Donkey Pluralities:
Plural Info States vs. Non-Atomic Individuals.

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1. Introduction.

The main goal of this presentation is to systematically distinguish two notions of plurality:

- **plural reference**, i.e. non-atomic individuals
- **plural discourse reference**

1. Introduction.

Plural discourse reference is:

reference to a **quantificational dependency**,

which is established and subsequently referred to in discourse,

between **sets of objects**,

e.g. atomic and / or non-atomic individuals.

1. Introduction.

Plural discourse reference:

1. Every person who buys **a^{u} book** on amazon.com and has **a$^{u'}$ credit card** uses it$_{u'}$ to pay for it$_{u}$.
2. Every boy who bought **a^{u} Christmas gift** for **a$^{u'}$ girl in his class** asked her$_{u'}$ deskmate to wrap it$_{u}$.

Both examples contain **multiple** instances of **singular** donkey anaphora.

1. Introduction.

1. Every person who buys **a^{u} book** on amazon.com and has **a$^{u'}$ credit card** uses it$_{u'}$ to pay for it$_{u}$.

(1) shows that singular 'donkeys' can refer to **sets** of objects.

2. Every boy who bought **a^{u} Christmas gift** for **a$^{u'}$ girl in his class** asked her$_{u'}$ deskmate to wrap it$_{u}$.

(2) shows that singular 'donkeys' can refer to a **dependency** between sets of objects.

1. Introduction.

1. Every person who buys **a^{u} book** on amazon.com and has **a$^{u'}$ credit card** uses it$_{u'}$ to pay for it$_{u}$.

This is a **mixed weak & strong** donkey sentence,

i.e. for **every** (strong) book that any credit-card owner buys on amazon.com,

there is **some** (weak) credit card that s/he uses to pay for the book.

1. Introduction.

The credit card can vary from book to book,

e.g. I can use my MasterCard to buy set theory books and my Visa to buy detective novels.

That is: although it receives a **weak** reading,
the indefinite ***a$^{u'}$ credit card*** can introduce a non-singleton **set** of credit cards.

[and the **strong** indefinite ***a^{u} book*** can also introduce a non-singleton **set**]

1. Introduction.

2. Every boy who bought **a^{u} Christmas gift** for **a$^{u'}$ girl in his class** asked her$_{u'}$ deskmate to wrap it$_{u}$.

Both 'donkeys' are strong: we consider **every** Christmas gift and **every** girl.

The restrictor of the donkey quantification introduces a **dependency** between the set of gifts and the set of girls:

each gift is correlated with the girl it was bought for.

1. Introduction.

2. Every boy who bought **a^{u} Christmas gift** for **a$^{u'}$ girl in his class** asked her$_{u'}$ deskmate to wrap it$_{u}$.

The nuclear scope of the donkey quantification retrieves not only the two sets of objects,
but also the **structure** associated with them (i.e. the dependency between them):

each gift was wrapped by the deskmate of the girl that the gift was bought for.

We have donkey anaphora to **structure** in addition to donkey anaphora to **values**.

1. Introduction.

2. Every boy who bought **a^{u} Christmas gift** for **a$^{u'}$ girl in his class** asked <u>her$_{u'}$</u> deskmate to wrap <u>it$_{u}$</u>.

The dependency between gifts and girls, i.e. the **structure** associated with the two sets of objects,

is **semantically** encoded and not pragmatically inferred.

Why?

1. Introduction.

2. Every boy who bought **a^{u} Christmas gift** for **a$^{u'}$ girl in his class** asked <u>her$_{u'}$</u> deskmate to wrap <u>it$_{u}$</u>.

Because it is not vague / underspecified and subsequently made precise based on various extra-linguistic factors.

Suppose John buys two gifts, one for Mary and the other for Helen. The two girls are deskmates.

(2) is true if John asked Mary to wrap Helen's gift and Helen to wrap Mary's gift.

(2) is not true if John asked each girl to wrap her own gift.

[note that the 'deskmate' relation is symmetric]

1. Introduction.

Problem 1: How should we analyze singular donkey anaphora to **structured sets** of individuals?

Problem 2: Why is it that singular donkey anaphora can involve **non-singleton** sets of individuals while being **incompatible with collective predicates:**

3. #Every farmer who owns **a^{u} donkey** gathers <u>it$_{u}$</u> around the fire at night.

(based on an example in Kanazawa 2001)

1. Introduction.

The solutions:

- *Singular* donkey indefinites and pronouns are:
  (i) plural and **distributive** at the discourse level (we can therefore account for donkey anaphora to structured sets);
  (ii) singular (atomic) at the domain level.
- Collective predicates require **non-atomic** individuals at the domain level or (at least) **collective** interpretation at the discourse level.

1. Introduction.

Moreover,

distinguishing **plural reference** and **plural discourse reference** enables us to account for the intuitive parallel between singular and plural donkey anaphora…

1. Introduction.

4. Every parent who gives **a^{u} balloon** to **two$^{u'}$ boys** expects <u>them$_{u'}$</u> to end up fighting (each other) for <u>it$_{u}$</u>.

(based on an example due to Maria Bittner, p.c.)

