

Presupposition projection as anaphora resolution

Ivan Rygaev

irygaev@gmail.com

Laboratory of Computational Linguistics

Institute for Information Transmission Problems RAS, Moscow, Russia

based on

Rob A. van Der Sandt (1992). Presupposition projection as anaphora resolution and related works

Presupposition

- Presupposition is an information which the speaker linguistically marks as taken for granted
 - i.e. already known by the audience
 - i.e. constituting a part of the common ground

Presupposition triggers

- Definite descriptions
 - *The king of France is bald*
 - > *There is a king of France*
- Complements of factive verbs
 - *John knows that the Earth is flat*
 - > *The Earth is flat*
- Clefts
 - *It was John who killed the butcher*
 - > *Somebody killed the butcher*
- Adverbs *even, too, again, etc.*

Presupposition and negation

- Negation does not affect presupposition
- If an affirmative sentence carries a presupposition
 - *The king of France is bald*
 - > *There is a king of France*
- Its negative counterpart carries the same presupposition
 - *The king of France is **not** bald*
 - > *There is a king of France*
- Some researchers define presupposition through this property

Presupposition projection

- Presuppositions also normally survive under other logical operators:
 - *If Fred has stopped beating Zelda, then Fred no longer resents Zelda's infidelity*
 - *> Fred has been beating Zelda*
 - *> Zelda has been unfaithful*
- And in other complex sentences:
 - *Bill does not know that all of Jack's children are bald*
 - *> All of Jack's children are bald*
 - *> Jack has children*

Presupposition projection

- Sometimes presuppositions seem to disappear in complex sentences:
 - *If Jack has children, then all of **Jack's children** are bald*
 - *Jack has children and all of **Jack's children** are bald*
 - *Either Jack has no children or all of **Jack's children** are bald*
- Presupposition projection problem:
 - How to determine the presuppositions of a complex sentence out of presuppositions of its parts?
 - Or at least describe a set of contexts in which the sentence can be felicitously uttered

Karttunen's satisfaction theory

- Plugs, holes and filters
- Presuppositions of *'if A then B'*:
 - Presupposition of A
 - Presupposition of B except those which are entailed by A
- Presuppositions are context dependent:
 - It is not possible to determine the presuppositions of a complex sentence out of the sentence itself without taking context into account
 - *If Nixon invites Angela Davis to the White House, Nixon will regret having invited a black militant to his residence*
 - *Angela Davis is a black militant*

Karttunen's satisfaction theory

- Instead of deriving the presuppositions of the whole sentence
- We define what context has to be like to admit (i.e. satisfy presuppositions of) the sentences
- Simple rules if we take into account 'local contexts'
- Context X admits '*if A then B*' just in case:
 - X admits A
 - $X+A$ admits B

Presupposition as anaphora

- In a series of papers (1988 – 1992) Rob van der Sandt proposed that presupposition and anaphora is essentially the same phenomenon:
 - *Theo has a little rabbit and **his rabbit** is grey*
 - *Theo has a little rabbit and **it** is grey*
 - *If Theo has a rabbit, **his rabbit** is grey*
 - *If Theo has a rabbit, **it** is grey*

Theories of presupposition

- Presuppositions are referring expressions
 - Presupposition picks out a certain referent
 - If there is none, the sentence is uninterpretable
- Semantic account
 - Presupposition is a proposition which is entailed both by a sentence and its negation
- Pragmatic account
 - Presupposition is an addition to a semantic content of a sentence and derived only after the semantic content is determined

Referring expressions theory

- Based on Frege compositional semantics
 - Reference of a complex expression is a function of the references of its parts
 - If some expressions do not refer the sentence cannot have a truth value
- But these sentences are interpretable even if the highlighted expressions have no reference:
 - *John has children and **his children** are bald*
 - *If a man gets angry, **his children** get frightened*
 - *Every man kissed **the girl who loved him***

Semantic account

- A sentence φ presupposes ψ just in case:
 - $\varphi \Rightarrow \psi$
 - $\neg \varphi \Rightarrow \psi$
- In classical logic this entails that ψ is a tautology (necessary true)
- Trivalent logic is required
 - If ψ is false then φ is undefined
 - But the relation of entailment is a classical one
 - This relation is monotonic
 - Which means it is preserved under growing of information

Semantic account

- Presuppositional inferences are not monotonic:
 - *It is possible that Harry's child is on holiday*
 - *> Harry has a child*
 - *It is not possible that Harry's child is on holiday*
 - *> Harry has a child*
 - *It is possible that Harry does not have a child, but it is also possible that Harry's child is on holiday*

Pragmatic account

- Presuppositions are
 - purely pragmatic
 - context-dependent
 - can be cancelled like Gricean implicatures
- Utterance information content consists of:
 - Semantic content
 - Pragmatic content which is computed on the basis of semantic content, contextual information and pragmatic principles

Pragmatic account

- Consequences
 - Utterance (sentence + context) is a primary information carrying unit, not sentence
 - Semantic content should be computed before pragmatic one
 - Pragmatic information should be represented separately

Pragmatic account problems

- A notion of semantic (propositional) content is counterintuitive and wrong in intensional contexts(?)
- We run into a binding problem with quantifiers
- Accommodation is not an incremental update:
 - Processing of presupposition does not just add new information to the context as assertion does
 - It adjusts the context against which the utterance is processed
- Computation of semantic content may depend on presuppositional one

Pragmatic account problems

- Quantifier problems
 - *Someone had a child and **his child** was bald*
 - *If a man gets angry, **his children** get frightened*
 - *Every boy kissed **the girl who loved him***
- *A child beats his cat*
 - Semantic content: there is a child and there is a cat and the child beats the cat
 - Pragmatic presupposition: there is a child who has a cat
 - Not necessarily the same child!

Presupposition as anaphora

- Presuppositions are just anaphors
 - Can be treated by the same mechanism as anaphora resolution
- But unlike pronouns they contain descriptive content
 - They can be accommodated
 - They have internal structure that must be represented
- Anaphoric properties of definite descriptions were noticed by McCawley, Lewis and Heim
 - But in addition they postulated separate presuppositional properties

Presupposition/anaphora parallels

- Presupposition
 - *Jack has children and all of **Jack's children** are bald*
 - *If Jack has children, then all of **Jack's children** are bald*
 - *Either Jack has no children or all of **Jack's children** are bald*
- Anaphora
 - *John owns a donkey. He beats **it**.*
 - *If John owns a donkey, he beats **it***
 - *Either John does not own a donkey or he beats **it***
- Problems have been formulated in different terms

Presupposition/anaphora parallels

- VP-anaphora:
 - *If someone solved the problem it was Julius who {solved it/did}*
 - *If Harry stopped smoking, John {stopped/did} too.*
- Full propositional anaphora:
 - *If John is ill, Mary regrets {that/that he is ill}*
 - *If John died, he did see his children before {that/he did/he died}*
- The difference is only in the capacity to accommodate
 - Descriptive content allows for accommodation

