Kamp & Reyle 1993, Ch. 2 (1)
Extension to Conditionals, Universals Quantification and Connectives

• FOUR NEW STRUCTURAL ENVIRONMENTS FOR ANAPHORA

A. *Conditionals*

(1) If Jones^x owns [a book on semantics]^y, he$_x$ uses it$_y$. (antec. drefs accessible in consequent)
(2) If Jones^x likes it$_y$, then he$_x$ owns Buddenbrooks^y. (conseq. PN-drefs accessible in antec.)
(3) # If Jones^x likes it$_y$, then he$_x$ owns [a book on semantics]^y. (conseq. ID-drefs **not** accessible in antec.)
(4) If Jones^x owns [a book on semantics]^y, [a student]^z uses it$_y$. (ID-drefs ∀ in antec., ∃ in conseq.)

B. *Universal quantification*

(5) Every farmer who owns [a donkey]^y beats it$_y$. (≡ If a farmer owns a donkey, he beats it.)
(6) # If [every farmer]^x owns [a donkey]^y, he$_x$ beats it$_y$. (limited lifespan for ∀-dref)
(7) # Every professor owns [a book on semantics]^y. It$_y$ is bizarre. (limited lifespan for ID-dref under ∀)

C. *Disjunction*

(8) Jones loves Lady Hermione or Smith loves her.
(9) # Bill owns [a Porsche]^y or Fred owns it$_y$. (ID-drefs **not** accessible across ∨)
(10) Fred or Bill solved every problem which Mary assigned. (NP-disjunction)
(11) Every man, woman or child admires Martina. (N-disjunction)

D. *Conjunction*

(12) Maria^x owns [a donkey]^y and she$_x$ likes it$_y$. (≡ Maria owns a donkey. She likes it.)
(13) # She$_x$ owns it$_y$ and Maria^x likes [a donkey]^y. (≡ # She owns it. Maria likes a donkey.)
(14) If Mary likes him and she owns a tape recorder, Fred gets it, and if Mary doesn't like him and she owns a tape recorder, then Fred doesn't get it.

• EXTENDING DRT: OVERVIEW OF CH. 2 THEORY (ignoring indexing)

In Ch. 2 the *essential extensions* of Ch. 1 theory are two new clauses in the definition of DRT syntax (df. 2.4.1, clause (g) for conditionals and universals, and clause (h) for disjunction), and the corresponding two clauses in the definition of DRT semantics (df. 2.4.2). DRT models remain unchanged (df. 1.2.1), and the definitions of subordination and accessibility are generalized to anaphoric patterns exemplified in (1)–(14) (dfs. 2.4.3 and 2.4.4).

In addition, to account for anaphora in examples like (14) K&R complicate the DRT construction algorithm and the definition of DRT syntax with a rather involved indexing system. Since this system plays no role in the DRT semantics or anywhere else in the book, I ignore it in the following overview of Ch. 2 theory.

DRT Syntax (cf. K&R df 2.4.1, p. 229)

(i) A *Discourse Representation Structure* (*DRS*) K *confined to a vocabulary* V and *dref set* R is a pair, consisting of a possibly empty subset $U_K \subseteq R$ and a possibly empty set Con_K of DRS-conditions confined to V and R.

(ii) A *DRS-condition confined to* V *and* R is an expression of one of the following forms:
(a) $\mathbf{x} = \mathbf{y}$, where $\mathbf{x}, \mathbf{y} \in R$
(b) $\pi(\mathbf{x})$, where $\mathbf{x} \in R$ and π is an individual constant from V
(c) $\eta(\mathbf{x})$, where $\mathbf{x} \in R$ and η is a unary predicate (corresponding to a common noun) from V
(d) $\mathbf{x}\zeta$, where $\mathbf{x} \in R$ and ζ is a unary predicate (corresponding to an intransitive verb) from V
(e) $\mathbf{x}\xi\mathbf{y}$, where $\mathbf{x}, \mathbf{y} \in R$ and ξ is a binary predicate from V
(f) $\neg K$, where K is a DRS confined to V and R.
(g) $K' \Rightarrow K''$, where K′ and K″ are DRSs confined to V and R.
(h) $K_1 \vee \ldots \vee K_n$, where $n \geq 2$ and $K_1, \ldots, K_n$ are DRSs confined to V and R.

