

# Semantic Theory

## week 8 – Dynamic Semantics

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Summer 2017

# Context theory

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Natural-language expressions can vary their meaning with context:

- *I, you, here, this, now, ...*

Idea:

- Model contexts as vectors: sequences of semantically relevant context data with fixed arity.
- Model meanings as functions from contexts to denotations – more specifically, as functions from specific context components to denotations.

# Defining a context vector

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- Context  $c = \langle a, b, l, t, r \rangle$ 
  - $a$  speaker
  - $b$  addressee
  - $l$  utterance location
  - $t$  utterance time
  - $r$  referred object

$$\llbracket I \rrbracket^{M,g,c} = \text{utt}(c) = a$$

$$\llbracket you \rrbracket^{M,g,c} = \text{adr}(c) = b$$

$$\llbracket here \rrbracket^{M,g,c} = \text{loc}(c) = l$$

$$\llbracket now \rrbracket^{M,g,c} = \text{time}(c) = t$$

$$\llbracket this \rrbracket^{M,g,c} = \text{ref}(c) = r$$

# Type-theoretic context semantics

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Model structure:  $M = \langle U, C, V \rangle$ , where  $U$  is the universe,  $C$  is the context set, and  $V$  is value assignment function that assigns non-logical constants functions from contexts to denotations of appropriate type.

Interpretation:

- $\llbracket a \rrbracket^{M,g,c} = V(a)(c)$ , if  $a$  is a non-logical constant
- $\llbracket a \rrbracket^{M,g,c} = g(a)$ , if  $a$  is a variable
- $\llbracket a(\beta) \rrbracket^{M,g,c} = \llbracket a \rrbracket^{M,g,c}(\llbracket \beta \rrbracket^{M,g,c})$
- etc.

# An example

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*I am reading this book*  $\Rightarrow$  read'(this-book')(I')

$$\llbracket \text{read}'(\text{this-book}')(\text{I}') \rrbracket^{M,g,c} = 1$$

$$\text{iff } \llbracket \text{read}' \rrbracket^{M,g,c}(\llbracket \text{this-book}' \rrbracket^{M,g,c})(\llbracket \text{I}' \rrbracket^{M,g,c}) = 1$$

$$\text{iff } V(\text{read}')(\text{ref}(c))(\text{utt}(c)) = 1$$

Context-invariant expressions are constant functions:

$$V(\text{read}')(c) = V(\text{read}')(c') \text{ for all } c, c' \in C$$

# Context-dependent expressions

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Deictic expressions depend on the physical utterance situation:

- *I, you, now, here, this, ...*

Anaphoric expressions refer to the linguistic context / previous discourse:

- *he, she, it, then, ...*

But there is more ...

# More context-dependent expressions

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Context dependence is a pervasive property of natural language:

- (1) *Every student must be familiar with the basic properties of first-order logic.*
- (2) *It is hot and sunny everywhere.*
- (3) *John always is late.*
- (4) *Bill has bought an expensive car.*
- (5) *Another one, please!*
- (6) *The student is working.*

Type-theory is too limited to account for this amount of context-dependence

# Another problem for traditional type theory

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Indefinite noun phrases and conditionals interact strangely...

*If a farmer owns a donkey, he beats feeds it.*

(1)  $\exists x \exists y [\text{farmer}(x) \wedge \text{donkey}(y) \wedge \text{owns}(x,y)] \rightarrow \text{feeds}(x,y)$

→ not closed (x and y occur free)

(2)  $\exists x \exists y [\text{farmer}(x) \wedge \text{donkey}(y) \wedge \text{owns}(x,y) \rightarrow \text{feeds}(x,y)]$

→ wrong truth conditions (much too weak)

(3)  $\forall x \forall y [\text{farmer}(x) \wedge \text{donkey}(y) \wedge \text{owns}(x,y) \rightarrow \text{feeds}(x,y)]$

→ correct, but how can it be derived compositionally?

Geach, 1962



# What are indefinites?

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Option I: Existential quantifiers? (cf. Russell, 1919)

**No:** donkey sentences

Option II: Universal quantifiers?

