lambda V_{\langle vt \rangle} \lambda e. [\mathbf{MXE}(e) \wedge \mathbf{max}(\lambda n \exists e' \leq e. V(e) \wedge {}^*\mathbf{girl}({}^*\mathbf{ag}(e')) \wedge |{}^*\mathbf{ag}(e')| = n) < 3]$

- After this entry combines with a verbal predicate V, it describes maximal events e such that the maximal number of girls that are agents of a Ving subevent of e is less than three.

- This verbal predicate is assumed to be of type vt, a set of events.

- For example:

(21) $[\![\text{sing}]\!] = \lambda e. {}^*\mathbf{sing}(e)$

- Krifka actually includes "hooks" to the various arguments of a verb in its denotation. I ignore this here for convenience as it does not affect the types:

(22) $[\![\text{sing}_{Krifka}]\!] = \lambda e. {}^*\mathbf{sing}(e) \wedge {}^*\mathbf{ag}(e, x_s)$

- We can then apply existential closure as usual:

(23) $[\![[\text{closure}]\!]([\![[\text{less than three girls}]_{ag}]\!]([\![\text{sing}]\!]))$
$= \exists e. [\mathbf{MXE}(e) \wedge \mathbf{max}(\lambda n \exists e' \leq e. {}^*\mathbf{sing}(e') \wedge {}^*\mathbf{girl}({}^*\mathbf{ag}(e')) \wedge |{}^*\mathbf{ag}(e')| = n)] < 3$

- This is true iff there is a maximal event e such that the maximal number of girls that are agents of a singing subevent of e is less than three.

- On the system in Champollion (2011, 2015), we can reuse the traditional entries in (17) and (18). We don't need maximal events.

(24) a. $[\![\text{less than three girls}]\!]$
$= \lambda P. |\{x | \mathbf{girl}(x)\} \cap \{x | P(x)\}| < 3$
  b. $[\![[\text{ag}] \text{ less than three girls}]\!]$
$= \lambda V \lambda f. |\{x | \mathbf{girl}(x)\} \cap \{x | V(\lambda e. [f(e) \wedge \text{AG}(e) = x])\}| < 3$
  c. $[\![[\text{closure}]\!]] = \lambda V. V(\lambda e. \mathbf{true})$
  d. $[\![\text{sing}]\!] = \lambda f \exists e [\mathbf{sing}(e) \wedge f(e)]$
  e. $[\![[\text{ag}] \text{ less than three girls sing}]\!]$
$= \lambda f. |\{x | \mathbf{girl}(x)\} \cap \{x | \exists e [\mathbf{sing}(e) \wedge f(e) \wedge \text{AG}(e) = x]\}| < 3$
  f. $[\![[\text{closure}] [\text{ag}] \text{ less than three girls sing}]\!]$
$= |\{x | \mathbf{girl}(x)\} \cap \{x | \exists e [\mathbf{sing}(e) \wedge \text{AG}(e) = x]\}| < 3$

- Krifka also uses maximal events to define negation:

  (25) $[\![\text{did not}_{Krifka}]\!]$
          $= \lambda P \lambda e \exists t [e = \bigoplus (\lambda e'[\tau(e') \leq t]) \wedge \neg \exists e''[P(e'') \wedge e'' \leq e]]$
          $= \lambda P \lambda e \exists t [\mathbf{MXE}(e) \wedge \neg \exists e''[P(e'') \wedge e'' \leq e]]$

- Based on this entry, Krifka translates a sentential event predicate like *John didn't laugh* as a predicate that is true of any fusion of events that all take place within some time, so long as none of them is an event of John's laughing:

  (26) $[\![\text{John did not laugh}]\!] =$
          $\exists e \exists t [e = \bigoplus (\lambda e'[\tau(e') \leq t])$
          $\wedge \neg \exists e''[e'' \leq e \wedge \mathbf{laugh}(e'') \wedge \mathbf{ag}(e'') = \mathbf{john}]]$

- Krifka's fusion-based negation system has been both influential and controversially debated (de Swart, 1996; de Swart and Molendijk, 1999; Zucchi and White, 2001; Giannakidou, 2002; Csirmaz, 2006; Condoravdi, 2008).

4.5   Recommended background reading

- Mereology surveys: Simons (1987), Casati and Varzi (1999), Varzi (2010), and Champollion and Krifka (2016)

- Link (1998): Link's collected work on mereology

- For the system presented today: Krifka (1989a, 1992)

- For the next lecture, Esipova and Champollion's (2017) analysis of *only*, poster:
  `http://iceland2017.nelsconference.org/wp-content/uploads/2017/10/esipova_champollion_poster.pdf`

Day 5

Only in event semantics

Today: *Only* in standard event semantics: Bonomi and Casalegno (1993) and Beaver and Clark (2008). Lexically non-predetermined material posing problems for (Neo-)Davidsonian accounts of *only*. Treatment of *only* in Esipova and Champollion (2017).

5.1   Meaning of *only*

- There are two main components to the meaning of *only*:

    - *only* presupposes that its prejacent is true;

    - *only* asserts that no (relevant) focus alternatives to its prejacent are true.

    (1)   Mary only [danced]$_\text{F}$.
          presupposition: Mary danced.
          assertion: Mary did nothing other than dance.

    (2)   Only [Mary]$_\text{F}$ danced.
          presupposition: Mary danced.
          assertion: No one other than Mary danced.

- We will refer to the component presupposing the truth of the prejacent as *presupposition* and to the component negating the alternatives to the prejacent as *exhaustification*.

- Can we have an analysis of *only* that correctly captures both components of its meaning in an off-the-shelf event-based system?

- In this lecture we will review two approaches to analyzing *only* in standard event semantics (i.e., one in which verbs denote sets of events or functions from individuals to sets of events):

    - a Classical Davidsonian approach in Bonomi and Casalegno (1993), which assumes that verbs denote functions from individuals to sets of events;

    - a standard Neo-Davidsonian approach in Beaver and Clark (2008), which assumes that verbs denote sets of events.

- We will see that both approaches run into a look-ahead problem when trying to handle lexically non-predetermined material (i.e., the material that is not pre-specified in lexical entries) outside the syntactic scope of *only*.

- The nature of this problem will give us an insight for a better analysis of *only* within quantificational event semantics (Esipova and Champollion, 2017).

5.2 *Only* in Classical Davidsonian event semantics: Bonomi and Casalegno 1993

- Bonomi and Casalegno (1993) (BoCa) were the first to develop an account of *only* in event semantics.