DRT Models (≡ K&R df 1.2.1, p. 94)

A *model* M *for a vocabulary* V is a triple $\langle U_M, Name_M, Pred_M \rangle$ consisting of:

(i) M's *universe* U_M

(ii) a function $Name_M$ which assigns an element of U_M to each indidual constant of V.
For each constant $\mathbf{c} \in V$, $Name_M(\mathbf{c})$ is called the *bearer of* **c** *according to* M.

(iii) a function $Pred_M$ which assigns:
- a subset of U_M to each 1-place predicate constant of V
- a set of *n*-tuples of elements of U_M to each *n*-place predicate constant of V ($n \geq 2$)

For each predicate constant $\mathbf{P} \in V$, $Pred_M(\mathbf{P})$ is called the *extension of* **P** *in* M.

DRT Semantics (≡ K&R df 2.4.2, p. 229)

Let $K = \langle U_K, Con_K \rangle$ be a proper DRS confined to V and R, let $M = \langle U_M, Name_M, Pred_M \rangle$ be a DRT model for V, and let f be an *embedding from* R *into* M (i.e. f is a function with $Dom(f) \subseteq R$ and $Ran(f) \subseteq U_M$).

(i) for any DRS condition $\gamma \in Con_K$, f *verifies* γ in M iff
- (a) γ is of the form $\mathbf{x} = \mathbf{y}$ and $f(\mathbf{x}) = f(\mathbf{y})$.
- (b) γ is of the form $\pi(\mathbf{x})$ and $f(\mathbf{x}) = Name_M(\pi)$.
- (c) γ is of the form $\eta(\mathbf{x})$ and $f(\mathbf{x}) \in Pred_M(\eta)$.
- (d) γ is of the form $\mathbf{x}\zeta$ and $f(\mathbf{x}) \in Pred_M(\zeta)$.
- (e) γ is of the form $\mathbf{x}\xi\mathbf{y}$ and $\langle f(\mathbf{x}), f(\mathbf{y}) \rangle \in Pred_M(\xi)$
- (f) γ is of the form $\neg K'$ and there is no extension g of f such that
  - $Dom(g) = Dom(f) \cup U_{K'}$
  - g verifies K' in M
- (g) γ is of the form $K' \Rightarrow K''$ and, for every extension g of f such that
  - $Dom(g) = Dom(f) \cup U_{K'}$
  - g verifies K' in M,

  there is an extension h of g such that
  - $Dom(h) = Dom(g) \cup U_{K''}$
  - h verifies K'' in M.
- (h) γ is of the form $K_1 \vee \ldots \vee K_n$ and, for some i ($1 \leq i \leq n$), there is an extension g_i of f such that
  - $Dom(g_i) = Dom(f) \cup U_{Ki}$
  - g verifies K_i in M

(ii) f *verifies* the DRS K in M iff f verifies each condition $\gamma \in Con_K$ in M.

(iii) K is *true in* M iff there is an embedding f from R into M such that $Dom(f) = U_K$ and f verifies K in M.

Translation from English into DRT (≈ K&R CRs, pp. 86, 121–4, 156, 169, 202–3, 221)

K&R's construction algorithm sort of works but is not fully worked out so some things seem to happen by magic. In particular, I have three queries:

Query 1: K&R say inconsistent things about their notion of a **triggering configuration**, especially about the crucial question *whether the top node of a triggering configuration has to match the top node of the constituent that is being processed*. On page 87–8 they seem to say that it normally does but doesn't have to, whereas in Ch. 2 they seem to say that it must. But if it must, then how can the clauses for *object NPs* (2nd clause of CR.PN, CR.PRO, CR.ID, and CR.EVERY) ever apply, given that VP is never the top node in this construction algorithm?

Query 2: This may be related to Query 1. In Ch. 2 K&R seem to say that their algorithm as it stands **prohibits** processing the **object before the subject**. What exactly is supposed to block this order of rule application?

