The Logic of German *ung*–Nominals

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Structure of the talk

- Motivation
- Some Data: *ung*–Nominals and their Disambiguation in Verbal Contexts
- DRS–constructions for *ung*–Nominals as Arguments of Verbs
- Logic Programming and integrity constarints
- DRSs as Integrity Constraints
- Integrity Constraints for DRS–constructions

- Semantic Representation of NL Sentences, Texts and Discourses: Discourse Representation Theory.

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- Inferences from (D)iscourse (R)epresentation (S)tructures.
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- German Deverbal Nouns on *-ung*:

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- *Regierung* (from *regieren* (to govern))

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- e (event)
- s (result state)
- o (other); can be material or abstract object either created during the event described by the verb or brought onto the scene by that event.

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- like other ambigous words, *ung*–nouns are often disambiguated by context.
- One source of desambiguation: the selection restrictions on arguments of predicates (mostly verbs).

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6. Die Absperrung der Botschaft wurde aufgehoben.
   The blocking-off of-the embassy was lifted.

(E1) absperren

absperren	verb e	DP: nom x	DP:acc y (+z) Territory Road/Plot of land/ Building/ (-z) Utility	(*mit*-PP) [z] [fence/ wall barricade]
SEL.RESTR.	event(e)	Agent(x)		

Semantic Representation:

	s_0 s_1 [s_2 s_3]	
	$s_0 \supset\subset e$	
s_0: accessible(y)	s_1:¬ accessible(y)	[s_2:present(z)]
	CAUSE(e,s_1)	[s_3: sperr(z,y)]
	Agent(e) = x	[CAUSE(e,s_2)]
		[CAUSE(e,s_3)]

(E1) Absperrung

Absperrung	noun	(*durch*-PP)	(DP:gen)	(*mit*-PP)
(i)	e	x	y	[z]
SEL.RESTR.	event(e)	Agent(x)	(+z) territory road/plot of land/building/ (-z)Utility	[fence/wall/ barricade]

Semantic Representation:

s_0 s_1 [s_2 s_3]

$s_0 \supset\subset e$

s_0: accessible(y)

s_1:¬ accessible(y)
CAUSE(e,s_1)
Agent(e) = x

[s_2:present(z)]
[s_3: sperr(z,y)]
[CAUSE(e,s_2)]
[CAUSE(e,s_3)]

(E1) Absperrung

Absperrung	noun	(DP:gen)	(*mit*-PP)
(ii)	s	y	[z]
SEL.RESTR.	state(s)	(+z) territory road/lot of land/building/ (-z)utility	[fence/wall/ barricade]

Semantic Representation:

$[s_2 \; s_3]$

s:¬ accessible(y)

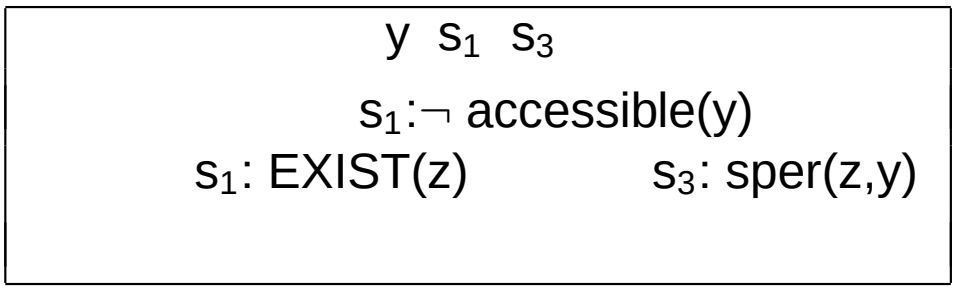
$[s_1$: PRES(z)]
$[s_3$: sperr(z,y)]

(E1) Absperrung

Absperrung	noun
(iii)	z
	fence/ wall/ barricade

SEL.RESTR.