2. Every boy who bought **a^{u} Christmas gift** for **a$^{u'}$ girl in his class** asked <u>her$_{u'}$</u> deskmate to wrap <u>it$_{u}$</u>.

1. Introduction: The Plan.

- **2. The proposal.**
  - Plural Compositional DRT (PCDRT): Compositional DRT (Muskens 1996) extended with two kinds of pluralities: plural info states and non-atomic individuals.
- **3. Solving the two problems.**
  - singular morphology and weak/strong indefinite articles;
  - Problem 1: singular donkey anaphora to structure;
  - Problem 2: the incompatibility between singular donkey anaphora and collective predicates.
- **4. More on the Weak / Strong Ambiguity.**
  - justifying the analysis of the weak / strong donkey ambiguity as an ambiguity in the indefinite article.
- **5. Conclusion.**
  - two ways of conflating plural reference and plural discourse reference.

2. The Proposal: Plural CDRT.

I introduce a new dynamic system,

which is couched in many-sorted type logic

and which extends Compositional DRT (CDRT, Muskens 1996) in two ways.

2. The Proposal: Plural CDRT.

First, in the spirit of the Dynamic Plural Logic of van den Berg (1994, 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.

Plural information states model **discourse-level plurality**, i.e. plural discourse reference.

2. The Proposal: Plural CDRT.

Second, following Link (1983) (see also Schwarzschild 1992 among others),

I model **domain-level plurality** as **non-atomic** individuals.

That is, I take the domain of individuals to be the power set a given non-empty set **IN** of entities,

i.e. $\wp^+(\mathbf{IN})$ $(:= \wp(\mathbf{IN})\backslash\{\varnothing\})$.

2. The Proposal: Plural CDRT.

The **sum** of two individuals:

$x \oplus y$, i.e. the union of the sets x and y.

e.g. $\{mary\} \oplus \{john\} = \{mary, john\}$

For a set of individuals X, the sum of the individuals in X (i.e. their union) is $\oplus X$.

e.g. $\oplus\{\{mary\}, \{john\}, \{bill\}\} = \{mary, john, bill\}$

2. The Proposal: Plural CDRT.

The **part-of** relation over individuals:

$x \leq y$ (intuitively, x is a part of y),

is the partial order induced by inclusion $\subseteq$ over the set $\wp^+(\mathbf{IN})$.

The **atomic** individuals are the singleton subsets of **IN**.

They are identified by means of a predicate **atom**:

$\mathbf{atom}(x) := \forall y \leq x (y = x)$

2. The Proposal: Plural CDRT.

I call the resulting system Plural CDRT (PCDRT).

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

it unifies – in dynamic type logic – Link's static analysis of plurality and van den Berg's Dynamic Plural Logic.

2. The Proposal: Plural CDRT.

We work with a Dynamic Ty2 logic, following Muskens' formulation of dynamic semantics (Muskens 1996) in Gallin's Ty2 (Gallin 1975).

Basic types:

- type t: truth-values;
- type e: individuals (atomic and non-atomic; variables: x, x' etc.);
- type s: 'variable assignments' (variables: i, j etc.).

[A suitable set of axioms ensures that the entities of type s behave as variable assignments.]

2. The Proposal: Plural CDRT.

- a dref for individuals u 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 (atomic or not) that the 'assignment' i assigns to the dref u.

2. The Proposal: Plural CDRT.

- dynamic info states I, J, K,… are sets of 'variable assignments', i.e. they are of type st
- a sentence is interpreted as a Discourse Representation Structure (DRS), i.e. as a relation of type $(st)((st)t)$ between an input info state I_{st} and an output info state J_{st}.

2. The Proposal: Plural CDRT.

The general form of a DRS is:

[**new drefs** | **conditions**]

i.e.

$\lambda I_{st} \lambda J_{st}.\ I[\textbf{new drefs}]J \wedge \textbf{conditions}J$

For example:

$[u, u' \mid person\{u\}, book\{u'\}, buy\{u, u'\}]$

i.e.

$\lambda I_{st}.\lambda J_{st}.\ I[u, u']J \wedge person\{u\}J \wedge book\{u'\}J \wedge buy\{u, u'\}J$

2. The Proposal: Plural CDRT.

DRS's of the form

[**conditions**]

are tests and they are interpreted as:

$\lambda I_{st} \lambda J_{st}.\ I = J \wedge \textbf{conditions}J$

For example:

$[book\{u'\}] := \lambda I_{st}.\lambda J_{st}.\ I = J \wedge book\{u'\}J$

2. The Proposal: Plural CDRT.

- an individual dref u stores a set of individuals (atomic and / or non-atomic) with respect to a plural info state I, abbreviated as:

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

  i.e. uI is the image of the set of 'assignments' I under the function u.

2. The Proposal: Plural CDRT.

We use **plural info states** to store sets of individuals,

instead of simply using dref's for sets of individuals (their type would be $s(et)$),

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

2. The Proposal: Plural CDRT.

Compositionality: in an extensional Fregean / Montagovian framework, the compositional aspect of interpretation is largely determined by the types for the extensions of the 'saturated' expressions, i.e. names and sentences.

Abbreviate them as **e** and **t**, respectively.

