Semantic Theory
Lecture 14: More Topics in Semantic Theory

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DRS: 2nd Extension

- **A discourse representation structure (DRS) K** is a pair $\langle U_K, C_K \rangle$, where
  - U_K is a set of discourse referents
  - C_K is a set of conditions
- **(Irreducible) conditions:**
  - $R(u_1, \ldots, u_n)$ — R n-place relation, $u_i \in U_K$
  - $u = v$ — $u, v \in U_K$
  - $u = a$ — $u \in U_K$, a is a proper name
  - $K_1 \Rightarrow K_2$ — K_1 and K_2 DRSs
  - $K_1 \vee K_2$ — K_1 and K_2 DRSs
  - $\neg K_1$ — K_1 DRS

Verifying Embedding: 2nd Extension

- An embedding f of K into M verifies K in M: $f \models_M K$

  iff f verifies every condition $\alpha \in C_K$.

- f verifies condition α in M ($f \models_M \alpha$):

(i)	$f \models_M R(x_1,\ldots, x_n)$	iff	$\langle f(x_1), \ldots , f(x_n)\rangle \in V_M(R)$
(ii)	$f \models_M x = a$	iff	$f(x) = V_M(a)$
(iii)	$f \models_M x = y$	iff	$f(x) = f(y)$
(iv)	$f \models M\ K1 \Rightarrow K2$	iff	for all $g \supseteq_{U_{K1}} f$ such that $g \models_M K_1$, there is a $h \supseteq_{U_{K2}} g$ such that $h \models_M K_2$
(v)	$\mathbf{f \models_M K_1 \vee K_2}$	iff	there is a $g_1 \supseteq_{UK1} f$ such that $g_1 \models_M K_1$ or there is a $g_2 \supseteq_{UK2} f$ such that $g_2 \models_M K_2$
(vi)	$\mathbf{f \models_M \neg K_1}$	iff	there is no $g \supseteq_{UK1} f$ such that $g \models_M K_1$

Translation from DRT to FOL

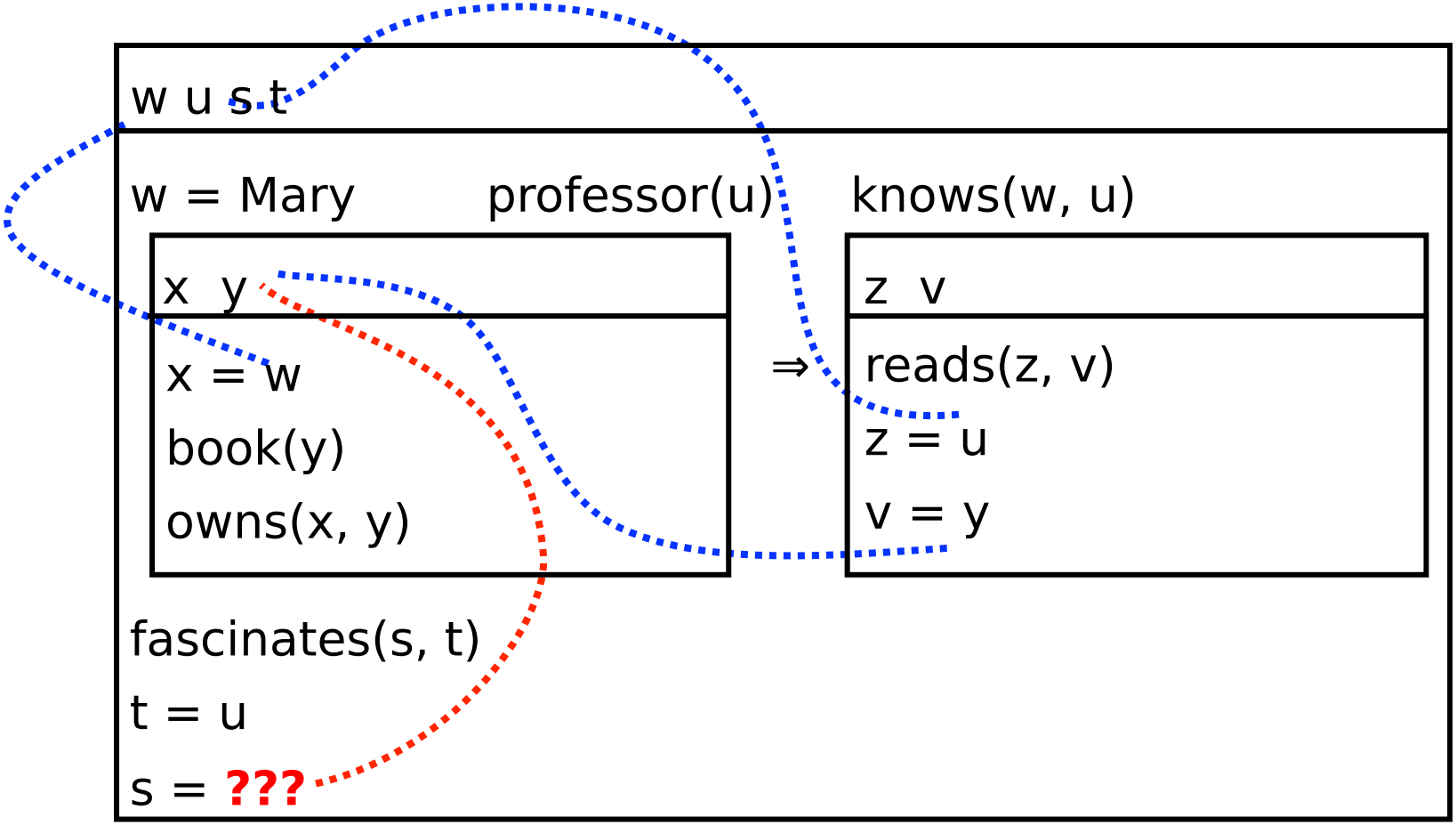
Translation function T is recursively defined on DRS structure:

