Relative

Atomicity

Two views of atomicity

- **Absolute Atomicity** (Link 1983, Schwarzshcild 1996, Chierchia 1998a,b, Landman 1989a,b, Winter 2001, etc.)
  - Atomic and non-atomic entities are distinguished at the model level
  - **Absolute atoms**: Minimal elements of $(D, \leq_i)$

- **Relative Atomicity** (Rothstein 2010, Landman 2011, 2016, Sutton & Filip 2016, Rothstein 2017, Sutton & Filip 2017, etc.)
  - Atomicity is defined relative to nouns
  - **Relative atoms**: Minimal entities with respect to some noun meaning

Goals

- Propose an 'intensional' theory of **RELATIVE ATOMICITY** without absolute atoms
- Empirical argument from **DP-external subatomic quantifiers**

> (1) a. The chair is **partly** yellow.
> b. The chairs are **partly** yellow.
> b. The furniture is **partly** yellow.

Puzzle: Direct subatomic quantification possible in (1a) and (1c), but not in (1b)

Absolute Atomicity

Absolute atoms

- **Domain**: $(D, \leq_i)$ is a join-semilattice
- **Absolute atoms**: $A := \min_{\leq_i} D = \{x \in D \mid \neg\exists y[y \leq_i x \wedge y \neq x]\}$
- **Complex entities**: $C := D - A$

Absolute atoms are often referenced in analyses of

1. Number marking: singular, plural, mass, etc.
2. Counting modifiers/quantifiers
3. Distributivity

If we give up on **absolute atoms**, we will have to reanalyse these phenomena

1. Number marking

- Singular count nouns denote sets of absolute atoms
- Plural count nouns denote the closure of their singular counterparts under $\sqcup_i$

(2) a. $[\![\textbf{cat}]\!] = \{x \in A \mid x \text{ is a cat}\}$

b. $[\![\textbf{cats}]\!] = \{\bigsqcup_i S \mid S \subseteq [\![\textbf{cat}]\!] \wedge S \neq \emptyset\}$

- Different views on mass nouns (Chierchia 1998a,b, 2010, Landman 2011, 2016, Link 1983, Rothstein 2010, 2017, Sutton & Filip 2016, 2017, among others)
  - Some (not all) are **extensional**, e.g.: COUNT = atom-based, MASS = no atoms

2. Counting modifiers/quantifiers

Counting modifiers/quantifiers count absolute atoms, and never complex entities

- "I saw three cats" won't be true if I saw c_1, c_2, and $c_1 \sqcup c_2$.

Counting vs. non-counting quantifiers

- "Most of the suitcases are yellow."
  - $\approx$ #(yellow atomic suitcases) > #(non-yellow atomic suitcases)
  - $\not\approx$ AREA(suitcases' yellow parts) > AREA(suitcases' non-yellow parts)
- But "Most of the water has evaporated"
  - $\approx$ VOLUME(evaporated water) > VOLUME(remaining water)

3. Distributivity

```
(3) The children made a snowman.
    a. Distributive: Each child made a snowman.
    b. Collective: The children made a snowman together
```

The covert distributivity operator Δ quantifies over absolute atoms

$$[\![\mathbf{\Delta}]\!] = \lambda P_{(e,t)}.\, \lambda x_e.\ \forall y \in A[y \leq_i x \rightarrow P(y) = 1]$$

Further topics

- Reciprocals (e.g., "The professors hate each other")
- Cumulative/Co-distributive readings (e.g., "The five dogs chased the three cats")

Sub-atomic quantification

Sub-atomic phenomena

Certain expressions access parts of absolute atoms (Link 1983, Krifka 1990, Wągiel 2018, 2019)

- **Sub-atomic quantifiers**

(4) a. **Part of** the flag is red.
b. The flag is **partly** red.

- Cumulativity/Co-distributivity

(5) a. The flag is red and white.
b. The kids ate my hamburger.

- (Pluralia tantum)

Two partial orders

To account for sub-atomic phenomena, we need another order: $(D, \leq_i, \leq_p)$

- Let's suppose: Whenever $x \leq_i y$, we have $x \leq_p y$
- But $x \leq_p y$ doesn't imply $x \leq_i y$
  - $[\![\textbf{Tim's face}]\!] \in A$
  - $[\![\textbf{Tim's nose}]\!] \in A$
  - $[\![\textbf{Tim's nose}]\!] \leq_p [\![\textbf{Tim's face}]\!]$ but $[\![\textbf{Tim's nose}]\!] \not\leq_i [\![\textbf{Tim's face}]\!]$

Atomic and sub-atomic quantifiers

(6) a. ✓Part/*Some of the suitcase is yellow.
b. *Part/✓Some of the suitcases are yellow.
c. ✓Part/✓Some of the luggage is yellow.

