Semantic Theory
week 6 – Events and Roles

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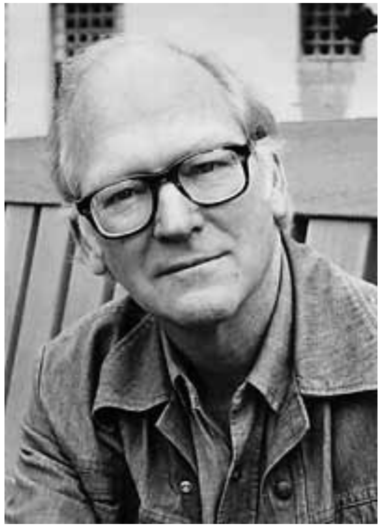
Davidson's event semantics



Verbs expressing events have an additional event argument, which is not realised at linguistic surface:

- kill $\mapsto$ $\lambda y \lambda x \lambda e(kill'(e,x,y))$ :: $\langle e,\langle e,\langle e,t\rangle\rangle\rangle$ *arity = n+1*

Sentences denote sets of events:

- $\lambda y \lambda x \lambda e(kill'(e,x,y))(b')(g') \Rightarrow^{\beta} \lambda e(kill'(e, g', b'))$ :: $\langle e,t\rangle$

Existential closure turns sets of events into truth conditions

- $\lambda P \exists e(P(e))$ :: $\langle\langle e,t\rangle,t\rangle$

- $\lambda P \exists e(P(e))(\lambda e(kill'(e,g',b'))) \Rightarrow^{\beta} \exists e(kill'(e,g',b'))$ :: t

Davidson (1967, 1980)

Interpreting events

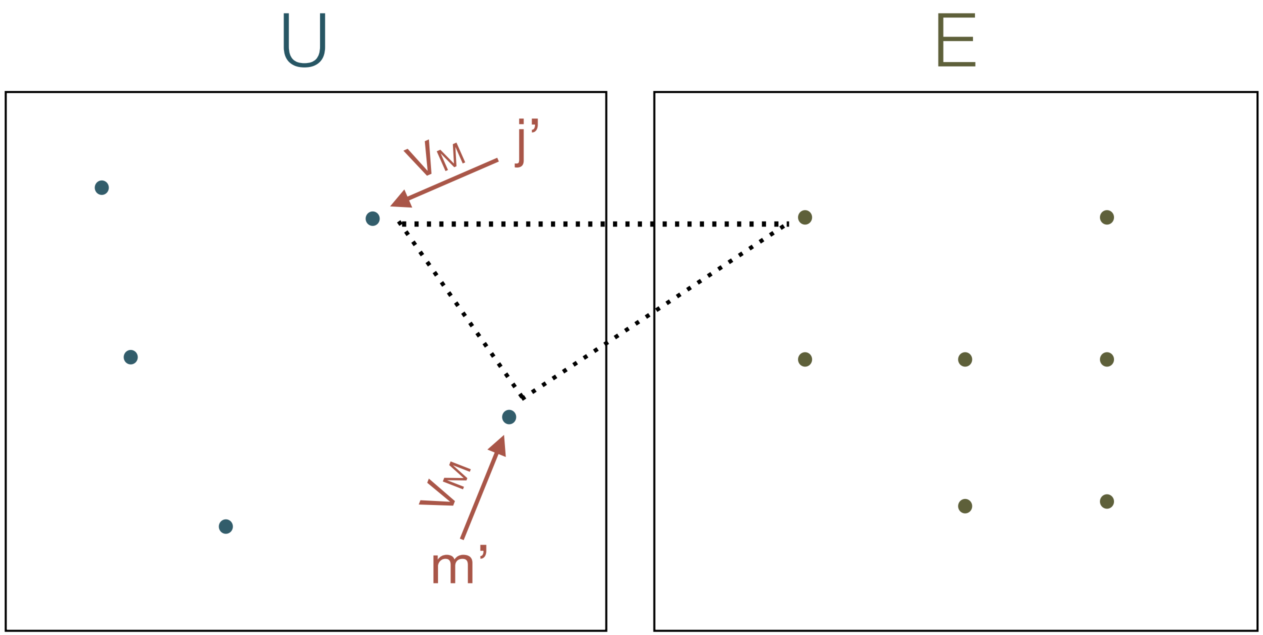
Events are interpreted relative to a model structure $M = \langle U, E, V \rangle$, and a sort-specific variable assignment g, where

- U is a set of "standard individuals" or "objects"
- E is a set of events
- $U \cap E = \varnothing$,
- V is an interpretation function like in first order logic
- $g(x) \in U$ for $x \in VAR_U$ $VAR_U = \{ x, y, z, \ldots , x_1, x_2, \ldots \}$ (Object variables)
- $g(e) \in E$ for $e \in VAR_E$ $VAR_E = \{ e, e', e'', \ldots, e_1, e_2, \ldots \}$ (Event variables)

Interpreting events (cont.)