- BoCa's original motivation for using event semantics to analyze *only* came from examples with various quantifiers as focus associates of *only*, as in (3). The subsequent discussion in the literature (von Fintel 1997; Sevi 2005; Beaver and Clark 2008, a.o.) mainly focused on similar quantifier-related issues. We will not worry about such examples, however.

(3)   Only [two boys]$_F$ cried.

- Here are examples of truth conditions BoCa derive for sentences with *only*:

(4) $[\![$Mary only [danced]$_F$$]\!]_{BoCa}$ =
        $\exists e[\mathbf{dance}(e) \wedge \mathbf{ag}(e, \mathbf{m}) \wedge$ *presupposition*
        $\forall e'[\mathbf{ag}(e', \mathbf{m}) \rightarrow \exists e''[\mathbf{dance}(e'') \wedge \mathbf{ag}(e'', \mathbf{m}) \wedge e' \leq e'']]]$ *exhaustification*
        (There is an event of Mary dancing, and every event whose agent is Mary is a subevent of an event of Mary dancing.)

(5) $[\![$Only [Mary]$_F$ danced$]\!]_{BoCa}$ =
        $\exists e[\mathbf{dance}(e) \wedge \mathbf{ag}(e, \mathbf{m}) \wedge$ *presupposition*
        $\forall e'[\exists x[\mathbf{dance}(e') \wedge \mathbf{ag}(e', x)] \rightarrow \exists e''[\mathbf{dance}(e'') \wedge \mathbf{ag}(e'', \mathbf{m}) \wedge e' \leq e'']]]$
        exhaustification
        (There is an event of Mary dancing, and every event of someone dancing is a subevent of Mary dancing.)

Exercise 5.1 Do (4) and (5) correctly capture the intuitive truth conditions of the corresponding sentences? Why or why not? □

- Now let's take a look at how BoCa arrive at those truth conditions.

- BoCa assume the Classical Davidsonian framework, e.g. (we ignore tense in this lecture):

(6)   a. $[\![$danced$]\!]_{BoCa} = \lambda x \lambda e.\mathbf{dance}(e) \wedge \mathbf{ag}(e, x)$
        b. $[\![$Mary$]\!]_{BoCa} = \lambda F_{\langle e, vt \rangle} \lambda e.F(\mathbf{m})(e)$

    c. $\quad$ ⟦Mary danced⟧$_{BoCa}$ = $\lambda e.\mathbf{dance}(e) \wedge \mathbf{ag}(e, \mathbf{m})$ $\qquad$ *before closure*

    d. $\quad$ ⟦Mary danced⟧$_{BoCa}$ = $\exists e[\mathbf{dance}(e) \wedge \mathbf{ag}(e, \mathbf{m})]$ $\qquad$ *after closure*

- BoCa adopt a mixture of a structured meaning (Jacobs 1983 et seq.) and an alternative semantics (Rooth 1992 et seq.) approach to focus. Here's a simplified overview of their approach to focus:

  - ⟦α⟧^{O} is the ordinary meaning of α, where α is any constituent.

  - ⟦α⟧^{B} is the background meaning of α, where α is any constituent.

  - The background meaning of α is always of the same type as its ordinary meaning.

  - Background meanings propagate just like ordinary meanings.

  - The background meaning of α is the same as its ordinary meaning, unless α is focused or contains a focused constituent but doesn't contain a focus-sensitive operator like *only*.

  - We will routinely omit superscripts when the ordinary meaning of α is the same as its background meaning.

  - Focus operates on the background meaning of an expression by replacing it with a "skeleton", determined by its syntactic category.

  - For example, the skeleton of any constituent that only combines with an agent, e.g., *danced*, is $\lambda x \lambda e.\exists f_{vt}[f(e) \wedge \mathbf{ag}(e, x)]$ ($\approx$ 'did something'), which is equivalent to $\lambda x \lambda e.\mathbf{ag}(e, x)$, thus:

(7) $\quad$ a. $\quad$ ⟦[danced]$_\text{F}$⟧$^B{}_{BoCa}$ = $\lambda x \lambda e.\mathbf{ag}(e, x)$

       b. $\quad$ ⟦Mary [danced]$_\text{F}$⟧$^B{}_{BoCa}$ = $\lambda e.\mathbf{ag}(e, \mathbf{m})$ $\qquad$ *before closure*

  - You may think of the background meaning of α as the disjunction of the focus alternatives of α.

- BoCa's *only* applies to expressions whose types end in vt and returns expressions of the same type (the ordinary and the background meaning of the result are the same):

(8) $\quad$ ⟦only $\alpha_{\langle T_1,...,T_N,vt \rangle}$⟧$_{BoCa}$ = $\lambda X^1_{T_1}...\lambda X^N_{T_N}\lambda e.$⟦$\alpha$⟧$^O(X^1)...(X^N)(e) \wedge$
$\forall e'[$⟦α⟧$^B(X^1)...(X^N)(e') \to \exists e''[$⟦$\alpha$⟧$^O(X^1)...(X^N)(e'') \wedge e' \leq e'']]$

- For example, here is how BoCa's *only* applies to VPs:

(9) $\quad$ ⟦only VP$_{\langle e,vt \rangle}$⟧$_{BoCa}$ = $\lambda x \lambda e.$⟦VP⟧$^O(x)(e) \wedge$
$\forall e'[$⟦VP⟧$^B(x)(e') \to \exists e''[$⟦VP⟧$^O(x)(e'') \wedge e' \leq e'']]$

- Applying *only* to [*danced*]$_\text{F}$ yields the following result:

(10) $\quad$ ⟦only [danced]$_\text{F}$⟧$_{BoCa}$ = $\lambda x \lambda e.\mathbf{dance}(e) \wedge \mathbf{ag}(e, x) \wedge$
$\forall e'[\mathbf{ag}(e', x) \to \exists e''[\mathbf{dance}(e'') \wedge \mathbf{ag}(e'', x) \wedge e' \leq e'']]$

- Combining the result in (10) with *Mary* and applying closure, yields the truth conditions in (4), repeated below:

  (4) $[\![$Mary only [danced]$_F]\!]_{BoCa} =$
         $\exists e[\mathbf{dance}(e) \wedge \mathbf{ag}(e, \mathbf{m}) \wedge$
         $\forall e'[\mathbf{ag}(e', \mathbf{m}) \rightarrow \exists e''[\mathbf{dance}(e'') \wedge \mathbf{ag}(e'', \mathbf{m}) \wedge e' \leq e'']]]$
         (There is an event of Mary dancing, and every event whose agent is Mary is a subevent of an event of Mary dancing.)