Binding theory of presupposition

- Presupposition as anaphora:
 - Presuppositions are bound or accommodated rather than cancelled, neutralized or suspended
 - Binding and accommodation can happen either at the top level of discourse structure or at some nested level
 - It is the first case where the sentence is said to presuppose something
 - Pragmatic principles constrain the possibility for presupposition to be bound/accommodated at a specific site

Binding vs satisfaction theory

- Satisfaction theory gives weaker presuppositions:
 - *If John made coffee, his wife will be happy*
 - Current context + 'John made coffee' should entail that John has a wife
 - It is enough to adjust the context with the conditional:
 - *If John made coffee, he has a wife*

Binding vs satisfaction theory

- Satisfaction theory does not predict ambiguity:
 - Context either satisfies presupposition or not
 - But an anaphor can be bound by different antecedent resulting into distinct interpretations
- *If John has grandchildren, **his children** must be happy*
 - Has two interpretations – presuppositional and not
 - Satisfaction theory predicts only the second reading
 - Binding theory provides both – binding in the antecedent vs accommodation at top level
 - *If John murdered his wife, he will be glad that she is dead*

Discourse representation theory

- *A farmer bought a car.*

| |
|----------------|
| x, y |
| farmer (x) |
| car (y) |
| buy (x, y) |

$\exists x \exists y (\text{farmer}(x) \wedge \text{car}(y) \wedge \text{buy}(x, y))$

- Discourse representation structure (DRS) consists of:
 - Set of discourse referents (markers, variables)
 - Set of conditions (properties, predicates)

Anaphora resolution

- *A farmer bought a car. It was pink.*

| |
|----------------|
| x, y, z |
| farmer (x) |
| car (y) |
| buy (x, y) |
| pink (z) |
| $z = y$ |

=

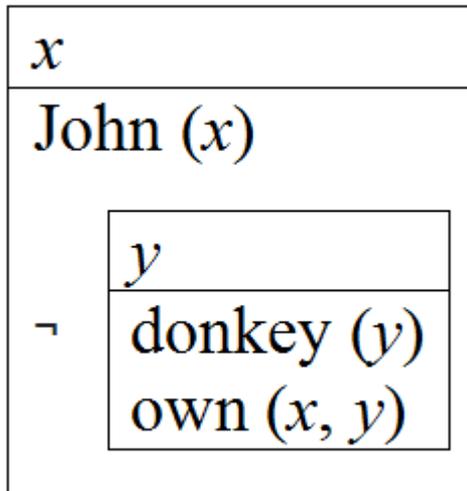
| |
|----------------|
| x, y |
| farmer (x) |
| car (y) |
| buy (x, y) |
| pink (y) |

$\exists x \exists y (\text{farmer}(x) \wedge \text{car}(y) \wedge \text{buy}(x, y) \wedge \text{pink}(y))$

- DRS is true in a model if:
 - There are individuals standing in the corresponding relations in the model

Complex DRS: negation

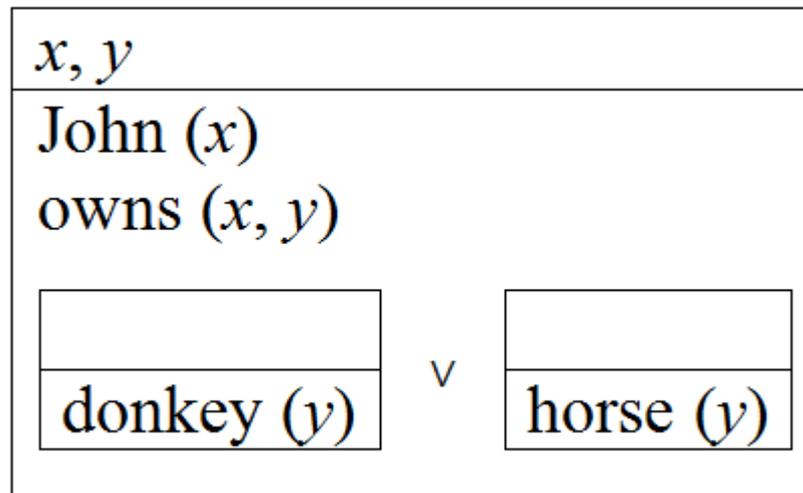
- *John owns no donkey*
- *John does not own a donkey*



$$\exists x (\text{John}(x) \wedge \neg \exists y (\text{donkey}(y) \wedge \text{own}(x, y)))$$

Complex DRS: disjunction

- *John owns a donkey or a horse*



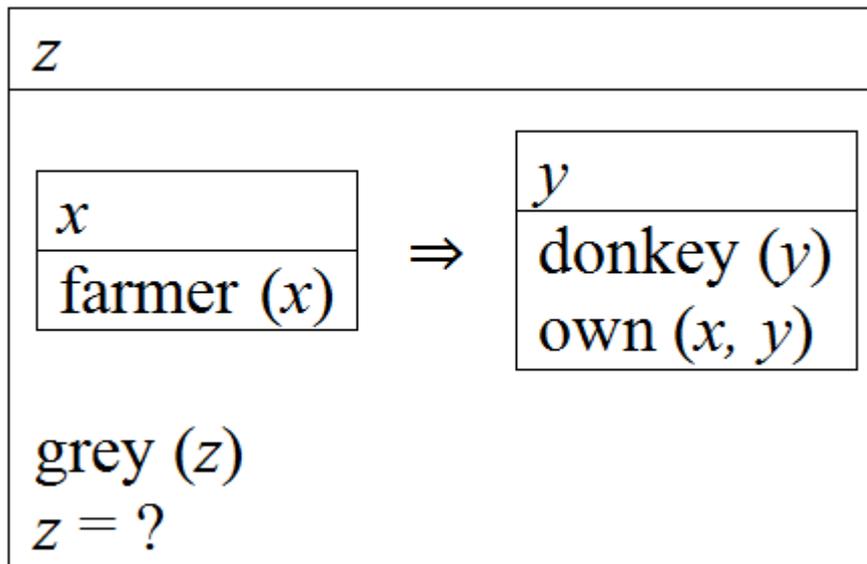
$\exists x \exists y (\text{John}(x) \wedge \text{owns}(x, y) \wedge (\text{donkey}(y) \vee \text{horse}(y)))$

DRS subordination and accessibility

- DRS B is subordinate to DRS A iff (informally):
 - B is embedded into A or
 - 'A => B' is a condition in some other DRS
- Accessibility
 - Discourse referent from DRS A is accessible to an (anaphoric) discourse referent in DRS B, just in case B is subordinate to A