In PCDRT, we assign the following dynamic types to the 'meta-types' **e** and **t**:

- **t** := $(st)((st)t)$ (a sentence is interpreted as a DRS)
- **e** := se (a name is interpreted as an individual dref)

2. The Proposal: Plural CDRT.

Extensional static logic with domain-level plurality:

- **e** is e (atomic and non-atomic entities) and **t** is t (truth-values)
- the denotation of the common noun ***book*** is of type (**et**), i.e. (et):

  book ⇝ $\lambda x_e.\ book_{et}(x)$

- the generalized determiner ***every*** is of type (**et**)((**et**)**t**), i.e. $(et)((et)t)$

2. The Proposal: Plural CDRT.

Plural Compositional DRT:

- the denotation of the common noun ***book*** is still of type (**et**):

  book ⇝ $\lambda v_{\mathbf{e}}.\ [book\{v\}]$
  ⇝ $\lambda v_{\mathbf{e}}.\ \lambda I_{st}\lambda J_{st}.\ I{=}J \wedge book\{v\}J$

- the generalized determiner ***every*** is still of type (**et**)((**et**)**t**):

  every^u ⇝ $\lambda P'_{\mathbf{et}}.\ \lambda P_{\mathbf{et}}.\ [\mathbf{every}_u(P'(u), P(u))]$
  ⇝ $\lambda P'_{\mathbf{et}}.\ \lambda P_{\mathbf{et}}.\ \lambda I_{st}\lambda J_{st}.\ I{=}J \wedge \mathbf{every}_u(P'(u), P(u))J$

2. The Proposal: Plural CDRT.

Truth:

A DRS D (type **t**) is *true* with respect to an input info state I_{st} iff $\exists J_{st}(DIJ)$.

3. Singular Number Morphology.

A **singular** donkey indefinite introduces (and a **singular** donkey pronoun retrieves) …

… an individual dref u (type se) which is:

- **plural at the discourse level**: it stores a set of individuals uI relative to a plural info state I;
- **distributive at the discourse level**: we predicate conditions with respect to each individual in the set uI;
- **singular at the domain level**: we require each individual in the set uI to be atomic, i.e. $\forall i \in I(\mathbf{atom}(ui))$.

3. Weak vs. Strong Indefinite Articles.

The analysis of weak vs. strong indefinites:

new dref's vs. **maximal** new dref's.

$a^{\mathbf{wk}:u}$ ⇝
$\lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ [u];\ \mathbf{dist}_u([\mathbf{atom}\{u\}];\ P'(u);\ P(u))$

$a^{\mathbf{str}:u}$ ⇝
$\lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ \mathbf{max}^u(\mathbf{dist}_u([\mathbf{atom}\{u\}];\ P'(u);\ P(u))$

where $\mathbf{atom}\{u\} := \lambda I_{st}.\ \mathbf{atom}(\oplus uI)$
and $D; D' := \lambda I_{st}J_{st}.\ \exists H_{st}(DIH \wedge DHJ)$

[i.e. ';' is dynamic conjunction
and '∧' is static, type-logical conjunction]

3. Donkey Anaphora to Structure.

2. Every$^{u''}$ boy who bought **a$^{\mathbf{str}:u}$ Christmas gift** for **a$^{\mathbf{str}:u'}$ girl in his class** asked <u>her$_{u'}$</u> deskmate to wrap <u>it$_u$</u>.

I	u (**all gifts**)		u' (**all girls**)
i_1	$x_1\ (=ui_1)$	x_1 was bought for y_1 →	$y_1\ (=u'i_1)$
i_2	$x_2\ (=ui_2)$	x_2 was bought for y_2 →	$y_2\ (=u'i_2)$
i_3	$x_3\ (=ui_3)$	x_3 was bought for y_3 →	$y_3\ (=u'i_3)$
…	…		…

For each $i \in I$, the gift in i was bought for the girl in i.

3. Donkey Anaphora to Structure.

2. Every$^{u''}$ boy who bought **a$^{str:u}$ Christmas gift** for **a$^{str:u'}$ girl in his class** asked her$_{u'}$ deskmate to wrap it$_{u}$.

The strong donkey indefinites introduce both

- **values**, i.e. the set of gifts $\{x_1, x_2, \ldots\}$ and the set of girls $\{y_1, y_2, \ldots\}$,

and

- **structure**, i.e. for each 'assignment' $i \in I$, the gift ui was bought for girl $u'i$.

3. Donkey Anaphora to Structure.

2. Every$^{u''}$ boy who bought **a$^{str:u}$ Christmas gift** for **a$^{str:u'}$ girl in his class** asked her$_{u'}$ deskmate to wrap it$_{u}$.

When we process the nuclear scope of the donkey quantification, we are **anaphoric** to both **values** and **structure**,

i.e. we elaborate on the dependency between u' and u introduced in the restrictor:

we require each 'assignment' $i \in I$ to be such that the deskmate of girl $u'i$ was asked to wrap gift ui.

3. Donkey Anaphora to Structure.

1. Every$^{u''}$ person who buys **a$^{str:u}$ book** on amazon.com and has **a$^{wk:u'}$ credit card** uses it$_{u'}$ to pay for it$_{u}$.