- Possible analysis:
  - *Part* is morphosyntactically incompatible with plural nouns
  - *Some* has mass and plural versions (like *much* and *many*)

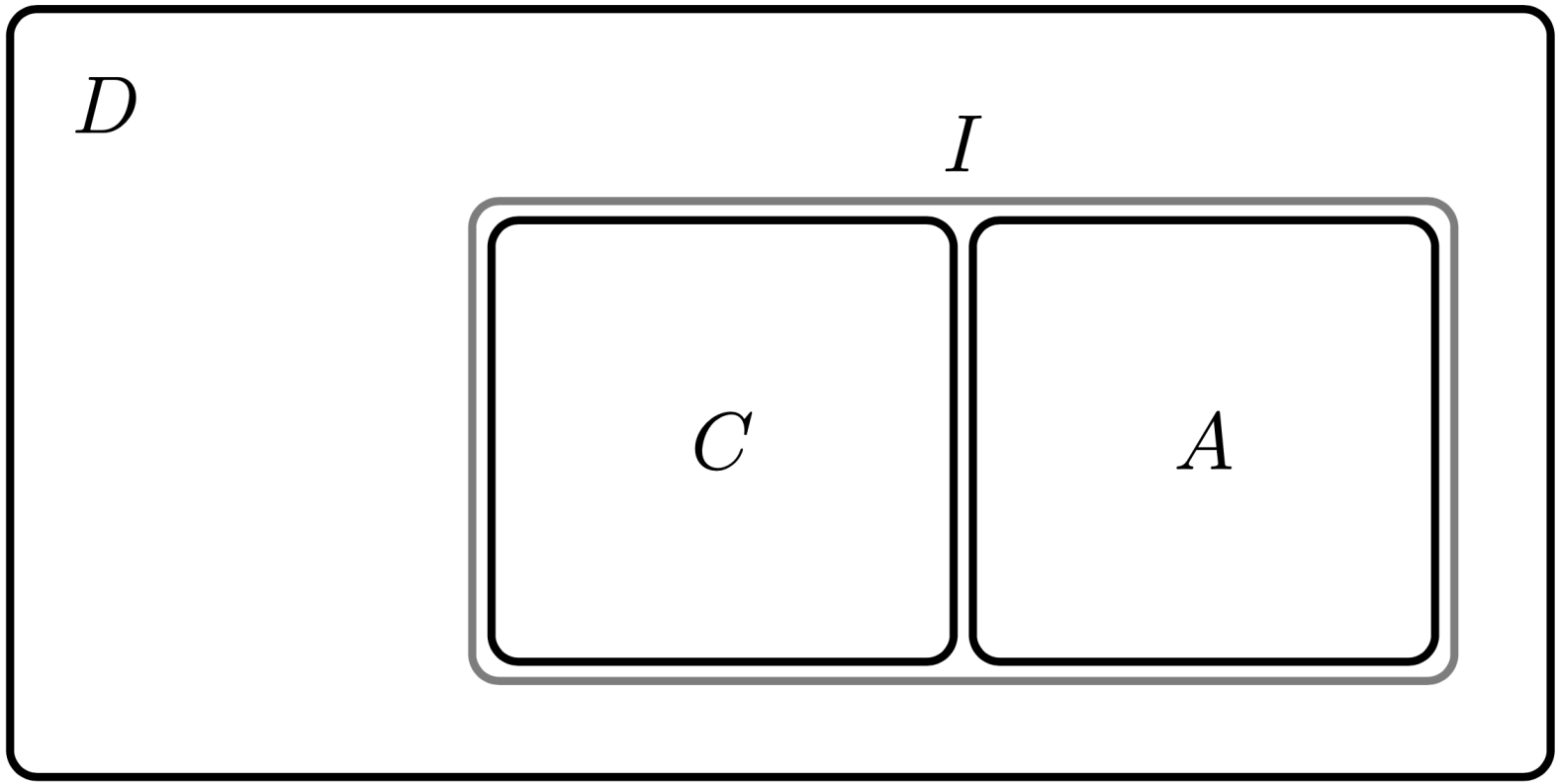
(7) a. $[\![\textbf{part (of)}]\!] = \lambda x_e.\, \lambda P_{(e,t)}.\ \exists y \in D[y \leq_p x \wedge P(y)]$

b. $[\![\textbf{some}_{\textbf{mass}}\textbf{(of)}]\!] = \lambda x_e.\, \lambda P_{(e,t)}.\ \exists y \in D[y \leq_p x \wedge P(y)]$

c. $[\![\textbf{some}_{\textbf{plural}}\textbf{(of)}]\!] = \lambda x_e.\, \lambda P_{(e,t)}.\ \exists y \in A[y \leq_i x \wedge P(y)]$