- Translation of DRSes:
  - $T(\langle\{u_1, \ldots, u_n\}, \{c_1, \ldots, c_n\}\rangle) = \exists u_1 \ldots \exists u_n[T(c_1) \wedge \ldots \wedge T(c_n)]$
- Translation of conditions:
  - $T(c) = c$, for atomic conditions c
  - $T(\neg K_1) = \neg T(K_1)$
  - $T(K_1 \vee K_2) = T(K_1) \vee T(K_2)$
  - $T(K_1 \Rightarrow K_2) = \forall u_1 \ldots \forall u_n [(T(c_1) \wedge \ldots \wedge T(c_n)) \rightarrow T(K_2)]$, for $K_1 = \langle\{u_1, \ldots , u_n\}, \{c_1, \ldots , c_n\}\rangle$
- For every closed DRS K and every appropriate model M:

  K is true in M iff T(K) is true in M.

Accessibility of Discourse Referents

- *Mary knows a professor. If she owns a book, he reads it. It fascinates him.*



Inaccesible Discourse Referents: Examples

(1) *If a professor owns a book, he reads it. It has 300 pages.*

(2) *It is not the case that a professor owns a book. He reads it.*

(3) *Every professor owns a book. He reads it.*

(4) *If every professor owns a book, he reads it.*

(5) *Peter owns a book, or Mary reads it.*

(6) *Peter reads a book, or Mary reads a newspaper article. It is interesting.*

Accesible Discourse Referents

- Discourse referents are accessible for anaphoric reference, if they are located
  - in the same local DRS
  - in a super-ordinate DRS
  - on the top level of an antecedent DRS of a duplex condition, if the pronoun occurs in the consequent DRS.

Formal Definition of Accessibility

- A DRS K_1 is a sub-DRS of a DRS K: $K_1 \leq K$

  iff K_1 occurs in one of the conditions of K.