DRS subordination and accessibility

- *Every farmer owns a donkey. *It is grey.*



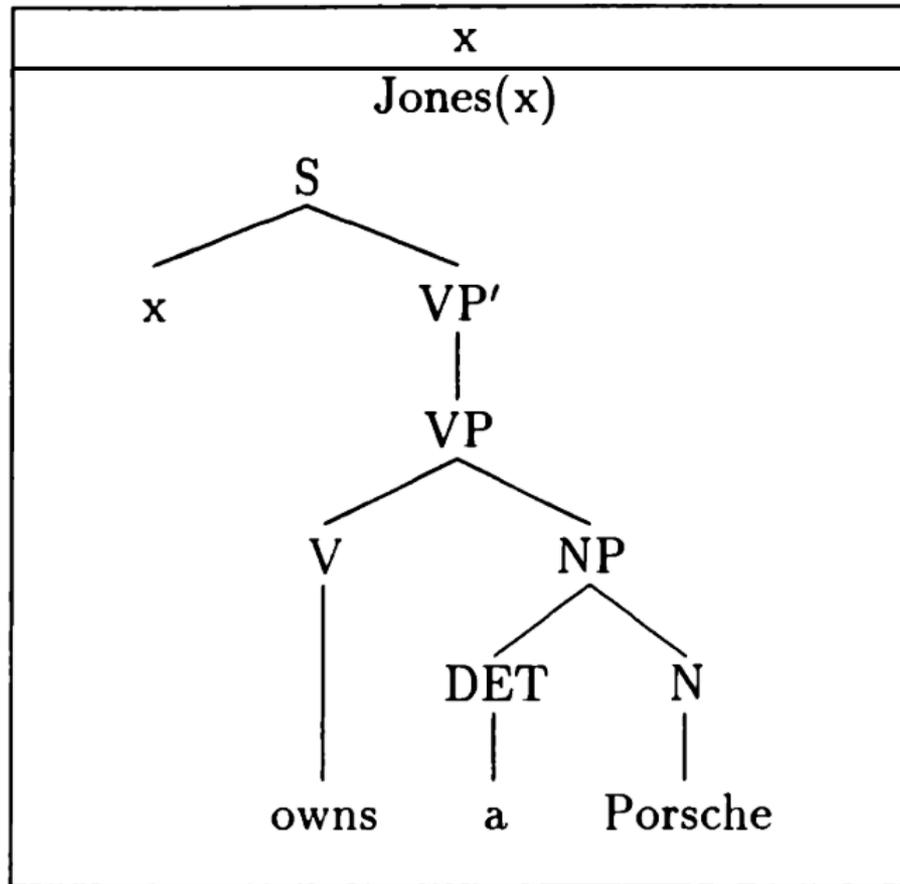
- Neither y nor x is accessible to z because they lie in subordinate DRSs

DRT summary

- Allows the scope of (top level) NPs to be extended indefinitely
- Explains binding of anaphoric pronouns which are not syntactically bound
- Explains impossibility of anaphoric links where the antecedent is inaccessible

Top-down construction procedure

- *Jones owns a Porsche*



Presupposition projection in DRT

- Bottom-up construction procedure
- First a separate sentence DRS is built and only after that it is merged into the main DRS
- Anaphoric elements are encoded separately in a DRS
 - They are not resolved online
 - They are processed only after the sentence DRS is merged into the main DRS
 - In addition to discourse referents and conditions there is now an A-structure – a set of presuppositional DRSs
 - Presuppositional DRS can have its own A-structure

Binding

- *John has a cat. His cat purrs*

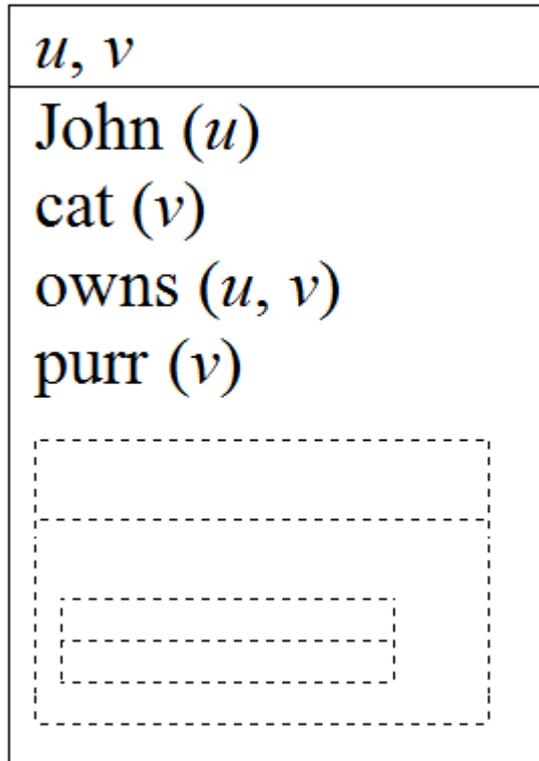
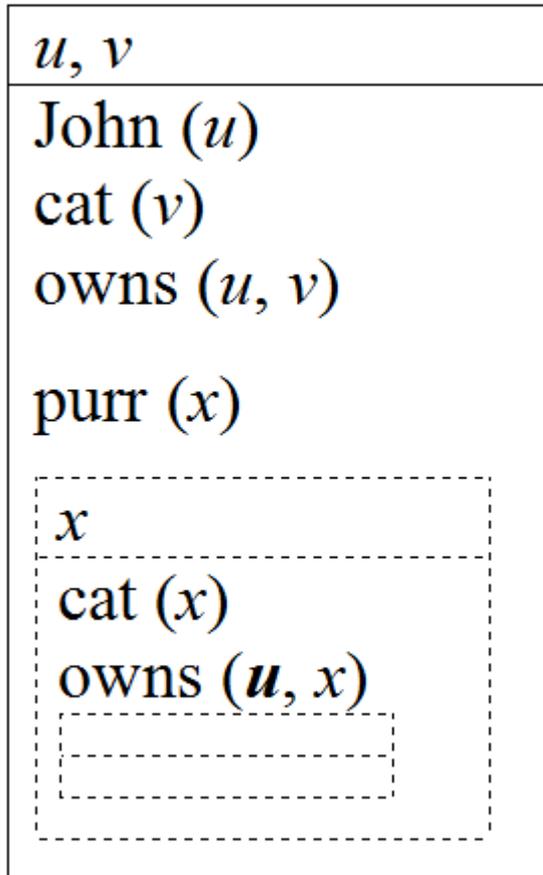
| |
|-----------------|
| y, x |
| John (y) |
| cat (x) |
| owns (y, x) |

| | | | | | |
|--|------------|-------------|-----------------|--|------------|
| | | | | | |
| purr (x) | | | | | |
| <table border="1" style="border-style: dashed; width: 100%;"> <tr> <td>x</td> </tr> <tr> <td>cat (x)</td> </tr> <tr> <td>owns (y, x)</td> </tr> <tr> <td> <table border="1" style="border-style: dashed; width: 100%;"> <tr> <td>y_{masc}</td> </tr> </table> </td> </tr> </table> | x | cat (x) | owns (y, x) | <table border="1" style="border-style: dashed; width: 100%;"> <tr> <td>y_{masc}</td> </tr> </table> | y_{masc} |
| x | | | | | |
| cat (x) | | | | | |
| owns (y, x) | | | | | |
| <table border="1" style="border-style: dashed; width: 100%;"> <tr> <td>y_{masc}</td> </tr> </table> | y_{masc} | | | | |
| y_{masc} | | | | | |

