Structured Discourse Reference to Propositions

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I. Introduction.

The main goal of this presentation is:

to introduce a notion of **structured discourse referents** which, together with a possible-worlds analysis of intensional phenomena,

can account for the interaction of **entailment particles** (e.g. *therefore / hence)* and **modal subordination**.

I. Introduction.

The resulting compositional dynamic system is couched in classical type logic.

It captures the **truth-conditions** of and the **modal** and **individual-level anaphoric connections** established in discourses like:

1. **a.** [A] man cannot live without joy.

   b. Therefore, when he is deprived of true spiritual joys, it is necessary that he become addicted to carnal pleasures. (Thomas Aquinas, attributed)

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I. Introduction.

The system makes possible an integrated analysis of several phenomena:

- entailment relations established **within** discourse by particles like *therefore* / *hence*;

- 'donkey' anaphora and modal subordination;

- the parallels between anaphora in the individual and modal domains.

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I. The Structure of the Presentation.

- The Informal Analysis of the Aquinas discourse.

- The Basic Proposal: Intensional Compositional DRT with Plural Info States (IP-CDRT).

- Conclusion.

II. Informal Analysis of Discourse (1).

1. **a.** [A] man cannot live without joy.
   b. Therefore, when he is deprived of true spiritual joys, it is necessary that he become addicted to carnal pleasures.

I will focus on only one of the meaning dimensions of this discourse, namely:

the **entailment** relation established by *therefore* between the **modal** premise (1a) and the **modal** conclusion in (1b).

(for the meaning multidimensionality associated with *therefore*, see for example Grice (1975) and Potts (2003))

II. Informal Analysis of Discourse (1).

We want to capture:

➢ the meaning of the entailment particle *therefore*, which:
- relates the **content** of the premise (1a) and the **content** of the conclusion in (1b)

- requires the latter to be **entailed** by the former.

The **content** of a sentence: its **truth-conditions**, i.e. the set of possible worlds in which the sentence is **true**.

Entailment: content **inclusion**, i.e. (1a) entails (1b) iff for any world *w*, if (1a) is true in *w*, so is (1b).

II. Informal Analysis of Discourse (1).

And we also want to capture:

➢ the **meanings** of premise (1a) and conclusion (1b)

The **meaning** of a sentence: its **context-change potential**, which encodes both content (truth-conditions) and anaphoric potential.

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II. Informal Analysis of Discourse (1).

Thus, on the one hand, we are interested in the **contents** of (1a) and (1b).

They are both modal quantifications.

(1a) involves a circumstantial modal base (Kratzer (1981)) and asserts that, in view of the circumstances, i.e. given that God created man in a particular way, as long as a man is alive, he must find some thing or other pleasurable.

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II. Informal Analysis of Discourse (1).

(1b) involves the same modal base and elaborates on the preceding modal quantification: in view of the circumstances, if a man is alive and he has no spiritual pleasure, he must have a carnal pleasure.

We need to make the contents of (1a) and (1b) **accessible in discourse** so that the entailment particle *therefore* can relate them.

II. Informal Analysis of Discourse (1).

On the other hand, we are interested in the **anaphoric potential** of (1a) and (1b), i.e. in the anaphoric connections between them,

which we need to establish their contents.

These connections are explicitly represented in discourse (2) below, which is intuitively equivalent to (1).

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II. Informal Analysis of Discourse (1/2).

2. **a.** If a^{u_1} man is alive, he$_{u1}$ must find something^{u_2} pleasurable / he$_{u1}$ must have a^{u_2} pleasure.

   b. Therefore, if he$_{u1}$ doesn't have any^{u_3} spiritual pleasure, he$_{u1}$ must have a^{u_4} carnal pleasure.

Indefinites – introduce a discourse referent (dref) u_1, u_2 etc., which is represented by a superscript

Pronouns – retrieve a dref, which is represented by a subscript.

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II. Informal Analysis of Discourse (1/2).

The indefinite *a man* in the antecedent of the conditional in (2a) introduces the dref u_1,

which is anaphorically retrieved by the pronoun *he* in the antecedent of the conditional in (2b).

This is an instance of **modal subordination** (Roberts (1989)), i.e. an instance of **simultaneous modal** and **individual-level** anaphora (see Frank (1996), Geurts (1999) and Stone (1999)), that is…

II. Informal Analysis of Discourse (1/2).

That is…

the conditional in (2b) covertly 'duplicates' the antecedent of the conditional in (2a), i.e. it asserts that:

if **a man is alive** and he doesn't have any spiritual pleasure, he must have a carnal one.

