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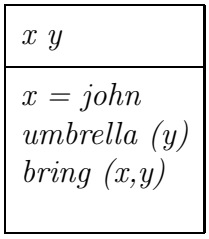
Negation and disjunction in DRT
(Krahmer and Muskens 1995, Krahmer 1998)

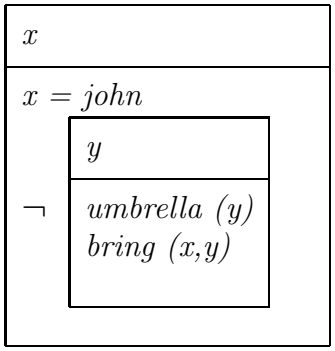
1 Negation in Standard DRT

The operator '¬' acts on the DRS of the negated constituent as follows:

(1) a. John brought an umbrella.



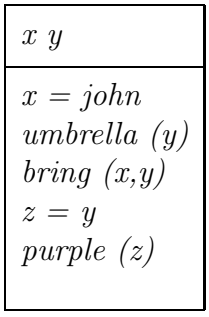
b. John didn't [bring an umbrella].



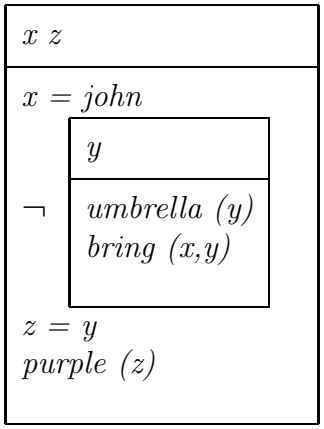
Syntax: negation introduces a non-atomic condition (i.e. one which contains a DRS as a component).

Semantics: this condition is satisfied by an assignment (which associates an individual a with the dref x) iff there is no assignment that satisfies the conditions of the embedded DRS (in other words, g satisfies the condition if for no b, b is an umbrella such that $g(x)$ brought b).

(2) a. John brought an umbrella.
It was purple.



b. John didn't [bring an umbrella].
It was purple.



- Problem with (2b): the dref y is *inaccessible* from the position of *it*.

Accessibility: a referent is accessible to a pronoun if the condition/DRS that contains the pronoun is subordinate to the DRS that contains the referent (in other words, y is not accessible from the superordinate DRS).

Standard DRT predicts: an indefinite in the scope of negation cannot antecede an anaphoric element outside the scope of negation:

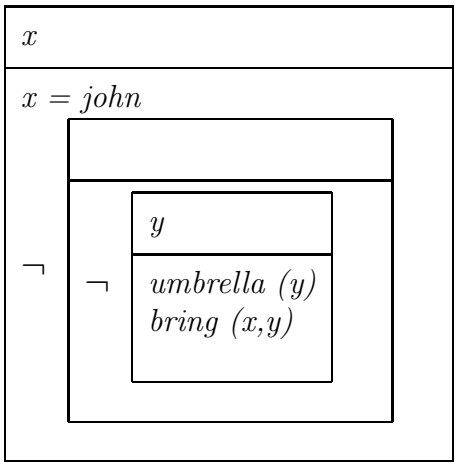
(3) a. Bill didn't [dare to ask a question]. # The lecturer answered **it**.
b. John failed [to find an answer]. # **It** was wrong.
c. John didn't [bring an umbrella]. # **It** was purple and it stood in the hallway.

2 The double negation problem

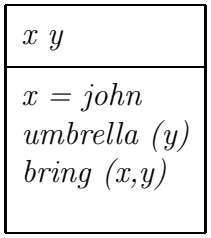
An observation: while a discourse referent cannot outlive a single negation (or a single verb with an inherently negative implication) it will not be blocked by a *double negation*.

(4) a. John didn't [fail [to find an answer]]. **The answer** was even right.
b. John didn't [remember not [to bring an umbrella]], although we had no room for **it**.
c. It is not true [that John didn't [bring an umbrella]]. **It** was purple and it stood in the hallway.

(5) a. Standard DRT gives us this:

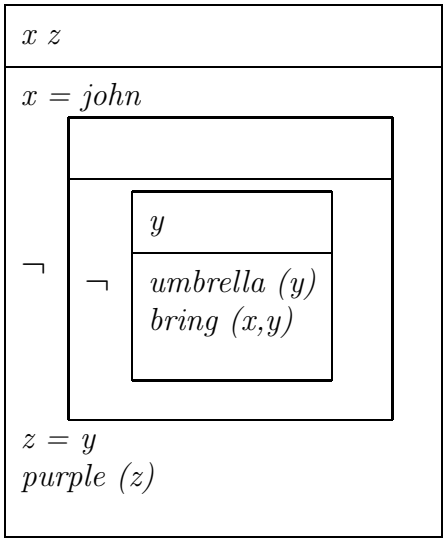


b. ... but, instead, we want this:

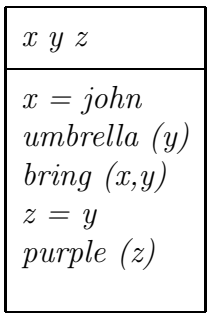


- If we try to add 'It was purple.' to the discourse, (5a) will give the wrong results while (5b) will give the right one
- because y will not be accessible to *it* in (5a) but will be accessible to *it* in (5b):

(6) a.



b.