- Let K, K_1, K_2 be DRSs such that K_1, $K_2 \leq K$, $x \in U_{K1}$, $\gamma \in C_{K2}$. x is **accessible** from γ in K iff
  - $K_2 \leq K_1$ or
  - there are K_3, $K_4 \leq K$ such that $K_1 \Rightarrow K_3 \in C_{K4}$ and $K_2 \leq K_3$

Revised Construction Rule for Pronouns

- **Triggering Configuration:**
  - Let K* be the main DRS that contains K
  - α a reducible condition in DRS K, containing $[_S [_{NP}\ \beta] [_{VP}\ \gamma]]$ or $[_{VP} [_V\ \gamma] [_{NP}\ \beta]]$ as substructure
  - β a personal pronoun.
- **Action:**
  - Add a new DR x to U_K.
  - Replace β in α by x.
  - Select an appropriate **DR y that is accessible from α in K***, and add x = y to CK.

Revised Construction Rule for Proper Names

- **Triggering Configuration:**
  - Let K* be the main DRS that containing K
  - α a reducible condition in DRS K, containing $[_S\ [_{NP}\ \beta]\ [_{VP}\ \gamma]]$ or $[_{VP}\ [_V\ \gamma]\ [_{NP}\ \beta]]$ as substructure.
  - β a proper name
- **Action:**
  - Add a new DR x to U_{K^*}.
  - Replace β in α by x.
  - **Add x = β to C_{K^*}.**

Accessibility and Truth-Conditional Semantics

(1) *There is a book that John doesn‘t own.*
He wants to buy it.

(2) *John does not own every book.*
?He wants to buy it.

(3) *One of the ten balls is not in the bag.*
It must be under the sofa.

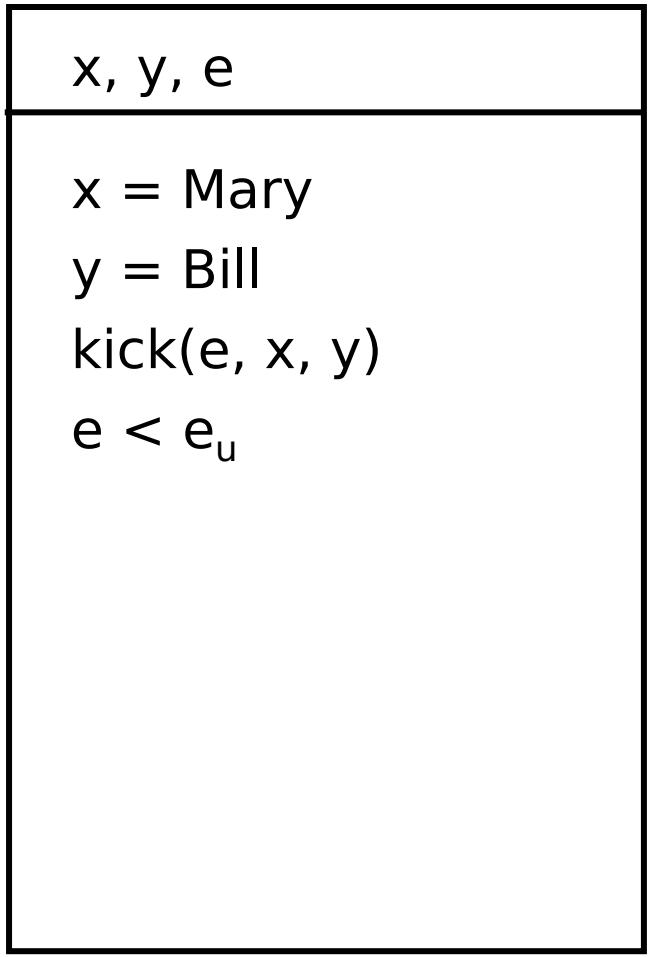
(4) *Nine of the ten balls are in the bag.*
? It must be under the sofa.

A Representational Theory of Meaning

- The different discourse-semantic status of the alternative sentence pairs is not predictable through the (identical) truth conditions of its component sentences.
- This means: **Natural language is not compositional on truth conditions.** Discourse structure plays an essential and independent role.
- DRT describes the impact of structural information on text interpretation. It is therefore called a **representational theory of meaning**.

