# Semantic Theory

Summer 2006

Presuppositions

M. Pinkal / A. Koller

## Some elementary number theory

- Theorem:
  The set of prime numbers is infinite, i.e. for every prime number p, there exists another prime number q > p.
- True or false?
  *The greatest prime number is odd.*
- True or false?
  *The greatest prime number is not odd.*

## Some geography

- True or false?
  *The king of Buganda is 42.*
- Does Buganda have a king?

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## Today

- Such facts that must be satisfied by the context in order to make a sentence interpretable are called *presuppositions*.
- Definite NPs trigger presuppositions, and we must deal with them.
- First: Some linguistic facts about presuppositions, and the projection problem.
- Then: van der Sandt's theory of presupposition as anaphora (built on top of DRT).

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## Trying to deal with definite NPs

- An approximate meaning representation of definite NPs says that there is exactly one individual with a certain property:
  - *the*
    $\Rightarrow \lambda F \lambda G \exists x[\forall y[F(y) \leftrightarrow x=y] \wedge G(x)]$
    $\Leftrightarrow \lambda F \lambda G \exists x[F(x) \wedge \forall y[F(y) \rightarrow x=y] \wedge G(x)]$
  - *the chancellor*
    $\Rightarrow \lambda G \exists x(\forall y(\text{chancellor}'(y) \leftrightarrow x=y) \wedge G(x))$
  - *the chancellor decides*
    $\Rightarrow \exists x(\forall y(\text{chancellor}'(y) \leftrightarrow x=y) \wedge \text{decides}'(x))$

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## Problem 1: Uniqueness doesn't have to be true

- *The chancellor decides*
  $\Rightarrow \exists x(\forall y(\text{chancellor}'(y) \leftrightarrow x=y) \wedge \text{decides}'(x))$
  "There is exactly one chancellor, and he decides."

- *The student is late*
  "There is exactly one student, and she is late." (?)

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## Problem 2: Interaction with negation

- *It is not the case that the chancellor decides* $\Rightarrow$
  $\neg\exists x(\forall y(\text{chancellor}'(y) \leftrightarrow x=y) \wedge \text{decides}'(x))$
  "Either there is no chancellor, or more than one, or there is exactly one chancellor and he doesn't decide."

- A correct representation for the sentence:
  $\exists x(\forall y(\text{chancellor}'(y) \leftrightarrow x=y) \wedge \neg\text{decides}'(x))$
  "There is exactly one chancellor, and he doesn't decide."

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## Problem 3: Falsity vs. uninterpretability

- *The greatest prime number is odd.*
  $\Rightarrow \exists x(\forall y(\text{g-p-n}'(y) \leftrightarrow x=y) \wedge \text{odd}'(x))$

- The formula is false, because it claims that there is a greatest prime number.
- But the sentence is not true or false: It just doesn't make sense. ("What do you mean -- greatest prime number?")

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## Presuppositions

- A sentence (with a definite NP) contains meaning information of two different types: the presupposition and the assertion.
  - Presupposition: the requirements that the context must satisfy so the utterance can be interpreted at all.
  - Assertion: the claims that are made, based on the context.

  $\exists x(\forall y(\text{chancellor}'(y) \leftrightarrow x=y) \wedge \text{decides}'(x))$

  "There is exactly one chancellor, and he decides."

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## Presupposition and negation

- Negation only applies to the assertion.
- The presupposition isn't negated. It is *projected* upwards, outside of the usual rules of semantic composition.

  $\exists x(\forall y(\text{chancellor}'(y) \leftrightarrow x=y) \wedge \neg\text{decides}'(x))$

  "There is exactly one chancellor, and he doesn't decide."

- Such a "survival" of negation is the standard test for presuppositions.

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## Further properties of projection

- Presuppositions "survive" not only negation, but also other kinds of embedding:
  - *The chancellor decides, or the states' prime ministers are responsible for decisions*
    *>> There is exactly one chancellor*
  - *John possibly regrets that Mary is married.*
    *>> Mary is married*
  - *Mary believes that John has stopped smoking.*
    *>> John used to smoke.*

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## Presupposition filtering

- But: There are contexts that can "neutralise" or filter some presuppositions; they block projection of these presuppositions.
  - *If John is out of town, then his wife is unhappy.*
    presupposes: *John is married*
  - *If John is married, then his wife is unhappy.*
    does not presuppose: *John is married*
  - *If John is married, then his daughter is unhappy.*
    presupposes: *John has a daughter.*

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## Presupposition cancellation

- In the context of negation, presupposition can also be overwritten or *cancelled* by explicitly claiming that they are false:
  - *John doesn't regret that Mary is married. Mary has no husband, and John knows about that.*
  - *The king of France isn't bald. France is a republic.*

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## Non-NP presupposition triggers

- Discourse particles (*only, even,* etc.)
  *Only Peter came to the party*
  *>> Peter came (and nobody else came to the party)*

- Factive verbs:
  *John regrets that Mary is married.*
  *>> Mary is married (and John regrets this)*

- Aspect verbs:
  *John has stopped smoking.*
  *>> John used to smoke (and he stopped doing it).*

- Cleft sentences:
  *It is Peter who ate the cake.*
  *>> Somebody ate the cake (and it was Peter who did it)*

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## Presuppositions: Summary

- Presupposition and assertion have a different status.
- Presuppositions are triggered by a number of different words and linguistic constructions, including definite NPs.
- Presuppositions behave differently than assertions in semantics construction: They are typically projected unchanged, rather than used in functional application.
- Projected presuppositions can be filtered in the semantic composition process, and can be cancelled by contextual knowledge
- The problem of determining the presuppositions of a larger expression from the presuppositions of its subexpressions is called the *projection problem*.