The interpretation of sentence (1) is similar, except for two important differences:

- the weak reading of the indefinite ***a$^{u'}$ credit card***;
- the structural dependency between books and credit cards is implicit in the restrictor and is explicitly established only in the nuclear scope.

3. Donkey Anaphora to Structure.

1. Every$^{u''}$ person who buys **a$^{str:u}$ book** on amazon.com and has **a$^{wk:u'}$ credit card** uses it$_{u'}$ to pay for it$_{u}$.

I	u (**all books**)		u' (**some cards**)
i_1	x_1 (=ui_1)	x_1 is somehow correlated with y_1 →	y_1 (=$u'i_1$)
i_2	x_2 (=ui_2)	x_2 is somehow correlated with y_2 →	y_2 (=$u'i_2$)
i_3	x_3 (=ui_3)	x_3 is somehow correlated with y_3 →	y_3 (=$u'i_3$)
…	…		…

3. Donkey Anaphora to Structure.

1. Every$^{u''}$ person who buys **a$^{str:u}$ book** on amazon.com and has **a$^{wk:u'}$ credit card** uses it$_{u'}$ to pay for it$_{u}$.

By the time we are done processing the restrictor:

- we introduce the **maximal** value for u
- we **non-deterministically** introduce some **suitable value** for u'
- we **non-deterministically** introduce some **structure** correlating the values of u and u'

3. Donkey Anaphora to Structure.

1. Every person who buys **a$^{str:u}$ book** on amazon.com and has **a$^{wk:u'}$ credit card** uses it$_{u'}$ to pay for it$_{u}$.

The nuclear scope is again anaphoric to both values and structure,

i.e. we test that the non-deterministically introduced value for u' and the non-deterministically introduced structure associating u' and u satisfy the nuclear scope condition.

3. Donkey Anaphora to Structure.

1. Every person who buys **a$^{str:u}$ book** on amazon.com and has **a$^{wk:u'}$ credit card** uses it$_{u'}$ to pay for it$_{u}$.

That is,

the nuclear scope **elaborates** on the unspecified dependency between u' and u introduced in the restrictor of the donkey quantification:

for each 'assignment' $i \in I$, we test that credit card $u'i$ is used to pay book ui.

3. Donkey Anaphora to Structure.

1. Every person who buys **a$^{str:u}$ book** on amazon.com and has **a$^{wk:u'}$ credit card** uses it$_{u'}$ to pay for it$_{u}$.

The credit cards co-vary with / are dependent on the books and introducing such a dependency does not require the strong indefinite ***a$^{str:u}$ book*** to scope over the weak indefinite ***a$^{wk:u'}$ credit card***…

… which we couldn't do because the two DP's are 'trapped' within their respective conjuncts.

3. Donkey Anaphora to Structure.

4. Every parent who gives **a$^{str:u}$ balloon** to **two$^{str:u'}$ boys** expects them$_{u'}$ to end up fighting (each other) for it$_{u}$.

This is analyzed in the same way as (2):

$$\mathbf{2\_atoms}(x_e) := |\{y_e: y \leq x \wedge \mathbf{atom}(y)\}| = 2$$

two$^{wk:u}$ ⇝

$$\lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ [u];\ \mathbf{dist}_u([\mathbf{2\_atoms}\{u\}];\ P'(u);\ P(u))$$

two$^{str:u}$ ⇝

$$\lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ \mathbf{max}^u(\mathbf{dist}_u([\mathbf{2\_atoms}\{u\}];\ P'(u);\ P(u))$$

3. Donkey Anaphora to Structure.

4. Every parent who gives **a$^{str:u}$ balloon** to **two$^{str:u'}$ boys** expects <u>them</u>$_{u'}$ to end up fighting (each other) for <u>it</u>$_{u}$.

I	u (**all baloons**)		u' (**all pairs of boys**)
i_1	x_1 $(=ui_1)$	$\xrightarrow{x_1 \text{ was given to } y_1}$	y_1 $(=u'i_1)$
i_2	x_2 $(=ui_2)$	$\xrightarrow{x_2 \text{ was given to } y_2}$	y_2 $(=u'i_2)$
i_3	x_3 $(=ui_3)$	$\xrightarrow{x_3 \text{ was given to } y_3}$	y_3 $(=u'i_3)$
…	…		…

For each $i \in I$, the balloon in i was given to the pair of boys in i.

3. Donkey Anaphora to Structure.

4. Every parent who gives **a$^{str:u}$ balloon** to **two$^{str:u'}$ boys** expects <u>them</u>$_{u'}$ to end up fighting (each other) for <u>it</u>$_{u}$.

The nuclear scope elaborates on this dependency by requiring each pair of boys $u'i$ to fight each other for the corresponding balloon ui.

Crucially, the collective predicate ***fight (each other)*** is felicitous because:

for each $i \in I$, $u'i$ is a **non-atomic** individual.

3. Singular 'Donkeys' and Collectives.

3. #Every farmer who owns **a$^{str:u}$ donkey** gathers <u>it</u>$_{u}$ around the fire at night.

Singular number morphology on donkey indefinites and pronouns contributes:
(i) **discourse-level distributivity**;
(ii) **domain-level singularity / atomicity**.