Semantic Representation:



(E2) *anstreichen*

anstreichen	verb e	DP:nom x	DP:acc y
SEL. RESTR.	event(e)	Agent(x)	Material object(y)

Semantic Representation:

e: anstreichen(x,y)

(D1) *die Absperrung der Botschaft*

y b
$\text{Absperrung}_{\{e,s,o\}}(y)$ Botschaft(b) $\rho(y,b)$

(D2) *die Absperrung der Botschaft wurde angestrichen*

(i)

$$t\ ev_{\langle +/-,\ +,\ + \rangle}\ y\ \ b\ \ [\ x\ ]$$

$$ev \subseteq t \prec n\ \ \text{Absperrung}_{\{e,s,o\}}(y)\ \ \text{Botschaft}(b)\ \ \rho(y,b)$$

e: anstreichen(x,y)

(ii)

$$t\ ev_{\langle +/-,\ +,\ + \rangle}\ y\ \ b\ \ [\ x\ ]$$

$$ev \subseteq t \prec n\ \ \text{Absperrung}_{\{o\}}(y)\ \ \text{Botschaft}(b)\ \ \text{Poss}(b,y)$$

e: anstreichen(x,y)

(D3) *die Absperrung der Botschaft wurde unterbrochen*

(i)

$$t \; e_{\langle +/-,+,+ \rangle} \; y \; b \; [\, x \,]$$

$$e \subseteq t \prec n \quad \text{Absperrung}_{\{e,s,o\}}(y) \qquad \text{Botschaft}(b) \quad \rho(y,b)$$

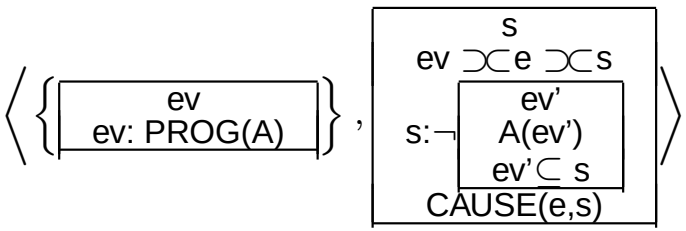
$$\text{e: unterbrechen}(x,y) \qquad \text{action}(y) \vee \text{activity}(y) \vee \text{state}(y)$$

(E3) *unterbrechen*

unterbrechen	verb	DP:nom	DP:acc
	e	x	y
	event(e)	Agent(x)	action / activity / state

Semantic Representation:

(i) Activity type(A) $\vee$ State type(A)



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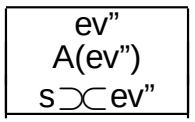
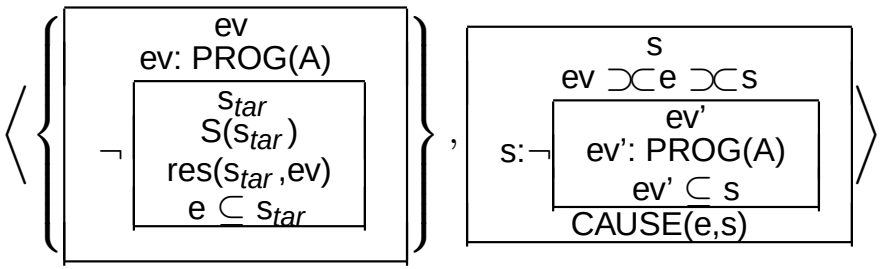


(ii) Action type(A) TARGETST(A,S)



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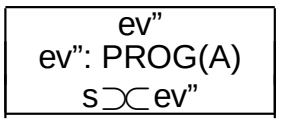

