Boolean semantics for count nouns and mass nouns

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Lecture 2 Iceberg semantics

2.1. Unsorting the theory.

2.1.1 The problem of distributivity.

Why don't we just get rid of sorting?
We need a complete Boolean algebra for counting?
It's not atomicity itself, but disjointness that guarantees the Boolean structure:

Fact: Let B be a complete Boolean algebra and $X \subseteq B$
If X is ***disjoint*** then *X is a complete atomic Boolean algebra with X as atoms.

So let's replace the semantics in terms of atomicity by:

Singular count noun semantics
cat $\rightarrow CAT_{wr}$ where CAT_{wt} is a **disjoint** subset of B.

Problem: This may help with counting, but it doesn't help with distribution.

Look at the following example:

(1) a. The four farmers teamed to buy a set of 80 *fencing units* and with this each built a *fence* on her side of the meadow, a *fencing structure* you can see till this day.
b. *The fencing units* are ***each*** 5 meters wide and 1 meter 20 high and *the fences* are ***each*** 100 meters long.

Let $\{u_1,\dots,u_{80}\}$ be a disjoint set of fencing units.
Let $f_1 = u_1 \sqcup\dots\sqcup u_{20}$ and $f_2 = u_{21} \sqcup\dots\sqcup u_{40}$ and $f_3 = u_{41} \sqcup\dots\sqcup u_{60}$ and $f_4 = u_{61} \sqcup\dots\sqcup u_{80}$
Let $s = f_1 \sqcup f_2 \sqcup f_3 \sqcup f_4$

fencing unit $\rightarrow FU_{wt} = \{u_1, \dots, u_{80}\}$
fence $\rightarrow FE_{wt} = \{f_1, \dots,f_4\}$
fencing structure $\rightarrow FS_{wt} = \{s\}$

Rothstein 2010 calls count noun *fence* 'contextually atomic'.
By this she means that what counts as *one fence* may differ from context to context:
In particular, in different contexts *fence* could denote $\{u_1, \dots, u_{80}\}$ or $\{s\}$.
We are interested in the definites in (1b above.
Look at the plural noun *fences*:

fences $\rightarrow {}^*FE_{wt} = \{0,f_1,f_2,f_3f_4, f_1\sqcup f_2, f_1\sqcup f_3, f_1\sqcup f_4,\dots\ f_1\sqcup f_2\sqcup f_3\sqcup f_4\}$

In the revized theory we don't have B-atoms. But the denotation $*FE_{wt}$ contains a set of $*FE_{wt}$-atoms, the minimal elements in $*FE_{wt}^{+}$: f_1, f_2, f_3, f_4.

Unfortunately, access to this set is lost at the level of the DP interpretation:

the fencing units	$\rightarrow \sigma(*FU_{wt}) = \quad u_1 \sqcup \ldots \sqcup u_{80}$
the fences	$\rightarrow \sigma(*FE_{wt}) = f_1 \sqcup \ldots \sqcup f_4 = u_1 \sqcup \ldots \sqcup u_{80}$

the fences are ***each*** 100 meters long: $\lambda x.\forall a \in ATOM_{\mathbf{?},x}: \alpha(a)\ (\sigma(*FE_{wt}))$ =

$$\forall a \in ATOM_{\mathbf{?},u_1 \sqcup \ldots \sqcup u_{80}}: \alpha(a)$$

The semantics cannot tell here what **?** is: $*FE_{wt}$ or $*FU_{wt}$.

2.1.2. Rothstein 2010

Rothstein 2010 assumes minimal sorting: she does have a domain **M** and **C**, but **C**-entities are built out of **M**-entities.
Rothstein distinguishes for lexical nouns: Root, Mass and Count interpretations.

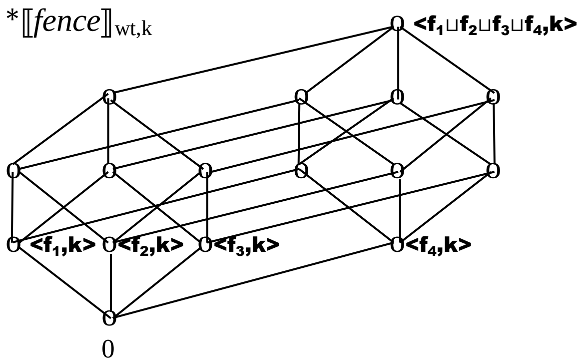
1. **Root interpretation of noun α** (+ some constraints that are irrelevant here)
   $[\![\alpha]\!]_{wt} \subseteq \mathbf{M}$ The *root* interpretation of a noun α is a subset of M