- And here is how BoCa's *only* applies to DPs:

  (11) $[\![$only DP$_{\langle\langle e, vt\rangle, vt\rangle}]\!]_{BoCa} = \lambda F_{\langle e, vt\rangle}\lambda e.[\![DP]\!]^O(F)(e) \wedge$
         $\forall e'[[\![$DP$]\!]^B(F)(e') \rightarrow \exists e''[[\![DP]\!]^O(F)(e'') \wedge e' \leq e'']]$

- The skeleton of DPs like *Mary* is $\lambda F_{\langle e, vt\rangle}\lambda e.\exists x[F(x)(e)]$ (simplified), thus:

  (12)   a. $[[$Mary$]_F]\!]^B{}_{BoCa} = \lambda F_{\langle e, vt\rangle}\lambda e.\exists x[F(x)(e)]$
         b. $[\![$only [Mary]$_F]\!]_{BoCa} = \lambda F_{\langle e, vt\rangle}\lambda e.F(\mathbf{m})(e) \wedge$
               $\forall e'[\exists x[F(x)(e')] \rightarrow \exists e''[F(\mathbf{m})(e'') \wedge e' \leq e'']]$

- Combining the result in (12b) with *danced* and applying closure yields the truth conditions in (5), repeated below:

  (5) $[\![$Only [Mary]$_F$ danced$]\!]_{BoCa} =$
         $\exists e[\mathbf{dance}(e) \wedge \mathbf{ag}(e, \mathbf{m}) \wedge$
         $\forall e'[\exists x[\mathbf{dance}(e') \wedge \mathbf{ag}(e', x)] \rightarrow \exists e''[\mathbf{dance}(e'') \wedge \mathbf{ag}(e'', \mathbf{m}) \wedge e' \leq e'']]]$
         (There is an event of Mary dancing, and every event of someone dancing is a subevent of Mary dancing.)

- Note that BoCa's *only* applies in-situ and relies on the argument structure of the expression it applies to to introduce the rest of the sentence into the scope of the universal quantifier responsible for exhaustification.

- It is thus crucial for BoCa to adopt Classical Davidsonian event semantics, because within the Neo-Davidsonian framework they wouldn't be able to correctly derive even simple sentences like *Mary only [danced]*$_F$.

- If *danced* simply denoted $\lambda e.\mathbf{dance}(e)$, the skeleton for it would be $\lambda e.\exists f_{vt}[f(e)]$, which is trivial and can be simplified as $\lambda e.\mathbf{true}$.

- BoCa's system would then yield the following denotation for *only [danced]*$_F$:

  (13) $[\![$only [danced]$_F]\!]_{BoCa\text{-}ND} = \lambda e.\mathbf{dance}(e) \wedge$
         $\forall e'\exists e''[\mathbf{dance}(e'') \wedge e' \leq e'']$

- The information about the agent can still be introduced into the the presupposition component via predicate modification, but it can no longer be introduced into the exhaustification component, resulting in incorrect truth conditions:

(14) $[\![\text{Mary only [danced]}_\text{F}]\!]_{BoCa\text{-}ND} = \exists e[\textbf{dance}(e) \wedge \textbf{ag}(e, \textbf{m}) \wedge$
$\forall e' \exists e''[\textbf{dance}(e'') \wedge e' \leq e'']]$
(There is an event of Mary dancing, and all events are subevents of dancing events.)

5.3   *Only* in standard Neo-Davidsonian event semantics: Beaver and Clark 2008

- Is it possible to have an analysis of *only* within the Neo-Davidsonian framework?

- Beaver and Clark (2008) (BeCl) adopt a simplified version of BoCa's exhaustification mechanism, but they keep their verbal entries Neo-Davidsonian:

(15) $[\![\text{danced}]\!]_{BeCl} = \lambda e.\textbf{dance}(e)$

- Similarly, they treat DPs that have combined with their theta roles as predicates of events:

(16) $[\![\text{Mary}_{ag}]\!]_{BeCl} = \lambda e.\textbf{ag}(e, \textbf{m})$

- BeCl further assume that focus makes the background meaning of an event predicate trivial:

(17) $[\![[\text{danced}]_\text{F}]\!]^{B}{}_{BeCl} = \lambda e.\textbf{true}$

- Instead of relying on the argument structure of the expression that *only* applies to, they try to hard-code the information about what we can possibly need to introduce into the scope of *only* after it has applied into the lexical entry of *only* itself.

- For example, BeCl's VP-level *only* introduces the information about the agent both into the presupposition and into the exhaustification components:

(18) $[\![\text{only VP}]\!]_{BeCl} = \lambda f_{vt}\lambda e.[\![\text{VP}]\!]^{O}(e) \wedge f(e) \wedge$
$\forall e'[[[\![\text{VP}]\!]^{B}(e') \wedge f(e')] \rightarrow [\![\text{VP}]\!]^{O}(e')]$

(19)   a. $[\![\text{only [danced]}_\text{F}]\!]_{BeCl} = \lambda f_{vt}\lambda e.\textbf{dance}(e) \wedge f(e) \wedge$
$\forall e'[[\textbf{true} \wedge f(e')] \rightarrow \textbf{dance}(e')]$
        b. $[\![\text{Mary only [danced]}_\text{F}]\!]_{BeCl} = \exists e[\textbf{dance}(e) \wedge \textbf{ag}(e, \textbf{m}) \wedge$
$\forall e'[\textbf{ag}(e', \textbf{m}) \rightarrow \textbf{dance}(e')]]$
(There is an event of Mary dancing, and all events whose agent is Mary are dancing events.)

- BeCl don't provide an event-based entry for *only* applying to DPs. One could deduce what it would be, however:

(20) $[\![\text{only DP}_\theta]\!]_{BeCl} = \lambda f_{vt}\lambda e. f(e) \wedge [\![\text{DP}_\theta]\!]^O(e) \wedge$
         $\forall e'[[f(e') \wedge [\![\text{DP}_\theta]\!]^B(e')] \rightarrow [\![\text{DP}_\theta]\!]^O(e')]$

- That would work for subject DPs, as in *Only* [*Mary*]$_F$ *danced*:

  (21)   a. $[\![\text{only } [\text{Mary}_{ag}]_F]\!]_{BeCl} = \lambda f_{vt}\lambda e. f(e) \wedge \textbf{ag}(e, \textbf{m}) \wedge$
                $\forall e'[f(e') \rightarrow \textbf{ag}(e', \textbf{m})]$
          b. $[\![\text{only } [\text{Mary}_{ag}]_F \text{ danced}]\!]_{BeCl} = \exists e[\textbf{dance}(e) \wedge \textbf{ag}(e, \textbf{m}) \wedge$
                $\forall e'[\textbf{dance}(e') \rightarrow \textbf{ag}(e', \textbf{m})]]$
                (There is an event of Mary dancing, and the agent of every dancing event is
                Mary.)