| | | | | | |
|--|------------|-------------|-----------------|--|------------|
| u, v | | | | | |
| John (u) | | | | | |
| cat (v) | | | | | |
| owns (u, v) | | | | | |
| purr (x) | | | | | |
| <table border="1" style="border-style: dashed; width: 100%;"> <tr> <td>x</td> </tr> <tr> <td>cat (x)</td> </tr> <tr> <td>owns (y, x)</td> </tr> <tr> <td> <table border="1" style="border-style: dashed; width: 100%;"> <tr> <td>y_{masc}</td> </tr> </table> </td> </tr> </table> | x | cat (x) | owns (y, x) | <table border="1" style="border-style: dashed; width: 100%;"> <tr> <td>y_{masc}</td> </tr> </table> | y_{masc} |
| x | | | | | |
| cat (x) | | | | | |
| owns (y, x) | | | | | |
| <table border="1" style="border-style: dashed; width: 100%;"> <tr> <td>y_{masc}</td> </tr> </table> | y_{masc} | | | | |
| y_{masc} | | | | | |

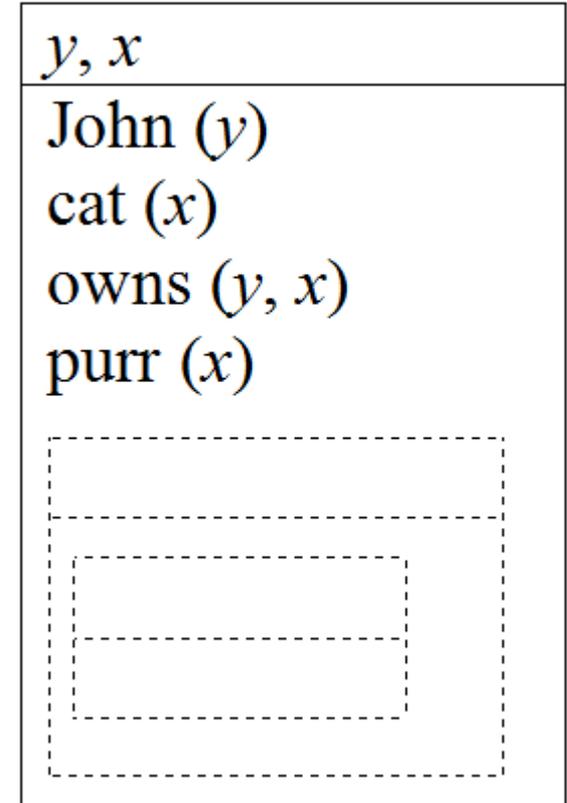
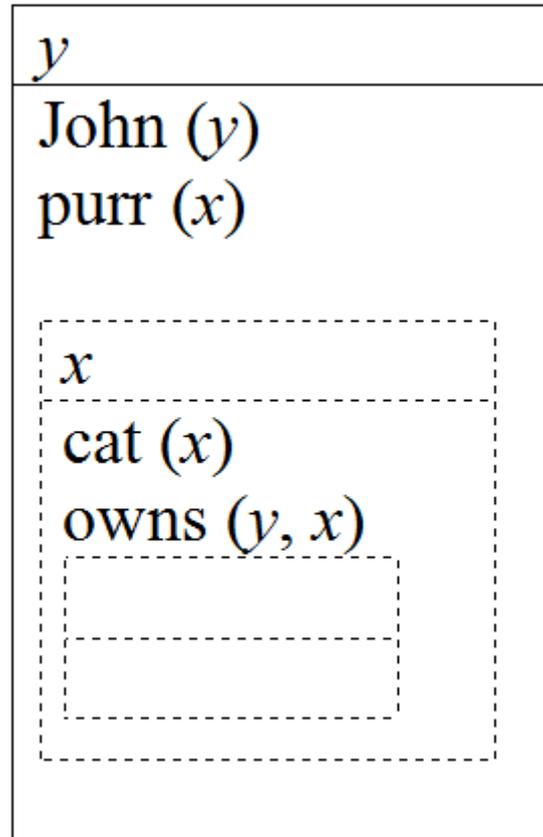
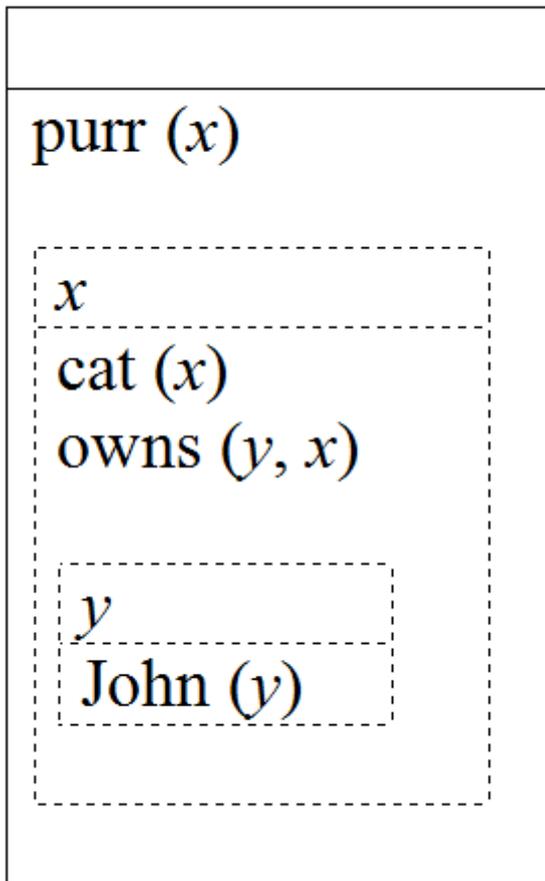
Binding