2. A ***counting context*** k is a subset of **M**, a set of objects that count as one in a given context.

3. **Singular count interpretation of noun α** (for default counting context k)
   $[\![\alpha]\!]_{wt,k} = \{<x,k>: x \in [\![\alpha]\!]_{wt} \cap k\}$ **condition:** $[\![\alpha]\!]_{wt} \cap k$ is disjoint

Idea: let k be a counting context such that $[\![\textit{fence}]\!] \cap k = \{f_1, f_2, f_3, f_4\}$.
Then $[\![\alpha]\!]_{wt,k} = \{<f_1,k>, <f_2,k>, <f_3,k>, <f_4,k>\}$
From this set of pairs we build the complete atomic Boolean algebra:

$*[\![\textit{fence}]\!]_{wt,k}$



The idea is: we don't do counting, count comparison, distribution in $[\![\textit{fence}]\!]$,
we don't do counting, count comparison, distribution in $*[\![\textit{fence}]\!]_{wt,k}$.

$[\![$*The fences*$]\!]_{wt,k}$ = $<f_1 \sqcup f_2 \sqcup f_3 \sqcup f_4,\mathbf{k}>$
$[\![$*The fencing*$]\!]_{wt}$ = $f_1 \sqcup f_2 \sqcup f_3 \sqcup f_4$

The supremums are strictly speaking not identical, but close enough to satisfy the intent of the supremum argument.

Problem 1: Contextual restriction

Take the above example.
Arguably, $k = \{u_1,\ldots,u_{80}, f_1,\ldots,f_4, s\}$, because all of these count as one – either one fencing-unit, or one fence, or one fencing-structure.

As argued above, the denotations you want to derive in this context are:

$[\![$ *fencing unit* $]\!]_{wt,\,k}$ = $\{<u_1,k>,\ldots,<u_{80},k>\}$
$[\![$ *fence* $]\!]_{wt,k}$ = $\{<f_1,k>,\ldots,<f_4,k>\}$
$[\![$ *fencing structure* $]\!]_{wt,\,k}$ = $\{<s,k>\}$

Problem: This is not what Rothstein derives.
Reason: $[\![$ *fence* $]\!]_{wt}$ is the interpretation of the **root-noun** *fence* in wt.
But, as Rothstein herself argues, since what counts as *one fence* is context dependent, arguably, $k \subseteq [\![$ *fence* $]\!]_{wt}$ and hence:

$[\![$ *fence* $]\!]_{wt,k}$ = $\{<u_1,k>,\ldots,<u_{80},k>, <f_1,k>,\ldots,<f_4,k>, <s,k>\}$

Diagnosis: Rothstein's intuition is that k restricts the root interpretation of *fence* to the objects that in context k count as one fence. But it doesn't do that.

Simple solution: Let k do contextual restriction on the root noun denotation,
let it map the root noun interpretation onto a subset:

Let k: $M \rightarrow M$, with $k(X) \subseteq X$, and $k(X)$ is disjoint if k is a default context

$$[\![\alpha]\!]_{wt,\,k} = \{<x,k>: x \in k([\![\alpha]\!]_{wt})\}$$

This gives:

$k([\![$ *fencing unit* $]\!]_{wt}) = \{u_1,\ldots,u_{80}\}$
$k([\![$ *fence* $]\!]_{wt}) = \{f_1,\ldots,f_4\}$
$k([\![$ *fencing structure* $]\!]_{wt}) = \{s\}$

and indeed:
$[\![$ *fencing unit* $]\!]_{wt,\,k}$ = $\{<u_1,k>,\ldots,<u_{80},k>\}$
$[\![$ *fence* $]\!]_{wt,k}$ = $\{<f_1,k>,\ldots,<f_4,k>\}$
$[\![$ *fencing structure* $]\!]_{wt,\,k}$ = $\{<s,k>\}$

Problem 2: Distribution.

are each 1 meter 20 high should distribute to $\mathbf{ATOM}_{<f_1 \sqcup \ldots \sqcup f_4, k>}$ = {<u_1,k>,…,<u_{80},k>}
are each 200 meters long should distribute to $\mathbf{ATOM}_{<f_1 \sqcup \ldots \sqcup f_4, k>}$ = {<f_1,k>,…,<f_4,k>}

Is there a problem? Well…
What is suppressed in the notation is that what are involved are different Boolean algebras:

⟦*the fencing units*⟧$_{wt, k}$ = $<f_1 \sqcup_{fencingunit} \ldots \sqcup_{fencingunit} f_4, k>$
⟦*the fences*⟧$_{wt, k}$ = $<f_1 \sqcup_{fence} \ldots \sqcup_{fence} f_4, k>$

Does that solve the problem? Not really.
The ⊔ operation of the *fence*-Boolean algebra is the restriction of the ⊔-operation of the *fencing unit*-Boolean algebra to the *fence*-Boolean algebra.