- However, the entry in (20) won't work for cases when *only* applies to objects, as in *Mary met only* [*John*]$_F$, because it only takes one vt argument to feed into the exhaustification component, which it will use up when combining the verb with the object. The information about the subject thus can still be introduced into the presupposition component via predicate modification, but cannot be introduced into the exhaustification component, yielding incorrect truth conditions.

  (22)   a. $[\![\text{met only } [\text{John}_{th}]_F]\!]_{BeCl} = \lambda e.\textbf{meet}(e) \wedge \textbf{th}(e, \textbf{j}) \wedge$
                $\forall e'[\textbf{meet}(e') \rightarrow \textbf{th}(e', \textbf{j})]$
          b. $[\![\text{Mary met only } [\text{John}_{th}]_F]\!]_{BeCl} = \exists e[\textbf{meet}(e) \wedge \textbf{th}(e, \textbf{j}) \wedge \textbf{ag}(e, \textbf{m}) \wedge$
                $\forall e'[\textbf{meet}(e') \rightarrow \textbf{th}(e', \textbf{j})]]$
                (There is an event of Mary meeting John, and the theme of every meeting event
                is John.)

- Thus, even at this point, we would have to either go back to the Classical Davidsonian framework (as in BoCa) or posit separate entries for *only* applying to subjects and objects.

- The second fix would result in a look-ahead problem: how does *only* know if it is combining with a subject or an object?

5.4   *Only* and adjuncts

- The look-ahead problem emerges even for the Classical Davidsonian-based analysis of *only* in BoCa when we start considering examples with adjuncts.

- In all the examples below the underlined material is outside the surface syntactic scope of *only* but is interpreted inside that scope. Yet, it's unclear how to introduce that material inside the scope of *only* (in particular, into the exhaustification component) in standard event semantics if *only* is interpreted in situ.

- In examples like (23) *only* applies to adjuncts:

(23) Mary danced [only [in the garden]$_F$].
True iff <u>Mary danced</u> in the garden and no events of <u>Mary dancing</u> occurred outside the garden.

- BoCa don't discuss adjuncts, but in standard event semantics adjuncts are treated as predicates of events of type vt ($\lambda e.\textbf{loc}(e) = \iota x.\textbf{garden}(x)$), so their focus "skeleton" for adjuncts would be a trivial one $\lambda e.\textbf{true}$.

- Under that assumption, BoCa's system derives the wrong truth conditions for (23):

(24) $[\![$Mary danced only [in the garden]$_F]\!]_{BoCa} =$
$\exists e[\textbf{dance}(e) \wedge \textbf{ag}(e, \textbf{m}) \wedge \textbf{loc}(e, \iota x.\textbf{garden}(x)) \wedge$
$\forall e'\exists e''[\textbf{loc}(e'', \iota x.\textbf{garden}(x)) \wedge e' \leq e'']]$
(There is an event of Mary dancing in the garden, and all events are subevents of events happening in the garden.)

- BeCl's system would run into a similar problem (again).

- Trying to pack the information about all the upcoming material either into the entry for the adjunct or into the entry for *only* would result in a severe look-ahead problem: there is no way we can know in advance what kind of verb the adjunct will be modifying.

- In examples like (25), *only* applies to an object DP, but there are VP-level adjuncts:

(25) Mary met [only [John]$_F$] in the garden.
True iff <u>Mary met</u> John <u>in the garden</u>, and <u>Mary met</u> no one else <u>in the garden</u>.

- BoCa's system will be able to introduce the verb's pre-specified arguments into the scope of *only*, but once again, it will fail to introduce the adjunct material:

(26) $[\![$Mary met only [John]$_F$ in the garden$]\!]_{BoCa} =$
$\exists e[\textbf{meet}(e) \wedge \textbf{ag}(e, \textbf{m}) \wedge \textbf{th}(e, \textbf{j}) \wedge \textbf{loc}(e, \iota x.\textbf{garden}(x)) \wedge$
$\forall e'[\exists y[\textbf{meet}(e) \wedge \textbf{ag}(e, \textbf{m}) \wedge \textbf{th}(e, y)] \rightarrow$
$\exists e''[\textbf{meet}(e) \wedge \textbf{ag}(e, \textbf{m}) \wedge \textbf{th}(e, \textbf{j}) \wedge e' \leq e'']]]$
(There is an event of Mary meeting John in the garden, and every event of Mary meeting someone is a subevent of an event of Mary meeting John.)

- BeCl's system would run into a similar problem (again).

- Once again, we would have to make *in the garden* a lexical argument of the verb, or make our *only* omniscient about the upcoming material. That would be defeating the original purpose of event semantics—handling lexically non-predetermined material.

- In examples like (27), a quantifier is binding into both the presupposition and the exhaustification components under *only*:

(27)   a.   With most knives Mary [only [buttered a toast]$_F$].
              True iff most knives x are such that <u>Mary</u> buttered a toast <u>with x</u>, and <u>Mary</u>
              did nothing other than buttering a toast <u>with x</u>.
        b.   At most parties Mary drank [only [beer]$_F$].
              True iff most parties x are such that <u>Mary drank</u> beer <u>at x</u>, and <u>Mary drank</u>
              nothing other than beer <u>at x</u>.

- The only way to handle (27a) in standard event semantics would be by assuming partial reconstruction into the VP (the theta role and the variable reconstruct, but the quantifier doesn't).

- In (27b), partially reconstructing the VP-level adjunct alone wouldn't introduce the necessary material into the object DP. We'd also need to give *only* or *only DP* LF scope over the rest of the sentence, but below *at most parties*.

- Summary of the problem:

  – We want to introduce non-predetermined material into the alternatives negated by *only* without creating a look-ahead problem.

  – Standard event semantics doesn't allow that if *only* is interpreted in situ.

  – Analyses of *only* that rely on standard event semantics can't handle examples like (23), (25), and (27).