**No:** (1) a. A dog came in. It is pretty.

b. Every dog came in. # It is pretty.

Option III: Ambiguous?

# Meanwhile at the philosophy department...

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What is meaning?

- Truth-conditions vs. context-change
- Sentence vs. discourse
- Semantics vs. pragmatics



# A new perspective on meaning

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## Dynamic Semantics:

- I. Basic semantic value: ~~truth-conditions~~  
→ context-change potential
- II. (In)definite NPs are ~~quantificational~~ → variables
- III. Existential quantification over ~~sentence~~ → discourse
- IV. Quantification is ~~selective~~ → unselective

# I. Context-change potential

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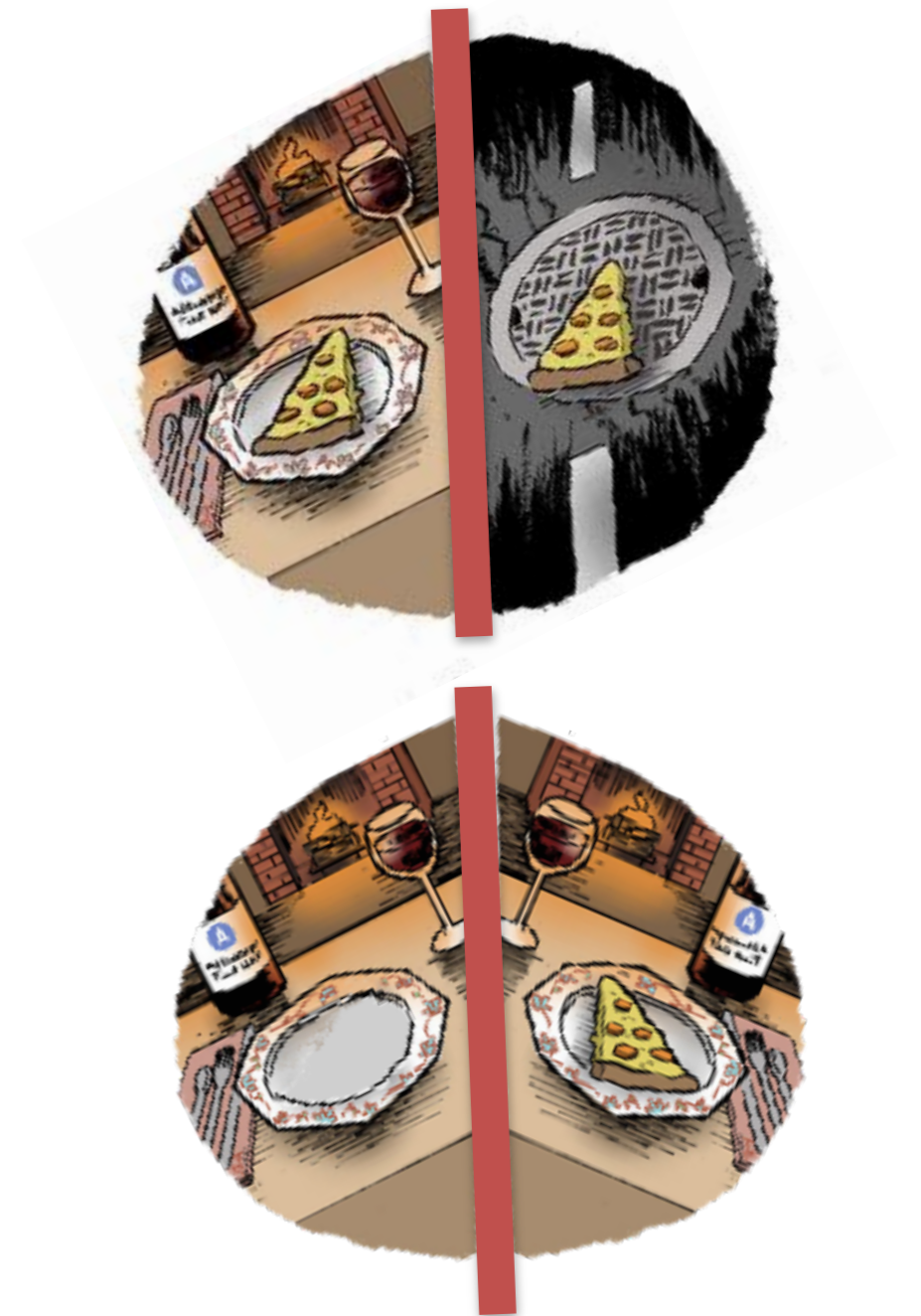
Context  $\leftrightarrow$  meaning