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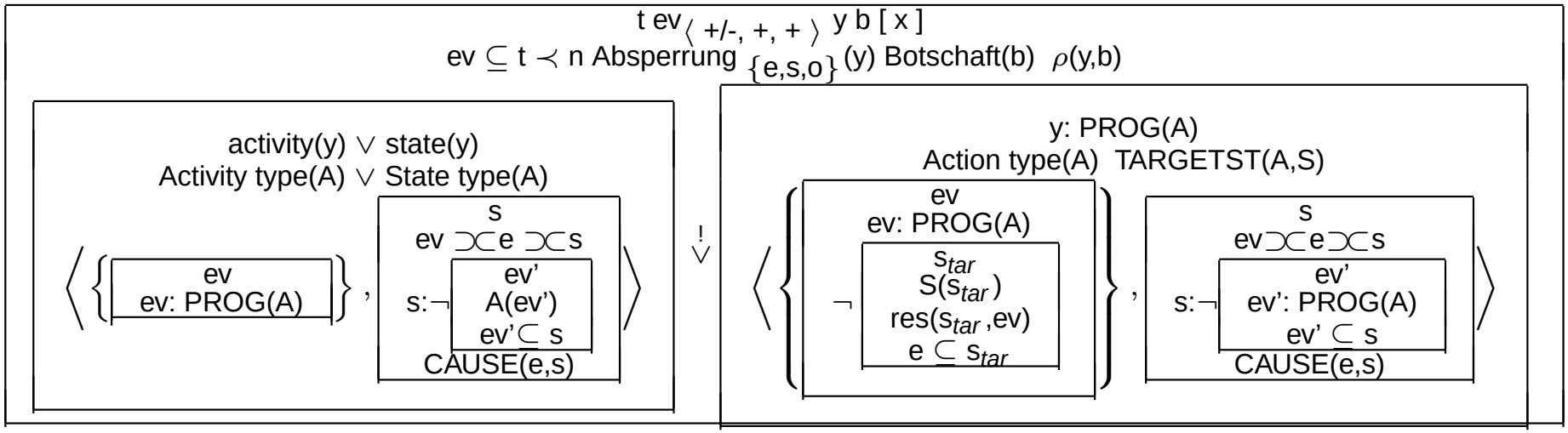

(D3) *die Absperrung der Botschaft wurde unterbrochen*

(iii)

$$t \; e_{\langle -, +, + \rangle} \; y \; b \; [x]$$

$$e \subseteq t \prec n \; [\text{Absperrung}_{\{e\}}(y)] \; \text{Botschaft}(b)$$

$$\text{Action type}(\text{PROG}(^{\wedge}\lambda \text{ev. ev:absperren}(x,b)))$$

$$\text{TARGETST}(\text{PROG}^{\wedge}\lambda \text{ev. ev:absperren}(x,b)), \text{PROG}(^{\wedge}\lambda \text{s.s: } \neg\text{accessible}(b)))$$

$$y\text{: PROG}(^{\wedge}\lambda \text{ev. ev:absperren}(x,b))$$

$$\neg \; \boxed{\begin{array}{c} s_{tar} \\ \hline s_{tar}\text{:}\neg\text{accessible}(b) \\ e \subseteq s_{tar} \\ \text{res}(s_{tar}, y) \end{array}} \qquad s\text{: } \neg \; \boxed{\begin{array}{c} ev' \\ \hline ev'\text{: PROG}(^{\wedge}\lambda \text{ev. ev:absperren}(x,b)) \\ ev' \subseteq s \end{array}}$$

(D3) *die Absperrung der Botschaft wurde unterbrochen*

(iv)

$$t \; e_{\langle -, +, + \rangle} \; y \; b \; [x]$$

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$$\text{Action type}(\text{PROG}(^{\wedge}\lambda ev.\ ev{:}\text{absperren}(x,b)))$$

$$\text{TARGETST}(\text{PROG}^{\wedge}\lambda ev.\ ev{:}\text{absperren}(x,b)), \text{PROG}(^{\wedge}\lambda s.s{:}\ \neg\text{accessible}(b)))$$

$$y{:}\ \text{PROG}(^{\wedge}\lambda ev.\ ev{:}\text{absperren}(x,b))$$

$$\neg \boxed{\begin{array}{c} s_{tar} \\ s_{tar}{:}\neg\text{accessible}(b) \\ e \subseteq s_{tar} \\ \text{res}(s_{tar}, y) \end{array}} \quad s{:}\ \neg \boxed{\begin{array}{c} ev' \\ ev'{:}\ \text{PROG}(^{\wedge}\lambda ev.\ ev{:}\text{absperren}(x,b)) \\ ev' \subseteq s \end{array}}$$

$$\text{PROG}(^{\wedge}\ \lambda ev.ev{:}\text{absperren}(x,b))(ev'')$$

$$s \supset\subset ev''$$

Tense, aspect and planning

Planning is defined as setting a goal and devising a sequence of actions that will achieve that goal, taking into account events in, and properties of the world and the agent.

goal G can be achieved in circumstances C

goal G can be achieved in circumstances C + D

The semantics of tense and aspect is profoundly shaped by concerns with goals, actions and consequences . . . temporality in the narrow sense of the term is merely one facet of this system among many. Such concerns seem to be the force that determines the logic that is required to capture its semantics as the particular kind of dynamic system outlined above, the structure of episodic memory, and the computational process of inference. [Steedman 1997]

Link between planning and linguistic processing

View a sentence S as a goal (make S true) to be achieved by updating the discourse model.

