Semantic Theory

Lecture 7 – Discourse Semantics II

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(Slides by Manfred Pinkal)

Indefinite noun phrases and conditionals

(1) *If a student works, the professor is happy.*

(2) ∃x[student(x) ∧ work(x)] → happy(the-professor)

(3) ∀x[student(x) ∧ work(x) → happy(the-professor)]

- Formulas (2) and (3) are logically equivalent
- ∃xA → B ⇔ ∀x[A → B]
  - provided that variable x does not occur free in B.

Indefinite noun phrases and conditionals

(1) *If a student works, she will be successful.*

(2) ∃x[student(x) ∧ work(x)] → successful(x)

(3) ∃x[student(x) ∧ work(x) → successful(x)]

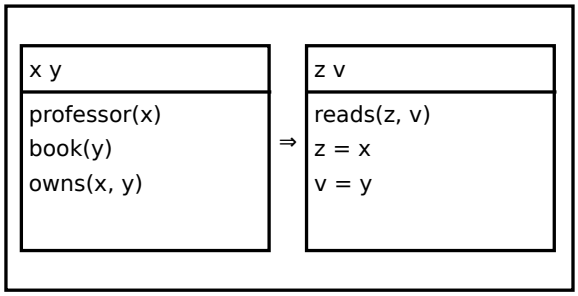
(4) ∀x[student(x) ∧ work(x) → successful(x)]

Problems:

- (2) is not closed (x occurs free)
- (3) has wrong truth conditions (much too weak)
- (4) is correct, but how can it be derived compositionally?

DRS for conditionals: An example

If a professor owns a book, he reads it.



DRS (1st 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
- **Reducible conditions:** as before

DRT Embeddings (Recap)

- Let
  - U_D a set of discourse referents,
  - $K = \langle U_K, C_K \rangle$ a DRS with $U_K \subseteq U_D$,
  - $M = \langle U_M, V_M \rangle$ an FOL model structure appropriate for K.
- An embedding of K into M is a (partial) function f from U_D to U_M such that $U_K \subseteq \text{Dom}(f)$.
- An embedding f of K into M verifies K in M ($f \models_M K$) iff f verifies every condition $\alpha \in C_K$.

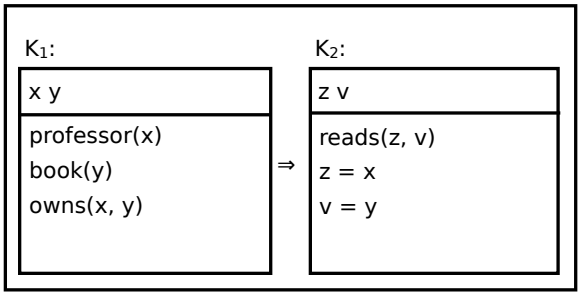
Verifying embeddings (1st extension, preliminary)

- **$f \models_M K_1 \Rightarrow K_2$**
  iff for all $g \supseteq_{UK1} f$ such that $g \models_M K_1$, we have $g \models_M K_2$
- We write $g \supseteq_U f$ for "$g \supseteq f$ and $Dom(g) = Dom(f) \cup U$"

The definition seems to work ...

If a professor owns a book, he reads it.

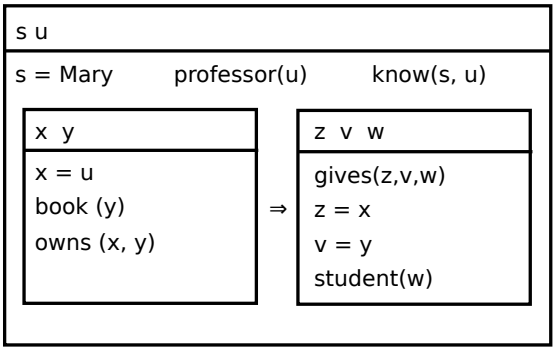
K_0:



$f \models_M K_1 \Rightarrow K_2$
iff for all $g \supseteq_{UK1} f$ such that $g \models_M K_1$, we have $g \models_M K_2$

... but it doesn't really!

Mary knows a professor. If he owns a book, he gives it to a student.