$\Rightarrow$  Context changes meaning

$\Leftarrow$  Meaning changes context

In dynamic semantics, the meaning of an expression is the effect it has on its context

**N.B.** This is a *generalisation* rather than an *alternative* to classical truth-conditional semantics



## II/III. Discourse variables & quantification

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“Division of labor” between definite and indefinite NPs:

- Indefinite NPs introduce discourse referents, which can serve as antecedents for anaphoric reference.
- Definite NPs refer to “old” or “familiar” discourse referents (which are already part of the meaning representation).

(1) *A dog came in. It barked.*

$\text{dog}(x) \wedge \text{came-in}(x) \wedge \text{barked}(x)$

... is true iff there is a value for  $x$  which verifies the conditions.

## IV. Unselective quantification

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Every farmer who owns a donkey feeds it

Every      farmer who owns a donkey      feeds it

quantifier      restriction      nuclear scope

... is true iff **for every value assignment** to  $x$  and  $y$ :

if  $\llbracket \text{farmer}(x) \wedge \text{donkey}(y) \wedge \text{owns}(x,y) \rrbracket^{M,g} = 1$  then  $\llbracket \text{feeds}(x,y) \rrbracket^{M,g} = 1$

Quantification is restricted to those individuals who satisfy the restriction (unselectively, i.e., all free variables are bound).



# Great minds..

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Hans Kamp



Discourse Representation  
Theory (DRT)

Irene Heim



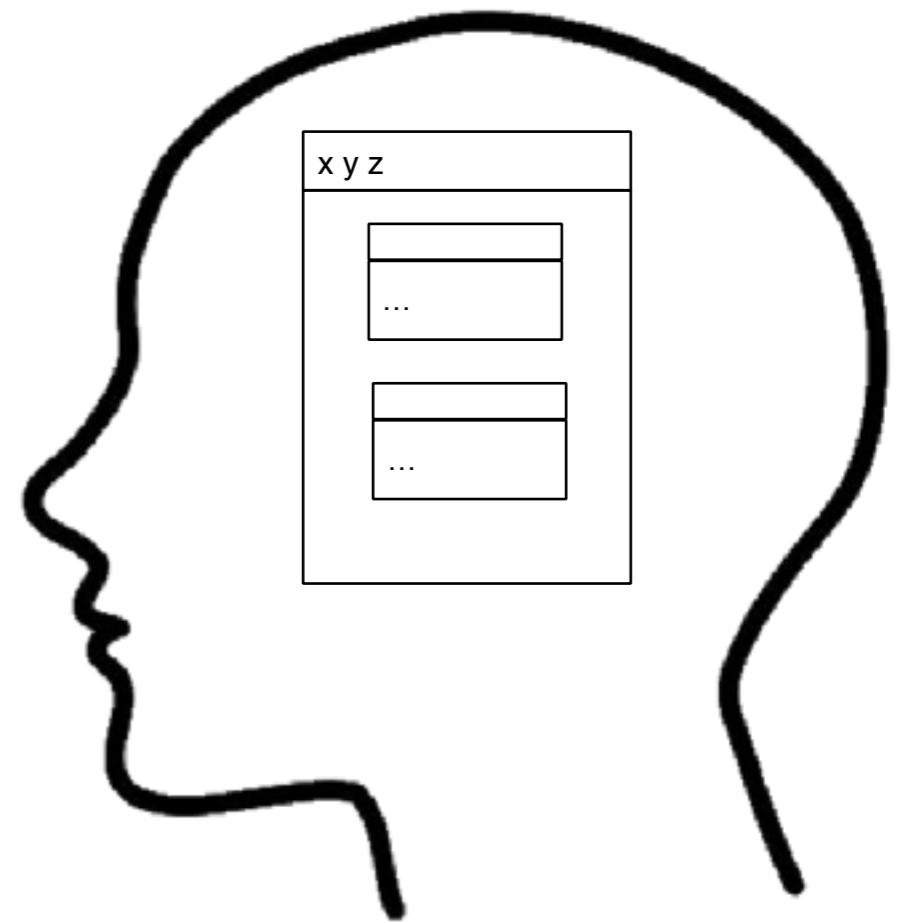
File Change Semantics  
(FCS)