One answer, which would also address Query 1, would be to revise the triggering configuration for object NPs a la CR.NEG, e.g., in CR.PN we include S over subject dref as follows $[_S\ \mathbf{u}\ [_{VP'}\ [_{VP}\ V\ [_{NP}\ [_{PN}\ \alpha]]]]]$, and likewise for other object NPs. If we then require that the top node of a triggering configuration must match the top node of the constituent that is being processed, this would ensure that the subject must be processed before the object, as desired.

Query 3: This is about **CR.OR** on p. 197. In particular, on p. 199, how is this rule supposed to derive the antecedent DRS of (2.127) when applied to the antecedent K_1 of (2.126)?

Finally, note the following revised definitions of subordination and accessibility:

DRS Subordination (= K&R df 2.4.3, p. 230)

Let K and K′ be DRSs.

(i) K is *immediately subordinate to* K′ iff either (a), (b) or (c):
 (a) $\neg K \in Con_{K'}$
 (b) $(K \Rightarrow K'') \in Con_{K'}$ or $(K'' \Rightarrow K) \in Con_{K'}$, for some K″
 (c) $(K_1 \vee \ldots \vee K_n) \in Con_{K'}$, for some $K_1,\ldots, K_n$, and $K = K_i$ for some i $1 \leq i \leq n$.

(ii) K is *subordinate to* K′, $K < K'$, iff either (a) or (b):
 (a) K is immediately subordinate to K′
 (b) there is a DRS K″ such that $K'' < K'$ and K is immediately subordinate to K″.

(iii) K is *weakly subordinate to* K′, $K \leq K'$, iff $K = K'$ or $K < K'$.

Dref Accessibility (= K&R df 2.4.4, p. 231)

Let K be a DRS, **x** a dref, and γ a DRS-condition.
We say that **x** is *accessible from* γ in K iff, for some $K' \leq K$ and K″,
(i) $\mathbf{x} \in U_{K'}$
(ii) $\gamma \in Con_{K''}$
(iii) either (a) or (b):
 (a) K″ is weakly subordinate to K′
 (b) K″ is weakly subordinate to some DRS K‴ such that, for some $K'''' \leq K$,
 $K' \Rightarrow K''' \in Con_{K''''}$

Kamp & Reyle 1993, Ch. 2 (2)
DRT Analysis of Discourses with Conditionals

- EXERCISE 2 (p. 162)

(a) Fred likes Mary. If she likes a book then he likes it.

- *DRS* K_a for (a): (derived in class)

```
 x   y

 Fred(x)
 Mary(y)
 x likes y
 __________        __________
| u  v      |     | w  z      |
| u = y     |     | w = x     |
| book(v)   |  ⇒  | z = v     |
| u likes v |     | w likes z |
|__________ |     |__________ |
    A                 C
```

- K_a is *not true* in the DRT model M_1:

$M_1 = \langle U_{M1}, Name_{M1}, Pred_{M1} \rangle$,

where

$U_{M1} = \{a, b, c, d, e, f\}$

$Name_{M1}(Mary) = a$ $\quad$ $Name_{M1}(Fred) = f$

$Pred_{M1}(book) = \{b\}$

$Pred_{M1}(likes) = \{\langle a, a\rangle, \langle a, b\rangle, \langle b, b\rangle, \langle a, d\rangle, \langle d, b\rangle, \langle a, e\rangle, \langle e, f\rangle\}$

Proof:

Suppose K_a had a verifying embedding into M_1, call it g. Then g must verify ‘Fred(x)’ and ‘Mary(y)’ so, by clause (i.b) of *DRT semantics*,

$g(x) = Name_{M1}(Fred) = f$, and

$g(y) = Name_{M1}(Mary) = a$.

But then, by clause (i.e), g fails to verify ‘x likes y’ since $\langle g(x), g(y)\rangle = \langle f, a\rangle \notin Pred_{M1}(likes)$.