Events and Tense in DRT

- *Mary kicked Bill.*



Event Anaphora

- *Mary kicked Bill. John has seen it.*

x, y, e, z, e‘, e‘‘
x = Mary y = Bill kick(e, x, y) $e < e_u$ z = John see (e‘, z, e‘‘) e‘‘ = e $e' < e_u$

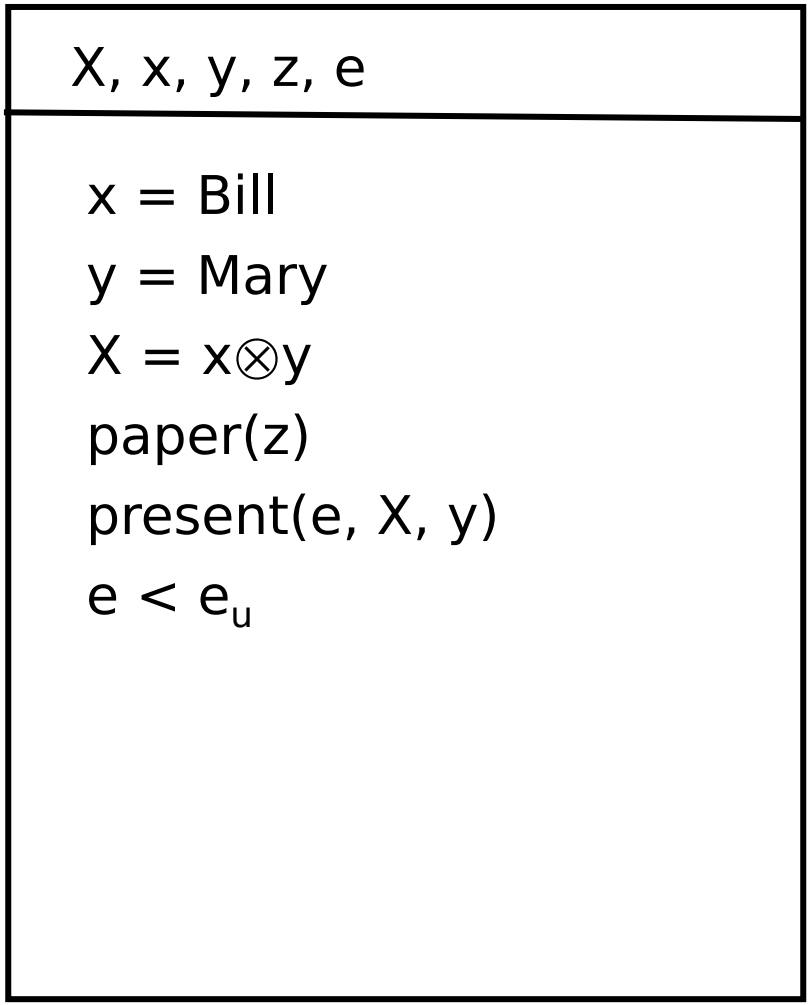
Simple past is anaphoric

- *Mary kicked Bill. He cried.*

x, y, e, z, e‘
x = Mary y = Bill kick(e, x, y) $e < e_u$ z = y cry (e‘, z) $e‘ < e_u$ e‘ > e

DRT and Plurals

- *Bill and Mary presented a paper.*



Plural Anaphora

- *Bill and Mary presented a paper. They got an A.*

X, x, y, z, e, Y, e‘
x = Bill y = Mary X = x⊗y paper(z) present(e, X, y) $e < e_u$ Y = X get-an-A(e‘, Y) $e' < e_u$ e‘ > e