Collective predicates require at least one of the following two:
(i) **discourse-level collectivity**;
(ii) **domain-level plurality / non-atomicity**.

3. Singular 'Donkeys' and Collectives.

3. #Every farmer who owns **a$^{str:u}$ donkey** gathers <u>it</u>$_{u}$ around the fire at night.

After we process the restrictor, we have an info state I such that:

for each $i \in I$, ui is an **atomic** donkey that some farmer has.

3. Singular 'Donkeys' and Collectives.

3. #Every farmer who owns **a$^{str:u}$ donkey** gathers <u>it</u>$_{u}$ around the fire at night.

When ***it***$_{u}$ accesses the value of u so that the rest of the nuclear scope can be predicated of u,

the singular number morphology on ***it***$_{u}$ requires the value of u to be accessed **distributively**,

i.e. for any individual x in the set uI, we assert that x is gathered around the fire at night.

But each x is an **atomic** donkey – hence the infelicity.

4. The Weak / Strong Donkey Ambiguity.

A 'two stage' argument:

- **the weak/strong donkey ambiguity is located in the donkey items themselves**, i.e. in the donkey indefinites and / or the donkey pronouns
- **the weak/strong donkey ambiguity is located in the donkey indefinites**

4. The Weak / Strong Donkey Ambiguity.

The weak/strong donkey ambiguity is located in the donkey items themselves, i.e. in the donkey indefinites and / or the donkey pronouns.

Two arguments:
- syntax/semantics side: we want to interpret mixed weak & strong donkey sentences **compositionally**
- semantics/pragmatics side: a **variety** of independent factors influence in a **defeasible** way which reading is selected in any given instance of donkey anaphora

4. The Weak / Strong Donkey Ambiguity.

Mixed donkey sentences and compositionality.

Consider (1) again: the weak indefinite ***a$^{u'}$ credit card*** in (1) is dependent on / co-varies with the strong indefinite ***a^{u} book***.

This dependency cannot be captured by syntactic manipulations because the two indefinites are in two distinct conjuncts:
they cannot be 'moved' out of them and the strong indefinite cannot take scope over the weak one.

4. The Weak / Strong Donkey Ambiguity.

Mixed donkey sentences and compositionality.

If the weak/strong donkey ambiguity is attributed to the generalized determiner (e.g. Rooth 1987, Heim 1990),

we end up packing the LF of the restrictor into the lexical entry of the determiner …

4. The Weak / Strong Donkey Ambiguity.

Mixed donkey sentences and compositionality.

… i.e. the generalized determiner has to encode at least three things:

- the dref's introduced by the indefinites in its restrictor, including indefinites that are 'buried' inside conjunctions;
- what reading (weak vs. strong) is assigned to each such indefinite;
- which indefinite is dependent on which – and such dependencies can be non-local, e.g. they can be established across conjuncts.

4. The Weak / Strong Donkey Ambiguity.

The pragmatics of donkey readings.

There are **many** factors that **defeasibly** influence what reading is preferred for any given donkey sentence:

- the logical properties of determiners (Kanazawa 1994)
- world-knowledge (the 'dime' example in Pelletier & Schubert 1989; see also Geurts 2002)
- the information (focus-topic-background) structure of the sentence (Kadmon 1987, Heim 1990)
- the kind of predicates that are used (total vs. partial predicates, Krifka 1996a and references therein)
- whether the donkey indefinite is referred back to by a donkey pronoun (Bäuerle & Egli 1985)

4. The Weak / Strong Donkey Ambiguity.

The pragmatics of donkey readings.

The most conservative hypothesis is to locate the weak/strong ambiguity at the level of the donkey items themselves (i.e. in the donkey indefinites and / or the donkey pronouns),

i.e. make the donkey items ambiguous between / underspecified for a weak and a strong meaning

and let more general and defeasible pragmatic inferences decide which meaning is selected in each particular case.

4. The Weak / Strong Donkey Ambiguity.

The weak/strong donkey ambiguity is located in the donkey indefinites.

5. (Today's newspaper claims that, based on the most recent statistics:)
   Every company who hired a^u Moldavian man, but no company who hired a^u Transylvanian man promoted him$_u$ within two weeks of hiring.

Every company who hired a Moldavian promoted **every** (strong) Moldavian it hired within two weeks, while there is no company who hired some Transylvanian and promoted **some** (weak) Transylvanian it hired within two weeks.

4. The Weak / Strong Donkey Ambiguity.

The weak/strong donkey ambiguity is located in the donkey indefinites.

The weak / strong donkey ambiguity cannot be located in the pronoun because:

there is only one pronoun in (5), but two distinct donkey readings.

Note that (5) does not seem to be an instance of ellipsis or Right Node Raising,

in which case we could have assumed that the pronoun is covertly duplicated at the level of LF.

4. The Weak / Strong Donkey Ambiguity.

The weak/strong donkey ambiguity is located in the donkey indefinites.

Consider also (6) below, where the intonational tune is the one associated with declarative sentences like

Every student and every professor was invited to the party,

whose LF is not derived by ellipsis and / or Right Node Raising.

4. The Weak / Strong Donkey Ambiguity.

Also, covertly duplicating at LF the pronouns in (5) and (6) by **rightward** ATB movement of the **VP** does not seem to be an independently motivated syntactic operation for English.