Individuated domain I

- $\leq_p$ is not 'well-founded' given atom-less nouns like *space, time, advice, line segment*
  (Alternatively, Cheirchia 1998a,b, 2010 maintains that all such cases are also built on atomic entities)
- $(D, \leq_p)$ is a join-semilattice (for any $x, y \in D, x \sqcup_p y \in D$)
- Option 1: Define $\leq_i$ in terms of $\leq_p$, as that part of $\leq_p$ that is well-founded
  - $\leq_i := \leq_p \restriction_I$
  - $I := \{\sqcup_p S \mid S \subseteq \min_{\leq_p} D \wedge S \neq \emptyset\}$
  - BUT $[\![\textbf{Tim's nose}]\!] \not\leq_p [\![\textbf{Tim's face}]\!]$
- Option 2: Define $\leq_i$ and $\leq_p$ separately



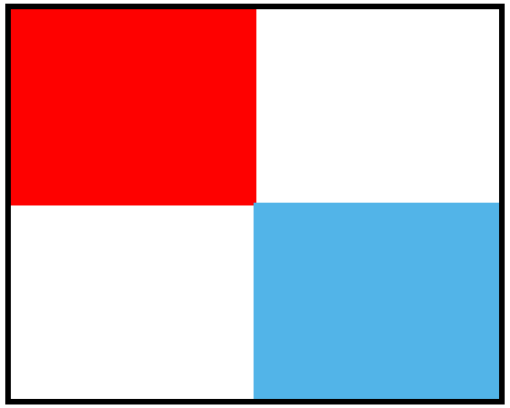
- A: atoms wrt $\leq_i$ C: complex wrt $\leq_i$ I: 'individuals'
- If you are Chierchia, $D = I$

DP external sub-atomic quantifiers

Partly + singular count

> (8) The flag is partly red.

- $[\![\textbf{The flag is partly red}]\!] = 1$ iff $\exists y \in D[y \leq_p [\![\textbf{the flag}]\!] \rightarrow \textsf{red}(y)]$
- This suggests: $[\![\textbf{partly}]\!] = \lambda P_{(e,t)}.\, \lambda x_e.\ \exists y \in D[y \leq_p x \rightarrow P(y)]$

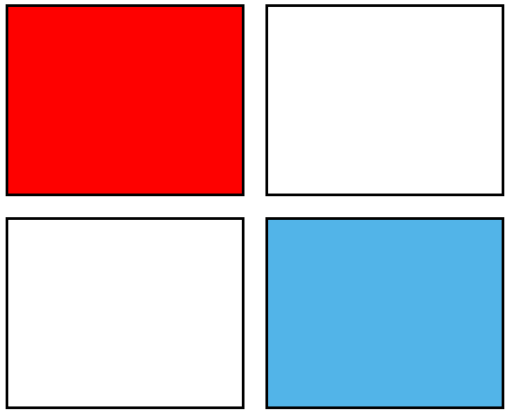


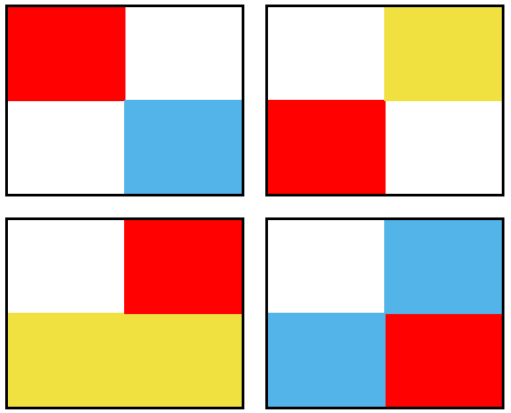
Partly + plural count

```
(9) The flags are partly red.
```

Given the semantics above:

- $[\![\textbf{The flags are partly red}]\!] = 1$ iff $\exists y \in D[y \leq_p [\![\textbf{the flags}]\!] \rightarrow \textbf{red}(y)]$
- **Problem**: Should be true in both scenarios (NB: inter-speaker variation)

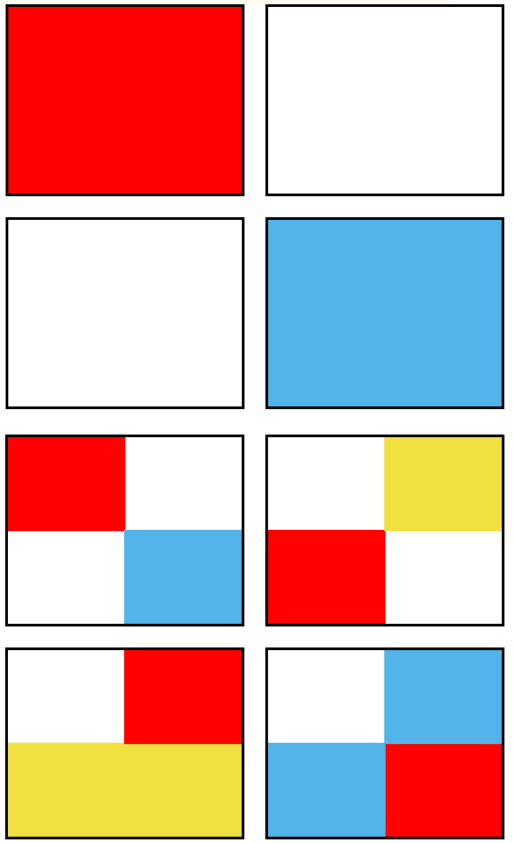




Partly + plural count (cont.)