# Discourse Representation Theory

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Mentalist and representationalist theory of the interpretation of discourse

- Discourse Representation Structures
- Construction procedure for DRSs
- Model-theoretic interpretation



(Kamp, 1981; Kamp & Reyle, 1993)



# Basic features of DRT

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- DRT models linguistic meaning as anaphoric potential (through DRS construction) plus truth conditions (through model embedding).
- In particular, DRT explains the ambivalent character of indefinite noun phrases:

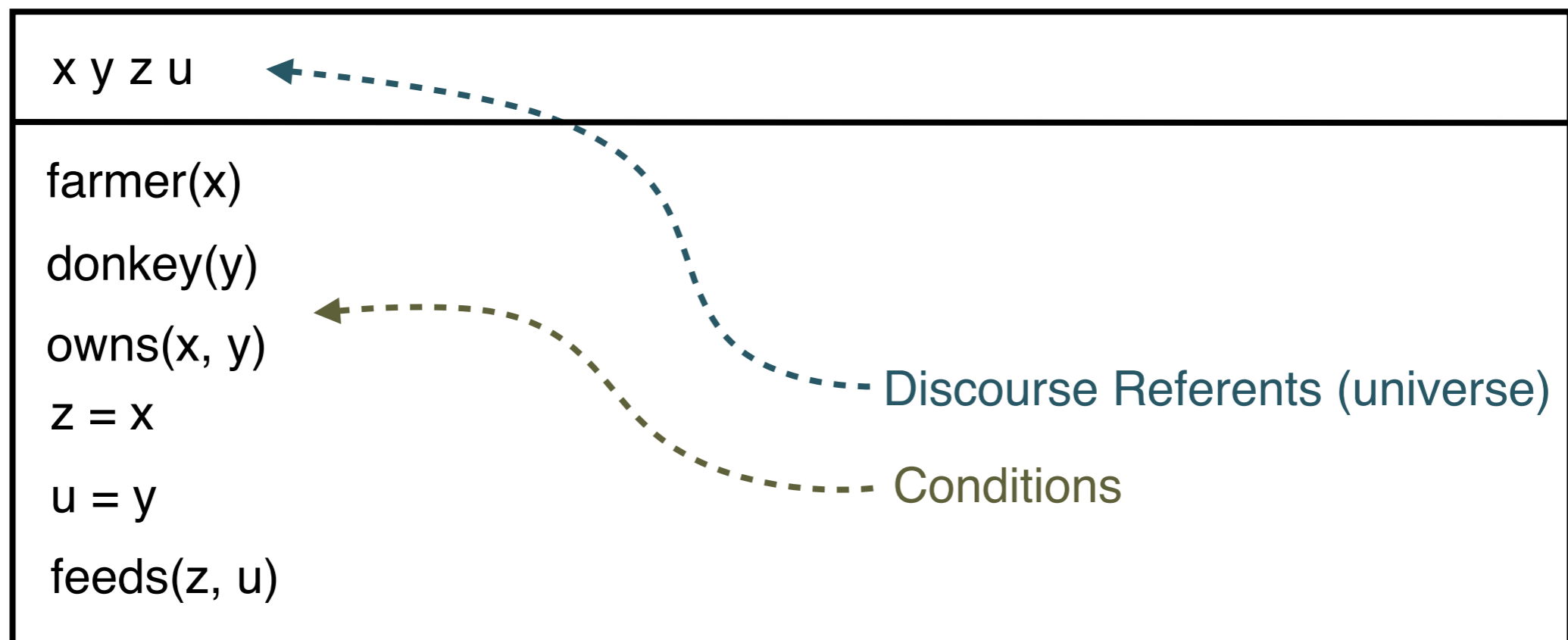
Indefinite NPs are expressions that introduce new reference objects into the context, and are truth conditionally equivalent to existential quantifiers.