And, even if rightward ATB movement of the VP is possible and independently motivated,

one needs to reconstruct the VP in **both** places to get two pronouns there

and the two reconstructed pronouns need to be assigned **different indices**.

4. The Weak / Strong Donkey Ambiguity.

Context: there is a Sunday fair where, among other things, people come to sell their young puppies – and they do want to get rid of all of them before they are too old. The fair entrance fee is one dollar.

The fair rules are strict: all the puppies need to be checked for fleas at the gate and, at the same time, the one dollar bills also need to be checked for authenticity because there are many faux-monnayeurs in the area. So:

6. Everyone who has a^u puppy and everyone who has a^u dollar brings it$_u$ to the gate to be checked.
   (based on an example due to Sam Cumming)

5. Conclusion.

The main goal of this presentation was to systematically distinguish two notions of plurality:

- **plural reference:** domain-level plurality, i.e. reference to non-atomic individuals;
- **plural discourse reference:** discourse-level plurality, i.e. reference to a quantificational dependency between sets of objects.

5. Conclusion.

[New] observation:

Plural discourse reference is possible with **singular** anaphora in relative-clause donkey sentences:

1. Every person who buys **a^u book** on amazon.com and has **a$^{u'}$ credit card** uses it$_{u'}$ to pay for it$_u$.
2. Every boy who bought **a^u Christmas gift** for **a$^{u'}$ girl in his class** asked her$_{u'}$ deskmate to wrap it$_u$.

5. Conclusion.

[New] observation:

Plural discourse reference is possible with simultaneous **singular** and **plural** (at the **domain level**) donkey anaphora:

4. Every parent who gives **a^u balloon** to **two$^{u'}$ boys** expects them$_{u'}$ to end up fighting (each other) for it$_u$.

5. Conclusion.

The distinction between the two kinds of pluralities was formally captured in terms of a new dynamic system formulated in classical type logic, **Plural Compositional DRT (PCDRT)**.

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.

5. Conclusion.

In PCDRT, we were able to account for:

- **singular** donkey anaphora to **structured sets** of individuals (Problem 1);
- the incompatibility between **singular** donkey anaphora and collective predicates (Problem 2).

3. #Every farmer who owns **a^u donkey** gathers it$_u$ around the fire at night.
(based on an example in Kanazawa 2001)

5. Conclusion.

The solution was to interpret **singular** donkey indefinites and pronouns as:

(i) plural and **distributive** at the discourse level (we can therefore account for donkey anaphora to structured sets);
(ii) singular (atomic) at the domain level.

Collective predicates require **non-atomic** individuals at the domain level or (at least) **collective** interpretation at the discourse level.

5. Conclusion.

PCDRT takes the research program in Muskens (1996),

i.e. the unification of **Montague semantics** and **dynamic semantics**, one step further:

it unifies – in classical type logic – Link's static analysis of (domain-level) plurality and van den Berg's Dynamic (discourse-level) Plural Logic.

5. Conclusion.

- Two ways of conflating plural reference and plural discourse reference:

(i) plural reference is dependent on plural discourse reference (van den Berg 1994, 1996, Nouwen 2003) – it fails to capture the parallel between singular and plural structured donkey anaphora (examples (2) and (4)) and plural 'sage plant' examples;

[That is, we store only atoms in the 'assignments' and we can access a non-atomic individual only by summing over a plural info state]

5. Conclusion.

- Two ways of conflating plural reference and plural discourse reference:

(ii) plural discourse reference is dependent on plural reference (Krifka 1996b) – it needs an independent notion of **cover** over and above plural info states for examples like:

Three lawyers hired five cleaners.
(Kamp & Reyle 1993)
The soldiers hit the targets.
(Winter 2000)

5. Conclusion.

[This way of making plural discourse reference dependent on plural reference, i.e. **parametrized sum individuals**, was first proposed in Barwise (1987) and Rooth (1987): each atom in a sum individual is associated with an assignment and we can access a set of assignments only via a set of atoms, i.e. via a non-atomic individual]

5. Conclusion.

- **singular** and **intra-sentential** donkey anaphora provides a much stronger argument for the idea that plural info states are **semantically** necessary;

[The parallel between the possibility of a pragmatic account of cross-sentential anaphora to value in

A^{u} *man came in. He*$_{u}$ *sat down*.

and the possibility of a pragmatic account of cross-sentential anaphora to structure in

Every^{u} *man saw a*$^{u'}$ *woman. They*$_{u}$ *greeted them*$_{u'}$.]

5. Conclusion.

- (choice and / or Skolem) functions can in principle be used to capture donkey anaphora to structure, but …

… they have to have variable arity depending on how many simultaneous 'donkeys' there are,

i.e. their arity is determined by the **discourse context** and we should encode this context dependency in the **info state** and not in the representation of a lexical item
(be it the donkey pronoun and / or the donkey indefinite article).

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6. Appendix: Maximization.

$\mathbf{max}^{u}(D) := \lambda I_{st}\lambda J_{st}.\ ([u];\ D)IJ \wedge \forall K_{st}(([u];\ D)IK \rightarrow uK{\subseteq}uJ)$

where:
D is a DRS of type $\mathbf{t} := (st)((st)t)$.