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## Presupposition theories

- Since the 70s (and before that, since Russell 1905), there have been a number of very different theories of presupposition. They are more or less successful in explaining presuppositions, and in modelling the projection problem.

- Here we present Rob van der Sandt's analysis (1992), which is based on DRT. Basic idea: *Presuppositions are anaphora*.

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## Definite NPs and presuppositions in DRT

- Idea: Expressions that trigger presuppositions are anaphora.
- For example, the existential presupposition of a definite NP is the requirement that the context must provide a suitable discourse referent.

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## Presupposition as anaphora

∃x(∀y(chancellor'(y) ↔ x=y) // decides'(x)
"There is a chancellor // he/she decides."

*John regrets that Mary is married.*
*>> Mary is married // John regrets this*

*John stopped smoking*
*>> John used to smoke // he has stopped doing that*

*It is Peter who ate the cake.*
*>> Somebody ate the cake // Peter did it.*

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## Definite NPs and presuppositions in DRT

- Idea: Expressions that trigger presuppositions are anaphora.
- For example, the existential presupposition of a definite NP is the requirement that the context must provide a suitable discourse referent.
- Other presuppositions involve anaphoric references to facts, properties, events, etc.
- Viewing presuppositions as anaphora explains why they "survive" negation. Anaphoric reference is not negated.

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## Van der Sandt: Basic principles

- Introduce „α-DRSs“ as a new type of complex condition.
- DRS construction proceeds in two steps:
  - Construction rules for definite NPs introduce α-DRSs (this yields a "proto-DRS").
  - In a second step, the α-DRSs are resolved (translation of a proto-DRS into a standard DRS)
- Presuppositions can be either bound or accommodated.
- Resolution of presuppositions is subject to a number of constraints, some of which encode Gricean maxims.

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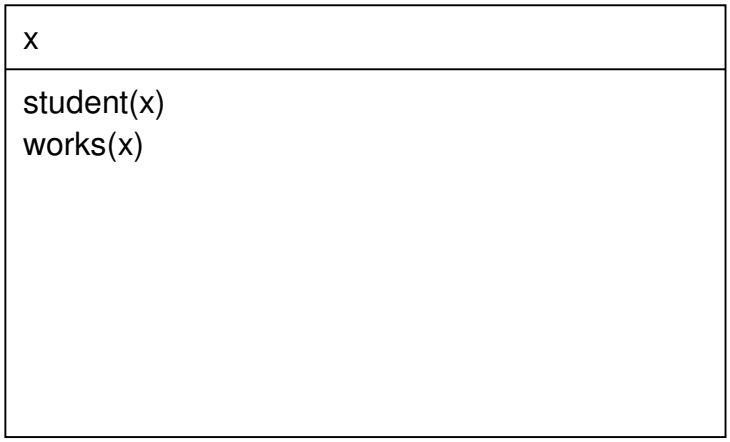
## Example: Binding [1]

- *A student works.*

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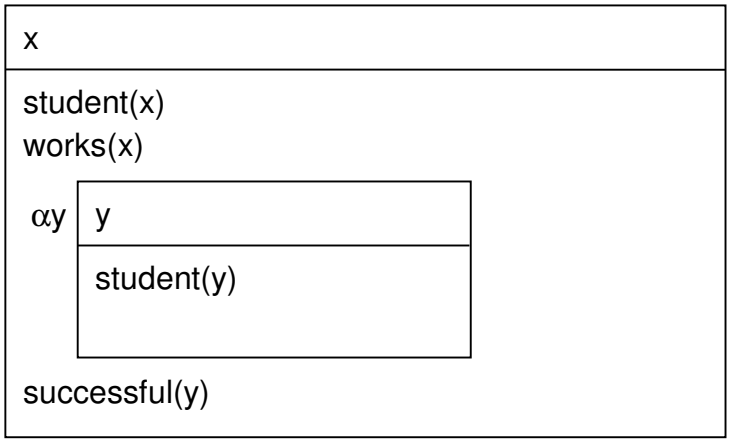
## Example: Binding [2]