Plural Anaphora

- *The students presented a paper. Three of them got an A.*

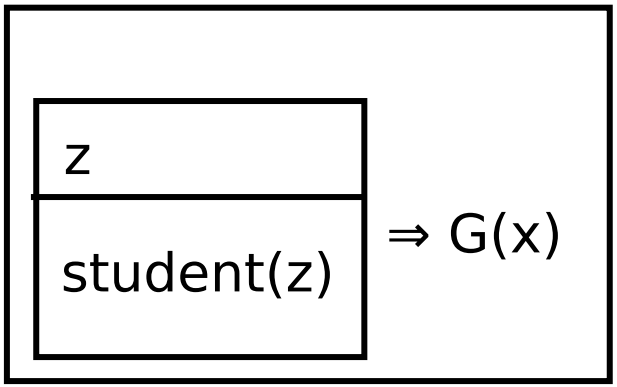
X, y, e, Y, Z, e‘
students(X)
paper(y)
present(e, X, y)
$e < e_u$
$Y = X$
$Z \lhd_i Y$
card(Y) = 3
get-an-A(e‘, Y)
$e‘ < e_u$
e‘ > e

Combining DRT and Type Theory

- Use λ-abstraction and reduction as we did before, but:
- Assume that the target representations which we want to arrive at are not First-Order Logic formulas, but DRSs.
- The result is called **λ-DRT**.

Lambda-DRSes

- An expression consists of a lambda prefix and a partially instantiated DRS.
- *every student* ⇒ λG



- Alternative notation:
  - λG [∅ | [z | student(z)] ⇒ G(z)]
- *works* ⇒ λx [∅ | work(x)]

λ-DRT: β-reduction

- *Every student works*
  - ⇒ λG[∅ | [z | student(z)] ⇒ G(z)]](λx [∅ | work(x)])
  - ⇔ [∅ | [z | student(z)] ⇒ (λx [∅ | work(x)])(z)]
  - ⇔ [∅ | [z | student(z)] ⇒ [∅ | work(z)]]

Merge

- The “merge” operation on DRSs combines two DRSs (sets of conditions and discourse referents, respectively).
- Let $K_1 = [\ U_1 \mid C_1\ ]$ and $K_2 = [\ U_2 \mid C_2\ ]$.
- **Merge:** $K_1; K_2 \Rightarrow [\ U_1 \cup U_2 \mid C_1 \cup C_2\ ]$
  - given that no discourse referent $u \in U_2$ occurs free in a condition $\gamma \in C_1$.

An Example

- *A student works. She is successful.*

- *a student* ⇒ λG ([z | student(z)]; G(z))
- *works* ⇒ λx [∅ | work(x)]
- *A student works*

⇒ λG ([z | student(z)] ; G(z))(λx[∅ | work(x)])

⇔ [z | student(z)] ; λx[∅ | work(x)](z)

⇔ [z | student(z)] ; [∅ | work(z)]

⇔ [z | student(z), work(z)]

An Example

- *A student works. She is successful.*

  - λK λK’(K;K’)([z | student(z), work(z)])([y |y=z, successful(z)])
  - ⇔ λK’([z | student(z), work(z)] ; K’)([y |y=z, successful(z)])
  - ⇔ [z | student(z), work(z)] ; [y |y=z, successful(z)]
  - ⇔ [z, y | student(z), work(z), y=z, successful(z)]

Caution: Variable Capturing!

- λK’([z | student(z), work(z)] ; K’)([|successful(z)])
  ⇔ [z | student(z), work(z)] ; [|successful(z)]
  ⇔ [z | student(z), work(z), successful(z)]
- Via the interaction of β-reduction and DRS-binding, discourse referents are captured.
- We somehow have to encode the potential for capturing discourse referents into the denotation of a λ-DRS. Possible, but tricky.

Presupposition

- *The sun is shining*
- *The king of France is bald*
- *The student is working*
- Definite NPs refer to familiar reference objects, i.e., to reference objects that are available in the context of utterance.
- The descriptive part of a definite noun phrase enables the addressee of an utterance to identify the referent intended by the speaker.
- Strictly speaking, the description does not semantically contribute to the proposition, which the speaker claims to be true (the **assertion**).
- However, for the utterance to be true (and to make sense at all), there must be a (salient) referent available that satisfies the description. This requirement is called a **presupposition**.

Presupposition

- *The sun is shining*
- **P:** *There is a sun* / **A:** *It is shining*
- *The student is working*
- **P:** *There is a student* / **A:** *He/she is working*

- Assertion and presupposition are different layers of meaning information that behave different in several respects.