# Indefinites and anaphora in DRT

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A context is represented as a Discourse Representation Structure (DRS) consisting of a set of referents and a set of conditions

*A farmer owns a donkey. He feeds it.*

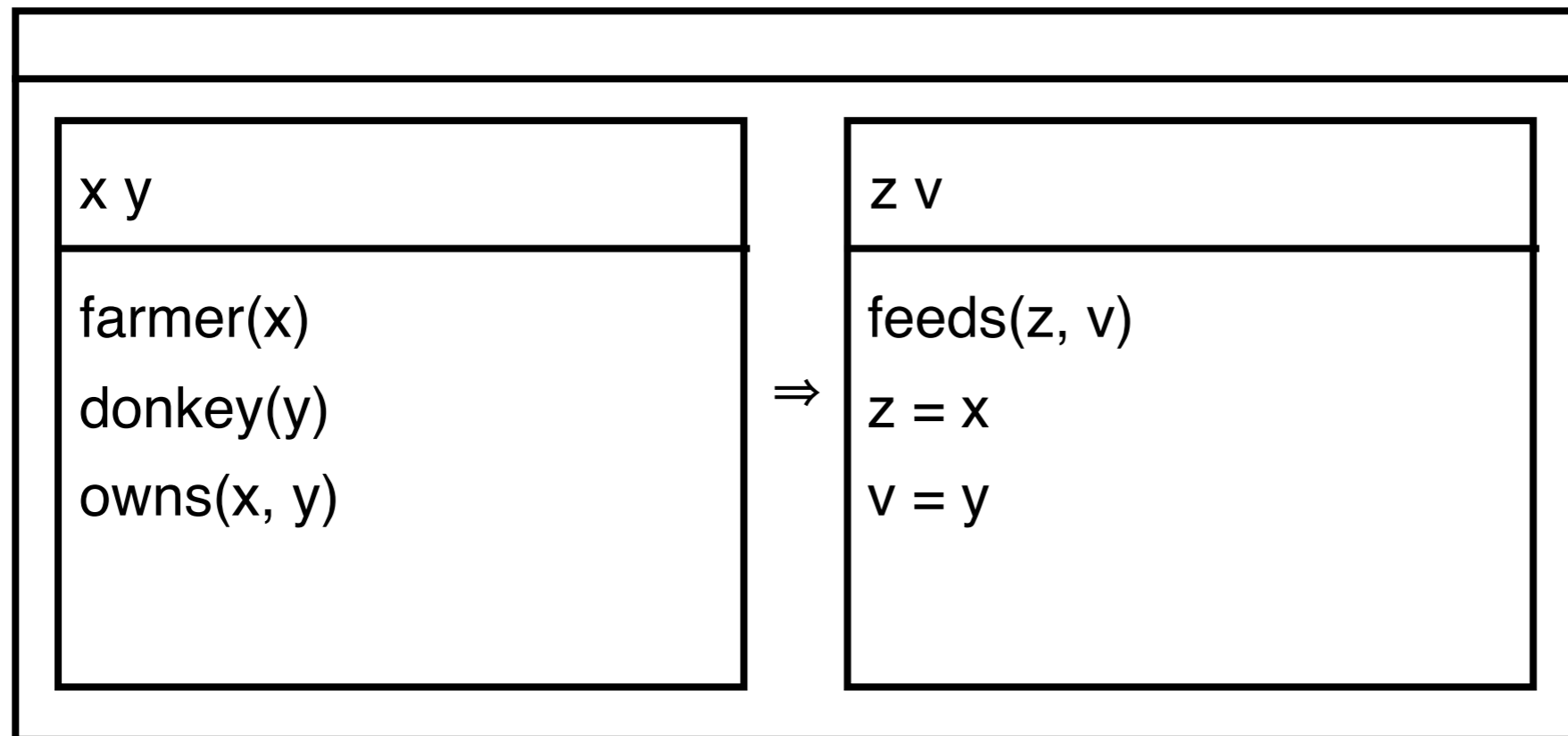


# Donkey sentences in DRT

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Unselective quantification is achieved by embedded contexts