So K_a is not verifiable in M_1 (by clause (ii)) and thus is not true in M_1 (by clause (iii)). □

- K_a is *not true* in the DRT model M_2:

  $M_2 = \langle U_{M2}, Name_{M2}, Pred_{M2}\rangle$,

  where

  $U_{M2} = \{a, b, c, d, e, f\}$

  $Name_{M2}(Mary) = a$ $Name_{M2}(Fred) = f$

  $Pred_{M2}(book) = \{b, c\}$

  $Pred_{M2}(likes) = \{\langle a, a\rangle, \langle a, b\rangle, \langle a, c\rangle, \langle a, e\rangle, \langle b, b\rangle, \langle d, b\rangle, \langle e, f\rangle, \langle f, a\rangle, \langle f, b\rangle, \langle f, d\rangle, \langle f, e\rangle, \langle f, f\rangle\}$

  Proof:

  Suppose K_a had a verifying embedding into M_2, call it g. Then g must verify 'Fred(x)' and 'Mary(y)' so, by clause (i.b) of *DRT semantics*,

  $g(x) = Name_{M2}(Fred) = f$, and

  $g(y) = Name_{M2}(Mary) = a$.

  But then, by clause (i.g), g fails to verify '$A \Rightarrow C$'. For g has an extension, to wit,

  $h = g \cup \{\langle u, a\rangle, \langle v, c\rangle\}$

  which verifies A in M_2 but cannot be extended to verify C in M_2. Specifically,

'u = y'	is verified, by clause (i.a), since	$h(u) = h(y) = a$,
'book(v)'	is verified, by clause (i.c), since	$h(v) = c \in Pred_{M2}(book)$,
'u likes v'	is verified, by clause (i.e), since	$\langle h(u), h(v)\rangle = \langle a, c\rangle \in Pred_{M2}(likes)$

  Now suppose h had an extension, say k, which verified C in M_2. Then k must verify 'w = x' and 'z = v' so, by clause (i.a), $k(w) = k(x)$ and $k(z) = k(v)$. Given $k \supseteq h \supseteq g$, we infer $k(w) = f$ and $k(z) = c$. But then, by clause (i.e), k fails to verify 'w likes z' in M_2, since $\langle k(w), k(z)\rangle = \langle f, c\rangle \notin Pred_{M2}(likes)$.

  So K_a is not verifiable in M_2 (by clause (ii)) and thus is not true in M_2 (by clause (iii)). □

- K_a is *true* in the DRT model M_3:

$M_3 = \langle U_{M3}, Name_{M3}, Pred_{M3} \rangle$,

where

$U_{M3} = \{a, b, c, d, e, f\}$

$Name_{M3}(Mary) = a$ $Name_{M3}(Fred) = f$

$Pred_{M3}(book) = \{b, c\}$

$Pred_{M3}(likes) = \{\langle a, a\rangle, \langle a, b\rangle, \langle a, c\rangle, \langle b, b\rangle, \langle d, b\rangle, \langle a, e\rangle, \langle a, f\rangle, \langle e, f\rangle, \langle f, a\rangle, \langle f, b\rangle, \langle f, c\rangle, \langle f, d\rangle, \langle f, e\rangle, \langle f, f\rangle\}$

Proof:

K_a has a verifying embedding into M_3, namely

$g = \{\langle x, f\rangle, \langle y, a\rangle\}$.

Specifically, given the definition of DRT semantics,

‘Fred(x)’	is verified, by clause (i.b), since	$g(x) = f = Name_{M3}(Fred)$
‘Mary(y)’	is verified, by clause (i.b), since	$g(y) = a = Name_{M3}(Mary)$
‘x likes y’	is verified, by clause (i.e), since	$\langle g(x), g(y)\rangle = \langle f, a\rangle \in Pred_{M3}(likes)$
‘A ⇒ C’	is verified, by clause (i.g).	