John kisses Mary $\mapsto \exists e\ (kiss(e, j', m'))$

$[\![\exists e\ (kiss(e, j', m'))]\!]^{M,g} = 1$
iff there is an $s \in E$ such that $[\![kiss(e, j', m')]\!]^{M,g[e/s]} = 1$
iff there is an $s \in E$ such that $\langle s, V_M(j'), V_M(m') \rangle \in V_M(kiss)$



Advantages of Davidsonian events

- ☑ Intuitive representation and semantic construction for adjuncts
- ☑ Uniform treatment of verb complements
- ☑ Uniform treatment of adjuncts and post-nominal modifiers
- ☑ Coherent treatment of tense information
- ☐ Highly compatible with analysis of semantic roles

Verbal arguments; a related problem?

(1) *John* ***broke*** *the window with a rock.*

(2) *A rock* ***broke*** *the window.*

(3) *The window* ***broke****.*

And we're back to the same entailment issue:

$\exists e(\text{break}_3(e, j, w, r)) \not\models \exists e(\text{break}_2(e, r, w)) \not\models \exists e(\text{break}_1(e, w))$

Semantic/Thematic roles

agent patient instrument

(1) *John* ***broke*** *the window with a rock.*

$\mapsto \exists e\ [break(e) \wedge agent(e, j) \wedge patient(e, w) \wedge instrument(e, r)]$

(2) *A rock* ***broke*** *the window.*

$\mapsto \exists e\ [break(e) \wedge patient(e, w) \wedge instrument(e, r)]$

(3) *The window* ***broke****.*

$\mapsto \exists e\ [break(e) \wedge patient(e, w)]$

In standard FOL: Thematic roles are implicitly represented by the canonical order of the arguments

In Davidsonian event semantics: Thematic roles are two-place relations between the event denoted by the verb, and an argument role filler.

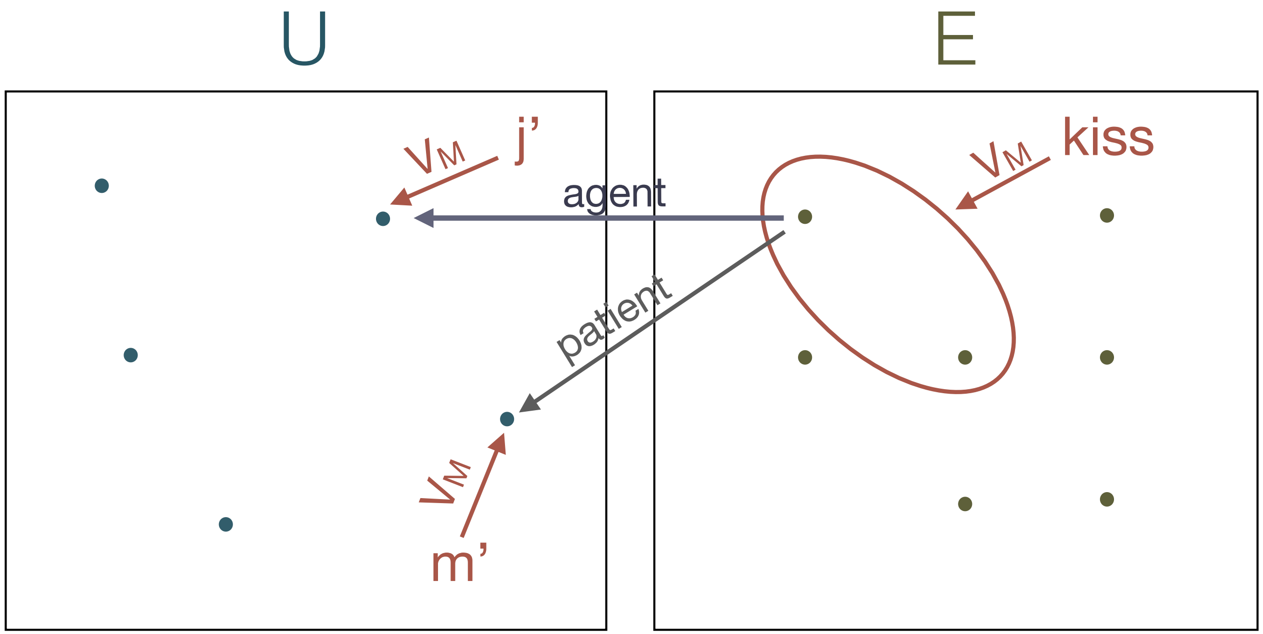
Interpretation of events with thematic roles