> (9) The flags are partly red.

- ⚠ $[\![\textbf{The flags are partly red}]\!] = 1$ iff
  $$\exists y \in D[y \leq_p [\![\textbf{the flags}]\!] \rightarrow \textsf{red}(y)]$$
- Alternative analysis:
  $[\![\textbf{partly}]\!] = \lambda P_{(e,t)}.\, \lambda x_e \notin C.\ \exists y \in D[y \leq_p x \rightarrow P(y)]$
- $[\![\textbf{The flags are } \Delta \textbf{ partly red}]\!] = 1$ iff
  $\forall z \in A[z \leq_i [\![\textbf{the flags}]\!] \rightarrow \exists y \in D[y \leq_p z \rightarrow \textsf{red}(z)]]$



Partly with mass vs. plural

(10) a. The furniture in this room is partly wooden.
     b. The table and chairs in this room are partly wooden.

(11) a. The information was partly false.
     b. The three pieces of information were partly false.

With $[\![\textbf{partly}]\!] = \lambda P_{(e,t)}.\, \lambda x_e \notin C.\ \exists y \in D[y \leq_p x \rightarrow P(y)]$, it must be:

- $[\![\textbf{the furniture in this room}]\!] \notin C$
- $[\![\textbf{the table and chairs in this room}]\!] \in C$

But intuitively, they are co-extensional

Partly + 'group noun'

(12) a. These letters are partly red.
     b. This logo is partly red.

(13) a. These playing cards are partly transparent.
     b. This deck of playing cards is partly transparent.

Again, different referents?

The puzzle of *partly*

🧐 *Partly* needs to know the number property of the head noun of its associate

- SINGULAR/MASS ⇒ direct sub-atomic quantification
- PLURAL ⇒ decompose into absolute atoms via Δ, then sub-atomic quantificatoin

How does *partly* access the necessary information compositionally?

- **ABSOLUTE ATOMICITY** encodes the relevant information in the referent

$$[\![\textbf{partly}]\!] = \lambda P_{(e,t)}.\, \lambda x_e \notin C.\ \exists y \in D[y \leq_p x \rightarrow P(y)]$$

- Consequently, SINGULAR/MASS vs. PLURAL refer to different entities, e.g.

$$[\![\textbf{the furniture}]\!] \neq [\![\textbf{the tables and chairs}]\!]$$

Further complications: 'plural mass nouns'

Some plural nouns behave like mass nouns (Erbach & Sudo 2023)

> (14) a. These mashed potatoes are partly cold.
>
> b. These french fries are partly uncooked.
>
> c. These noodles are partly green.

The referents are intuitively (optinally) mass-y.

💡 But only some specific nouns allow for this

> (15) a. These flags are partly red.
>
> b. These apples are partly green.

Partial predicates

Partial predicates give rise to related problems (thanks for Vincent Homer, p.c.)

```
(16) a. The towel is wet.
     b. The towels are wet.
```

Excursus: More on DP-external quantifiers

Two positions for DP-external quantifiers

(17) a. The flag is partly red.
     b. The flags are Δ partly red.

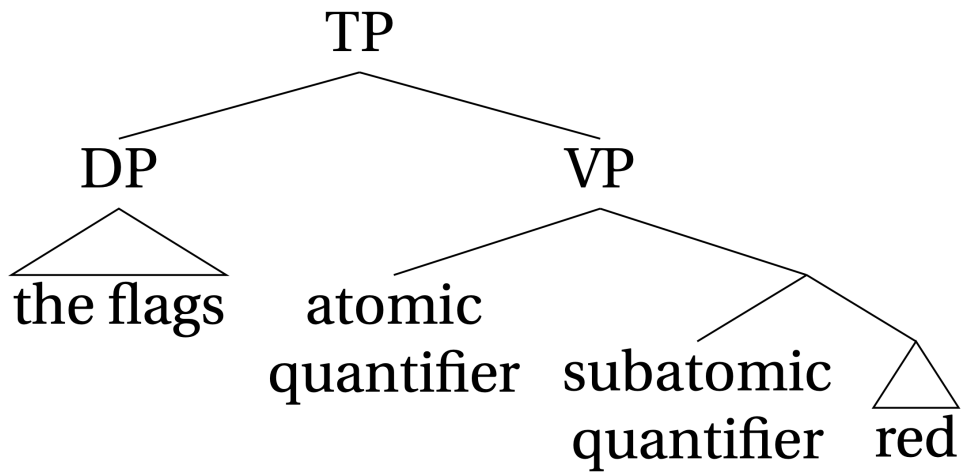
(18) a. The flags are all partly red.
     b. The flags are Δ Δ red.

(19) a. The flag is Δ red.
     b. The flag is entirely red.