For, by clauses (i.a), (i.c) and (i.e), g has (exactly) two minimal extensions which verify A,

$h_1 = g \cup \{\langle u, a\rangle, \langle v, b\rangle\}$ (given $b \in Pred_{M3}(book)$ and $\langle a, b\rangle \in Pred_{M3}(likes)$)

$h_2 = g \cup \{\langle u, a\rangle, \langle v, c\rangle\}$ (given $c \in Pred_{M3}(book)$ and $\langle a, c\rangle \in Pred_{M3}(likes)$)

As required by clause (i.g), both h_1 and h_2 have a minimal extension which verifies C, namely:

$k_1 = h_1 \cup \{\langle w, f\rangle, \langle z, b\rangle\}$ (given $\langle f, b\rangle \in Pred_{M3}(likes)$)

$k_2 = h_2 \cup \{\langle w, f\rangle, \langle z, c\rangle\}$ (given $\langle f, c\rangle \in Pred_{M3}(likes)$)

So K_a has a verifying embedding into M_3 (by clause (ii)) and thus is true in M_3 (by clause (iii)). □

Kamp & Reyle 1993, Ch. 2 (3)
DRT Analysis of Discourses with Universal Quantifiers

- SELECTED EXERCISES p. 180

(2f) Fred likes every man who likes him. Fred doesn't like every man who Mary likes.

- *DRS* K for (2f):

```
 x   u   w
 Fred(x)
 ____________       ____________
 |  y   z     |     |            |
 |  man(y)    |     |  x likes y |
 |  z = x     |  ⇒  |            |
 |  y likes z |     |            |
 |____________|     |____________|
    A1                 C1

 Fred(u)
 Mary(w)
    ____________________________________
    |   ____________       ____________  |
    |  |  v          |    |            | |
    |  |  man(v)     |    |  u likes v | |
 ¬  |  |  w likes v  | ⇒  |            | |
    |  |_____________|    |____________| |
    |     A2                 C2          |
    |____________________________________|
      N
```

- K is *not true* in the DRT model M_2 (in exercise 3 on p. 180):

$M_2 = \langle U_{M2}, Name_{M2}, Pred_{M2}\rangle$,

where

$U_{M2} = \{a, b, c, d, e, f\}$

$Name_{M2}(Mary) = a$ $\qquad$ $Name_{M2}(Fred) = f$

$Pred_{M2}(man) = \{d, e, f\}$

$Pred_{M2}(likes) = \{\langle a, a\rangle, \langle a, b\rangle, \langle a, c\rangle, \langle a, e\rangle, \langle b, b\rangle, \langle d, b\rangle, \langle e, f\rangle, \langle f, a\rangle, \langle f, b\rangle, \langle f, d\rangle, \langle f, e\rangle, \langle f, f\rangle\}$

Proof:

Suppose K had a verifying embedding into M_2, call it g. Then g must verify 'Fred(x)', 'Fred(u)' and 'Mary(w)' so, by clause (i.b) of *DRT semantics*, $g(x) = g(u) = Name_{M2}(Fred) = f$, and $g(w) = Name_{M2}(Mary) = a$.

But then, by clause (i.f), g fails to verify '¬N'. For there is an extension of g, to wit h = g, which verifies N in M_2. Specifically, by clause (i.g), h verifies '$A_2 \Rightarrow C_2$', i.e., every minimal extension of h which verifies A_2 has a minimal extension which verifies C_2. In fact, h has just one minimal extension which verifies A_2, namely $k = h \cup \{\langle v, e\rangle\}$ (by clauses (i.c) and (i.e), given $e \in Pred_{M2}(man)$ and $\langle a, e\rangle \in Pred_{M2}(likes)$), and this has a minimal extension, to wit $k' = k$, which verifies C_2 (by clause (i.e) given $\langle f, e\rangle \in Pred_{M2}(likes)$).

So K has no verifying embedding into M_2 (by clause (ii)) and so is not true in M_2 (by clause (iii)). □

- K is *true* in the following DRT model M_4:

  $M_4 = \langle U_{M4}, Name_{M4}, Pred_{M4}\rangle$,

  where

  $U_{M4} = \{a, b, c, d, e, f\}$

  $Name_{M4}(Mary) = a$ $Name_{M4}(Fred) = f$

  $Pred_{M4}(man) = \{d, e, f\}$

  $Pred_{M4}(likes) = \{\langle a, a\rangle, \langle a, b\rangle, \langle a, c\rangle, \langle a, d\rangle, \langle a, e\rangle, \langle a, f\rangle, \langle b, b\rangle, \langle d, b\rangle, \langle e, f\rangle, \langle f, a\rangle, \langle f, b\rangle, \langle f, e\rangle, \langle f, f\rangle\}$

  Proof:

  K is verified in M_4 by the embedding $g = \{\langle x, f\rangle, \langle u, f\rangle, \langle w, a\rangle\}$. For given the definition of DRT semantics,

  'Fred(x)' is verified, by clause (i.b), because $g(x) = Name_{M4}(Fred) = f$

  '$A_1 \Rightarrow C_1$' is verified, by clause (i.g), because every minimal extension of g which verifies A_1 has a minimal extension which verifies C_1. More precisely, A_1 is verified by two minimal extensions of g, to wit

  $h_1 = g \cup \{\langle y, e\rangle, \langle z, f\rangle\}$ (given $e \in Pred_{M4}(man)$ and $\langle e, f\rangle \in Pred_{M4}(likes)$)

  $h_2 = g \cup \{\langle y, f\rangle, \langle z, f\rangle\}$ (given $f \in Pred_{M4}(man)$ and $\langle f, f\rangle \in Pred_{M4}(likes)$)

  and each of these has a minimal extension which verifies C_1, namely:

  $k_1 = h_1$ (given $\langle f, e\rangle \in Pred_{M4}(likes)$)

  $k_2 = h_2$ (given $\langle f, f\rangle \in Pred_{M4}(likes)$)

  'Fred(u)' is verified, by clause (i.b), because $g(u) = Name_{M4}(Fred) = f$

  'Mary(w)' is verified, by clause (i.b), because $g(w) = Name_{M4}(Mary) = a$

  '¬N' is verified, by clause (i.f), because g has no minimal extension which verifies N.

  Subproof: Suppose there was such an extension, call it h. Then, since $g \subseteq h$ and $Dom(h) = Dom(g) \cup U_N = Dom(g)$, we infer h = g. So g itself would have to verify '$A_2 \Rightarrow C_2$'. But it can't because it has a minimal extension, to wit

  $k = g \cup \{\langle v, d\rangle\}$

  which verifies A_2 (given $d \in Pred_{M4}(man)$ and $\langle a, d\rangle \in Pred_{M4}(likes)$) and cannot be extended to verify C_2 (given $\langle f, d\rangle \notin Pred_{M4}(likes)$).

  So K has a verifying embedding into M_2 (to wit g, by clause (ii)) and so is true in M_2 (by clause (iii)). □

(4b) Every woman who loves every cat hates every dog who hates every cat.

- *DRS* K_{4b} for (4b):

```
 ______________________________        ______________________________________________________
| x                            |      |  ______________________________                       |
| woman(y)                     |      | | z                            |                      |
|  ______       ____________   |      | | dog(z)                       |      ____________    |
| | y    |     |            |  |      | |  ________     ___________    |     |            |   |
| |cat(y)|  ⇒  | x loves y  |  |  ⇒   | | | u      |   |           |   |  ⇒  | x hates z  |   |
| |______|     |____________|  |      | | | cat(u) | ⇒ | z hates u |   |     |____________|   |
|   A1            C1           |      | | |________|   |___________|   |       C2             |
|______________________________|      | |   A3             C3          |                      |
  A0                                  | |______________________________|                      |
                                      |   A2                                                  |
                                      |_______________________________________________________|
                                        C0
```

- DRT model $M = \langle U_M, Name_M, Pred_M \rangle$,

  where

  $U_M = \{a, b, c, d, e, f\}$

  $Pred_M(woman) = \{a, b, c\}$ $Pred_M(cat) = \{d, e\}$ $Pred_M(dog) = \{f\}$

  $Pred_M(loves) = \{\langle a, a\rangle, \langle a, d\rangle, \langle a, e\rangle, \langle b, a\rangle, \langle b, d\rangle, \langle b, e\rangle, \langle c, b\rangle, \langle c, d\rangle, \langle d, f\rangle, \langle f, a\rangle\}$

  $Pred_M(hates) = \{\langle a, b\rangle, \langle a, f\rangle, \langle b, b\rangle, \langle b, f\rangle, \langle c, a\rangle, \langle d, a\rangle, \langle e, b\rangle, \langle f, d\rangle, \langle f, e\rangle\}$

  Is K_{4b} true or not true in this model? Prove it.