I will analyze the simpler and more transparent discourse in (2) instead of the naturally occurring discourse in (1).

II. Summary: The Problem.

When we **compositionally** assign meanings to:

- the modalized conditional in (2a), i.e. the premise,
- the modalized conditional in (2b), i.e. the conclusion,
- the entailment particle *therefore*,

we have to capture:

- the **intuitively correct truth-conditions** of the whole discourse and
- the **modal** and **individual-level anaphoric connections** between the two sentences of the discourse and within each one of them.

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III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

I introduce a new dynamic system couched in many-sorted type logic, which extends Compositional DRT (CDRT, Muskens (1996)) in two ways.

First: in the spirit of the Dynamic Plural Logic of van den Berg (1996),

I model information states I, J etc. as **sets of variable assignments** i, j etc. and

I let **sentences** denote **relations** between such *plural info states*.

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III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

Second: in the spirit of Stone (1999),

I analyze **modal anaphora** by means of **dref's for** *static* **modal objects**.

This is in contrast to Geurts (1999) and Frank (1996) among others, who use dref's for **contexts** (i.e. for info states) to analyze modal anaphora and thus:

(i) complicate the architecture of the system, e.g. the info states are not necessarily well-founded (at least in principle);

(ii) fail to capture the parallel between anaphora and quantification in the individual and the modal domain (see Stone (1999) and Schlenker (2005) among others for more discussion).

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

I call the resulting system Intensional Plural CDRT (IP-CDRT).

IP-CDRT takes the research program in Muskens (1996), i.e. the unification of Montague semantics and dynamic semantics, one step further:

IP-CDRT unifies – in dynamic type logic – the static Lewis (1973) / Kratzer (1981) analysis of modal quantification and van den Berg's Dynamic Plural Logic.

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III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

We work with a Dynamic Ty3 logic.

Following Muskens (1996), we extend Ty2 (Gallin (1975)) with a basic type whose elements are meant to model variable assignments.

Basic types (**I** ignore the temporal and eventuality domains):

- type t: truth-values;
- type e: individuals (variables: x, x' etc.);
- type s: 'variable assignments' (variables: i, j etc.);
- type **w**: possible worlds (variables: w, w' etc.).

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III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

- a dref for individuals u is is a function of type se from 'assignments' i_s to individuals x_e

(the subscripts on terms indicate their type)

Intuitively, the individual $u_{se}i_s$ is the individual that the 'assignment' i assigns to the dref u.

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

- a dref for possible worlds p is is a function of type $s\mathbf{w}$ from 'assignments' i_s to *possible worlds* $w_{\mathbf{w}}$

  Intuitively, the world $p_{s\mathbf{w}}i_s$ is the world that the 'assignment' i assigns to the dref p.

- dynamic info states I, J, K,… are sets of 'variable assignments', i.e. they are of type st

  A sentence is interpreted as a DRS, i.e. a relation of type $(st)((st)t)$ between an input and an output info state.

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III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

- an individual dref u stores a set of individuals with respect to a plural info state I, abbreviated as:

$$uI := \{u_{se}i_s : i_s \in I_{st}\}$$

- a dref p stores a set of worlds, i.e. a **proposition**, with respect to an info state I, abbreviated as:

$$pI := \{p_{sw}i_s : i_s \in I_{st}\}$$

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

Propositional dref's have two uses:

- they store **contents**, e.g. the content of the premise (2a);

- they store **possible scenarios** (in the sense of Stone (1999)), e.g. the set of worlds introduced by the conditional antecedent in (2a).

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

We use **plural info states** to store sets of individuals and propositions

instead of simply using dref's for sets of individuals or sets of possible worlds

(their types would be $s(et)$ and $s(\mathbf{w}t)$)

because we need to store in our information states both the **values** assigned to various dref's and the **structure** associated with those values.

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III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

To see this, consider the **multiple plural anaphora** in (3) and the **modal subordination** in (4).

3.   **a.** Every^u man saw a$^{u'}$ woman.

     b. They$_u$ greeted them$_{u'}$.

4.   **a.** A^u wolf might^p enter the cabin.

     b. It$_u$ would$_p$ attack John.

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

We do not simply have anaphora to sets, but anaphora to **structured** sets:

- if man m_1 saw woman n_1 and m_2 saw n_2, (3b) is interpreted as asserting that m_1 greeted n_1, not n_2, and that m_2 greeted n_2, not n_1;

  the structure of the greeting is the same as the structure of the seeing.