Verifying embeddings for conditionals (final)

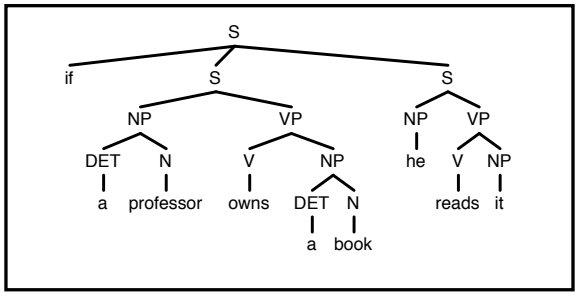
- **$f \models_M K1 \Rightarrow K2$**
  iff for all $g \supseteq_{UK1} f$ such that $g \models_M K_1$
  there is a $h \supseteq_{UK2} g$ such that $h \models_M K_2$

Construction Rule for Conditionals

- **Triggering configuration:**
  - α is a reducible condition in DRS K of the form $[_S$ if $[_S$ β] (then) $[_S$ γ]]
- **Action:**
  - Remove α from C_K.
  - Add $K_1 \Rightarrow K_2$ to C_K, where
    - $K_1 = \langle \emptyset, \{ \beta \} \rangle$
    - $K_2 = \langle \emptyset, \{ \gamma \} \rangle$
- **Remark:** $K_1 \Rightarrow K_2$ is called a duplex condition; K_1 the "antecedent DRS" and K_2 the "consequent DRS."

An example

If a professor owns a book, he reads it.



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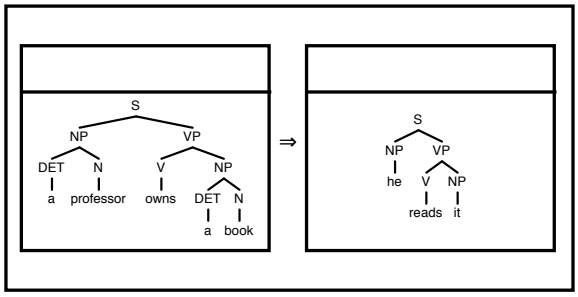

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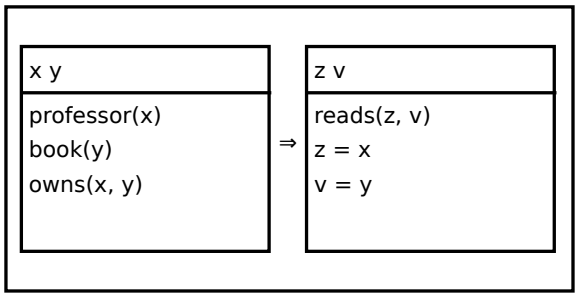


Construction rule for universal NPs

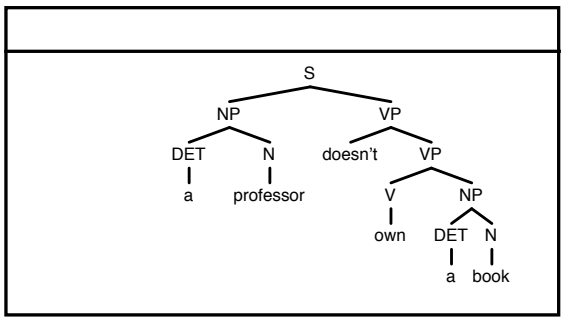
- **Triggering configuration:**
  - α is a reducible condition in DRS K; α contains a subtree $[_S\ [_{NP}\ \beta]\ [_{VP}\ \gamma]]$ or $[_{VP}\ [_V\ \gamma]\ [_{NP}\ \beta]]$
  - β = every δ
- **Action:**
  - Remove α from CK.
  - Add $K_1 \Rightarrow K_2$ to C_K, where
    - $K_1 = \langle \{x\}, \{\delta(x)\} \rangle$ and
    - $K_2 = \langle \emptyset, \{\alpha'\} \rangle$
    - obtain α’ from α by replacing β by x

Construction rule for negations

- **Triggering configuration:**
  - α is a reducible condition in DRS K of the form $[_S\ \beta\ [_{VP}$ doesn't $[_{VP}\ \gamma]]]$
- **Action:**
  - Remove α from C_K
  - Add $\neg K_1$ to C_K, where $K_1 = \langle \emptyset, \{\ [_S\ \beta\ [_{VP}\ \gamma]]\ \} \rangle$

Example (1st reading)

A professor doesn't own a book.



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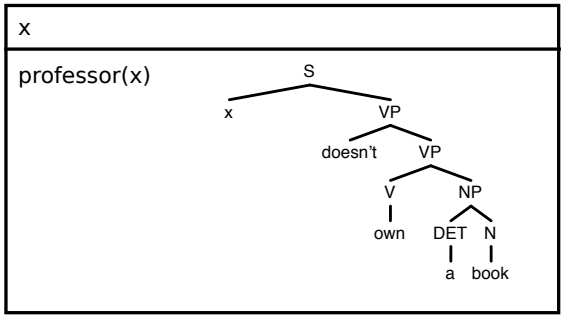

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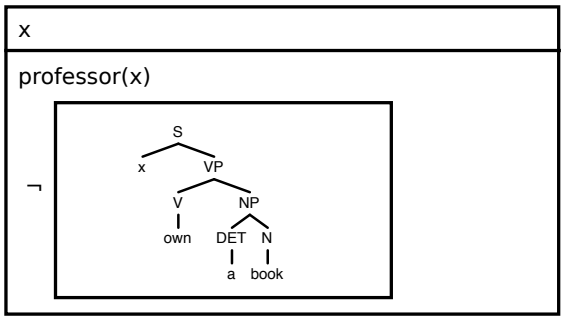