- *John has a cat. His cat purrs*



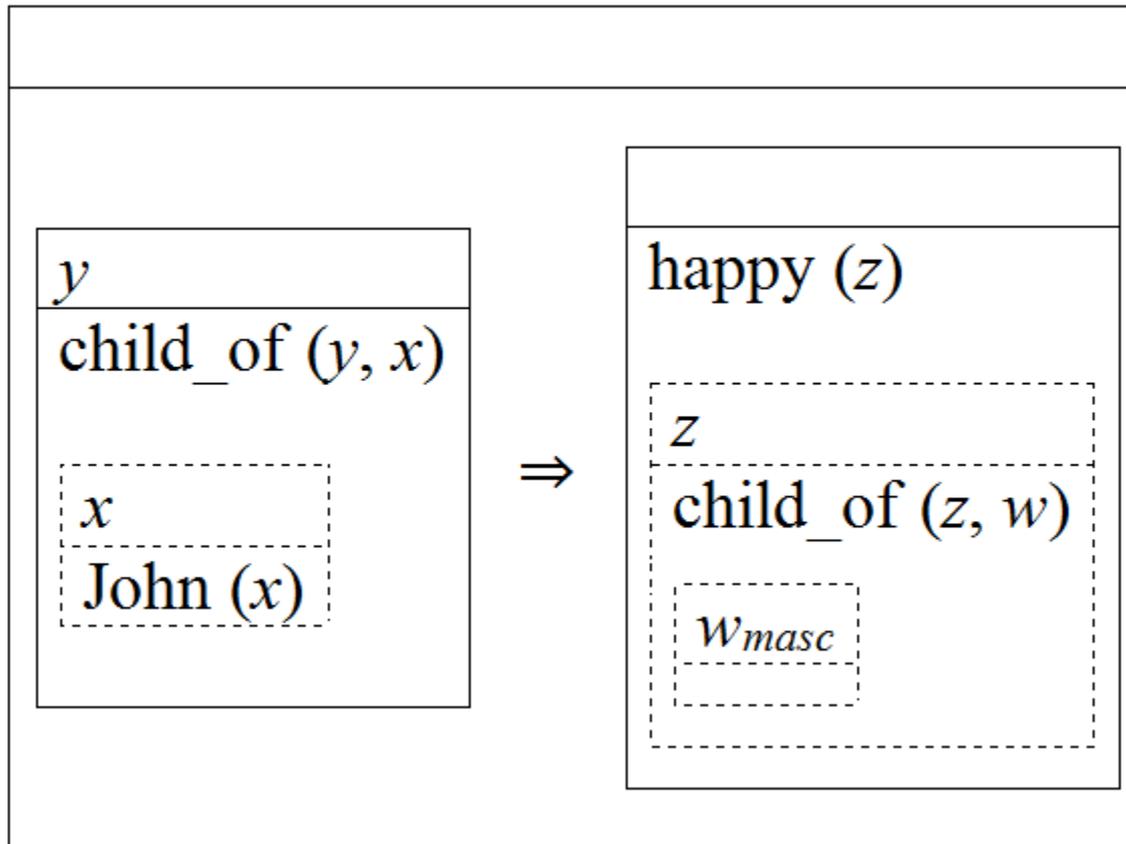
Accommodation

- *John's cat purrs*



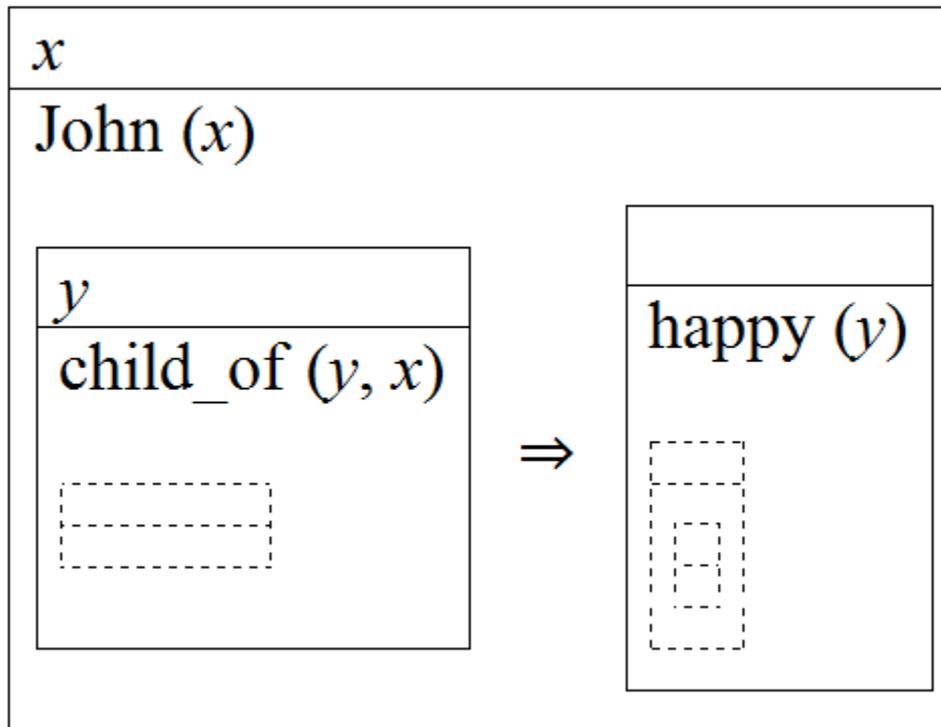
Presupposition “neutralization”

- *If John has a child, his child is happy*



Presupposition “neutralization”

- *If John has a child, his child is happy*

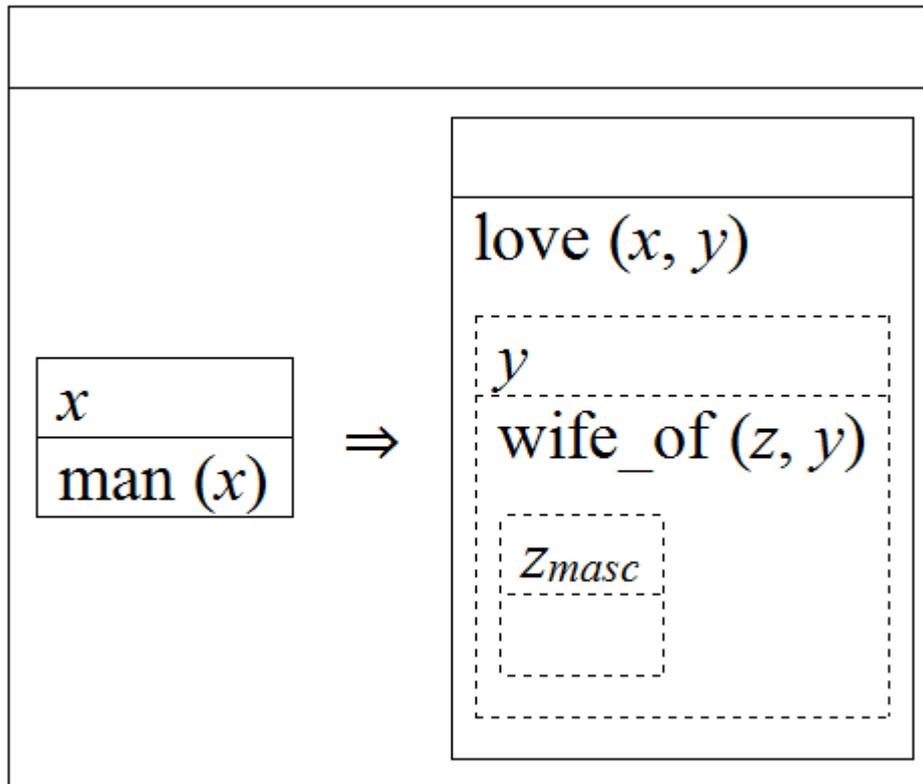


Constraints on resolution

- Possible resolutions of a presuppositional DRS B into a DRS A:
 - A is on B's projection line
 - B's A-structure is empty
 - There is no DRS on B's projection line which A-structure is not empty
 - A contains no free variables after the resolution