5.5   *Only* in quantificational event semantics: Esipova and Champollion (2017)

- If we assume that *only* applies in situ, we want to give it access to the underspecified future of the derivation (in computer science and work like Barker and Shan (2014), the term for the future of the derivation is *continuation*).

- The framework presented in Days 2 and 3 (Champollion, 2015) treats verbs and verbal projections as sets of sets of events (type $\langle vt, t \rangle$) and all arguments and adjuncts are of type $\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle$, taking verbs or verbal projections and modifying them:

(28)   a.   ⟦danced⟧ = $\lambda f_{vt} \exists e.\mathbf{dance}(e) \wedge f(e)$
        b.   ⟦Mary$_{ag}$⟧ = $\lambda V_{\langle vt, t \rangle} \lambda f_{vt}.V(\lambda e.f(e) \wedge \mathbf{ag}(e) = \mathbf{m})$
        c.   ⟦in the garden⟧ = $\lambda V_{\langle vt, t \rangle} \lambda f_{vt}.V(\lambda e.f(e) \wedge \mathbf{loc}(e) = \iota x.\mathbf{garden}(x))$

- The f variable in the denotations above represents the underspecified future of the derivation (it is a continuation variable).

- We can thus use the f variable to introduce non-predetermined material into the alternatives negated by *only* effortlessly while interpreting *only* in situ.

- In Esipova and Champollion (2017) we propose a uniform analysis of *only* within that framework that is entirely type-driven (no look-ahead problem).

- Our *only* takes a constituent α and (i) checks the presupposition that the ordinary semantic value of α holds of its arguments, and (ii) asserts that all (relevant) alternatives to α don't hold of those arguments:

(29) $[\![$only $\alpha_{\langle T_1,\dots,T_N,t\rangle}]\!] = \lambda X^1_{T_1}\dots\lambda X^N_{T_N}.[\![\alpha]\!]^O(X^1)\dots(X^N) \wedge$
  $\forall Y[[Y \in [\![\alpha]\!]^A \wedge Y \neq [\![\alpha]\!]^O] \to \neg Y(X^1)\dots(X^N)]$

  $[\![\alpha]\!]^O$ = ordinary semantic value of α,
  $[\![\alpha]\!]^A$ = set of alternatives to α (Rooth, 1992)

- We will routinely omit the $Y \neq [\![\alpha]\!]^O$ conjunct for simplicity.

- Below are the specific versions of this entry for when *only* applies to VPs and for when it applies to $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$ constituents (arguments and adjuncts alike):

(30) a. $[\![$only VP$]\!] = \lambda f_{vt}.[\![\text{VP}]\!]^O(f) \wedge \forall V'[V' \in [\![\text{VP}]\!]^A \to \neg V'(f)]$
  b. $[\![$only XP$_{\langle\langle vt,t\rangle,\langle vt,t\rangle\rangle}]\!] = \lambda V_{\langle vt,t\rangle}\lambda f_{vt}.[\![\text{XP}]\!]^O(V)(f) \wedge$
    $\forall M'[M' \in [\![\text{XP}]\!]^A \to \neg M'(V)(f)]$

- For example, this is how we derive *Mary only [danced]*$_\text{F}$:

(31) $[\![$Mary only [danced]$_\text{F}]\!] =$
  a. $([\![\text{Mary}_{ag}]\!]([\![\text{only}]\!]([\![\text{[danced]}]\!]_\text{F})))([\![\text{closure}]\!]) =$
  b. $([\![\text{Mary}_{ag}]\!]$
    $(\lambda f_{vt}.\exists e[\textbf{dance}(e) \wedge f(e)] \wedge \forall V'[V' \in [\![\text{danced}]\!]^A \to \neg V'(f)]))([\![\text{closure}]\!]) =$
  c. $((\lambda V_{\langle vt,t\rangle}\lambda f_{vt}.V(\lambda e.f(e) \wedge \textbf{ag}(e) = \textbf{m}))$
    $(\lambda f_{vt}.\exists e[\textbf{dance}(e) \wedge f(e)] \wedge \forall V'[V' \in [\![\text{danced}]\!]^A \to \neg V'(f)]))([\![\text{closure}]\!]) =$
  d. $(\lambda f_{vt}.\exists e[\textbf{dance}(e) \wedge f(e) \wedge \textbf{ag}(e) = \textbf{m}] \wedge$
    $\forall V'[V' \in [\![\text{danced}]\!]^A \to \neg V'(\lambda e.f(e) \wedge \textbf{ag}(e) = \textbf{m})])([\![\text{closure}]\!]) =$
  e. $\exists e[\textbf{dance}(e) \wedge \textbf{ag}(e) = \textbf{m}] \wedge$
    $\forall V'[V' \in [\![\text{danced}]\!]^A \to \neg V'(\lambda e.\textbf{ag}(e) = \textbf{m})]$
    (There is an event of Mary dancing, and all alternatives to *danced* return false if fed $\lambda e.\textbf{ag}(e) = \textbf{m}$.)
  f. If our only alternative is *sang* (i.e., $\lambda f.\exists e[\textbf{sing}(e) \wedge f(e)]$), this is equivalent to:
    $\exists e[\textbf{dance}(e) \wedge \textbf{ag}(e) = \textbf{m}] \wedge \neg\exists e'[\textbf{sing}(e') \wedge \textbf{ag}(e') = \textbf{m}]$

- And this is the result we get for *Only [Mary]*$_\text{F}$ *danced*:

(32) $[\![$Only [Mary]$_\text{F}$ danced$]\!] =$
  a. $(([\![\text{only}]\!]([\![\text{[Mary}_{ag}]_\text{F}]\!]))([\![\text{danced}]\!]))([\![\text{closure}]\!]) =$
  b. $\exists e[\textbf{dance}(e) \wedge \textbf{ag}(e) = \textbf{m}] \wedge$
    $\forall M'[M' \in [\![\text{Mary}_{ag}]\!]^A \to \neg M'(\lambda f_{vt}.\exists e[\textbf{dance}(e) \wedge f(e)])(\lambda e.\textbf{true})]$

(There is an event of Mary dancing, and all alternatives to $Mary_{ag}$ return false if fed $\lambda f_{vt}.\exists e[\textbf{dance}(e) \wedge f(e)]$ and then $\lambda e.\textbf{true}$.)