*If a farmer owns a donkey, he feeds it.*



# DRS Syntax

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A discourse representation structure (DRS)  $K$  is a pair  $\langle U_K, C_K \rangle$ , where:

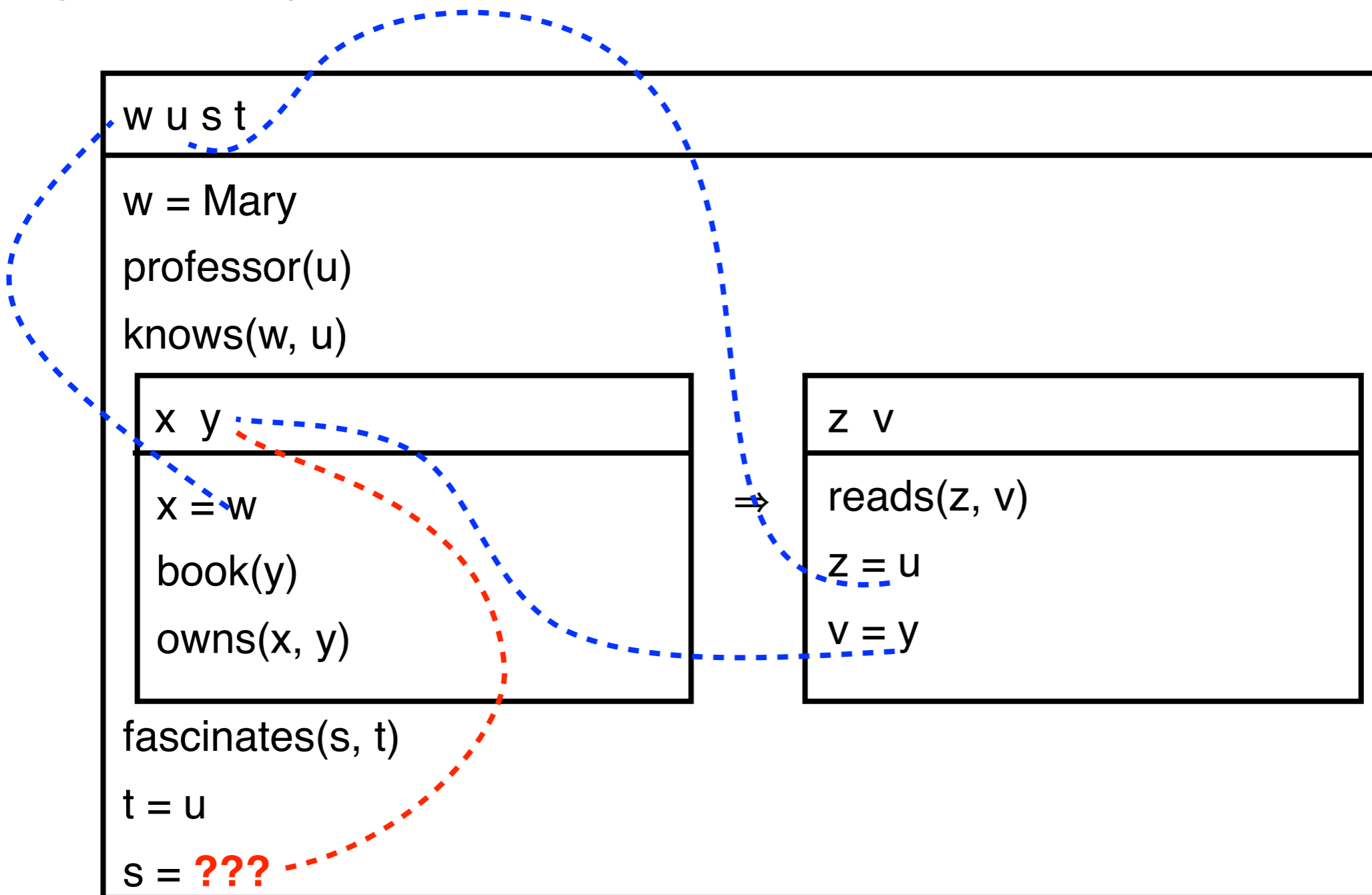
- $U_K \subseteq U_D$  and  $U_D$  is a set of discourse referents, and
- $C_K$  is a set of well-formed DRS conditions