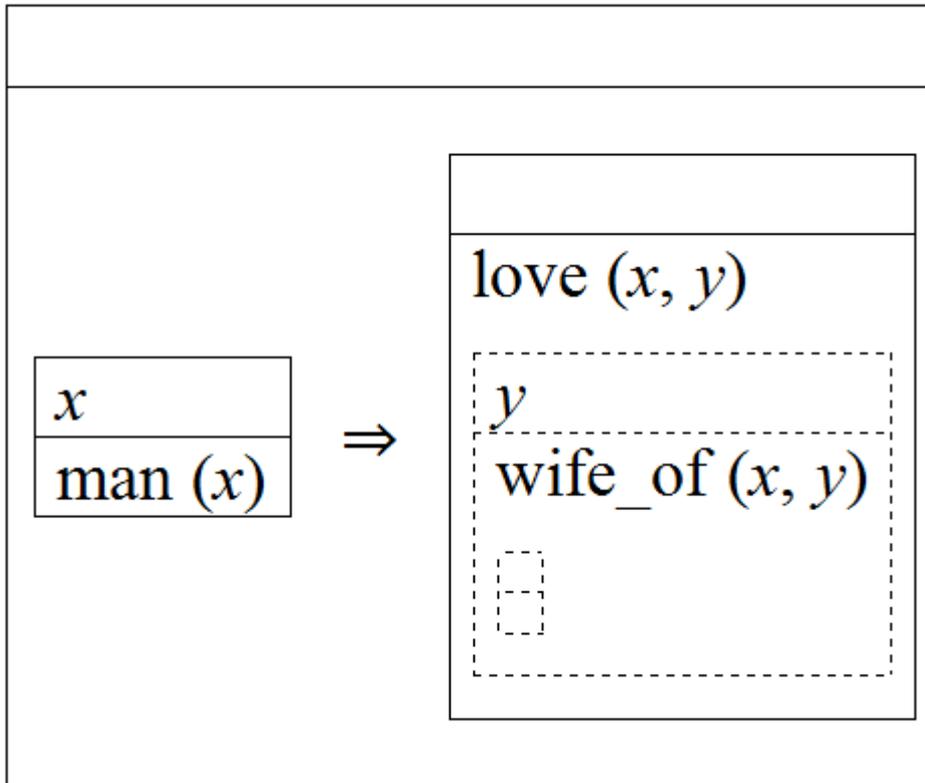
Free variable constraint

- *Every man loves his wife*
 - Original sentence DRS



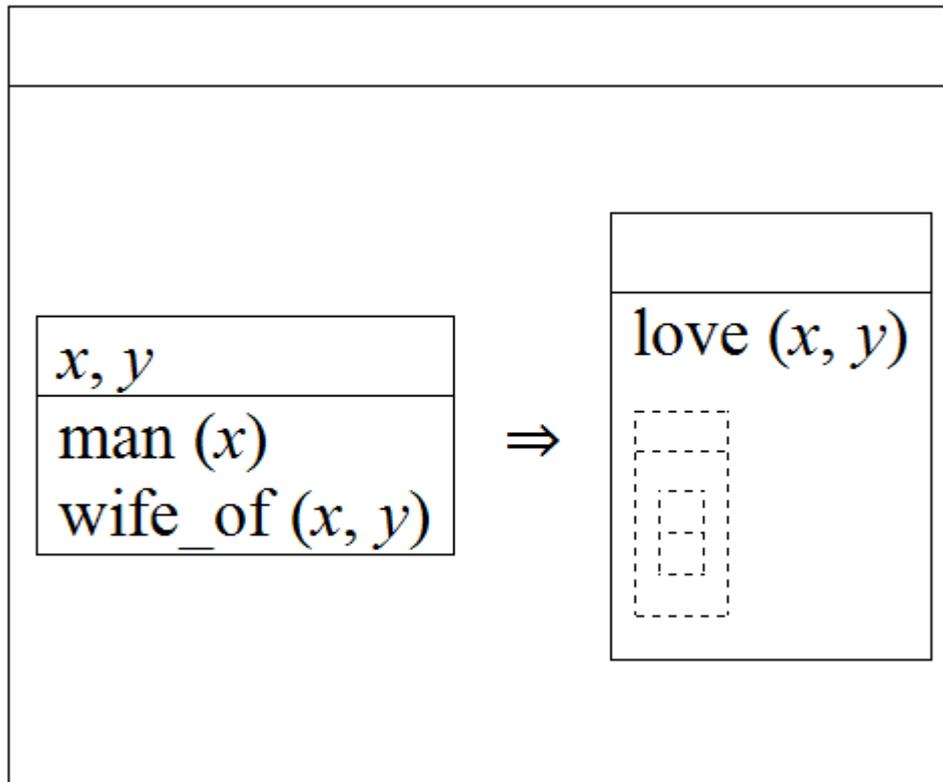
Free variable constraint

- *Every man loves his wife*
 - After processing the pronoun



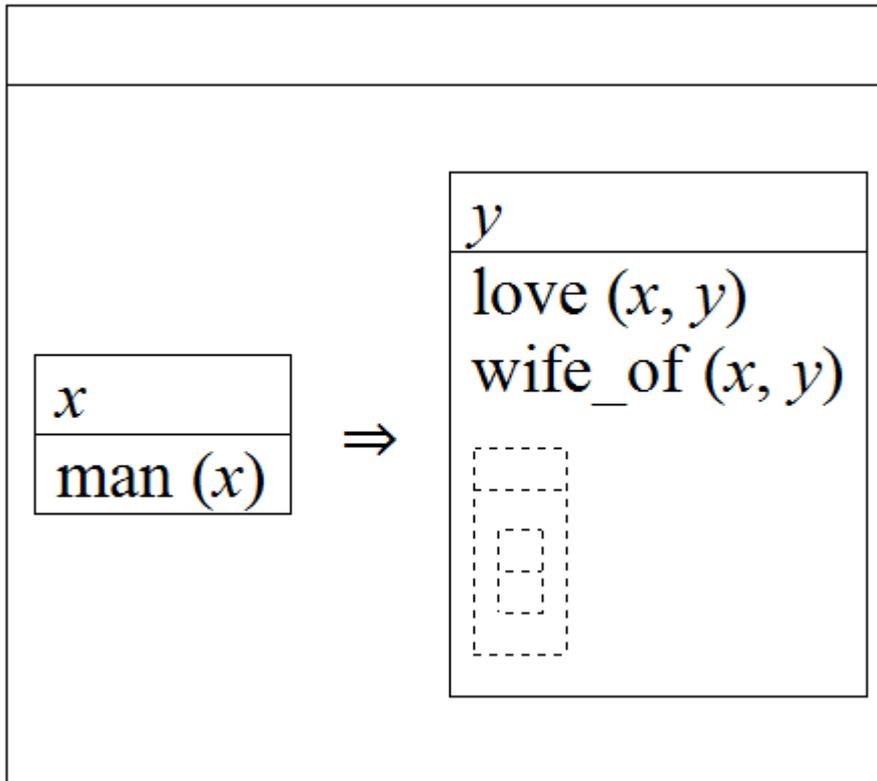
Free variable constraint

- *Every man loves his wife*
 - First interpretation



Free variable constraint

- *Every man loves his wife*
 - Second interpretation



Constraints on resolution

- Admissible resolutions:
 - Global consistency – the main DRS must stay consistent
 - Global informativeness – new main DRS is not entailed by the previous one
 - Local consistency – no subordinate DRS contradicts a superordinate one
 - Local informativeness – no subordinate DRS is entailed by a superordinate one