c. If our only alternative is $John_{ag}$ (i.e., $\lambda V_{\langle vt,t\rangle}\lambda f_{vt}.V(\lambda e.f(e) \wedge \textbf{ag}(e) = \textbf{j}))$, this is equivalent to:
    $\exists e[\textbf{dance}(e) \wedge \textbf{ag}(e) = \textbf{m}] \wedge \neg\exists e'[\textbf{dance}(e') \wedge \textbf{ag}(e') = \textbf{j}]$

- The f variable allows us to effortlessly introduce any upcoming material into the negated alternatives. Thus, we can easily handle the examples with adjuncts below:

(33) ⟦Mary danced only [in the garden]$_{\text{F}}$⟧ =
  a. $(⟦\text{Mary}_{ag}⟧(((⟦\text{only}⟧(⟦[\text{in the garden}]_{\text{F}}⟧))(⟦\text{danced}⟧)))(⟦\text{closure}⟧)$ =
  b. $\exists e[\textbf{dance}(e) \wedge \textbf{ag}(e) = \textbf{m} \wedge \textbf{loc}(e) = \iota x.\textbf{garden}(x)] \wedge$
      $\forall M'[M' \in ⟦\text{in the garden}⟧^A \rightarrow$
      $\neg M'(\lambda f_{vt}.\exists e[\textbf{dance}(e) \wedge f(e)])(\lambda e.\textbf{ag}(e) = \textbf{m})]$
      (There is an event of Mary dancing in the garden, and all alternatives to *in the garden* return false if fed $\lambda f_{vt}.\exists e[\textbf{dance}(e) \wedge f(e)]$ and then $\lambda e.\textbf{ag}(e) = \textbf{m}$.)

(34) ⟦Mary met only [John]$_{\text{F}}$ in the garden⟧ =
  a. $(⟦\text{Mary}_{ag}⟧(⟦\text{in the garden}⟧(((⟦\text{only}⟧(⟦[\text{John}_{th}]_{\text{F}}⟧))(⟦\text{met}⟧))))(⟦\text{closure}⟧)$ =
  b. $\exists e[\textbf{meet}(e) \wedge \textbf{ag}(e) = \textbf{m} \wedge \textbf{loc}(e) = \iota x.\textbf{garden}(x) \wedge \textbf{th}(e) = \textbf{j}] \wedge$
      $\forall M'[M' \in ⟦\text{John}_{th}⟧^A \rightarrow$
      $\neg M'(\lambda f_{vt}.\exists e[\textbf{meet}(e) \wedge f(e)])(\lambda e.\textbf{ag}(e) = \textbf{m} \wedge \textbf{loc}(e) = \iota x.\textbf{garden}(x))$
      (There is an event of Mary meeting John in the garden, and all alternatives to $John_{th}$ return false if fed $\lambda f_{vt}.\exists e[\textbf{meet}(e) \wedge f(e)]$ and then $\lambda e.\textbf{ag}(e) = \textbf{m} \wedge \textbf{loc}(e) = \iota x.\textbf{garden}(x)$.)

(35) ⟦With most knives Mary only [buttered a toast]$_{\text{F}}$⟧ =
  a. $(⟦\text{with most knives}⟧(⟦\text{Mary}⟧(⟦\text{only}⟧(⟦[\text{buttered a toast}]_{\text{F}}⟧)))(⟦\text{closure}⟧)$ =
  b. $((\lambda V_{\langle vt,t\rangle}\lambda f_{vt}.\textbf{most}(\textbf{knife})(\lambda x.V(\lambda e.f(e) \wedge \textbf{instr}(e) = x)))$
      $(⟦\text{Mary}⟧(⟦\text{only}⟧(⟦[\text{buttered a toast}]_{\text{F}}⟧)))(⟦\text{closure}⟧)$ =
  c. $\textbf{most}(\textbf{knife})(\lambda x.\exists e[\textbf{butter}(e) \wedge \textbf{ag}(e) = \textbf{m} \wedge \textbf{toast}(\textbf{th}(e)) \wedge \textbf{instr}(e) = x]$
      $\wedge \forall V'[V' \in ⟦\text{buttered a toast}⟧^A \rightarrow \neg V'(\lambda e.\textbf{ag}(e) = \textbf{m} \wedge \textbf{instr}(e) = x)])$
      (Most knives x are such that [there is an event of Mary buttering a toast with x and all alternatives to *buttered a toast* return false if fed $\lambda e.\textbf{ag}(e) = \textbf{m} \wedge \textbf{instr}(e) = x$].)

(36) ⟦At most parties Mary drank only [beer]$_{\text{F}}$⟧ =
  a. $(⟦\text{at most parties}⟧(⟦\text{Mary}⟧(((⟦\text{only}⟧(⟦[\text{beer}]_{\text{F}}⟧))(⟦\text{drank}⟧))))(⟦\text{closure}⟧)$ =
  b. $\textbf{most}(\textbf{party})(\lambda x.\exists e[\textbf{drink}(e) \wedge \textbf{ag}(e) = \textbf{m} \wedge \textbf{beer}(\textbf{th}(e)) \wedge \textbf{loc}(e) = x]$
      $\wedge \forall M'[M' \in ⟦\text{beer}⟧^A \rightarrow \neg V'(\lambda f.\exists e[\textbf{drink}(e) \wedge f(e)])(\lambda e.\textbf{ag}(e) = \textbf{m} \wedge \textbf{loc}(e) = x)])$
      (Most parties x are such that [there is an event of Mary drinking beer at x and all alternatives to *beer* return false if fed $\lambda f.\exists e[\textbf{drink}(e) \wedge f(e)]$ and then $\lambda e.\textbf{ag}(e) = \textbf{m} \wedge \textbf{loc}(e) = x$].)

Exercise 5.2 Do the results in (33)–(36) correctly capture the intuitive truth conditions of the corresponding sentences? Translate them into plain English to answer this question. □

- One could try to save standard event semantics approaches to *only* by positing that *only* in interpreted higher than where it appears in the structure, i.e., assure that it always applies to sentential event predicates, after all the arguments and adjuncts have been collected.

- However, we would then need to make additional assumptions about examples with multiple instances of *only*, such as (37):

(37)   Only [Mary]$_F$ only [danced]$_F$.
       OK: Mary was the only one who did nothing else but dance.
       Not: Dancing was the only activity that was done by no one else but Mary.

- In such examples the instances of *only* are interpreted in a nested way according to their surface syntactic scope.