The problem:

- double negation in Standard DRT is not "cancelable"
- negation does not keep track of drefs.

The fix:

- restore the classic law of double negation in a dynamic setting
- have negation manipulate accessibility relations:
  - introduce *active* and *passive* drefs
  - one negation makes active drefs passive and a second one makes them active again

> "The negation in Double Negation DRT does not fire a discourse referent from the interpretation process, it merely places it on half-pay. A second negation brings the referent back to active service again." (Krahmer 1998:19)

3 The solution

3.1 Formalization

Syntax: in Standard DRT, if K is a DRS, $\neg K$ is a condition and there is no operator which takes us from conditions to DRSs again; let the negation $\sim K$ of a DRS K be a DRS itself.

(7) Standard DRT
  a. conditions: Pt, $t_1 R t_2$, $t_1 = t_2$, $\neg K$, $K_1 \vee K_2$, $K_1 \Rightarrow K_2$
  b. DRSs: $[universe \mid conditions]$, $K_1; K_2$

(8) Double Negation DRT
  a. conditions: Pt, $t_1 R t_2$, $t_1 = t_2$, $K_1 \vee K_2$, $K_1 \Rightarrow K_2$

b. DRSs: $[\mathit{universe} \mid \mathit{conditions}]$, $K_1; K_2$, $\sim K$

Semantics: associate each DRS K with two binary relations between assignments: its extension $[\![K]\!]^+$ and its anti-extension $[\![K]\!]^-$

(9) Standard DRT
   a. conditions: sets of assignments that satisfy the conditions
   b. DRSs: binary relations between sets of assignments

(10) Double Negation DRT
   a. conditions: sets of assignments that satisfy the conditions
   b. DRSs: the extension of a non-negated DRSs is as before; its anti-extension is the extension of $[\ |\neg K]$ (in other words, $[\![K]\!]^+ = [\![K]\!]$ and $[\![K]\!]^- = [\![[\ |\neg K]]\!]$)

Outcome:

- we give negation a DRS and it gives us a DRS back:
  $[\![\sim K]\!]^+ = [\![K]\!]^-$ and $[\![\sim K]\!]^- = [\![K]\!]^+$
- $\sim\sim K$ is equivalent with K (i.e. $[\![K_1]\!]^+ = [\![K_2]\!]^+$ and $[\![K_1]\!]^- = [\![K_2]\!]^-$)
- negation is now a flip-flop operator that switches between positive and negative extensions

Accessibility: keep track of passive drefs in addition to active ones and define accessibility accordingly.

(11) *Active and passive drefs:*
   a. $\mathrm{ADR}(\mathit{universe} \mid \mathit{conditions}) = \mathit{universe}$
      $\mathrm{PDR}(\mathit{universe} \mid \mathit{conditions}) = \emptyset$
   b. $\mathrm{ADR}(K_1; K_2) = \mathrm{ADR}(K_1) \cup \mathrm{ADR}(K_2)$
      $\mathrm{PDR}(K_1; K_2) = \emptyset$
   c. $\mathrm{ADR}(\sim K) = \mathrm{PDR}(K)$
      $\mathrm{PDR}(\sim K) = \mathrm{ADR}(K)$

Outcome: when a new DRS is added, the drefs that are accessible from it include the drefs accessible in the previous DRS and the ones *active* in the previous DRS.

(12) If $\mathrm{ACC}(K_1; K_2) = X$, then $\mathrm{ACC}(K_1) = X$ and $\mathrm{ACC}(\mathrm{K}_2) = X \cup \mathrm{ADR}(K_1)$

3.2 The umbrella examples

Single negation

(13) John didn't [bring an umbrella]. # It was purple and it stood in the hallway.

a.