Acceptability violation

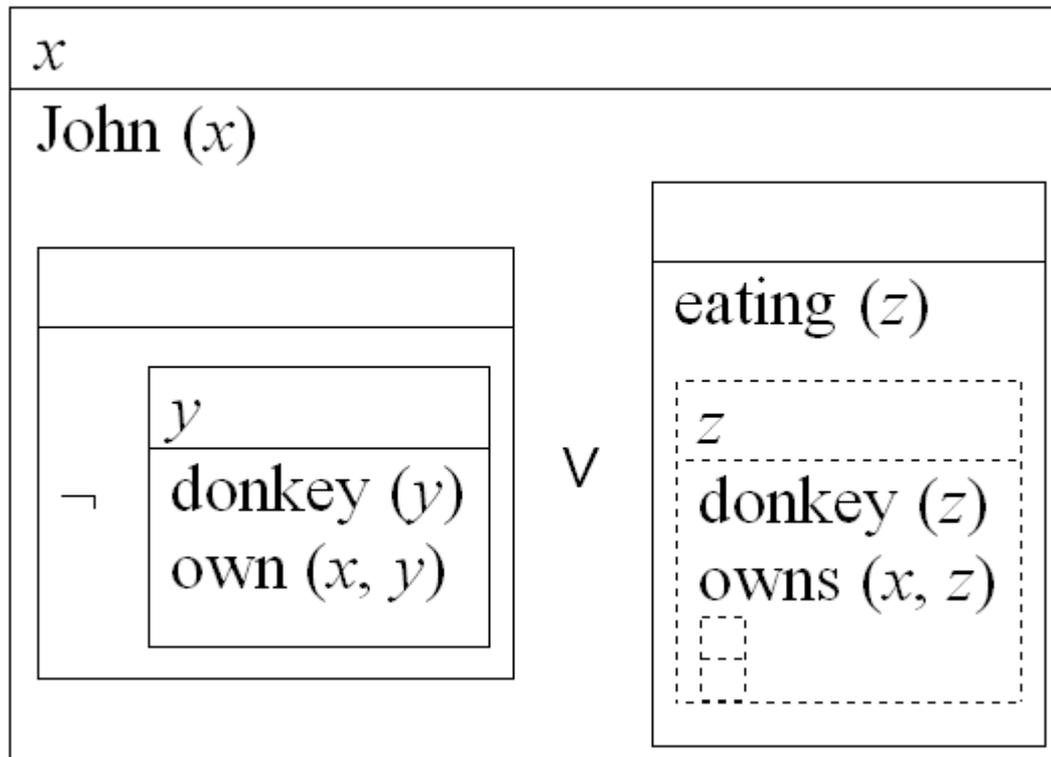
- Globally non-informative:
 - *John has a dog. John has a dog. John has a dog.*
 - *John managed to buy a dog. John has a dog.*
 - *John has a dog. Either he has a dog or he has a cat.*
- Locally non-informative or contradicting:
 - *John has a dog. If he has a dog, he has a cat.*
 - *John has a dog. If he has a cat, he has no dog.*
 - *John has no dog. Either he has a dog or he has a cat.*

Two possible procedures

- Up-down projection line
 - Go up projection line looking for an admissible binding site
 - If not found, go down projection line looking for an admissible accommodation site
 - If not found, a presupposition failure ensues
- Take all and filter out
 - Calculate a set of all possible resolutions
 - Filter out non-admissible ones
 - If the resulting set is empty, a presupposition failure ensues
 - Else sort the set by a preference order (relative distance, discourse principles, non-linguistic knowledge)