- Our analysis interprets *only* in situ and captures this fact effortlessly:

(38)   a.   ⟦Only [Mary]$_F$ only [danced]$_F$⟧ =
       b.   (⟦only [Mary$_{ag}$]$_F$⟧(⟦only [danced]$_F$⟧))(⟦[closure]⟧) =
       c. $\exists e[\mathbf{dance}(e) \wedge \mathbf{ag}(e) = \mathbf{m}] \wedge \forall V'[V' \in \llbracket\text{danced}\rrbracket^A \rightarrow \neg V'(\lambda e.\mathbf{ag}(e) = \mathbf{m})] \wedge$
            $\forall M'[M' \in \llbracket\text{Mary}_{ag}\rrbracket^A \rightarrow$
            $\neg M'(\lambda f.\exists e[\mathbf{dance}(e) \wedge f(e)] \wedge \forall V'[V' \in \llbracket\text{danced}\rrbracket^A \rightarrow \neg V'(f)])(\lambda e.\mathbf{true})]$
            (Mary only danced, and all alternatives to *Mary$_{ag}$* return false if fed the denotation of the VP *only danced* and then $\lambda e.\mathbf{true}$.)
       d.   If our only alternative to *Mary$_{ag}$* is *John$_{ag}$* (i.e., $\lambda V_{\langle vt,t\rangle}\lambda f_{vt}.V(\lambda e.f(e)\wedge\mathbf{ag}(e) = \mathbf{j})$) and our only alternative to *danced* is *sang* (i.e., $\lambda f_{vt}.\exists e[\mathbf{sing}(e) \wedge f(e)]$), this is equivalent to:
            $\exists e[\mathbf{dance}(e) \wedge \mathbf{ag}(e) = \mathbf{m}] \wedge \neg\exists e'[\mathbf{sing}(e') \wedge \mathbf{ag}(e') = \mathbf{m}]$
            $\wedge \neg(\exists e''[\mathbf{dance}(e'') \wedge \mathbf{ag}(e'') = \mathbf{j}] \wedge \neg\exists e'''[\mathbf{sing}(e''') \wedge \mathbf{ag}(e''') = \mathbf{j}])$
            (Mary danced and didn't sing, and it's not true that [John danced and didn't sing].)

5.6   Conclusion

- Standard event semantics runs into a look-ahead problem when dealing with examples in which non-predetermined material needs to be introduced into the alternatives negated by *only* after it has applied.

- Champollion's (2015) quantificational event semantics allows us to avoid this problem and have a uniform, type-driven analysis of *only*, interpreted in situ, without giving up any of the freedom of Neo-Davidsonian event semantics or assuming any LF phenomena such as partial reconstruction.

- More generally, this framework allows us to operate on focus alternatives locally and then keep updating them along with the rest of the derivation.

    – Thus, the approach to *only* in Esipova and Champollion (2017) is extendable to other focus-sensitive items, like *always*:

(39)   With most knives Mary always [butters toasts]_F.

    – It also allows us to exhaustify focused elements in 'contrastive topic + focus' configurations locally (see also Esipova (2017)):

(40)   Mary sometimes sings and sometimes sings and dances.
        (Some times x are such that Mary sings at x and doesn't dance at x, and some times x are such that Mary both sings and dances at x.)

5.7 Recommended background reading

- Literature on *only* and exhaustification in general: Szabolcsi (1981), Groenendijk and Stokhof (1984), and Rooth (1992).

- *Only* in standard event semantics: Bonomi and Casalegno (1993) and Beaver and Clark (2008).

- Esipova and Champollion's (2017) analysis of *only*, poster:
  `http://iceland2017.nelsconference.org/wp-content/uploads/2017/10/esipova_champollion_poster.pdf`

Appendix A

Solutions to exercises

Answer to Exercise 1.1:

(7)   a.   Brutus stabbed Caesar on the forum at noon.
       b.   Brutus stabbed Caesar on the forum.
       c.   Brutus stabbed Caesar at noon.
       d.   Brutus stabbed Caesar.

The following entailment relations hold: (7a) entails all others; (7d) is entailed by all others; neither (7b) nor (7c) entails the other. When you arrange these sentences on a sheet accordingly and draw arrows between them, it looks like a diamond.

Answer to Exercise 1.2:

(18)   a.   Brutus did not stab Caesar on the forum at noon.
       b.   Brutus did not stab Caesar on the forum.
       c.   Brutus did not stab Caesar at noon.
       d.   Brutus did not stab Caesar.

The following entailment relations hold: (18a) is entailed by all others; (18d) entails all others; neither (18b) nor (18c) entails the other. Analogous entailments also hold between the following formulas:

(19)   a. $\neg \exists e[\textbf{stabbing}(e, \textbf{brutus}, \textbf{caesar}) \wedge \textbf{loc}(e) = \textbf{forum} \wedge \textbf{time}(e) = \textbf{noon}]$
       b. $\neg \exists e[\textbf{stabbing}(e, \textbf{brutus}, \textbf{caesar}) \wedge \textbf{loc}(e) = \textbf{forum}]$
       c. $\neg \exists e[\textbf{stabbing}(e, \textbf{brutus}, \textbf{caesar}) \wedge \textbf{time}(e) = \textbf{noon}]$
       d. $\neg \exists e[\textbf{stabbing}(e, \textbf{brutus}, \textbf{caesar})]$

(20)   a.   Nobody stabbed Caesar on the forum at noon.
       b.   Nobody stabbed Caesar on the forum.
       c.   Nobody stabbed Caesar at noon.
       d.   Nobody stabbed Caesar.

The following entailment relations hold: (20a) is entailed by all others; (20d) entails all others; neither (20b) nor (20c) entails the other. Analogous entailments also hold between the following formulas:

(21)   a. $\neg\exists x.\exists e[\textbf{stabbing}(e, x, \textbf{caesar}) \wedge \textbf{loc}(e) = \textbf{forum} \wedge \textbf{time}(e) = \textbf{noon}]$
        b. $\neg\exists x.\exists e[\textbf{stabbing}(e, x, \textbf{caesar}) \wedge \textbf{loc}(e) = \textbf{forum}]$
        c. $\neg\exists x.\exists e[\textbf{stabbing}(e, x, \textbf{caesar}) \wedge \textbf{time}(e) = \textbf{noon}]$
        d. $\neg\exists x.\exists e[\textbf{stabbing}(e, x, \textbf{caesar})]$

Answer to Exercise 3.1: If the conjoined verb phrases in the sentence (16) are interpreted as event predicates, as in (17a), they cannot be interpreted intersectively. By contrast, if the conjoined verb phrases are interpreted as event quantifiers, as on the present proposal, the intersective interpretation is unproblematic. This is because rule (12), repeated below as (18), ends up causing logical conjunction to have wide scope over the event quantifiers (17b). Of course, in order for the present proposal to work, the meanings of modifiers like *quickly* have to be lifted appropriately, as in (19).

