Semantic Theory
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Lexical Semantics II: Event Semantics

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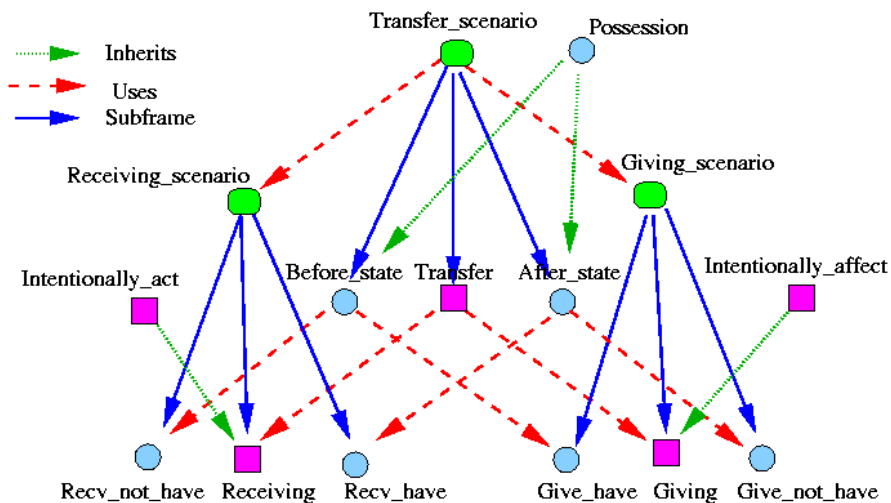

Examples Annotated with Thematic Roles

– *[The window]$_{pat}$ broke*
– *[A rock]$_{inst}$ broke [the window]$_{pat}$*
– *[John]$_{ag}$ broke [the window]$_{pat}$ [with a rock]$_{inst}$*

– *[Peter]$_{ag}$ gave [Mary]$_{rec}$ [the book]$_{pat}$*
– *[Mary]$_{rec}$ received [the book]$_{pat}$ [from Peter]$_{ag}$*

An example for a Frame Instantiation

- COMMERCIAL_TRANSACTION
  - SELLER: Airbus
  - BUYER: China Southern
  - GOODS: five A380 superjumbo planes
  - PRICE: 220 million Euro

Frame-to-Frame-Relations
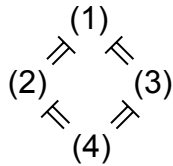
Event Semantics: Donald Davidson's Problem

(1) The gardener killed the baron at midnight in the park

(2) The gardener killed the baron at midnight

(3) The gardener killed the baron in the park

(4) The gardener killed the baron

The interpretation of adjunct constructions

- First attempt:
- (1) $\Rightarrow$ $kill_4(g, b, m, p)$
  (2) $\Rightarrow$ $kill_3(g, b, m)$
  (3) $\Rightarrow$ $kill_2(g, b, p)$
  (4) $\Rightarrow$ $kill_1(g, b)$

The interpretation of adjunct constructions

- A problem: How can the logical entailment relations between the different uses of *kill* be explained?

$$\begin{array}{ccc} & (1) & \\ & \diagup \quad \diagdown & \\ (2) & & (3) \\ & \diagdown \quad \diagup & \\ & (4) & \end{array}$$

The interpretation of adjunct constructions

- Naïve FOL interpretation does not solve the problem:

  - $kill_4(g, b, m, p) \not\models kill_3(g, b, m)$
  - $kill_3(g, b, m) \not\models kill_1(g, b)$
  - etc.

Adjunct Interpretation: Second Attempt

- Fixed arity of the underlying predicate; syntactically not realized predicates are existentially bound:

  (1) $\Rightarrow$ kill(g, b, m, p)

  (2) $\Rightarrow \exists y$ kill(g, b, m, y)

  (3) $\Rightarrow \exists x$ kill(g, b, x, p)

  (4) $\Rightarrow \exists x \exists y$ kill(g, b, x, y)

Another Problem

- The entailment relations are obtained, but:
- What is the correct arity of an event verb/ its underlying predicate?

  The gardener killed the baron at midnight in the park under cover of absolute darkness with a shotgun …

- Also the order of adjuncts (as compared to complements) (usually) has no impact on the truth conditions of the sentence.

Third Attempt: Higher-order Logic

- Adjuncts are analysed as sentence modifiers (type <t,t>):
  (1) $\Rightarrow$ in the park(at-midight(kill(g, b)))
- The analysis solves the arity problem, but entailment relations arelost again:
  at-midnight(kill(g, b)) $\nvDash$ kill(g, b)
- Note also that the order of adjuncts (as compared to complements) (usually) has no impact on the truth conditions of the sentence.