John kisses Mary $\mapsto$ $\exists e\,(kiss(e) \wedge agent(e, j') \wedge patient(e,m'))$

$[\![\ \exists e\,(kiss(e) \wedge agent(e, j') \wedge patient(e,m'))\ ]\!]^{M,g} = 1$

iff there is an $s \in E$ such that $[\![kiss(e)]\!]^{M,g[e/s]} = 1$ and $[\![\ agent(e, j')]\!]^{M,g[e/s]} = 1$ and $[\![patient(e,m')]\!]^{M,g[e/s]} = 1$

iff there is an $s \in E$ such that $s \in V_M(kiss)$ and $\langle s, V_M(j')\rangle \in V_M(agent)$ and $\langle s, V_M(m')\rangle \in V_M(patient)$



Thematic roles & verbal differences/similarities

Different verbs allow different thematic role configurations

(1) a. *John **broke** the window with a rock* ⟶ agent, patient, instrument
b. *John **smiled** at Mary* ⟶ agent, recipient

(2) a. *The window **broke*** ⟶ allows inanimate subject
b. **The **bread** cut* ⟶ does not allow inanimate subject

Thematic roles capture equivalences and entailment relations between different predicates

(3) a. *Mary **gave** Peter the book*
b. *Peter **received** the book from Mary*

$\forall e[give(e) \leftrightarrow receive(e)] \models (3a) \leftrightarrow (3b)$

Determining the role inventory

Fillmore (1968): "thematic roles form a small, closed, and universally applicable inventory conceptual argument types."

A typical role inventory might consist of the roles:

- Agent, Patient, Theme, Recipient, Instrument, Source, Goal, Beneficiary, Experiencer.

But… there are some difficult cases:

(1) *Lufthansa is replacing its 737s with Airbus 320*

(2) *John sold the car to Bill for 3,000€*

(3) *Bill bought the car from John for 3,000€*

Semantic corpora with thematic roles

- Propbank: includes a separate role inventory for every lemma
- FrameNet: “Frame-based” role inventories

Frames are structured schemata representing complex prototypical situations, events, and actions

(1) *[$_{\text{Agent}}$ Lufthansa] is replacing$_{\text{Frame: REPLACING}}$ [$_{\text{Old}}$ its 737s] [$_{\text{New}}$ with Airbus A320s]*

(2) *[$_{\text{Agent}}$ Lufthansa] is substituting$_{\text{Frame: REPLACING}}$ [$_{\text{New}}$ Airbus A320s] [$_{\text{Old}}$ for its 737s]*

Semantic corpora with thematic roles (cont.)

Propbank (Palmer et al. 2005): Annotation of Penn TreeBank with predicate-argument structure.

(1) [$_{\text{Arg0}}$ Lufthansa] is replacing [$_{\text{Arg1}}$ its 737s] [$_{\text{Arg2}}$ with Airbus A320s]

Pred	replace
Arg0	Lufthansa
Arg1	its737s
Arg2	AirbusA320s

(2) [$_{\text{Arg0}}$ Lufthansa] is substituting [$_{\text{Arg1}}$ Airbus A320s] [$_{\text{Arg2}}$ for its 737s]

Pred	substitute
Arg0	Lufthansa
Arg1	AirbusA320s
Arg2	its737s

FrameNet (Baker et al. 1998): A database of frames and a lexicon with frame information

(3) [$_{\text{Agent}}$ Lufthansa] is replacing$_{\text{Frame: REPLACING}}$ [$_{\text{Old}}$ its 737s] [$_{\text{New}}$ with Airbus A320s]