(16)   The ball rotated quickly and heated up slowly.

(17)   ⟦rotate quickly⟧ ⊓ ⟦heat up slowly⟧ =
        a. $\lambda e.\textbf{rotate}(e) \wedge \textbf{quickly}(e) \wedge \textbf{heat-up}(e) \wedge \textbf{slowly}(e)$
        b. $\lambda f.[\exists e.\textbf{rotate}(e) \wedge \textbf{quickly}(e) \wedge f(e)]$
              $\wedge[\exists e'.\textbf{heat-up}(e') \wedge \textbf{slowly}(e') \wedge f(e')]$

(18) $\sqcap_{\langle \tau,\tau\tau\rangle} =_{def} \begin{cases} \wedge_{\langle t,tt\rangle} & \text{if } \tau = t \\ \lambda X_\tau \lambda Y_\tau \lambda Z_{\sigma_1}.X(Z) \sqcap_{\langle \sigma_2,\sigma_2\sigma_2\rangle} Y(Z) & \text{if } \tau = \langle \sigma_1, \sigma_2\rangle \end{cases}$

(19)   ⟦quickly⟧ $= \lambda V.\lambda f.V(\lambda e.\textbf{quickly}(e) \wedge f(e))$

When the verb phrase denotation (17b) is combined with the denotation of the subject, the result predicts that sentence (15) is true just in case there is an event e in which the ball rotated quickly and there is an event e' in which it heated up slowly.

Answer to Exercise 3.2:

(25)   John caught and ate a fish.

Supposing that there are only *agent* and *theme*, the "one-fish" reading of (25) can be represented as follows:

(26) $[\exists x.\textbf{fish}(x) \wedge [\exists e.\textbf{catch}(e) \wedge \textbf{ag}(e) = j \wedge \textbf{th}(e) = x] \wedge [\exists e'.\textbf{eat}(e') \wedge \textbf{ag}(e') = j \wedge \textbf{th}(e') = x]]$

And this is the "two-fish" reading:

(27) $[\exists x.\mathbf{fish}(x) \wedge \exists e.\mathbf{catch}(e) \wedge \mathbf{ag}(e) = j \wedge \mathbf{th}(e) = x] \wedge [\exists y.\mathbf{fish}(y) \wedge \exists e'.\mathbf{eat}(e') \wedge$
$\mathbf{ag}(e') = j \wedge \mathbf{th}(e') = y]$

Answer to Exercise 4.1: If we consider $e_4 = e_1 \oplus e_2 \oplus e_3$, we have a counterexample to the cumulativity assumption for thematic roles, for the following reasons. The themes of e_1, e_2, e_3 are the hole, the rosebush, and the soil, while the theme of e_4 is just the rosebush. The theme of e_4 is not the sum of the themes of e_1, e_2, and e_3. This violates cumulativity.

One way to respond to this challenge is to reject the assumption that the mereological parthood relation should model all parthood relations that can be intuitively posited. In this case, we do not need to assume that e_4 is actually the sum of e_1, e_2, and e_3. Even though the existence of e_4 can be traced back to the occurrence of e_1, e_2, and e_3, nothing forces us to assume that these three events are actually parts of e_4, just like we do not consider a plume of smoke to be part of the fire from which it comes, even though its existence can be traced back to the fire. Without the assumption that e_4 contains e_1 through e_3 as parts, Kratzer's objection against cumulativity vanishes. See also Williams (2009) and Piñón (2011) for more discussion.

Answer to Exercise 4.2:

(14)   Less than three girls sang.

   a.   Wrong paraphrase: "There was an event which contained singing by less than three girls"

The thing that is wrong about this paraphrase is that it is true even if three or more girls sang. For whenever three girls sing, you can take two of them away and the remaining girl still sings. So there is an event in which that girl sings, and the paraphrase is true in virtue of that event.

For a better paraphrase, see the main text.

Answer to Exercise 5.1:

(4) $[\![\text{Mary only } [\text{danced}]_{\text{F}}]\!]_{BoCa} =$
$\exists e[\mathbf{dance}(e) \wedge \mathbf{ag}(e, \mathbf{m}) \wedge$
$\forall e'[\mathbf{ag}(e', \mathbf{m}) \rightarrow \exists e''[\mathbf{dance}(e'') \wedge \mathbf{ag}(e'', \mathbf{m}) \wedge e' \leq e'']]]$
(There is an event of Mary dancing, and every event whose agent is Mary is a subevent of an event of Mary dancing.)

(5) $[\![\text{Only } [\text{Mary}]_{\text{F}} \text{ danced}]\!]_{BoCa} =$
$\exists e[\mathbf{dance}(e) \wedge \mathbf{ag}(e, \mathbf{m}) \wedge$
$\forall e'[\exists x[\mathbf{dance}(e') \wedge \mathbf{ag}(e', x)] \rightarrow \exists e''[\mathbf{dance}(e'') \wedge \mathbf{ag}(e'', \mathbf{m}) \wedge e' \leq e'']]]$
(There is an event of Mary dancing, and every event of someone dancing is a subevent of Mary dancing.)

The results above correctly capture the intuitive truth conditions of the corresponding sentences under the standard cumulativity assumptions of algebraic event semantics:

- If we assume lexical cumulativity for verbs, all parts of a dancing event are themselves dancing events. Thus, (5) assures that all events whose agent is Mary are dancing events, i.e., that Mary did nothing but dance.

- If thematic roles are sum homomorphisms (e.g., the agent of the sum of two events is the sum of their agents), which follows from the cumulativity assumption for theta roles, the agent of all subevents of an event of Mary dancing is Mary. Thus, (5) assures that the agent of all dancing events is Mary, i.e., no one but Mary danced.

   Answer to Exercise 5.2: Yes, assuming we only consider relevant alternatives (which we probably need to assume anyway).

   (35)′   Mary danced in the garden, and she didn't dance anywhere else.

   (36)′   Mary met John in the garden, and she didn't meet anyone else in the garden.

   (37)′   Most knives are such that Mary buttered a toast and didn't do anything else with them.

   (38)′   Most parties are such that Mary drank beer and didn't drink anything else at them.

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