The language of the event calculus

- Ontology: eventtypes, fluents (time-dependent properties, such as activities), real numbers, individuals.
- Terms include fluent-valued and eventtype-valued functions.

- $\mathit{Initially}(f)$
- $\mathit{Happens}(e, t)$
- $\mathit{Initiates}(e, f, t)$
- $\mathit{Terminates}(e, f, t)$

The language of the event calculus: Continued

- Primitive predicates 3: Continuous change
- $\mathit{Releases}(e, f, t)$
- $\mathit{Trajectory}(f_1, t, f_2, d)$

- Primitive predicates 3: no f-relevant events between t_1 and t_2
- $\mathit{Clipped}(t_1, f, t_2)$

- Primitive predicates 4: Truth predicate
- $\mathit{HoldsAt}(f, t)$

Axiomatization: an example

If a fluent holds initially or has been initiated by some event occurring at time t and no event terminating f has occurred between t and $t' > t$, then f holds at t'.

Axiom

$$Initially(f) \rightarrow HoldsAt(f, 0)$$

Axiom

$$HoldsAt(f, r) \wedge r < t \wedge \neg\exists s < r\, HoldsAt(f, s) \wedge \neg Clipped(r, f, t) \rightarrow HoldsAt(f, t)$$

Axiom

$$Happens(e,t) \wedge Initiates(e,f,t) \wedge$$
$$t < t' \wedge \neg Clipped(t,f,t') \rightarrow HoldsAt(f,t')$$

Axiom

$$Happens(e,t) \wedge Initiates(e,f_1,t) \wedge$$
$$t < t' \wedge t' = t + d \wedge Trajectory(f_1,t,f_2,d) \wedge \neg Clipped(t,f_1,t') \rightarrow$$
$$HoldsAt(f_2,t')$$

Axiom

$$Happens(e,s) \wedge t < s < t' \wedge$$
$$(Terminates(e,f,s) \vee Releases(e,f,s)) \rightarrow Clipped(t,f,t')$$

(1) It was hot. Jean took off his sweater.

World knowledge contains no link to the effect that taking off one's sweater changes the temperature. Since it is hot at some time before *now*, the state *hot* must either hold initially or have been initiated. The latter requires an event, which is however not given by the discourse. Therefore *hot* holds initially. Similarily no terminating event is mentioneed, so that *hot* extends indefinitely, and it follows that the event described by the second sentence must be positioned inside *hot*.

Integrity constraints: Motivation

Given q and

$\phi_1 \rightarrow q$

$\phi_2 \rightarrow q$

$\vdots$

$\phi_n \rightarrow q$

we want to conclude that q can only be the case because one of the ϕ_i is the case.

Example: The perfect

(2) I have caught the flu.

$Initiates(e, f, t)$

$HoldsAt(f, now)$

If a fluent has been initiated by some event occurring at time t and no event terminating f has occurred between t and $t' > t$, then f holds at t'.

HoldsAt(f, now) *succeeds*

$$\{Initiates(e, f, t)\}$$

$$\downarrow \textbf{update}$$

$$\{Initiates(e, f, t), Happens(e, t)\}$$

$\neg Clipped(t, f, now)$ is established by negation as failure.

(3) Max arrived.

m	t	e
$Max(m)$	$t < n$	$e \subseteq t$
	$e : arrive(m)$	

$$max(\mathrm{x}, \mathrm{t}) \rightsquigarrow max[\mathrm{x}, \hat{\mathrm{s}}]$$

$$arrive(\mathrm{x}, \mathrm{t}) \rightsquigarrow \exists \mathrm{s}.arrive[\mathrm{x}, \mathrm{s}]$$

(4) $?HoldsAt(max[\mathrm{x}, \hat{\mathrm{s}}], \mathrm{t}), Happens(\exists \mathrm{s}.arrive[\mathrm{x}, \mathrm{s}], \mathrm{t}),$
$\mathrm{t} < now,$ succeeds