Projection vs. Composition

- *Bill read the paper*
- **P:** *There is a paper* / **A:** *Bill read it*
- *Bill didn't read the paper*
- **P:** *There is a paper* / **A:** *Bill didn't read it*

Compare with:

- *Bill read a paper*
- *Bill didn't read a paper*
- **Presupposition survives negation**

Projection vs. Composition

- Presuppositions also survive embedding under other operators:
- *Bill will probably read the paper.*
- *Mary believes that Bill read the paper.*
- *Bill must read the paper, or he will fail the exam.*

- The **assertion** of a complex sentence is computed by function application.
- The presuppositions are "**projected**": The presuppositions of a complex sentence are the set of presuppositions of its parts.

Entailment Properties: Presupposition Cancellation

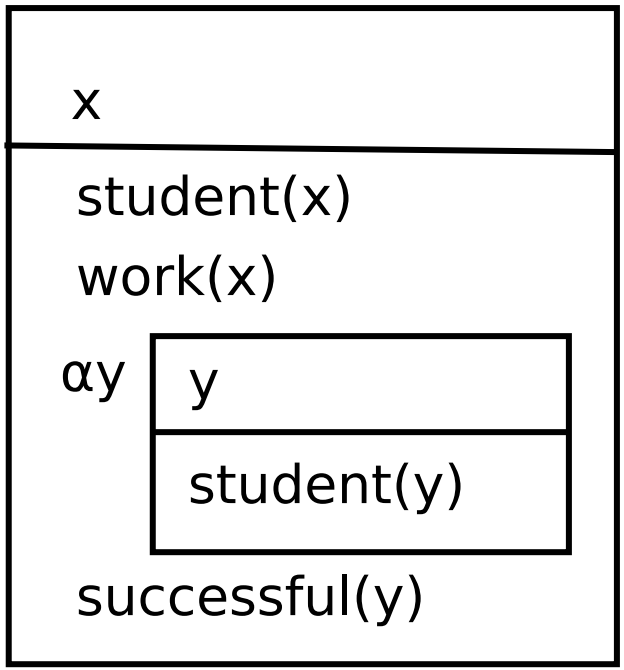
- *Did you read the paper I gave you?*
- *No, I haven't read the paper you gave me*
- *... Actually, you didn't give me any paper.*
- *Bill's children must be happy to have him as father*
- *... if Bill has any children.*

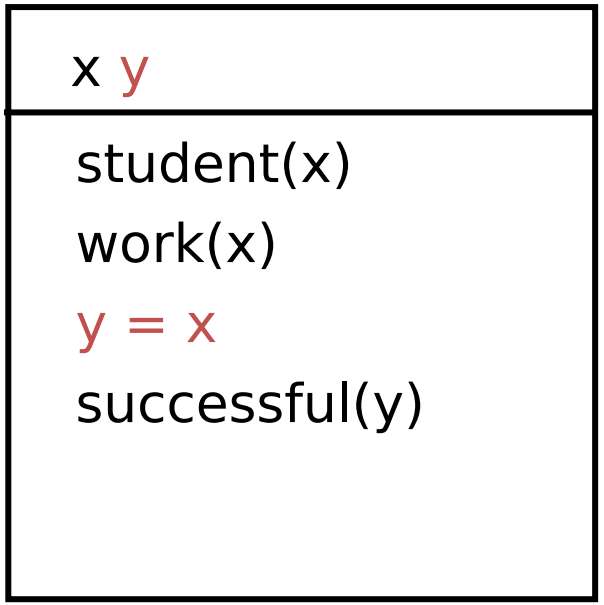
- Presuppositions can be cancelled by explicitly denying or questioning their truth.

- ***The king of Samoa*** *is visiting*
- ***The movie I saw yesterday night*** *was interesting.*
- If a presupposition is not is not satisfied in the context of utterance, it may be “accommodated” by the addressee.
- In this way, presuppositions can make a proper contribution to utterance meaning.

