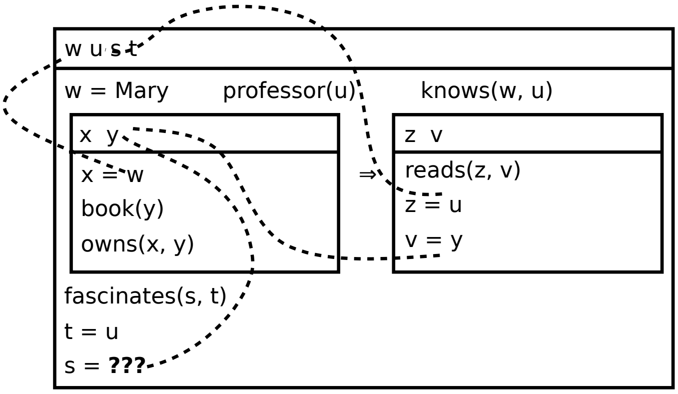
Translation from DRT to FOL

- DRSs
  - $T(\langle\{u_1, \dots, u_n\}, \{c_1, \dots, c_n\}\rangle) = \exists u_1 \dots \exists u_n[T(c_1) \wedge \dots \wedge T(c_n)]$
- Conditions:
  - $T(c) = c$ for atomic conditions c
  - $T(\neg K_1) = \neg T(K_1)$
  - $T(K_1 \vee K_2) = T(K_1) \vee T(K_2)$
  - $T(K_1 \Rightarrow K_2) = \forall u_1 \dots \forall u_n [(T(c_1) \wedge \dots \wedge T(c_n)) \rightarrow T(K_2)]$,
    for $K_1 = \langle\{u_1, \dots , u_n\}, \{c_1, \dots , c_n\}\rangle$
- For every closed DRS K and every appropriate model M, K is true in M iff T(K) is true in M.

Anaphora and accessibility

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



Accessible discourse referents

Cases of non-accessibility:

(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 newpaper article. It is interesting.*

Accessible discourse referents

The following discourse referents are accessible for a condition:

- DRs in the same local DRS
- DRs in a superordinate DRS
- DRs on the top level of an antecedent DRS, if the condition occurs in the consequent DRS.

Subordination

- A DRS K_1 is an immediate sub-DRS of a DRS $K = \langle U_K, C_K \rangle$ iff C_K contains a condition of the form
  - $\neg K_1$,
  - $K_1 \Rightarrow K_2$,
  - $K_2 \Rightarrow K_1$,
  - $K_1 \vee K_2$ or
  - $K_2 \vee K_1$.

Subordination

- K_1 is a sub-DRS of K (notation: $K_1 \leq K$) iff
  - $K_1 = K$ or
  - K_1 is an immediate sub-DRS of K or
  - there is a DRS K_2 such that $K_2 \leq K_1$ and K_1 is an immediate sub-DRS of K.
  - (i.e. reflexive, transitive closure)
- K_1 is a proper sub-DRS of K iff $K_1 \leq K$ and $K_1 \neq K$.

Accessibility

- Let K, K_1, K_2 be DRSs such that
  - $K_1, K_2 \leq K$,
  - $x \in U_{K1}$,
  - $\gamma \in CK2$
- 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.

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*}.

Is accessibility a truth-conditional property?

(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.

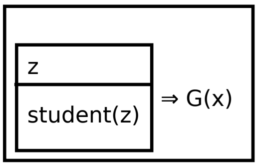
DRT is non-compositional

- DRT is non-compositional on truth conditions: The different discourse-semantic status of the text pairs is not predictable through the (identical) truth conditions of its component sentences.
- Since structural information which cannot be reduced to truth conditions is required to compute the semantic value of texts, DRT is called a representational theory of meaning.

Wait a minute …

- Why can’t we just combine type theoretic semantics and DRT?
- 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.

λ-DRSs

- 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)]]

(Naïve) Merge

- The “merge” operation on DRSs combines two DRSs (conditions and universes).
- Let $K_1 = [\ U_1 \mid C_1\ ]$ and $K_2 = [\ U_2 \mid C_2\ ]$.
- **Merge:** $K_1; K_2 \Rightarrow [\ U_1 \cup U_2 \mid C_1 \cup C_2\ ]$

Merge: An example

- *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)]

λ-DRT and Merge: An example

- *A student works. She is successful.*
- Compositional analysis:
  - λK λK'(K;K')([z | student(z), work(z)])([|successful(z)])
  - ⇔ λK'([z | student(z), work(z)] ; K')([|successful(z)])
  - ⇔ [z | student(z), work(z)] ; [|successful(z)]
  - ⇔ [z | student(z), work(z), successful(z)]

Merge again

- The "merge" operation on DRSs combines two DRSs (conditions and universes).
- Let K_1 = [U_1 | C_1] and K_2 = [U_2 | C_2].
- **Merge:** K_1 ; K_2 ⇒ [$U_1 \cup U_2$ | $C_1 \cup C_2$]
  - under the assumption that no discourse referent $u \in U_2$ occurs free in a condition $\gamma \in C_1$.

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.
- But the β-reduced DRS must still be equivalent to the original DRS!
- This means that we somehow have to encode the potential for capturing discourse referents into the denotation of a λ-DRS. Possible, but tricky.