(4c) If a man likes a woman who loves every cat, then, if she likes him, then he hates every dog.

- Construct the *DRS* K_{4c} for the salient reading of (4c).
- Construct a DRT model where K_{4c} is true. Prove that K_{4c} is true in this model.
- Construct a DRT model where K_{4c} is not true. Prove that K_{4c} is not true in this model.

Kamp & Reyle 1993, Ch. 2 (4)
DRT Analysis of Discourses with Disjunction

- EXAMPLE OF CR.OR(NP)

(1) [Fred or Bill] solved every problem which Mary assigned.

- *DRS* K_1 for (1):

```
x  y  z  w

Fred(x)
Bill(y)
Mary(z)
Mary(w)
 ______________________________________        ______________________________________
|  _____________        _____________   |     |  _____________        ____________    |
| | u           |      |             |  |     | | v           |      |            |   |
| | problem(u)  |      | x solved u  |  |     | | problem(v)  |      | y solved v |   |
| | z assigned u|  =>  |             |  |  v  | | w assigned v|  =>  |            |   |
| |_____________|      |_____________|  |     | |_____________|      |____________|   |
|   A1                   C1             |     |   A2                   C2             |
|______________________________________ |     |______________________________________ |
    D1                                            D2
```

- K_1 is *true* in the DRT model $M_1 = \langle U_{M1}, Name_{M1}, Pred_{M1}\rangle$, where

$U_{M1} = \{a, b, c, d, e, f\}$

$Name_{M1} = \{\langle Mary, a\rangle, \langle Bill, b\rangle, \langle Fred, f\rangle\}$

$Pred_{M1}(problem) = \{c, d, e\}$

$Pred_{M1}(assigned) = \{\langle a, c\rangle, \langle a, e\rangle\}$ $Pred_{M1}(solved) = \{\langle b, c\rangle, \langle b, e\rangle, \langle f, c\rangle, \langle f, d\rangle\}$

Proof:

K_1 is verified in M_1 by the embedding $g = \{\langle x, f\rangle, \langle y, b\rangle, \langle z, a\rangle, \langle w, a\rangle\}$. For by the def. of DRT semantics,

'Fred(x)' is verified, by clause (i.b), because $g(x) = f = Name_{M1}(Fred)$

'Bill(y)' is verified, by clause (i.b), because $g(y) = b = Name_{M1}(Bill)$

'Mary(z)' is verified, by clause (i.b), because $g(z) = a = Name_{M1}(Mary)$

'Mary(w)' is verified, by clause (i.b), because $g(w) = a = Name_{M1}(Mary)$

'$D_1 \vee D_2$' is verified, by clause (i.h), because one of the disjuncts is verified by a minimal extension of g. More precisely, D_2 is verified by the extension h = g. This verifies '$A_2 \Rightarrow C_2$', by clause (i.g), because the two minimal extensions of h = g which verify A_2, namely

$k_1 = g \cup \{\langle v, c\rangle\}$ (given $c \in Pred_{M1}(problem)$ and $\langle a, c\rangle \in Pred_{M1}(assigned)$)

$k_2 = g \cup \{\langle v, e\rangle\}$ (given $e \in Pred_{M1}(problem)$ and $\langle a, e\rangle \in Pred_{M1}(assigned)$)

both have a minimal extension which verifies C_2, namely:

$l_1 = k_1$ (given $\langle b, c\rangle \in Pred_{M1}(solved)$)

$l_2 = k_2$ (given $\langle b, e\rangle \in Pred_{M1}(solved)$)

So K_1 has a verifying embedding into M_1 (to wit g, by clause (ii)) and so is true in M_1 (by clause (iii)). □

- K_1 is *not true* in the DRT model $M_2 = \langle U_{M2}, Name_{M2}, Pred_{M2}\rangle$, where

  $U_{M2} = \{a, b, c, d, e, f\}$

  $Name_{M2} = \{\langle Mary, a\rangle, \langle Bill, b\rangle, \langle Fred, f\rangle\}$

  $Pred_{M2}(problem) = \{c, d, e\}$

  $Pred_{M2}(assigned) = \{\langle a, c\rangle, \langle a, e\rangle\}$ $Pred_{M2}(solved) = \{\langle b, c\rangle, \langle f, e\rangle\}$