Δ: *Homogeneous* distributivity operator (details omitted here)

Two positions with plural subjects

- **Atomic quantifiers** quantify over atomic parts
- **Sub-atomic quantifiers** quantify over sub-atomic parts



(cf. Aldridge & Neeleman 2015)

- If the subject is singular, no atomic quantifier.

Lexical restrictions

	Atomic	Sub-atomic
partly	❌	✅
mostly	✅	✅
half	✅	✅
all	✅	✅
each	✅	❌
Δ	✅	✅

Ambiguity

(20) a. *The flags are partly Δ red.
     b. The flags are Δ partly red.

(21) a. The flags are mostly Δ red.
     b. The flags are Δ mostly red.

(For some speakers, 'partly' seems to be also ambiguos)

More uses and positions

- Quality readings (Aldridge & Neeleman 2015)

(22) a. The door is entirely half transparent.
     b. The doors are all entirely half transparent.

- Group member quantification

(23) The committees are each mostly half Japanese.

- Occasion readings

(24) I mostly danced.

'Intensional' theory of Relative Atomicity

New model assumptions

- Only $\leq_p$, the intuitive part-whole relation. We'll just write $\leq$ from now on
- **No absolute atoms** in the model (because unnecessary)
- $(D, \leq)$ is a join semi-lattice

- A bit of history:
  - Link 1983 postulated two domains and two partial orders ($(E, \leq_i)$ and $(D, \leq)$)
  - One domain eliminated later
  - Proposal: Eliminate $\leq_i$

For now I will ignore non-canonical plural nouns like *potatoes*

Illustration of the proposal

If there are no absolute atoms, how do DP-external quantifiers know what to quantify over?

Proposal: Count nouns have the **intensional effect** of making $[\![\cdot]\!]$ 'blind' to certain parts of the model. Such a restricted domain may have minimal elements = **relative atoms**

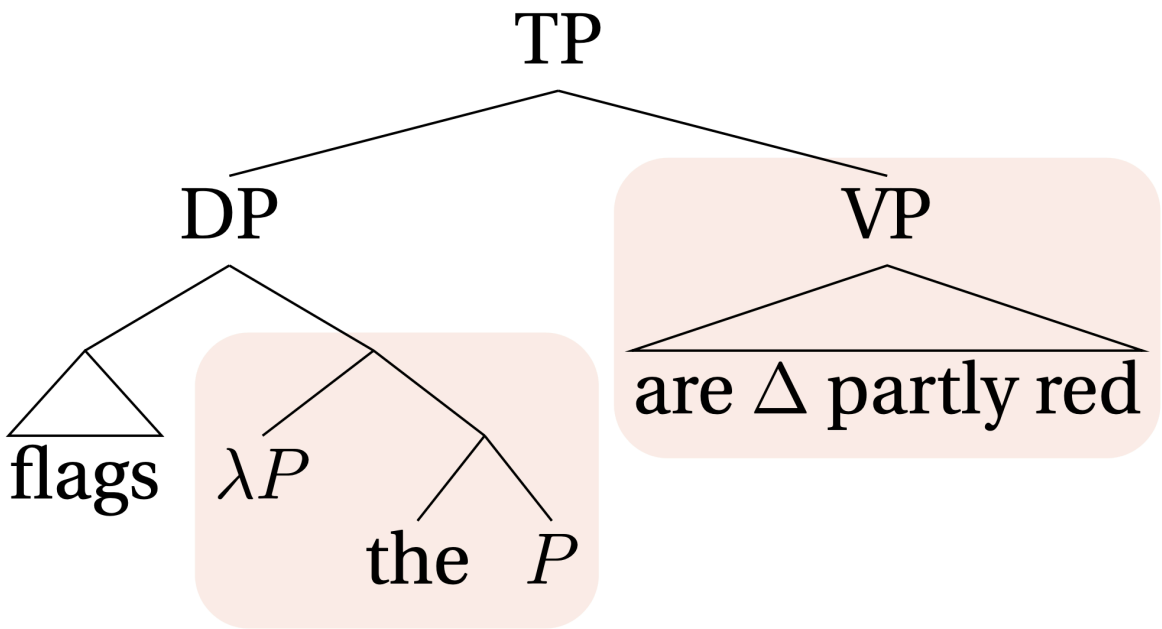


Illustration of the proposal (cont.)