- *A student works. The student is successful.*

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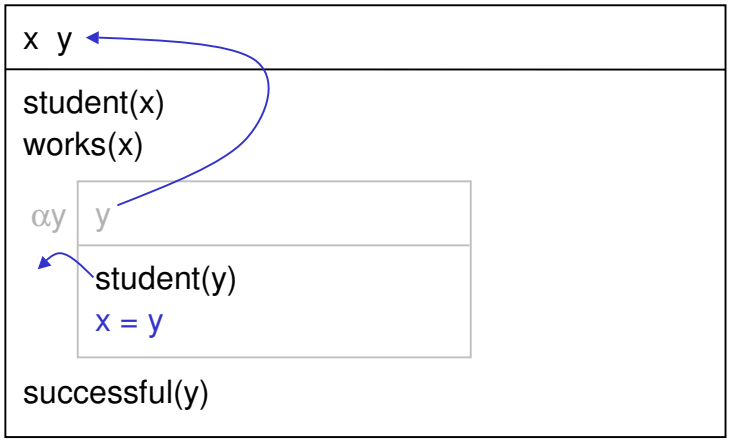


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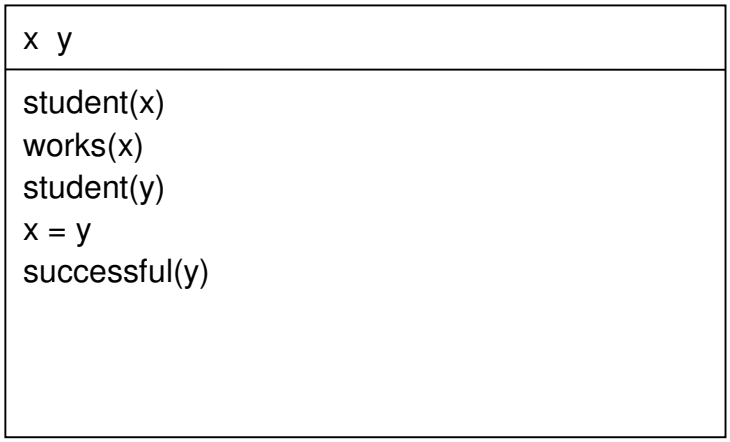
## Example: Binding [4]

- *A student works. The student is successful.*

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## Accommodation

- *The king of Buganda is 42.*
- *The movie I saw yesterday was really interesting.*
- *We regret that we have no free rooms available.*

We can often use expressions that trigger presuppositions although the context doesn't satisfy the presupposition.

The missing information is silently added to the context ("accommodated") as we interpret the sentence.

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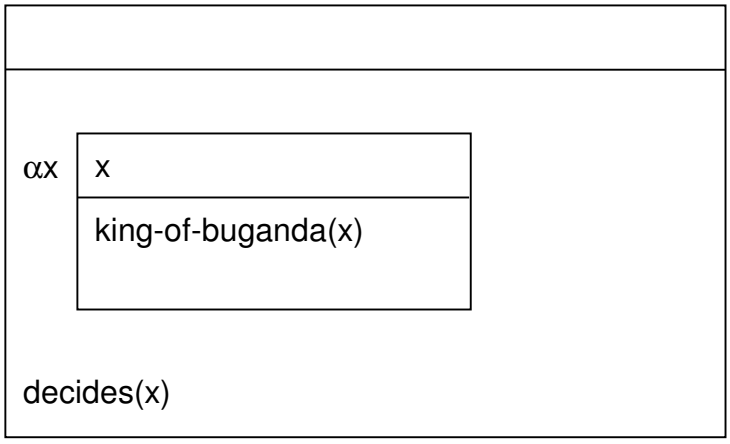
## Example: Accommodation [1]

- *The king of Buganda decides.*

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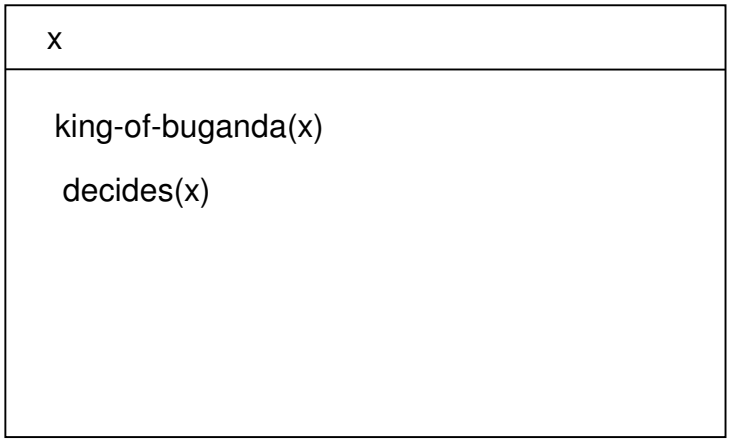
## Example: Accommodation [2]

- *The king of Buganda decides.*

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## DRS construction for definite NPs [1]

- A (proto-)DRS is a triple $\langle U_K, C_K, A_K \rangle$ such that
  - $U_K$ is a set of discourse referents
  - $C_K$ is a set of (atomic or complex) conditions
  - $A_K$ is a set of "anaphoric" (alpha-) DRSs of the form $\alpha z$ K', where z is a discourse referent and K' is a proto-DRS.