## Well-formed DRS conditions:

- $R(u_1, \dots, u_n)$       *where:*  $R$  is an  $n$ -place relation,  $u_i \in U_D$
- $u = v$        $u, v \in U_D$
- $u = a$        $u \in U_D$ ,  $a$  is a constant
- $\neg K_1$        $K_1$  is a DRS
- $K_1 \Rightarrow K_2$        $K_1$  and  $K_2$  are DRSs
- $K_1 \vee K_2$        $K_1$  and  $K_2$  are DRSs

# Anaphora and accessibility

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



# Non-accessible discourse referents

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## 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 newspaper article. It is interesting.*

# Accessible discourse referents

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The following discourse referents are accessible for a condition:

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

We need a formal notion of DRS subordination

# Subordination

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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  $K_2 \vee K_1$ .

$K_1$  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  $K_1 \leq K_2$  and  $K_2$  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  $K_1 \neq K$ .



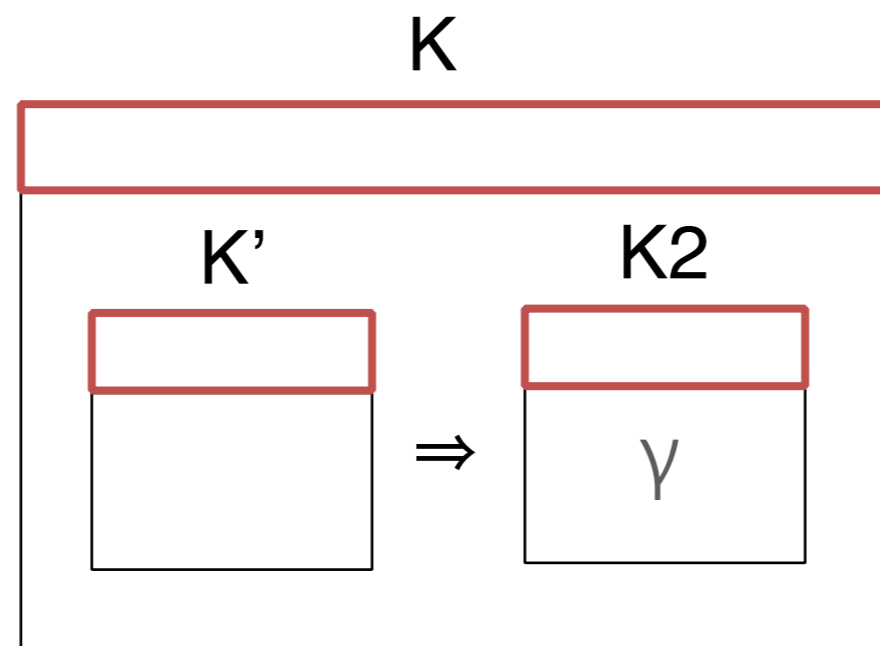
# Accessibility

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Let  $K, K_1, K_2$  be DRSs such that  $K_1, K_2 \leq K, x \in U_{K_1}, \gamma \in C_{K_2}$

$x$  is accessible from  $\gamma$  in  $K$  iff

- $K_2 \leq K_1$  or
- there are  $K_3, K_4 \leq K$  such that  $K_1 \Rightarrow K_3 \in C_{K_4}$  and  $K_2 \leq K_3$



# Literature

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## References:

- Hans Kamp (1981), Irene Heim (1980)

## Reading:

- Hans Kamp and Uwe Reyle: From Discourse to Logic, Kluwer: Dordrecht 1993.

## Links:

- <https://plato.stanford.edu/entries/dynamic-semantics/>
- <https://plato.stanford.edu/entries/discourse-representation-theory/>