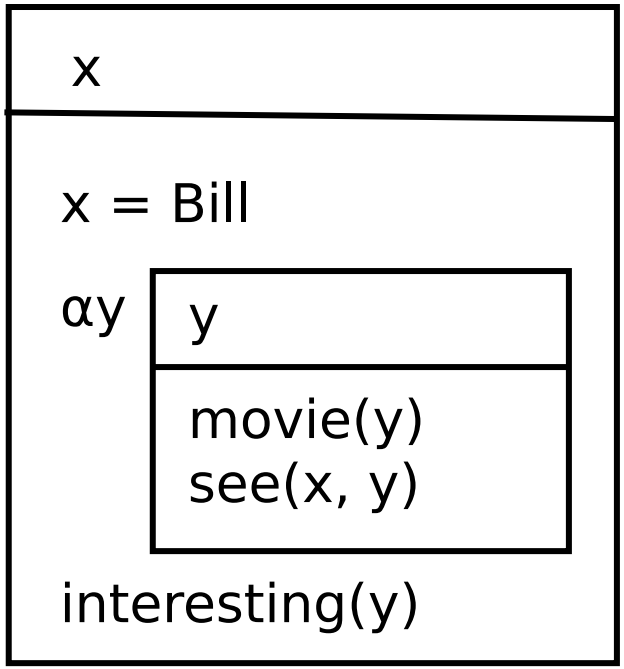
Preupposition in DRT

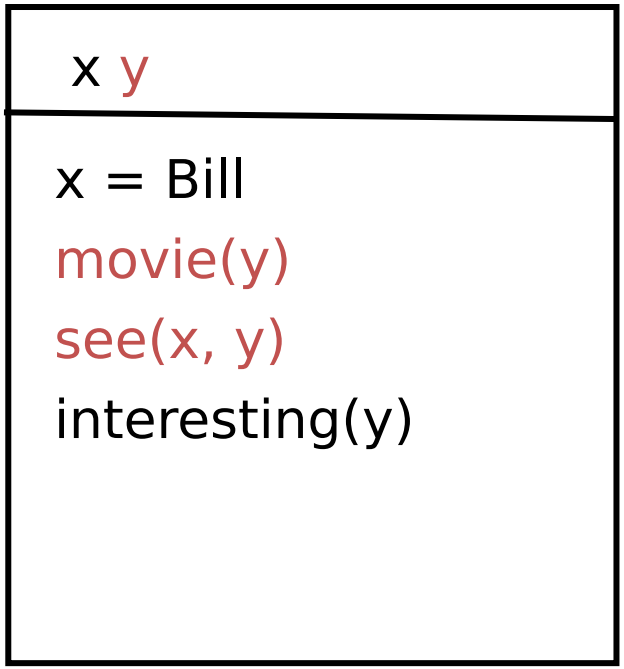
- Two-step DRS Construction:
- Build Proto-DRSes containing unresolved representations of definite NPs ("**α-conditions**").
- Resolve the α-conditions to obtain (standard) DRSes.
- Example: *A student works. she is successful.*





Presupposition in DRT: Accommodation





More „Presupposition Triggers“

- Factive verbs:
  - *Mary regrets that John is married.*
  - **P:** *John is married/* **A:** *Mary regrets it*
- Aspectual verbs:
  - *John has stopped smoking*
  - **P:** *John used to smoke /* **A:** *John stopped doing it*
- *It*-clefts:
  - *It was John who ate the cake*
  - **P:** *Somebody ate the cake /* **A:** *John did it.*
- Sentence particles (*only, even*):
  - *Only John found a solution*
  - **P:** *John found a solution/* **A:** *Nobody else did.*

Information Structure

- *Who ate the cake?*
- *Bill a⇔te the cake.*

- *What did Bill eat?*
- *Bill ate the cake*

- Utterances of a sentence in general can be partitioned into a presupposed part (the „**background**“), and an asserted part (the „**focus**“).
- This **focus-background articulation** establishes (part of) the **information structure** of an utterance, which is orthogonal to the syntactic structure.

Literature

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