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

I	u (men)		u' (women)	...
i_1	m_1 $(=ui_1)$	$\xrightarrow{m_1\ saw\ n_1}$	n_1 $(=u'i_1)$	...
i_2	m_2 $(=ui_2)$	$\xrightarrow{m_2\ saw\ n_2}$	n_2 $(=u'i_2)$	...
i_3	m_3 $(=ui_3)$	$\xrightarrow{m_3\ saw\ n_3}$	n_3 $(=u'i_3)$	...
...	...		...	...

For each $i \in I$, the man in i saw the woman in i.

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

- similarly, (4b) asserts that, if a wolf entered the cabin, it would attack John,

  i.e. if a black wolf x_1 enters the cabin in world w_1 and a white wolf x_2 enters the cabin in world w_2, then x_1 attacks John in w_1, not in w_2, and x_2 attacks John in w_2, not in w_1.

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

I	…	u (wolves)	p (worlds)	…
i_1	…	$x_1 (=ui_1)$	$w_1 (=pi_1)$	…
i_2	…	$x_2 (=ui_2)$	$w_2 (=pi_2)$	…
i_3	…	$x_3 (=ui_3)$	$w_3 (=pi_3)$	…
…	…	…	…	…

For each $i \in I$, the wolf in i entered the cabin in the possible world in i.

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

A plural info state I stores the **quantificational structure** associated with sets of individuals and possible worlds:

- (3a) requires each variable assignment $i \in I$ to be such that the man u_i saw the woman u'_i;

  (3b) elaborates on this structured dependency: for each $i \in I$, the man u_i greeted the woman u'_i.

- (4a) outputs an info state I such that, for each $i \in I$, the wolf u_i enters the cabin in the world p_i;

  (4b) elaborates on this structured dependency: for each $i \in I$, the wolf u_i to attack John in world p_i.

III. The Basic Proposal: Intensional Plural CDRT (IP-CDRT).

We also need plural info states to capture structured anaphora between the premise(s) and the conclusion of **therefore** discourses like (5) and (6).

5. **a.** Every^u man saw a$^{u'}$ woman.

   b. Therefore, they$_u$ noticed them$_{u'}$.

6. **a.** A^u wolf might^p enter the cabin.

   b. It$_u$ would$_p$ see John$^{u'}$.

   c. Therefore, it$_u$ would$_p$ notice him$_{u'}$.

7. **a. CONTENT**^{p_1}**:**

  if^{p_2} (a^{u_1} man_{p2} is $alive_{p2}$);

  must$^{p_3}_{p1,\mu,\omega}$(p_2, p_3); he_{u1} has_{p3} a^{u_2} $pleasure_{p3}$.

b. THEREFORE$^{p_4}_{p*,\mu*,\omega*}$(p_1, p_4)**:**

  if^{p_5} ($p_5 \Subset p_2$; **not**(he_{u1} has_{p5} a^{u_3} spiritual $pleasure_{p5}$));

  must$^{p_6}_{p4,\mu,\omega}$ (p_5, p_6); he_{u1} has_{p6} a^{u_4} carnal $pleasure_{p6}$.

The representation in (7) is basically **a network of structured anaphoric connections.**

III. The Basic IP-CDRT Analysis of Discourse (1/2).

The conditional in (7a):

- the morpheme *if* introduces a propositional dref p_2 that stores the content of the antecedent;

  we need this distinct dref because the antecedent in (2b) is anaphoric to it (due to modal subordination)

III. The Basic IP-CDRT Analysis of Discourse (1/2).

The conditional in (7a) (ctd.):

- the indefinite *a man* introduces an individual dref u_1, which is later retrieved:

  (i) by the pronoun *he* in the consequent of (2a), i.e. by 'donkey' anaphora,

  (ii) by the pronoun *he* in the antecedent of (2b), i.e. by modal subordination.

III. The Basic IP-CDRT Analysis of Discourse (1/2).

The conditional in (7a) (ctd.):

- the modal verb *must* in the consequent contributes a tripartite quantificational structure and it relates three propositional dref's: p_1, p_2 and p_3.

p_1: it stores the content of the whole modalized conditional.

p_2: it was introduced by the antecedent;
it is anaphorically retrieved by *must*;
it provides the restrictor of the modal quantification.

III. The Basic IP-CDRT Analysis of Discourse (1/2).

The conditional in (7a) (ctd.):

p_3 : it is introduced by the modal *must*;

it is the nuclear scope of the modal quantification;

the modal verb constrains it to contain the set of **ideal** worlds among the set of p_2-worlds…

…ideal relative to the p_1-worlds, a **circumstantial** modal base (MB) μ and an **empty** ordering source (OS) ω.

- finally, we test that the set of ideal worlds stored in p_3 satisfies the remainder of the consequent.