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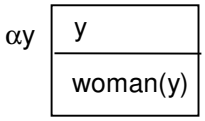
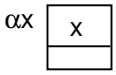
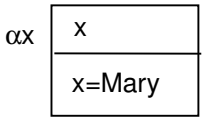
## DRS construction for definite NPs [2]

- The DRS construction rules for all definite NPs introduce alpha-DRSs:
  - Definite descriptions
    *the woman*
  - pronouns
  - proper names
    *Mary*

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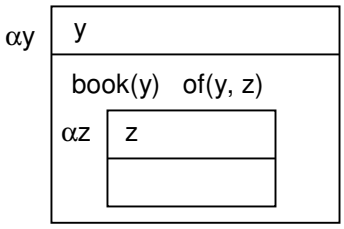
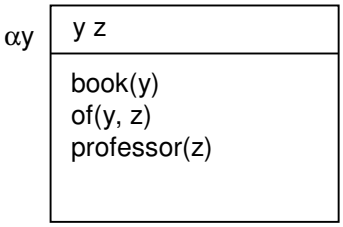
## Complex Alpha-DRSs

- *his book*




- *the book of a professor*

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## Resolution by binding

- Let
  - K, K‘ DRSs, K‘ ≤ K
  - $\gamma = \alpha x K_s \in K$‘, $K_s$ is $\alpha$-free
  - $y \in U_{K_t} \leq K$ a DR that is accessible and suitable for $\gamma$
- Remove $\gamma$ from K' and extend $K_t$ with $U_{K_s}$, $C_{K_s}$, and the condition x=y.

  Note: Because $K_s$ must be $\alpha$-free, complex Alpha-DRSs are always resolved from the inside out.

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## Resolution by accommodation

- Let
  - K, K‘ DRSs, K‘ ≤ K
  - $\gamma = \alpha x K_s \in K$‘, $K_s$ is $\alpha$-free
  - $K_t \leq K$ a DRS that is accessible for $\gamma$.
- Remove $\gamma$ from K' and extend $K_t$ with $U_{K_s}$ and $C_{K_s}$.

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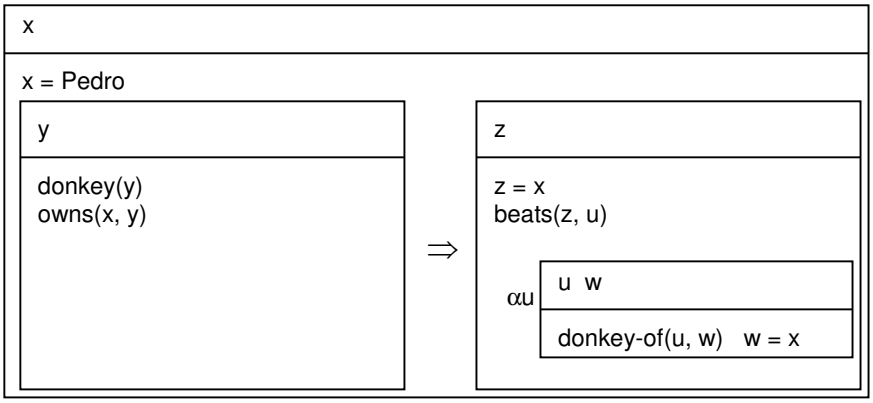
## Example: Binding [1]

- *If Pedro owns a donkey, he beats his donkey.*

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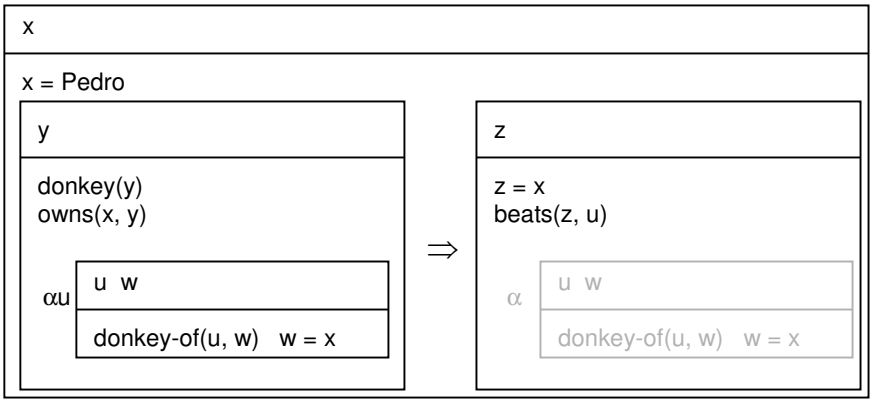
## Example: Binding [2]