John didn't bring an umbrella

b.
x
$x = john$

;

x didn't bring an umbrella

c.
x
$x = john$

; ∼

y
umbrella(y) *x brought y*

d.
x
$x = john$

; ∼

y
umbrella(y) *x brought y*

;

It was purple and it stood in the hallway

(14) a. $\mathrm{ADR}(K_1) = x$
b. $\mathrm{ADR}(\sim K_2) = \mathrm{PDR}(K_2) = \emptyset$ (y won't make it to the main DRS)
c. $\mathrm{ADR}(K_1;\ K_2) = \mathrm{ADR}(K_1) \cup \mathrm{ADR}(\sim K_2) = x$
d. $\mathrm{ACC}(K_1;\ K_2) = \emptyset$
e. then $\mathrm{ACC}((K_1;\ K_2);K_3) = \mathrm{ACC}(K_1;\ K_2) \cup \mathrm{ADR}(K_1;\ K_2) = x$ (so y is not accessible to the pronoun *it* in K_3)

Double negation

(15) It is not true [that John didn't [bring an umbrella]]. It was purple and it stood in the hallway.

a.
It is not true that John didn't bring an umbrella

b. ∼

John didn't bring an umbrella

c.
x
$x = john$

; ∼

x didn't bring an umbrella

d.
x
$x = john$

; ∼∼

x brought an umbrella

e.

x
$x = john$

;

y
$umbrella(y)$ $x\ brought\ y$

f.

$x\ y$
$x = john$ $umbrella(y)$ $x\ brought\ y$

;

It was purple and it stood in the hallway

4 The disjunction problem

4.1 Disjunction in Standard DRT

(16) a. # Either Louis XIV had a mistress or he hid **her** from his wife.
b. # Jones owns a car or he drives **it**.
c. # Either there's a bathroom in this house, or **it**'s in a funny place.

(17) Jones owns a car or he hides it.

x
$x = jones$

y
$car\ (y)$ $own\ (x,y)$

$\vee$

he hides it

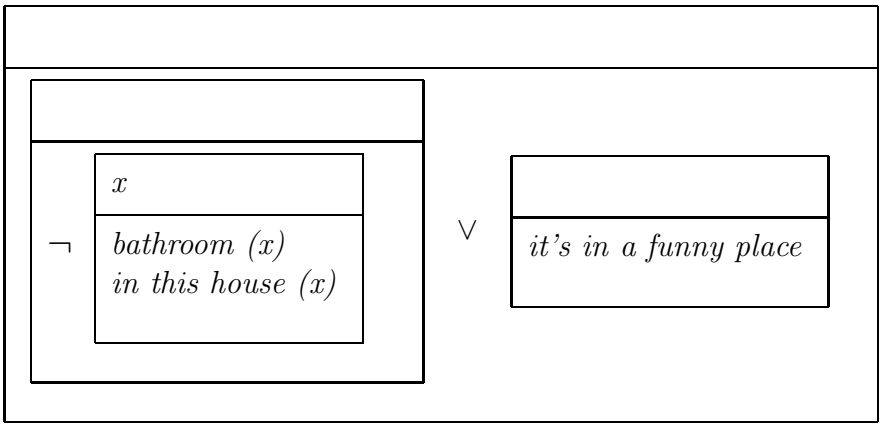
- Problem with (17): the dref z is *inaccessible* from the position of *it*.

Standard DRT predicts: no anaphoric links are possible between two parts of a disjunction.

4.2 The bathroom examples

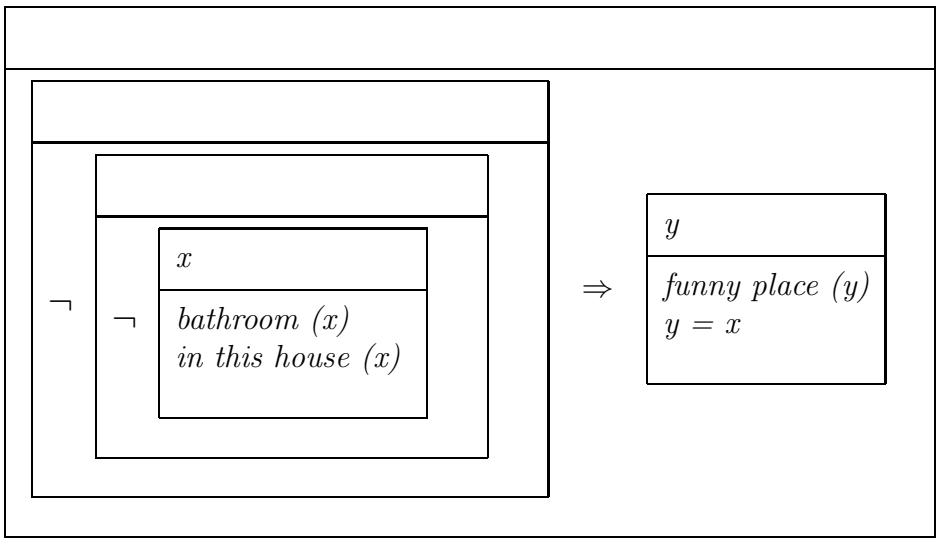
An observation: anaphora is possible if the antecedent occurs in the first part of a disjunction and within the scope of negation, and the anaphoric elements is in the second part of the same disjunction.