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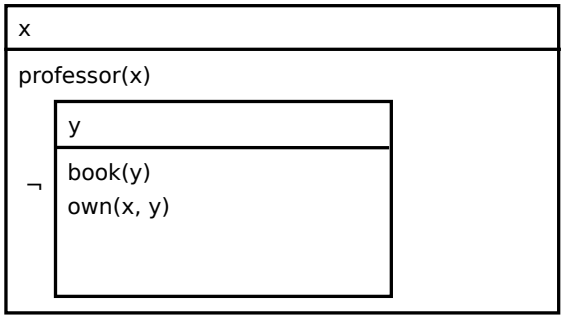

Example (2nd reading)

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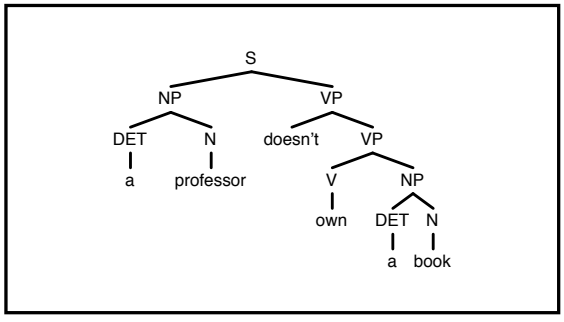

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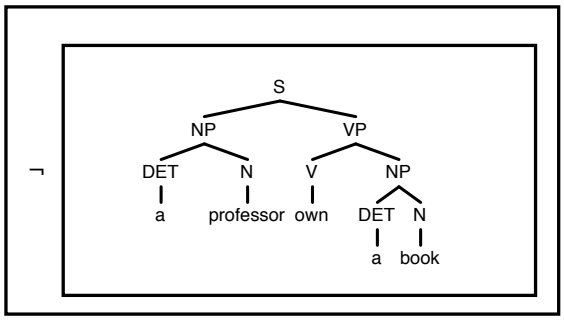

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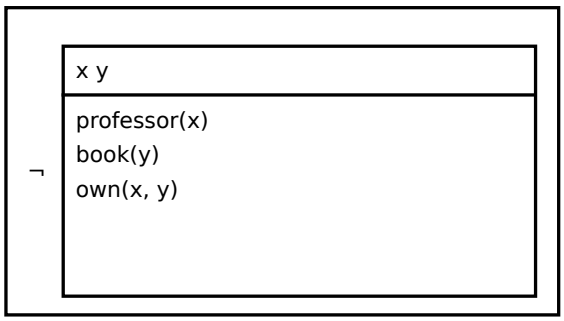
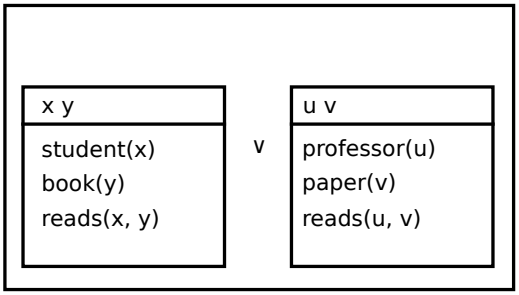


Construction rule for clausal disjunction

- **Triggering configuration:**
  - α is a reducible condition in DRS K of the form $[_S\ [_S\ \beta]$ or $[_S\ \gamma]]$
- **Action:**
  - Remove α from C_K
  - Add $K_1 \vee K_2$ to C_K, where
    - $K_1 = \langle \emptyset, \{\beta\} \rangle$ and
    - $K_2 = \langle \emptyset, \{\gamma\} \rangle$

An example

A student reads a book, or a professor reads a paper.



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  - $u = v$ $u, v \in U_K$
  - $u = a$ $u \in U_K$, 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 embeddings

- f verifies condition α in M ($f \models_M \alpha$):
  - $f \models_M R(x_1, \ldots, x_n)$ iff $\langle f(x_1), \ldots, f(x_n) \rangle \in V_M(R)$
  - $f \models_M x = a$ iff $f(x) = V_M(a)$
  - $f \models_M x = y$ iff $f(x) = f(y)$
  - $f \models_M K_1 \Rightarrow K_2$ iff for all $g \supseteq_{UK1} f$ such that $g \models_M$ there is a $h \supseteq_{UK2} g$ such that $h \models_M K_2$
  - $f \models_M \neg K_1$ iff there is no $g \supseteq_{UK1} f$ such that $g \models_M K_1$
  - $f \models_M K_1 \vee K_2$ 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 $g_2 \models_M K_2$