- *If Pedro owns a donkey, he beats his donkey.*

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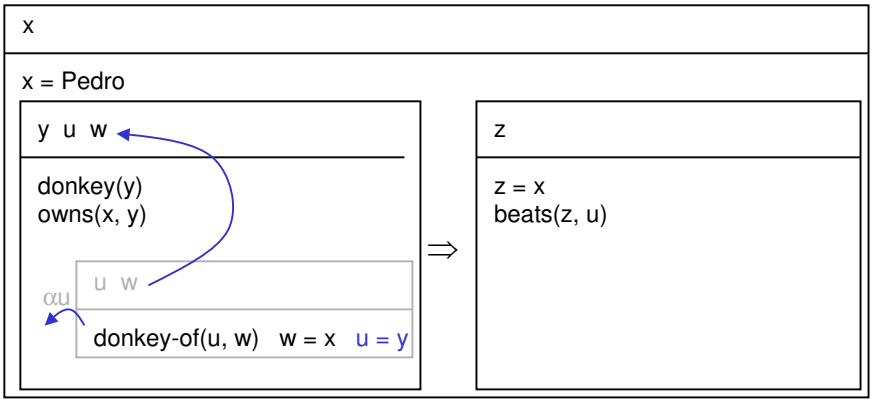
## Example: Binding [3]

- *If Pedro owns a donkey, he beats his donkey.*

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## Example: Binding [4]

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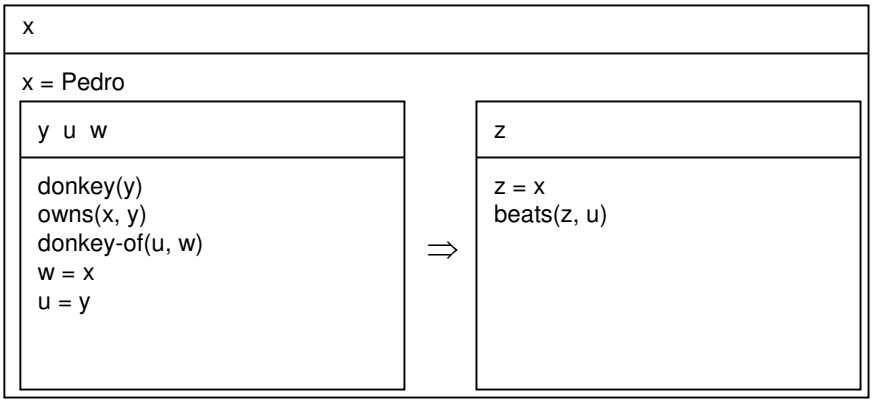


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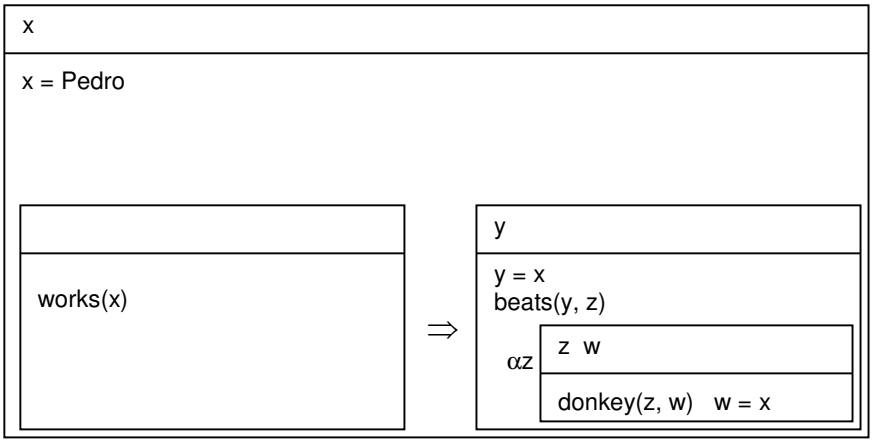
## Example: Accommodation [1]

- *If Pedro works, he beats his donkey.*

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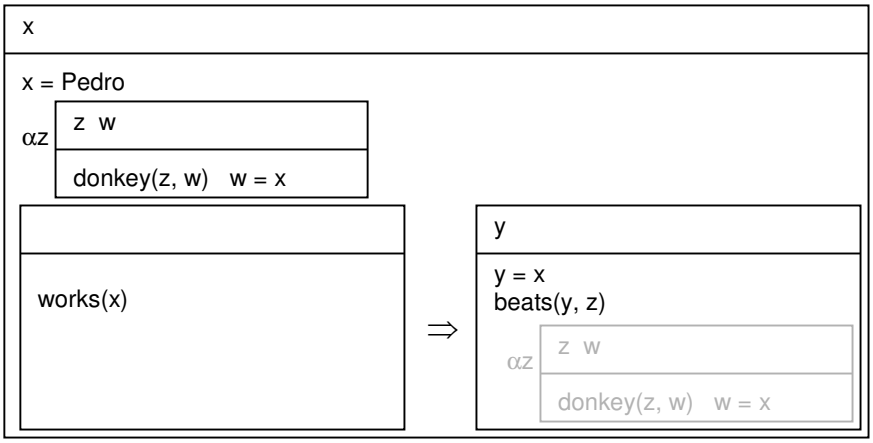
## Example: Accommodation [2]