  Proof:

  Suppose K_1 had a verifying embedding into M_2, call it g. Then g must verify 'Fred(x)', 'Bill(y)', 'Mary(z)' and 'Mary(w)' so, by clause (i.b) of DRT semantics, $g(x) = Name_{M2}(Fred) = f$, $g(y) = Name_{M2}(Bill) = b$, and $g(z) = g(w) = Name_{M2}(Mary) = a$. But then, by clause (i.h), g fails to verify '$D_1 \vee D_2$' since neither D_1 nor D_2 can be verified in M_2 by the minimal extension h = g.

  Specifically, in D_1 the condition '$A_1 \Rightarrow C_1$' cannot be verified because h = g has a minimal extension, to wit $k_1 = g \cup \{\langle u, c\rangle\}$, which verifies A_1 (given $c \in Pred_{M2}(problem)$ and $\langle a, c\rangle \in Pred_{M2}(assigned)$) but has no minimal extension which verifies C_1 (given $\langle f, c\rangle \notin Pred_{M2}(solved)$).

  Similarly, in D_2 the condition '$A_2 \Rightarrow C_2$' cannot be verified because h = g has a minimal extension, to wit $k_2 = g \cup \{\langle v, e\rangle\}$, which verifies A_2 (given $e \in Pred_{M2}(problem)$ and $\langle a, e\rangle \in Pred_{M2}(assigned)$) but has no minimal extension which verifies C_2 (given $\langle b, e\rangle \notin Pred_{M2}(solved)$).

  So K_1 has no verifying embedding into M_2 (by clause (ii)) and so is not true in M_2 (by clause (iii)). □

- EXAMPLES OF CR.OR(≠NP)

(2) [Bill loves Mary] or [Fred loves her]. (√ anaphora to PN-dref)

```
 x  y  z

 Bill(x)
 Fred(y)
 Mary(z)
 ___________      ___________
|           |    | u         |
|           |    | u = z     |
| x loves z |  v | y loves u |
|___________|    |___________|
   D1               D2
```

(3) # [Bill owns a Porsche] or [Fred owns it]. (# anaphora to ID-dref)

Ill-formed DRS because dref **z** in D_1 is not accessible from '**u = z**' in D_2

```
 x  y

 Bill(x)
 Fred(y)
 ____________      ___________
| z          |    | u         |
| Porsche(z) |    | u = z     |
| x owns z   |  v | y owns u  |
|____________|    |___________|
   D1                D2
```

• PROBLEM: N DISJUNCTION

(4) Every [man, woman or child] admires Martina.

Kamp & Reyle 1993, Ch. 2 (5)
DRT Analysis of Discourses with Conjunction

- EXAMPLES OF CR.AND (ignoring indices)

(1) [Maria owns a donkey] and [she likes it]. (≡ Maria owns a donkey. She likes it.)

- *DRS* K_1 for (1):

x y u v
Maria(x) donkey(y) x owns y u = x v = y u likes v

- PROBLEM 1: If we ignore indices, then we also derive *DRS* K_1 for

(1′) [She owns it] and [Maria owns a donkey].

(2) Maria [owns and loves] a donkey.

- *DRS* K_2 for (2) (with CR.AND applied *after* CR.ID)

x y
Maria(x) donkey(y) x owns y x loves y

- PROBLEM 2: If CR.AND applies *before* CR.ID, we get a DRS with counterintuitive verification conditions:

x y z
Maria(x) donkey(y) x owns y donkey(z) x loves z

As far as I can see, there is nothing in Ch. 2 of K&R, even including indexing, to block this derivation. Arguably, it is needed to derive the salient reading of

(2′) Maria [sold and bought] a car.

So what kind of story could we tell to account for both (2) and (2′)?

(3) [If Mary likes him and she owns a tape recorder, then Fred gets it]
and [if she doesn't like him and she owns a tape recorder, then Fred doesn't get it].

EXERCISE: If we ignore indices, we get lots of DRSs. Derive one DRS with intuitively correct verification conditions and one where the index-less system overgenerates.