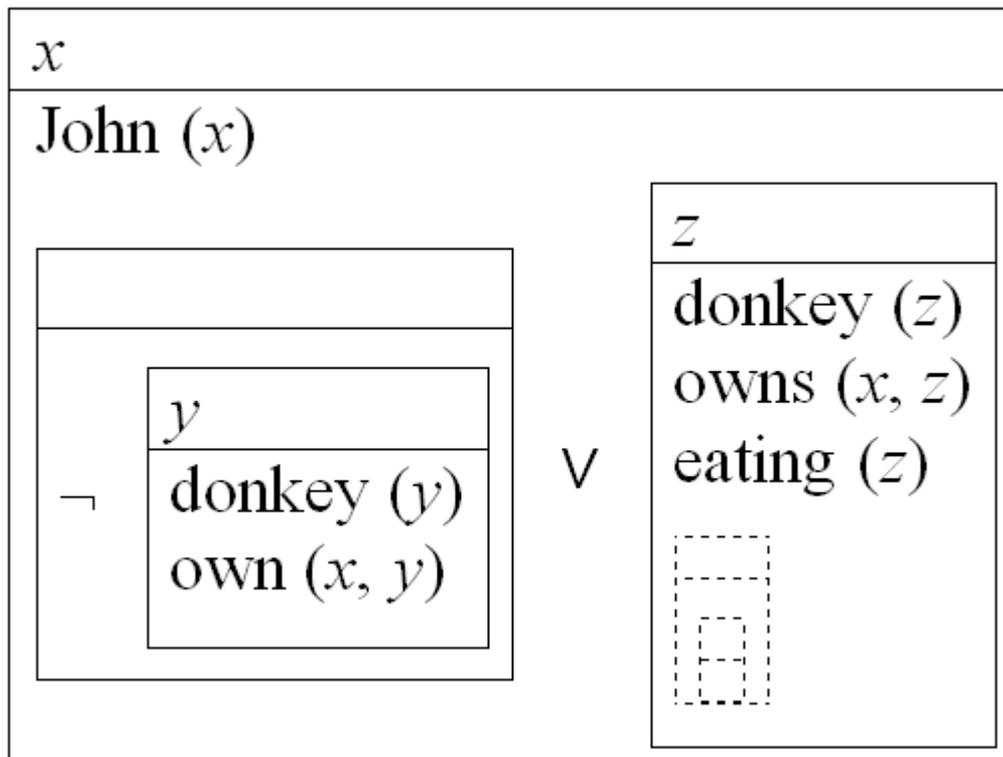
Disjunction and negation

- *Either John has no donkey or his donkey is eating quietly in the stable*



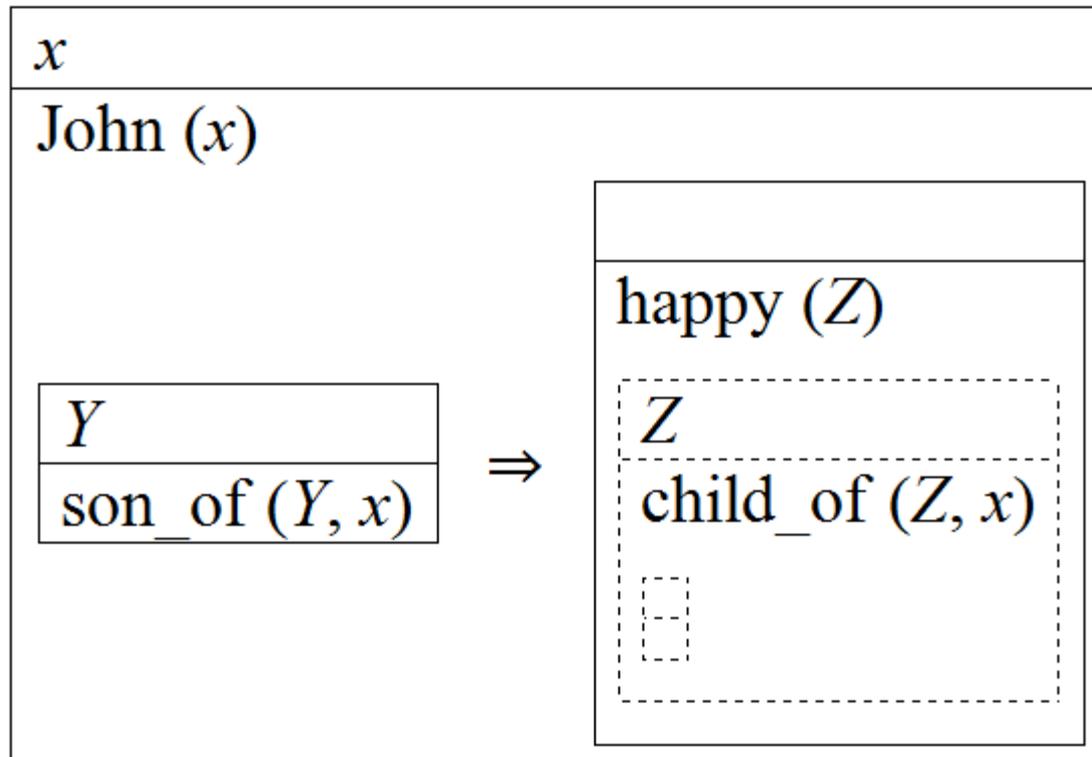
Disjunction and negation

- *Either John has no donkey or his donkey is eating quietly in the stable*



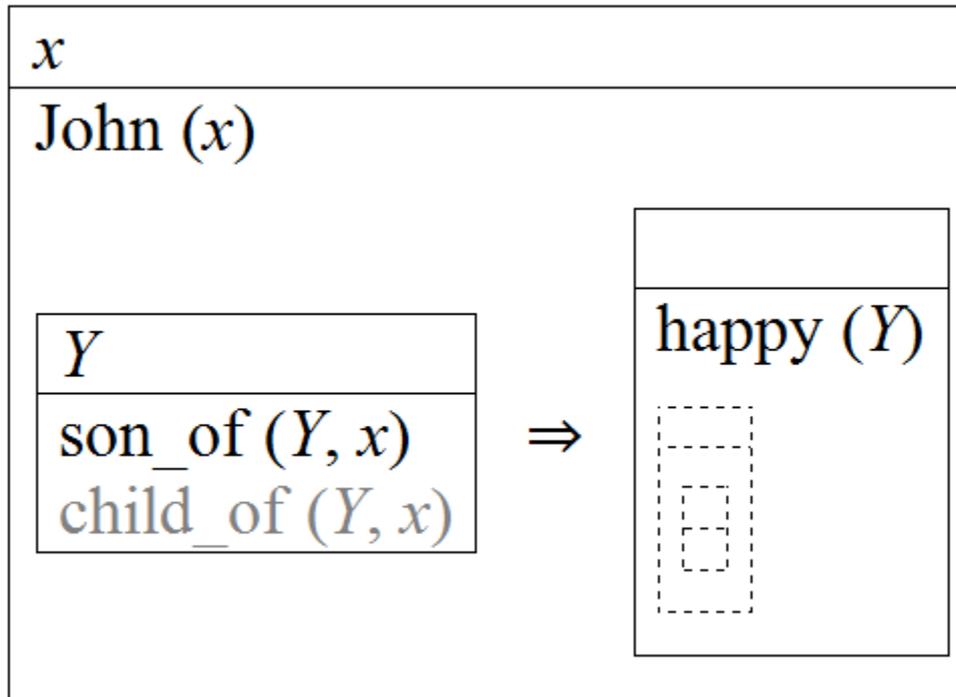
Binding vs accomodation

- *If John has sons, his children are happy*



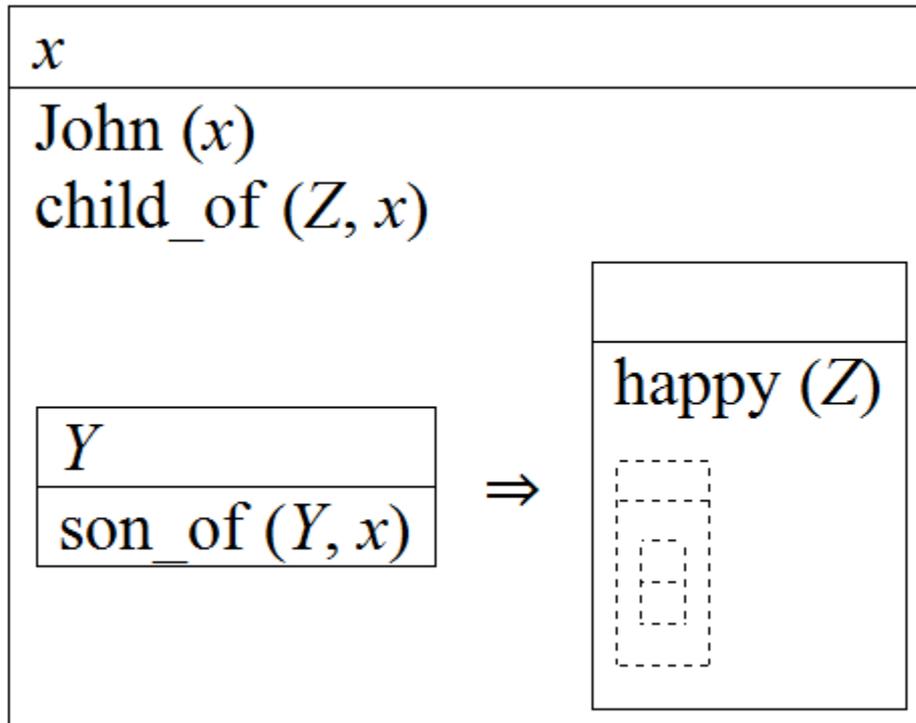
Binding

- *If John has sons, his children are happy*



Accommodation

- If John has sons, his children are happy*



Thank you!