- *If Pedro works, he beats his donkey.*

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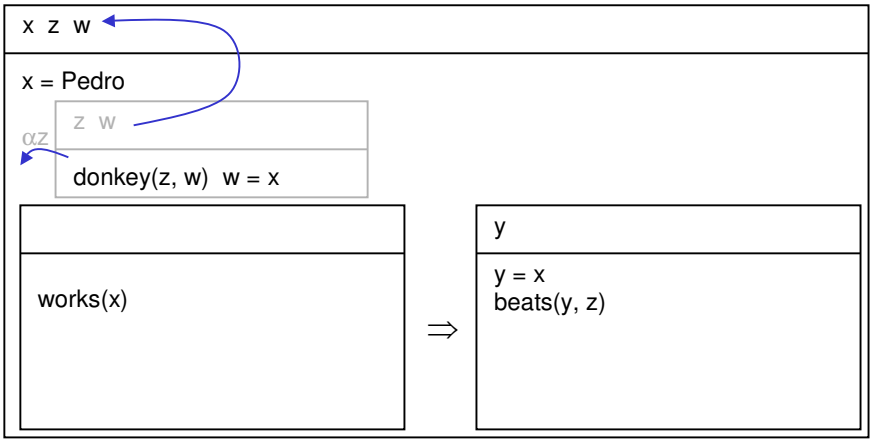
## Example: Accommodation [3]

- *If Pedro works, he beats his donkey.*

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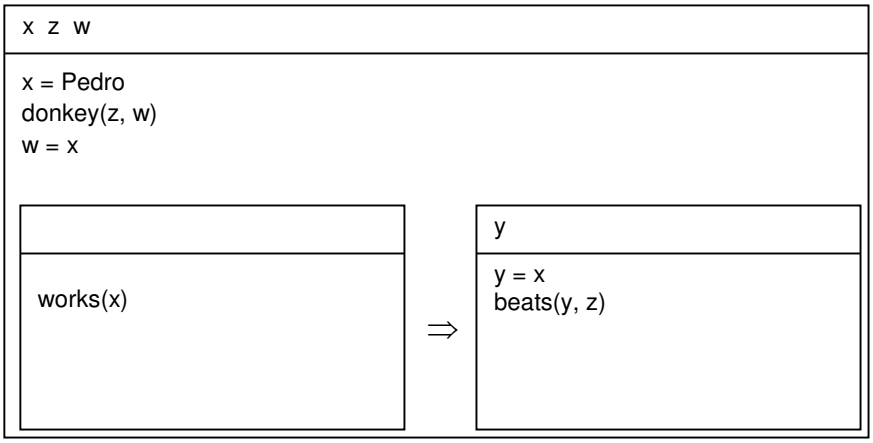


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## Constraints and preferences on projection

- The two resolution rules specify possible places where $\alpha$-DRSs can be bound or accommodated.
- But so far, we can bind or accommodate almost anywhere!
- Van der Sandt theory also contains:
  - constraints that restrict where binding or accommodation is admissible
  - principles that say in which order we should try the possible binding and accommodation options.

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## Preference principles

- Binding is preferred over accommodation.
- Binding works "upwards" along the accessibility relation: The "closest" possible antecedent is preferred.
- Accommodation works "downwards" along the accessibility relation. It is preferred to accommodate into the highest possible DRS.

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## Constraints on projection

- Free variable constraint:
  - The resolved DRS may not contain any free discourse referents.
- (Local) consistency and informativity constraints

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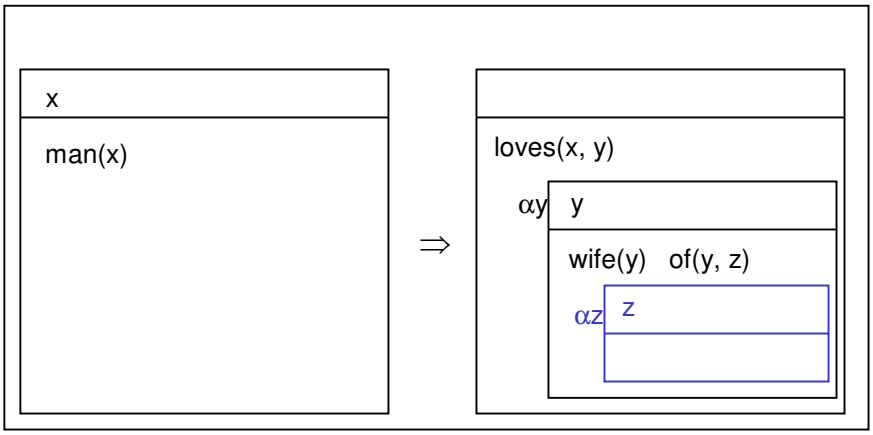
## The Free Variable Constraint

*Every man loves his wife.*

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## The Free Variable Constraint