Davidson's Solution

- Verbs expressing events have an additional argument position for an event variable, which is not realised at linguistic surface:
  $kill \Rightarrow \lambda x \lambda y \lambda e.kill(e,x,y)$, where kill: <e,<e,<e,t>>>
- Adjuncts express two-place relations between events and the respective "cirumstantial entities" (a time, a location, ...)
- In finite/tensed clauses, the event variable is existentially bound:
  The gardener killed the baron at midnight in the park
  $\Rightarrow \exists e[\ kill(e,g,b) \wedge time(e, m) \wedge location(e, p)\ ]$

Davidson's Solution

- Event verbs are represented by relations of a fixed arity (number of syntactic complements +1)
- Event verbs have an argument position occupied by an event variable.
- Adjuncts are represented by two-place relations.
- Entailments follow straightforwardly, as well as the fact that adjunct semantics is order-independent:
- $\exists e[\ \text{kill}(e,g,b) \wedge \text{time}(e, m) \wedge \text{location}(e, p)\ ]$

  $I= \exists e[\ \text{kill}(e,g,b) \wedge \text{time}(e, m)\ ]$

  $I= \exists e[\ \text{kill}(e,g,b)\ ]$

Compositional Semantics for Adjunct constructions

- Adjuncts are analysed as intersective modifiers for event predicates (type: <<e,t>,<e,t>>), in full analogy to intersective noun modifiers (adjectiveds, PPs):
  - *red* $\Rightarrow \lambda F \lambda x[F(x) \wedge \text{red}(x)]$
  - *at midnight* $\Rightarrow \lambda E \lambda e[E(e) \wedge \text{time}(e, \text{midnight})]$

  The gardener killed the baron at midnight

  $\Rightarrow \lambda E \lambda e[E(e) \wedge \text{time}(e, \text{midnight})](\lambda e.\text{kill}(e, g, b))$

  $\Leftrightarrow \lambda e.\text{kill}(e, g, b) \wedge \text{time}(e, \text{midnight})$

  In finite clauses, the event variable is eventually bound:

  $\Rightarrow \exists e.\text{kill}(e, g, b) \wedge \text{time}(e, \text{midnight})$

Uniform treatment of modifiers

- One semantic representation for the use of PPs as adjuncts and postnominal modifiers:

  in the park $\Rightarrow \lambda F \lambda x[F(x) \wedge location(x, p)]$

- Local adjunct /event modifier

  [[The gardener killed the baron] in the park]

- Post-nominal modifier of an event-denoting deverbal noun:

  The [[murder] in the park]

- Post-nominal modifier of an standard common noun:

  The [[pavillon] in the park]

  Note: Event semantics provides a natural interpretation for deverbal common nouns.

„Neo-Davisonian" Event Semantics

- Complements can be treated analogously to adjuncts: Event verbs are represented as one-place event predicates. Thematic roles are two-place relations linking arguments to the event denoted by the verb:

  The gardener killed the baron at midnight in the park

  $\Rightarrow \exists e\ [kill(e) \wedge ag(e,g) \wedge pat(e,b) \wedge time(e,m) \wedge location(e,p)]$

- Neo-Davidsonian semantics allows the partioning of semantic information into minimal pieces, but:

- Proper interpretation of the role relations anticipates knowledge of the event predicate, to some extent.

Event anaphora in DRT

- *The gardener killed the baron . It happened at midnight.*
- *Yesterday, I went by train from Hamburg to Saarbrücken. That was a boring trip.*

- Event referents
  - a new kind of discourse referents
  - are introduced (e.g.) by finite clauses
  - and can be referred to by nominal anaphoric expressions

Event anaphora in DRT

•*The gardener killed the baron . It happened at midnight.*

e, g, b
gardener(g)   baron(b)   kill(e,g,b)

e, g, b,e'
gardener(g)   baron(b)   kill(e,g,b)   midnight(m)   time(e',m)   e'=e

FOL Model Structure with Events

- Like standard FOL Model Structure M = <U,V>, except that the universe is subdivided into
  - a set of standard individuals U_S, and
  - a set of events U_E, which is partially ordered by a "temporally precedes" relation.

Temporal relations in an Event Semantics

- Event Semantics allows the explicit representation of tense and temporal relations in FOL/DRT

  John left $\Rightarrow \exists e[\, leave(e, j^*) \wedge e < e_u\,]$

  where < is interpreted as temporal precedence, and is the utterance event.

  John left, after Peter had arrived

  $\Rightarrow \exists e_1 \exists e_2[\, leave(e_1, j^*) \wedge\ e_1 < e_u \wedge arrive(e_2, p) \wedge e_2 < e_1\,]$

Temporal relations in an Event Semantics

John left, after Peter had arrived

j, e, p, e'

leave(e,j)
$e < e_u$

arrive(e',p)
$e' < e$

Events, activities, states

- Davidsonian event semantics works well for verbs expressing individual events that have a specific temporal location (like in *The gardener killed the baron* or *John left*).
- Activities (*John is walking, working*), usually expressed by the progressive form in English, lack a precise temporal location: If I am working during a time interval, I am also working during all sub-intervals – representation via discourse referents is problematic.
- Events and activities are usually subsumed under the common concept of "eventualities", in contrast to states (*John lives in Saarbrücken*, *John likes Mary*).
- Event-denoting expressions resemble ordinary "countable" common nouns. Activities and states are semantically similar to plurals and mass nouns.

What else?

- Semantics of tense and aspect is a large and important research area in natural language semantics.
- Unfortunately, we had no opportunity to look into it, as well as into many other interesting questions of NL Semantics, e.g. the semantics of
  - plurals, mass nouns, collective predicates
  - spatial prepositions
  - adjectives, comparatives, superlatives
  - vague expressions
  - metaphors and metonymies