- the first conjunct introduces u as a new dref and makes sure (by DHJ) that each individual in the set uJ satisfies D, i.e. we store **only** individuals that satisfy D;
- the second conjunct enforces the maximality requirement: any other set uK that 'satisfies' D is included in uJ, i.e. we store **all** the individuals that satisfy D.

6. Appendix: Discourse-level Distributivity.

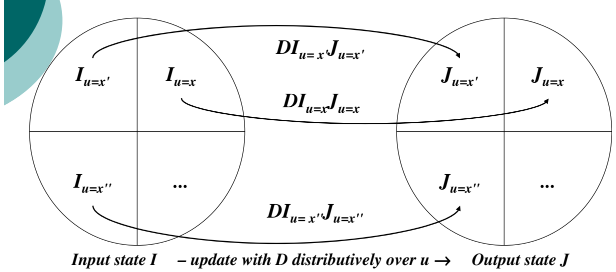
$\mathbf{dist}_{u}(D) := \lambda I_{st}\lambda J_{st}.\ uI{=}uJ \wedge \ \forall x_{e}{\in} uI(DI_{u=x}J_{u=x})$

where:
u is of type $\mathbf{e} := se$,
D is a DRS of type $\mathbf{t} := (st)((st)t)$,
$I_{u=x} := \{i_{s}{\in} I_{st}\text{: } ui{=}x\}$.

- the first conjunct $uI{=}uJ$ ensures that there is a bijection between the partition cells induced by the dref u over the input state I and the partition cells induced by u over the output state J
- the second conjunct $\forall x{\in} uI(DI_{u=x}J_{u=x})$ ensures that every partition cell in the input info state I is related by the DRS D to the corresponding partition cell in the output state J

6. Appendix: Discourse-level Distributivity.

Updating the info state *I* with *D* distributively over *u*.



6. Appendix: Discourse-level Distributivity.

Some properties:

- $\mathbf{dist}_{u}(D;\ D') = \mathbf{dist}_{u}(D);\ \mathbf{dist}_{u}(D')$

  for any dref u of type $\mathbf{e} := se$ and any DRS's D and D' such that $\forall\langle I, J\rangle{\in} D(uI{=}uJ)$ and $\forall\langle I, J\rangle{\in} D'(uI{=}uJ)$

  [i.e. **dist** distributes over dynamic conjunction]

- $\mathbf{dist}_{u}(\mathbf{dist}_{u'}(D)) = \mathbf{dist}_{u'}(\mathbf{dist}_{u}(D))$
- $\mathbf{dist}_{u}(\mathbf{dist}_{u}(D)) = \mathbf{dist}_{u}(D)$

6. Appendix: Generalized Determiners.

Selective Generalized Determiners in PCDRT.

$\boldsymbol{det}^{u} \rightsquigarrow \lambda P'_{\mathbf{et}}.\ \lambda P_{\mathbf{et}}.\ [\mathbf{det}_{u}(P'(u), P(u))]$,

where:

$\mathbf{e} := (se)$, $\mathbf{t} := (st)((st)t)$

and

$\mathbf{det}_{u}(D, D') := \lambda I_{st}.\ \mathbf{DET}(u[DI], u[(D; D')I])$,

where:

$u[DI] := \{\oplus uJ\text{: } ([u \mid \mathbf{atom}\{u\}]; D)IJ\}$,

$\mathbf{atom}\{u\} := \lambda Ist.\ \mathbf{atom}(\oplus uI)$,

DET is the corresponding static determiner.

6. Appendix: Other PCDRT Definitions.

- $[u] := \lambda I_{st}J_{st}.\ \forall i_{s}{\in}I(\exists j_{s}{\in}J(i[u]j)) \wedge \forall j_{s}{\in}J(\exists i_{s}{\in}I(i[u]j))$
- $book\{u\} := \lambda I_{st}.\ book(\oplus uI)$
- $R\{u_1, \ldots, u_n\} := \lambda I_{st}.\ R(\oplus u_1 I, \ldots, \oplus u_n I)$
- $own \rightsquigarrow \lambda Q_{(\mathbf{et})\mathbf{t}}.\ \lambda v_{\mathbf{e}}.\ Q(\lambda v'_{\mathbf{e}}.\ [own_{e(et)}\{v, v'\}])$
- $\mathbf{atom}\{u\} := \lambda I_{st}.\ \mathbf{atom}(\oplus uI)$,
  where $\mathbf{atom}(x_e) := \forall y_e{\leq}x(y{=}x)$
- $\mathbf{2\_atoms}\{u\} := \lambda I_{st}.\ \mathbf{2\_atoms}(\oplus uI)$,
  where $\mathbf{2\_atoms}(x_e) := |\{y_e\text{: } y{\leq}x \wedge \mathbf{atom}(y)\}|{=}2$