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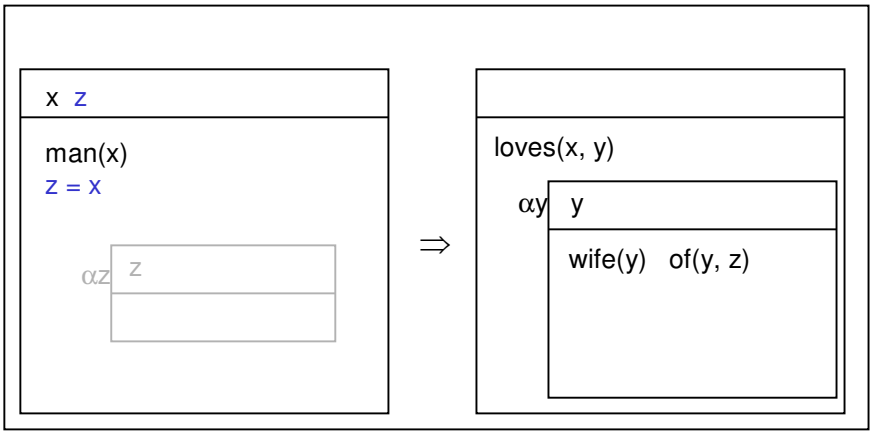


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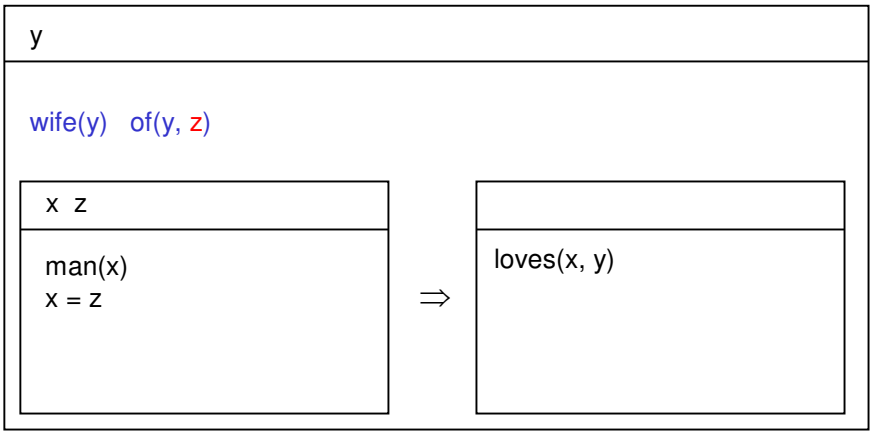
## The Free Variable Constraint

Inadmissible resolution:

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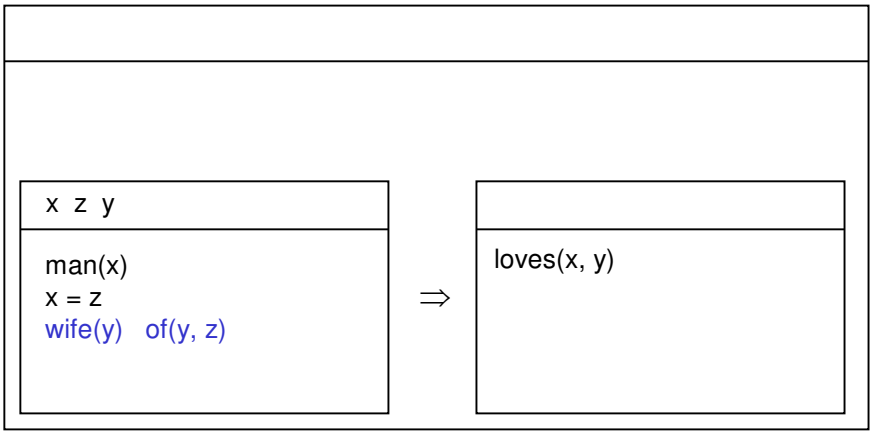
## The Free Variable Constraint

Admissible resolution:

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## Gricean conversational principles

- Highest principle of conversation for speakers: Be cooperative!
- E.g.: Make informative contributions – utterances that are neither tautological nor inconsistent. ("Maxim of quantity" – other maxims: "Tell the truth"/Quality; "Be orderly"/Manner; "Make relevant contributions"/Relevance)
- Conversational principle for hearers/addressees: Assume that the speaker observes the highest conversational maxime.- Try to interpret utterances such that they make sense. This leads to:
- "Conversational implicatures":
  - "The next gas station is around the corner", implicates: Speaker has no reason to assume that station is closed.
  - "The king of Buganda is 42", implicates: There is a king of Buganda
- Maxim of quantity leads to a number of concrete and general implicature schemes, e.g.: Clausal Implicatures:
  - In a conditional or disjunction, the assertion a well as the negation of the clauses should be compatible with the context (i.e., neither inconsistent nor entailed)

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## DRT Anaphora Resolution and Gricean Maximes

- The resolved DRS must be *consistent* and *informative*.
  - Consistency: The resolved DRS must be satisfiable (taking background knowledge into account).
  - Informativity: The resolved DRS may not be entailed by our background knowledge.
  - Local consistency: No sub-DRS must be inconsistent with any superordinate DRS.
  - Local informativity: No sub-DRS must be entailed by any superordinate DRS.