- *Partly* presupposes that the current domain doesn't have relative atoms, so cannot be in the direct scope of a plural count noun
- Operators like Δ reset the current domain

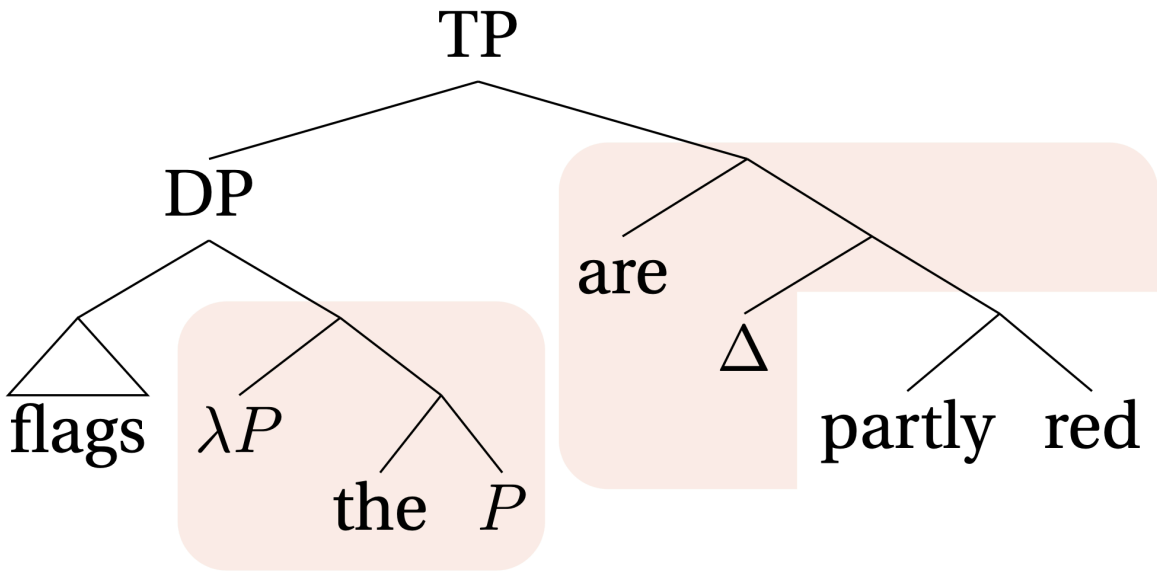


Illustration of the proposal (cont.)

- **Intensional effects**
  - A plural noun's intensional effect is to temporarily remove the 'sub-atomic' parts of its extensions, introducing **relative atoms**
  - Singular count nouns keep all the sub-parts, so no relative atoms
  - Mass nouns use the entire domain $(D, \leq)$, so no relative atoms
- ∴ *Partly* can directly operate on the extensions of singular count and mass nouns
- A mass and a plural may be co-extensional, but differ intensionally

> 👉 **Mass/count is partly INTENSIONAL**

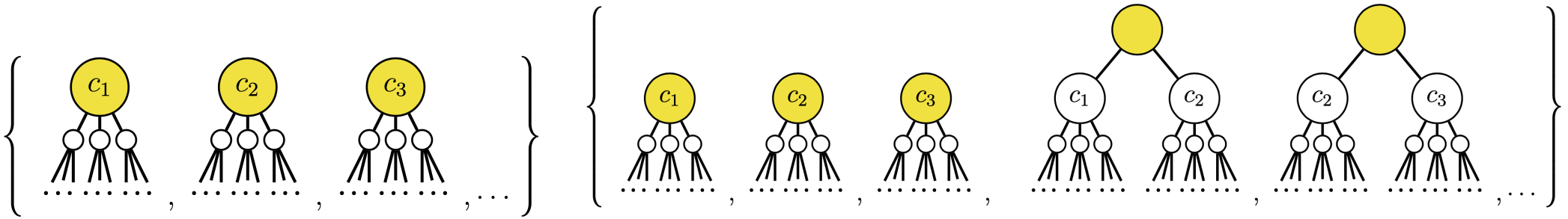
More details

Caveat: I will be formally sloppy in certain compositional details. See the Appendix of the handout version of this talk for formal details

Number morphology

No reference to absolute atoms

- Singular nouns refer to sets of things describable by them, but they have non-trivial parts, e.g. $[\![\mathbf{cat}]\!] = \{x \in D \mid x \text{ is a cat}\}$
- Plural counterparts denote any combinations of them, e.g. $[\![\mathbf{cats}]\!] = \{\sqcup S |\ S \subseteq [\![\mathbf{cat}]\!] \wedge S \neq \emptyset\}$

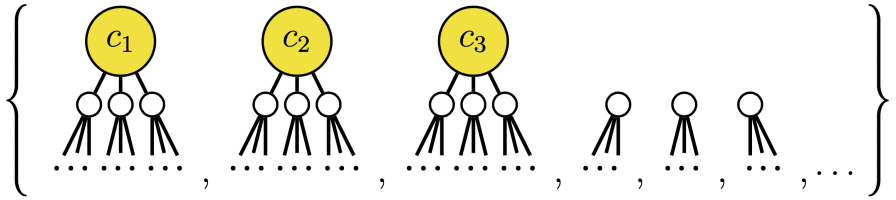


- Want to allow $[\![\mathbf{the\ furniture}]\!] = [\![\mathbf{the\ table\ and\ chairs}]\!]$