- $\mathit{Initially}(\mathit{barrier}(0))$
- $\mathit{HoldsAt}(\mathit{barrier}(m), t) \wedge \mathit{HoldsAt}(\mathit{construct}, t) \rightarrow \mathit{Happens}(\mathit{finish}, t)$
- $\mathit{Initiates}(\mathit{start}, \mathit{construct}, t)$
- $\mathit{Initiates}(\mathit{finish}, \mathit{barrier}(m), t)$
- $\mathit{Terminates}(\mathit{finish}, \mathit{construct}, t)$
- $\mathit{HoldsAt}(\mathit{barrier}(x), t) \rightarrow \mathit{Trajectory}(\mathit{construct}, t, \mathit{barrier}(x + g(d)), d)$
- $\mathit{Releases}(\mathit{start}, \mathit{barrier}(0), t)$

Absperrung der Botschaft

$absperr(x, y, t)$
$absperr(x, b, t)$

Define via Fefermann coding a term:

$$e = \exists t.absperr[x, b, t]$$

Definition

Suppose a scenario for the fluent f is given. In the context of this scenario, the event e is interpreted using f by *hierarchical planning* if $Happens(start_f, s) \wedge s < r < t \wedge HoldsAt(f, r) \wedge Happens(finish_f, t) \rightarrow Happens(e, r)$

$Happens(start_{construct}, s) \wedge s \leq r \leq t \wedge HoldsAt(construct, r) \rightarrow Happens(e, r)$

Assume eventtype *verhinder* is given. We then arrive at the following integrity constarint:

$$Happens(e,t), Happens(verhinder(e),t), t < now \ succeeds$$

Problem: nothing follwows from this

$$Happens(e,t), Happens(behinder(e),t), t < now \ succeeds$$

(5) Die Absperrung der Botschaft wurde verhindert.

$$\mathit{Happens}(e,t), \mathit{Happens}(\mathit{finish},t), t < \mathit{now}\ \mathit{fails}$$

(6) Die Absperrung der Botschaft wurde abgebrochen.

$Happens(start, s) \wedge Initiates(start, f, s) \wedge s < r \leq t \wedge \neg Happens(finish, r) \wedge Happens(e', t) \wedge Terminates(e', f, t) \rightarrow Happens(abbrechen(e), t)$,

where e is again the eventtype defined via hierarchical planning.

$$Happens(e, t), Happens(abbrechen(e), t), t < now\ succeeds$$

(7) Die Absperrung der Botschaft wurde unterbrochen.

$$Happens(start, s) \wedge Initiates(start, f, s) \wedge s < r \leq t \wedge \neg Happens(finish, r) \wedge Happens(e', t) \wedge Terminates(e', f, t) \wedge t < t' \wedge Happens(e'', t') \wedge Initiates(e'', f, t') \rightarrow Happens(unterbrechen(e), t'),$$

where e is again the eventtype defined via hierarchical planning.

$$Happens(e, t), Happens(unterbrechen(e), t), t < now\ succeeds$$

(8) Die Absperrung der Botschaft wurde unterbrochen und nie wieder aufgenommen.

$$Happens(abbrechen(e), t') \vee (\ldots \wedge Happens(e'', t') \wedge Initiates(e'', f, t')) \rightarrow Happens(unterbrechen(e), t')$$

(9) Die Absperrung der Botschaft wurde aufgehoben.

Die Absperrung der Botschaft $= \mathit{barrier}(m)$
$\mathit{Happens}(\mathit{aufheben}(f,t) \rightarrow \neg \mathit{HoldsAt}(f,t)$
Derive: $\neg \mathit{HoldsAt}(\mathit{barrier}(m),t)$

Axiom

$\mathit{HoldsAt}(f,r) \wedge r < t \wedge \neg \exists s < r \mathit{HoldsAt}(f,s) \wedge$
$\neg \mathit{Clipped}(r,f,t) \rightarrow \mathit{HoldsAt}(f,t)$

Axiom

$$Happens(e, s) \wedge t < s < t' \wedge (Terminates(e, f, s) \vee Releases(e, f, s)) \rightarrow Clipped(t, f, t')$$

$Relases(e, barrier(m), s)$ or $Terminates(e, barrier(m), s)$

(10) Jede Absperrung der Botschaft wurde verhindert.

$$Happens(e, t), Happens(finish_{construct}, t), t < now \; fails$$