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## Consistency and informativity

- Further reading on this topic:
  - Rob van der Sandt (1992). *Presupposition projection as anaphora resolution*. Journal of Semantics 9:223-267.
- For an implementation of van der Sandt's (somewhat informally specified) consistency and informativity constraints using theorem provers, see also:
  - Johan Bos (2003). *Implementing the Binding and Accommodation Theory for Anaphora Resolution and Presupposition Projection*. Computational Linguistics 29(2).

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## Presupposition filtering

- There are contexts that can "neutralise" or filter some presuppositions; they block projection of these presuppositions.
  - *If John is out of town, then his wife is unhappy.*
    presupposes: *John is married*
  - *If John is married, then his wife is unhappy.*
    does not presuppose: *John is married*

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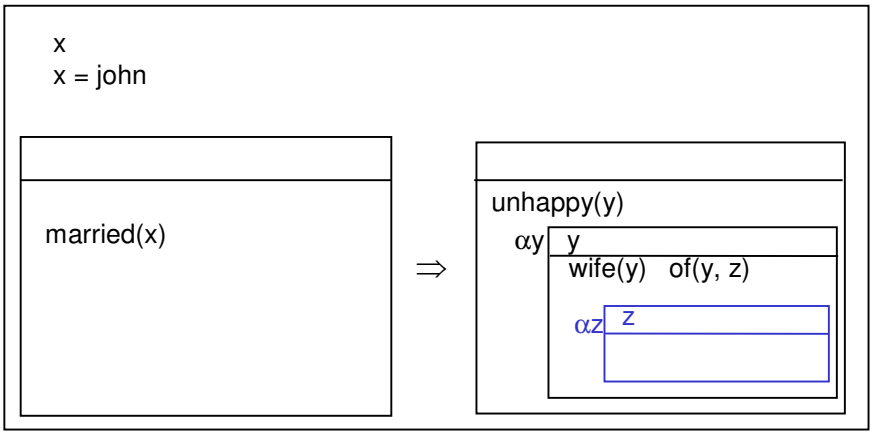
## The Free Variable Constraint

*If John is married, then his wife is unhappy.*

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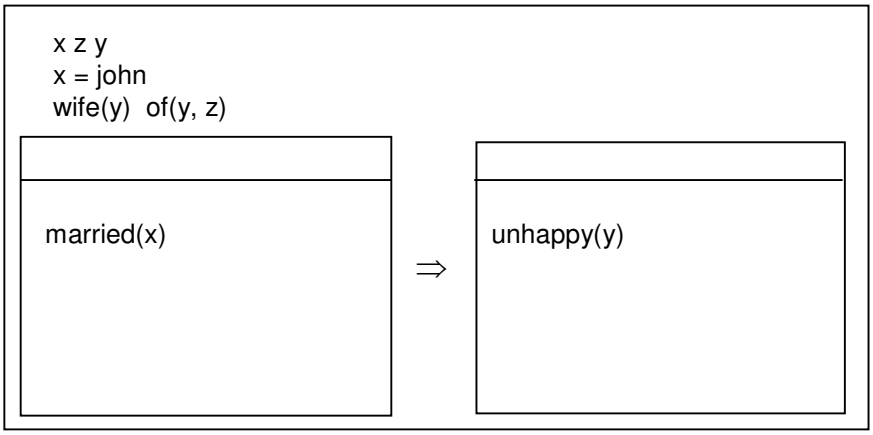
## The Free Variable Constraint

Out: Antecedent DRS of conditional is entailed by main DRS

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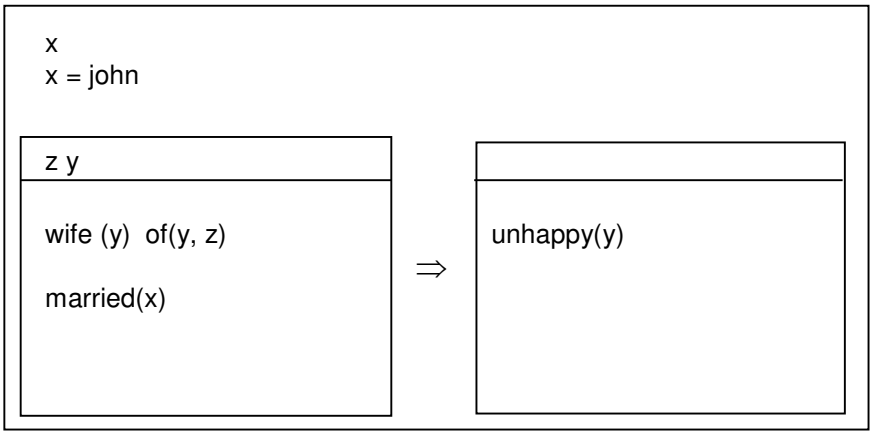
## The Free Variable Constraint

Correct: No implicature violation

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## Summary

- Presupposition:
  - Precondition for interpretability of a sentence
  - Survives embedding in negation and other contexts
  - Not subject to compositional semantics construction, but is projected upwards
- Van der Sandt's presupposition theory:
  - presuppositions as anaphora
  - extend DRS with markers for unresolved presuppositions
  - resolve by binding or accommodation
  - subject to constraints and preferences

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