III. The Basic Analysis of Discourse (1/2).

The entailment particle *therefore*:

- it relates **contents** and not meanings;

- it is analyzed as a modal relation expressing **logical consequence**

- thus, discourse (1/2) is analyzed as a modal quantification that relates (the contents of) two embedded modal quantifications, the second of which is modally subordinated to the first.

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III. The Basic IP-CDRT Analysis of Discourse (1/2).

The entailment particle *therefore* (ctd.):

- *therefore* contributes a **necessity** modal relation and introduces a tripartite quantificational structure:

  the restrictor is p_1 (the content of the premise)

  the nuclear scope is the newly introduced dref p_4, which stores the set of ideal p_1-worlds…

  … ideal relative to the dref p^* (the dref for the actual world w^*), an **empty** MB μ^* and an **empty** OS ω^*.

III. The Basic IP-CDRT Analysis of Discourse (1/2).

The entailment particle *therefore* (ctd.):

- the MB μ^* and the OS ω^* are **empty** because *therefore* is interpreted as **logical consequence**.

- since μ^* and ω^* are empty, the dref p_4 is identical to p_1.

III. The Basic IP-CDRT Analysis of Discourse (1/2).

The entailment particle *therefore* (ctd.):

- analyzing *therefore* as an instance of modal quantification predicts that we can interpret it relative to different MB's and OS's.

  This prediction is borne out.

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III. The Basic IP-CDRT Analysis of Discourse (1/2).

The entailment particle *therefore* (ctd.):

- *therefore* expresses **causal consequence** in:

    Reviewers are usually people who would have been poets, historians, biographers, etc., if they could; they have tried their talents at one or the other, and have failed; **therefore** they turn critics.

    (Samuel Taylor Coleridge, *Lectures on Shakespeare and Milton*)

III. The Basic IP-CDRT Analysis of Discourse (1/2).

The entailment particle *therefore* (ctd.):

- *therefore* seems to express a form of **practical inference** in:

  We cannot put the face of a person on a stamp unless said person is deceased. My suggestion, **therefore**, is that you drop dead.

  (attributed to J. Edward Day; letter, never mailed, to a petitioner who wanted himself portrayed on a postage stamp)

III. The Basic IP-CDRT Analysis of Discourse (1/2).

The conditional in (7b):

- the conditional in (7b) is interpreted like the conditional in (7a),

    except that its antecedent is anaphoric to the antecedent of the conditional in (7a), i.e. to the dref p_2.

- the dref p_5 is a **structured** subset of p_2, symbolized as $p_5 \Subset p_2$.

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III. The Basic IP-CDRT Analysis of Discourse (1/2).

The conditional in (7b) (ctd.):

- we need the **structured inclusion** $p_5 \Subset p_2$

  because we want p_5 to preserve the structure associated with the p_2-worlds,

  i.e. to preserve in p_5 the previously established association between the p_2-worlds and the u_1-men in them.

III. The Basic IP-CDRT Analysis of Discourse (1/2).

The conditional in (7b) (ctd.):

- the modal verb *must* in (7b):

 it is anaphoric to p_5;

 it introduces the set of worlds p_6 containing all the ideal p_5-worlds – ideal relative to the p_4-worlds, μ and ω, i.e. the same as the MB and the OS in the premise (7a);

 finally, it checks that in each ideal p_6-world, all its associated u_1-men have a carnal pleasure.

III. More examples.

IP-CDRT can scale up to account for a wide range of examples.

Consider the modal subordination example in (9) below from Roberts (1996).

9.   **a.** You should buy a lottery ticket and put it in a safe place.

b. You're a person with good luck.

c. It might be worth millions.

III. More examples.

The *might* modal quantification in (9c) is restricted by the **content** of the first conjunct below the modal *should* in (9a),

i.e. it is interpreted as asserting that, given that you're a generally lucky person,
if you buy a lottery ticket, it might be worth millions.

Crucially, (9c) is not restricted by the content of both conjuncts in (9a) or the set of deontically ideal worlds contributed by *should*.

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III. More examples.

Roberts (1996) proposes to analyze (9c) by **accommodating** a suitable domain restriction for the quantification contributed by *might*.

The accommodation procedure (possibly involving syntactic copying operations at the level of Logical Form) is left largely unspecified and unrestricted.

Moreover, it is far from clear that accommodation is the right way to go **when the relevant domain restriction is in fact provided by the preceding discourse.**

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III. More examples.

In contrast, IP-CDRT provides the framework for an analysis of (9c) in terms of **content anaphora**.