(4) [$_{\text{Agent}}$ Lufthansa] is substituting$_{\text{Frame: REPLACING}}$ [$_{\text{New}}$ Airbus A320s] [$_{\text{Old}}$ for its 737s]

Frame	REPLACING
Agent	Lufthansa
Old	its737s
New	AirbusA320s

Advantages of Davidsonian events

- ☑ Intuitive representation and semantic construction for adjuncts
- ☑ Uniform treatment of verb complements
- ☑ Uniform treatment of adjuncts and post-nominal modifiers
- ☑ Plausible treatment of tense information
- ☑ Compatible with analysis of semantic roles

… but how does it combine with other semantic constructs?

A problem with events and quantification

John kissed Mary

$\mapsto$ λP.P(j') [λP.P(m')(λyλxλe [kiss(e) ∧ agent(e,x) ∧ patient(e,y)])]

$\Rightarrow^{\beta}$ λe [kiss(e) ∧ agent(e,j') ∧ patient(e,m')]

$\Rightarrow^{\text{E-CLOS}}$ ∃e [kiss(e) ∧ agent(e,j') ∧ patient(e,m')]

John kissed every girl

$\mapsto$ λP.P(j') [λP.∀x(girl'(x) → P(x))(λyλxλe [kiss(e) ∧ agent(e,x) ∧ patient(e,y)])]

$\Rightarrow^{\beta}$ λe [∀x(girl'(x) →kiss(e) ∧ agent(e,j') ∧ patient(e,x)]

$\Rightarrow^{\text{E-CLOS}}$ ∃e [∀x(girl'(x) → kiss(e) ∧ agent(e,j') ∧ patient(e,x)]

Two solutions to the event quantification problem

Solution I

Interpret sentences as generalized quantifiers over events: $\langle\langle e,t\rangle,t\rangle$ instead of $\langle e,t\rangle$ (E-CLOS part of lexical semantics) (Champollion, 2010; 2015)

kiss $\mapsto \lambda F_{\langle v,t\rangle}.\exists e\,(\text{kiss}(e) \wedge F(e)) :: \langle\langle v,t\rangle,t\rangle \approx \{\, F \mid F \cap \text{KISS} \neq \varnothing \}$

separate type for events!

Solution II

Introduce separate types for regular NPs and quantified NPs, and restrict existential closure to regular NPs (Winter & Zwarts, 2011; de Groote & Winter, 2014)