Intension of number morphology

- **Key assumption**: Number morphology has intensional effects
- New aspect of intensionality: **restricted domains**
  - Normally, evaluation relative to the entire domain of the model, $(D, \leq)$
  - Count nouns temporarily introduce restricted domains in semantic derivation
  - Such restricted domains may have minimal elements = **relative atoms**
- Notation: $S^{\leq} := (S, \leq\restriction_S)$
  - $S \subseteq D$
  - $\leq\restriction_S := \{(x, y) \mid x \leq y \wedge x, y \in S\}$

Singular count nouns



- The interpretation of *cat* itself is insensitive to the domain parameter
- It uses the set of all individual cats **and their parts** as the new restricted domain, ${}^{\downarrow}\mathtt{CAT}^{\leq}$

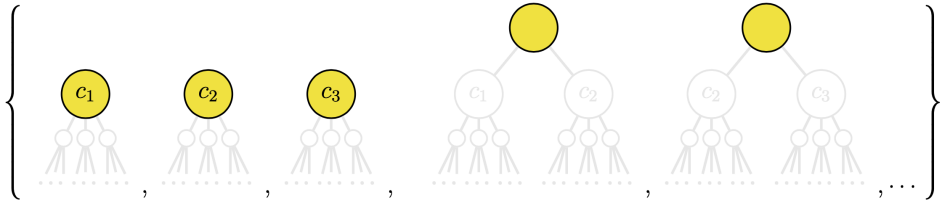
(for any $S \subseteq D$, ${}^{\downarrow}S := \{x \in D \mid \exists y \in S[x \leq y]\}$)

The VP is interpreted relative to this new restricted domain, ${}^{\downarrow}\mathtt{CAT}^{\leq}$.

$$[\![\textbf{the cat VP}]\!]^{S^{\leq}} \Leftrightarrow [\![\textbf{VP}]\!]^{{}^{\downarrow}\mathtt{CAT}^{\leq}}\left([\![\textbf{the cat}]\!]^{{}^{\downarrow}\mathtt{CAT}^{\leq}}\right)$$

- *Partly* in the VP will be happy, because there are no relative atoms in ${}^{\downarrow}\mathtt{CAT}^{\leq}$:
  - $\ulcorner\textbf{partly}\urcorner \in \mathrm{dom}([\![\cdot]\!]^{S^{\leq}})$ iff $\min(S^{\leq}) = \emptyset$
  - If so, $[\![\textbf{partly}]\!]^{S^{\leq}} = \lambda P_{(e,t)}.\, \lambda x_e : x \in S.\ \exists y \in D[y \leq x \wedge P(y)]$

Plural count nouns



Cats introduces a restricted domain with relative atoms, $^{\uparrow}\mathtt{CAT}^{\leq}$

(for any $S \subseteq D$, $^{\uparrow}S := \{x \in D | \exists y \in S[y \leq x]\}$)

$$[\![\textbf{the cats VP}]\!]^{S^{\leq}} \Leftrightarrow [\![\textbf{VP}]\!]^{^{\uparrow}\mathtt{CAT}^{\leq}}\left([\![\textbf{the cats}]\!]^{^{\uparrow}\mathtt{CAT}^{\leq}}\right)$$

- $\ulcorner\textbf{partly}\urcorner \in \mathrm{dom}([\![\cdot]\!]^{S^{\leq}})$ iff $\min(S^{\leq}) = \emptyset$
- *Partly* won't be happy right below *the cats*
- The atomic distributive quantifier Δ resets the intensional parameter

$$[\![\Delta\ \textbf{VP}]\!]^{S^{\leq}} = \lambda x : x \in S.\ \forall y \in \min(S^{\leq})[y \leq x \rightarrow [\![\textbf{VP}]\!]^{(D,\leq)}(y)]$$

Each

- *Each* requires a plural associate

```
(25) a. These suitcases each weigh 20kg.
     b. *This baggage each weighs 20kg.
```

- *Each* (and Δ) presupposes the current domain to contain relative atoms (and resets the intensional parameter)
  - $\ulcorner \mathbf{each} \urcorner \in \mathrm{dom}([\![\cdot]\!]^{S^{\leq}})$ iff $\min(S^{\leq}) \neq \emptyset$
  - $[\![\mathbf{each\ VP}]\!]^{S^{\leq}} = \lambda x_e : x \in S.\ \forall y \in \min(S^{\leq})[y \leq x \rightarrow [\![\mathbf{VP}]\!]^{(D,\leq)}(y)]$

Mass nouns

- Mass nouns use the entire domain, so *partly* will be happy under its immediate scope