An anaphoric analysis of (9c) is desirable because:

- it is (arguably) more restricted than an accommodation account;
- it can capture the connection between (9c) and the preceding discourse, i.e. (9a), in a simple and formally explicit way.

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III. More examples.

IP-CDRT provides the kind of formal system that can be extended in the usual ways to account for the diverse range of naturally occurring *therefore* discourses:

- *therefore* can relate two deontic modal quantifications:

10. It is necessary for me to establish a winner image. Therefore, I have to beat somebody.
    (attributed to Richard Nixon)

III. More examples.

- *therefore* can be anaphoric to a modal quantification involving a comparative correlative :

11. If you commit a big crime then you are crazy, and the more heinous the crime the crazier you must be. Therefore you are not responsible, and nothing is your fault.

    (attributed to Peggy Noonan)

III. More examples.

- *therefore* can interact with VP cataphora:

12. I can, therefore I blog.
    (http://normblog.typepad.com/normblog/2006/03/i_can_therefore.html)

- *therefore* can be embedded in an attitude report:

III. More examples.

13. This is the site that Darlene, the woman who emailed [m]e, runs. Her blog is more popular than [m]y blog.

You might think that I would therefore not like her, but you would be wrong.

I love Darlene, even if she has the best blogger website address.

(http://whatwouldjb.blogspot.com/2006/04/what-else-would-jesus-blog.html)

This discourse seems to be interpreted as follows:

you might think that **[** *I would not like her because her blog is more popular than mine* **]**.

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IV. Conclusion.

The main contribution of the paper is the introduction of **structured discourse referents** for **individuals** and **propositions**,

formalized in a compositional dynamic system based on classical type logic and in the context of a possible-world analysis of intensional phenomena.

This enables us to account for discourses in which **entailment particles** interact with multiple **modalized conditionals**, **'donkey' anaphora** and **modal subordination**.

IV. Conclusion.

The account is part of two larger research programs:

- the unification of Montague semantics and dynamic semantics

  (see Muskens (1996) among others)

- the investigation of the anaphoric and quantificational parallels between the individual and the modal domain

  (see Stone (1999) and Schlenker (2005) among others, building on Partee (1973, 1984)).

IV. Conclusion.

- IP-CDRT extends the empirical coverage of previous account of modal subordination and provides simpler analyses:

  It is not clear that Geurts (1996) and Frank (1999) can compositionally analyze discourses like (1/2).

  Insofar as they can, the analyses are more complicated because of their discourse referents for info states – which also prevents them from formally capturing the anaphoric and quantificational parallels between the individual and the modal domain.

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IV. Conclusion.

The analysis of modal verbs in Stone (1999) does not associate contents with modal quantifications – so the meaning of *therefore* cannot be captured.

Kamp & Reyle (1993), van den Berg (1996), Krifka (1996) and Nouwen (2003) account only for anaphora and dynamic quantification in the individual domain.

IV. Conclusion.

- technically, IP-CDRT simplifies and extends both van den Berg (1996) and Stone (1999)

- compositionality at the sub-sentential / sub-clausal level follows automatically, given that the dynamic system is formulated in type logic; also, standard techniques in Montague semantics (e.g. type-shifting) become available

IV. Conclusion.

- the received wisdom that natural language does not make (discourse) reference to **possible worlds** as it does to individuals,

  the classical expression of which is Montague's IL, where reference to and quantification over possible worlds is only implicit,

  is captured by IP-CDRT: even the simplest intensional dref, i.e. a possible-world dref, stores a proposition (a **set** of worlds) with respect to a **plural** info state.

IV. Conclusion.

In contrast, discourse reference to **propositions**, i.e. to **partially** specified intensional objects, is common:

entailment particles involve discourse reference to **contents** (of clauses or of larger discourse segments)

modal subordination and **modal anaphora** in general involve discourse reference to **possible scenarios**

And discourse reference to contents and possible scenarios is just discourse reference to **propositions** in two different guises.

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IV. Conclusion.

- finally, IP-CDRT over-generates with respect to the kind of propositional anaphoric patterns it allows (almost anything goes)…

  … but this is very much like the over-generation problem faced by dynamic systems for individual-level anaphora.

IV. Conclusion.

And, just as anaphora resolution in the individual domain requires a much richer theory over and above a basic dynamic system (see for example Grosz et al. (1995) and Asher & Lascarides (2003)),

I expect that various refinements of the IP-CDRT system, e.g. modeling plural info states as sets of stacks and implementing a system of prominence-guided anaphora (following Nouwen (2003) and Bittner (2005) among others) will substantially decrease the over-generation.

Acknowledgments.

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