- $\mathbf{sg} := \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\ \mathbf{dist}_{v}([\mathbf{atom}\{v\}]; P(v))$
- $\mathbf{sing} := \lambda Q_{(\mathbf{et})\mathbf{t}}.\lambda P_{\mathbf{et}}.\ Q({}_{\mathbf{sg}}P)$, where ${}_{\mathbf{sg}}P := \mathbf{sg}(P)$
- $\mathbf{sing} := \lambda\mathfrak{R}_{(\mathbf{et})((\mathbf{et})\mathbf{t})}.\lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ \mathfrak{R}({}_{\mathbf{sg}}P')({}_{\mathbf{sg}}P)$
- weak indef's: $\mathbf{indef}^{\mathbf{wk}:u} := \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ [u]; P'(u); P(u)$
- strong indef's: $\mathbf{indef}^{\mathbf{str}:u} := \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ \mathbf{max}^{u}(P'(u); P(u))$
- $\mathbf{pron}_{u} := \lambda P_{\mathbf{et}}.\ P(u)$

6. Appendix: Other PCDRT Definitions.

- $a^{\mathbf{wk}:u} \rightsquigarrow \mathbf{sing}(\mathbf{indef}^{\mathbf{wk}:u}) = \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ [u];\ {}_{\mathbf{sg}}P'(u);\ {}_{\mathbf{sg}}P(u)$
- $a^{\mathbf{str}:u} \rightsquigarrow \mathbf{sing}(\mathbf{indef}^{\mathbf{str}:u}) = \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ \mathbf{max}^{u}({}_{\mathbf{sg}}P'(u);\ {}_{\mathbf{sg}}P(u))$
- $he_{u} \rightsquigarrow \mathbf{sing}(\mathbf{pron}_{u}) = \lambda P_{\mathbf{et}}.\ {}_{\mathbf{sg}}P(u)$

- $\mathbf{2} := \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\ \mathbf{dist}_{v}([\mathbf{2\_atoms}\{v\}]; P(v))$
- $\mathbf{two} := \lambda\mathfrak{R}_{(\mathbf{et})((\mathbf{et})\mathbf{t})}.\lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ \mathfrak{R}({}_{\mathbf{2}}P')({}_{\mathbf{2}}P)$, where ${}_{\mathbf{2}}P := \mathbf{2}(P)$
- $\delta := \lambda P_{\mathbf{et}}.\lambda v_{\mathbf{e}}.\ \mathbf{dist}_{v}(P(v))$
- $\mathbf{pl} \rightsquigarrow \lambda Q_{(\mathbf{et})\mathbf{t}}.\lambda P_{\mathbf{et}}.\ Q({}_{\delta}P)$, where ${}_{\delta}P := \delta(P)$

- $two^{\mathbf{wk}:u} \rightsquigarrow \mathbf{two}(\mathbf{indef}^{\mathbf{wk}:u}) = \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ [u];\ {}_{\mathbf{2}}P'(u);\ {}_{\mathbf{2}}P(u)$
- $two^{\mathbf{str}:u} \rightsquigarrow \mathbf{two}(\mathbf{indef}^{\mathbf{str}:u}) = \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ \mathbf{max}^{u}({}_{\mathbf{2}}P'(u);\ {}_{\mathbf{2}}P(u))$
- $them_{u} \rightsquigarrow \mathbf{pl}(\mathbf{pron}_{u}) = \lambda P_{\mathbf{et}}.\ {}_{\delta}P(u)$

6. Appendix: Other PCDRT Definitions.

- $\mathbf{ana\_det}_{u} := \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ P'(u); P(u)$
- $\mathbf{pl} \rightsquigarrow \lambda\mathfrak{R}_{(\mathbf{et})((\mathbf{et})\mathbf{t})}.\lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ \mathfrak{R}({}_{\delta}P')({}_{\delta}P)$

- $the_{sg:u} \rightsquigarrow \mathbf{sing}(\mathbf{ana\_det}_{u}) = \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ {}_{\mathbf{sg}}P'(u);\ {}_{\mathbf{sg}}P(u)$
- $the_{pl:u} \rightsquigarrow \mathbf{pl}(\mathbf{ana\_det}_{u}) = \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ {}_{\delta}P'(u);\ {}_{\delta}P(u)$

- $the^{sg:u} \rightsquigarrow \lambda P'_{\mathbf{et}}.\ \lambda P_{\mathbf{et}}.\ \mathbf{max}^{u}(P'(u)); [\mathbf{atom}\{u\}]; P(u)$
  (existence & uniqueness – the Russellian analysis)
- $her_{u}^{u'} \rightsquigarrow \lambda P'_{\mathbf{et}}.\lambda P_{\mathbf{et}}.\ \mathbf{dist}_{u}([\mathbf{atom}\{u\}];$
  $\mathbf{max}^{u'}(P'(u'); [of\{u', u\}]); [\mathbf{atom}\{u'\}]; P(u'))$
  (possessives as singular Russellian definites)

- $\sim D := \lambda I_{st}.\ \neg\exists K_{st}(DIK)$, where D is a DRS

- $gather \rightsquigarrow \lambda Q_{(\mathbf{et})\mathbf{t}}.\lambda v_{\mathbf{e}}.\ Q(\lambda v'_{\mathbf{e}}.[\sim[\mathbf{atom}\{v'\}], gather\{v, v'\}])$,
  where $gather\{v, v'\} := \lambda I_{st}.\ gather(\oplus vI, \oplus v'I)$