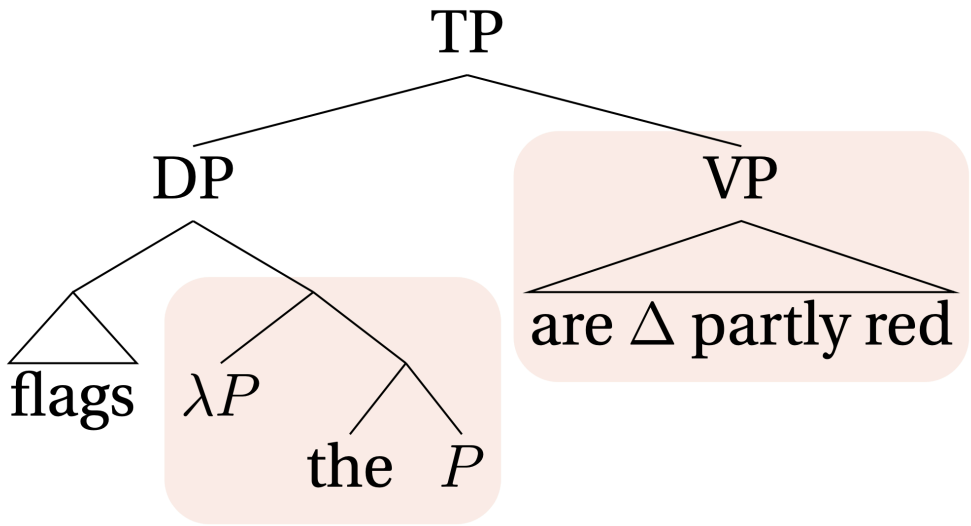
$$[\![\textbf{the ketchup VP}]\!]^{S^{\leq}} \Leftrightarrow [\![\textbf{VP}]\!]^{(D,\leq)}\left([\![\textbf{the ketchup}]\!]^{(D,\leq)}\right)$$

- Mass/count is partly intensional
- Some plural nouns like *potatoes* (can) behave like mass nouns
    - This is a property of specific nouns, not of model-theoretic objects

DP-internal matters

Assumption: Nouns take scope at the DP edge and intensionally affect both NP and VP.

Extensionally they simply reconstruct (cf. Charlow 2014, 2020)



Reanalysing counting modifiers/quantifiers

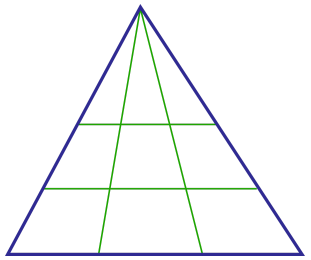
Counting modifiers/quantifiers like numerals require relative atoms

- $\ulcorner \mathbf{three} \urcorner \in \mathrm{dom}([\![\cdot]\!]^{S^{\leq}})$ iff $\min(S^{\leq}) \neq \emptyset$
- If so,
  $[\![\mathbf{three}]\!]^{S^{\leq}} = \lambda P_{(e,t)}.\, \lambda Q_{(e,t)}.\, \exists X \subseteq \min(S^{\leq})[|X| = 3 \wedge P(\bigsqcup X) \wedge Q(\bigsqcup X)]$

This accounts for why it's bad to say "three furniture", "six logo"

- Many accounts of this restriction are morphosyntactic
- In the present account, it has to do with the presence of relative atoms
- Cf. *three letters* vs. *three logos*

Some complications and further thoughts



- Numerals only count minimal individuals. How do we deal with counting of overlapping individuals? (e.g.'How many triangles are there?', von Neumann universe)
- Intensinoal sensitivity of predication
  - "The golden ring is new" vs. "The gold is old"
  - Some predicates are also sensitive to the intensional parameter (e.g. 'new as ring', 'old as gold')
  - But a distributive operator does not seem to affect the interpretation of the predicate ("The rings are all new')

Conclusions

Relative Atomicity

- Without absolute atoms, we reanalysed
  - Number morphology, mass/count
  - DP-internal counting quantifiers
  - DP-external quantifiers, including Δ
- Empirical motivation: Semantic restrictions on DP-external quantifiers like *partly*
- **Key idea**: Plural count nouns introduce **relative atoms**; some quantifiers need them
- Consequence: One domain and one partial order $(D, \leq)$
- To do: Comparisons with other theories of relative atoms (Rothstein 2010, Landman 2011, 2016, Sutton & Filip 2016, Rothstein 2017, Sutton & Filip 2017)

Groups and intensionality

- Plural-to-group shift

```
(26) The Galapagos Islands are partly in the northern hemisphere.
```

```
(27) a. The homework was partly interesting.
     b. The homework assignemnts were partly interesting.
```

- Groups have intensional aspects, e.g. a team is more than just its members
    - In the present system, all nouns can be seen as 'group nouns', e.g. a cat is more than just its parts
    - Maybe relevant for intentionality of predication ("the ring is new")

Open issues

- Relative atoms of conjunction and disjunction

(28) a. The furniture and paintings are partly red.
b. The furniture or the painting is partly red.

- Cross-sentential relative atoms? (cf. Schwarzschild 1995)

(29) We have cows and sheep here. They each live in a barn.

- Obligatory classifier languages, e.g. Japanese

(30) **pan san-ko / san-hon / san-mai / san-hukuro**
bread three-CL_{round} / three-CL_{long} / three-CL_{flat} / three-CL_{bag}