john $\mapsto j :: e$

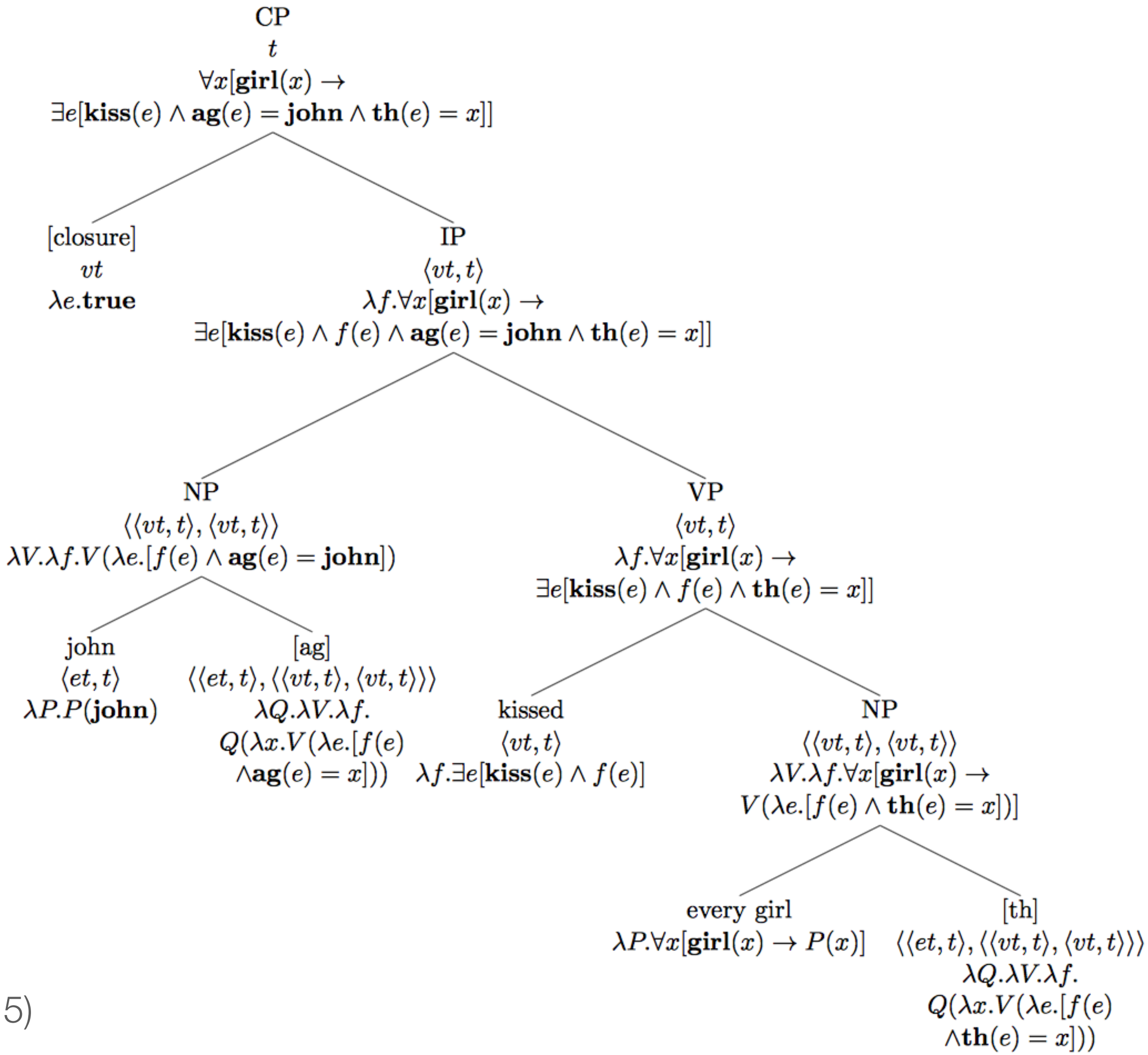
every girl $\mapsto \lambda P\lambda Q.\forall x(\text{girl}(x) \rightarrow Q(x)) :: \langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$

kiss $\mapsto \lambda x\lambda y\lambda e.\text{kiss}(e,x,y) :: \langle e,\langle e,\langle v,t\rangle\rangle\rangle$

e-clos $\mapsto \lambda P.\exists e(P(e)) :: \langle\langle v,t\rangle,t\rangle$

separate type for events!

Solution I: Sentences as GQs over events



(Champollion, 2010; 2015)

Solution II: Type-restriction for existential closure

$$\dfrac{\vdash \textsc{every} : N \to (NP \to S) \to S \qquad \vdash \textsc{girl} : N}{\vdash \textsc{every girl} : (NP \to S) \to S}\ (1)$$

$$\dfrac{\dfrac{\vdash \textsc{kissed} : NP \to NP \to V \qquad x : NP \vdash x : NP}{x : NP \vdash \textsc{kissed}\, x : NP \to V} \qquad \vdash \textsc{john} : NP}{x : NP \vdash \textsc{kissed}\, x\, \textsc{john} : V}\ (2)$$

$$\dfrac{\dfrac{\vdash \textsc{e-clos} : V \to S \qquad \begin{matrix} \vdots\ (2) \\ x : NP \vdash \textsc{kissed}\, x\, \textsc{john} : V \end{matrix}}{x : NP \vdash \textsc{e-clos}\,(\textsc{kissed}\, x\, \textsc{john}) : S}}{\vdash \lambda x.\, \textsc{e-clos}\,(\textsc{kissed}\, x\, \textsc{john}) : NP \to S}\ (3)$$

$$\dfrac{\begin{matrix} \vdots\ (1) \\ \vdash \textsc{every girl} : (NP \to S) \to S \end{matrix} \qquad \begin{matrix} \vdots\ (3) \\ \vdash \lambda x.\, \textsc{e-clos}\,(\textsc{kissed}\, x\, \textsc{john}) : NP \to S \end{matrix}}{\vdash \textsc{every girl}\,(\lambda x.\, \textsc{e-clos}\,(\textsc{kissed}\, x\, \textsc{john})) : S}$$

(Winter & Zwarts, 2011; de Groote & Winter, 2014)