(18) Either there's no bathroom in this house, or it's in a funny place.

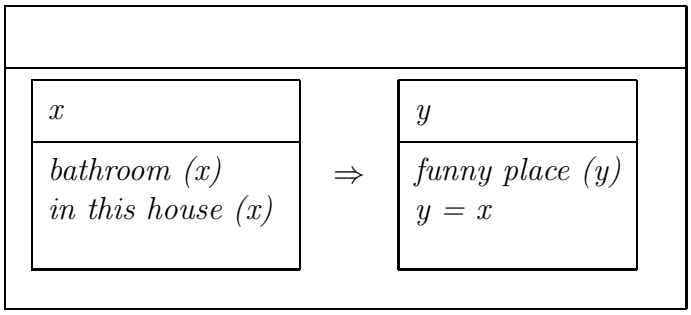


Another observation: $K_1 \vee K_2$ is equivalent with $[\ |\neg K_1] \Rightarrow K_2$

(19) a. Standard DRT gives us this:



b. ... but, instead, we want this:

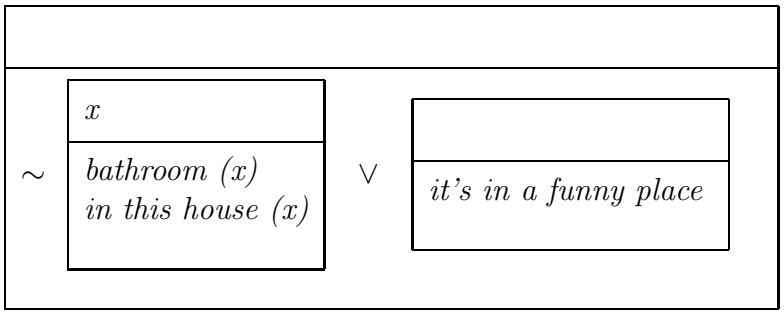


- the problem with (19a) is that *it* cannot be resolved to the dref x because it is inaccessible for it
- however, the disjunction problem has been reduced to the double negation problem and can be solved as follows

4.3 The solution

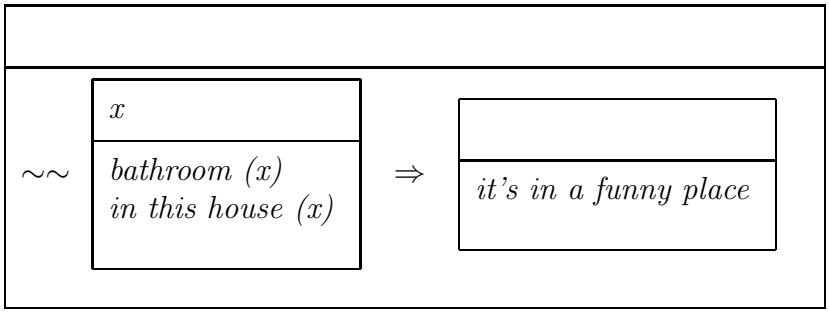
We obtain (20a) instead of (18):

(20) a. Either there's no bathroom in this house, or it's in a funny place.

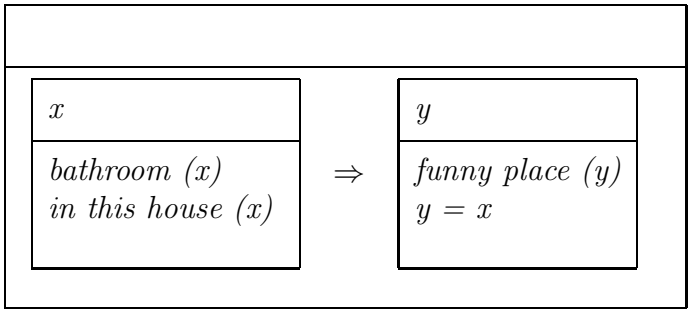


is equivalent with

b.



c.



5 Conclusion

Standard DRT makes the wrong prediction that double negation is double plug for anaphora; two problems arise:

- the double negation problem (*umbrellas*), and
- the disjunction problem (*bathrooms*), which reduces to the double negation problem.

Double Negation DRT solves the problem by borrowing some ideas from partial logic to let negation (∼)

- switch between positive and negative extensions, and
- update the context.

References

Krahmer, E. 1998. *Presupposition and anaphora*. University of Chicago Press.

Krahmer, E., and R. Muskens. 1995. Negation and disjunction in discourse representation theory. *Journal of Semantics* 12:357.