The distributive predicate $\lambda x.\forall a \in ATOM_x: \alpha(x)$ cannot tell in this case whether it sees:
$<f_1 \sqcup_{fence} \ldots \sqcup_{fence} f_4, k>$ or $<f_1 \sqcup_{fencingunit} \ldots \sqcup_{fencingunit} f_4, k>$.

Diagnosis:
The semantic theory has to tell $^{D}\alpha$, when it applies to an object, ***what*** set of atoms it should distribute to. This is not worked out in Rothstein's framework (and technically cumbersome to do).

2.1.3. Grammatical solutions to distribution.

What about deriving 'distributivity' via a null nominal element, the contents of which gets reconstructed (versions of this are proposed with some frequency in the analysis of partitives):

[$_{DP}$ each [$_{NP}$ of [$_{DP}$ the fences]]]
[$_{DP}$ each [$_{NP}$ **[$_{NP}$ e]** of [$_{DP}$ the ***fence***-s]]]
[$_{DP}$ each [$_{NP}$ [$_{NP}$ ***fence***-] of [$_{DP}$ the ***fence***-s]]]
$FE_{wt} \cap \lambda x.x \sqsubseteq \sigma(*FE_{wt}) = \lambda a.FE_{wt}(a) \wedge a \sqsubseteq \sigma(*FE_{wt})$

The problem is that it is not clear what predicate should get reconstructed.
Look at the following Dutch examples of partitives:

(2) a. Elk van de werknemers werd geinterviewed
Each of the employees was interviewed

Elk [α] van de ***werknemer***-s werd geinterviewed
$\lambda x.\alpha(x) \wedge x \sqsubseteq \sigma(*EMP_{wt})$
Strategy 1: α = [$_N$ *werknemer*-] with interpretation EMP_{wt}
Strategy 2: α = [$_{NP}$ *werknemers*] with interpretation $*EMP_{wt}$
D = ATOM $_{*EMP_{wt}}$

Modal cases show that strategy 1 is not tenable:

(2) b. Elk van de vroegere werknemers werd geinterviewed
Each of the former employees was interviewed

Elk [α] van de ***vroegere werknemer***-s werd geinterviewed
$\lambda x.\alpha(x) \wedge x \sqsubseteq \sigma(*(\text{FORMER}(\text{EMP}))_{wt})$
Strategy 1: $\alpha = [_N$ *werknemer-*] with interpretation EMP_{wt}

D shouldn't be a set of employees; it should be a set of former employees.

But strategy 2 gets into problems with:

(2) c. Elk van de elkaar belasterende werknemers werd geinterviewed.
Each of the each other slandering employees was interviewed

Strategy 2: $\alpha = [_{NP}$ *elkaar belasterende werknemers*]

Problem:
This denotes a set of pluralities $\mathbf{Z} = \lambda x{*}\text{EMP}_{wt}(x) \wedge \text{S-eo}(x)$: a set sums whose parts stand in the reciprocal slandering relation
And $\text{ATOM}_{\mathbf{Z}}$ is itself a set of pluralities. i.e. $\text{ATOM}_{\mathbf{Z}} \cap \text{EMP}_{wt} = \emptyset$.

The plurality adjective lifts the denotation ***off the singular ground*****.**
Problem: **Z** is a set of sums of employees.
Z is a set of sums of employee parts, … etc. etc.
The semantics cannot tell which is meant.
The distribution set D cannot be reconstructed from the meaning of the predicate.

Diagnosis:
The question whether or not there is a nul nominal element in these constructions is tangential to the semantic problem. The semantic problem is a ***compositionality problem*****:**
-The semantics needs access the distribution set in the interpretation of the complex expression.
-The required set cannot be reconstructed from the full NP meaning, nor is there another constituent from the meaning of which the required distribution set can be reconstructed.

Iceberg semantics: The relevant distribution set is built up **compositionally**

Elk van de drie elkaar belasterende **werknemer**s
$D_1 = \text{EMP}_{wt}$ The set of single employees
Elk van de drie elkaar belasterende **werknemers**
$D_2 = ({*}\text{EMP}_{wt}) \cap \text{EMP}_{wt} = \text{EMP}_{wt}$
Elk van de drie **elkaar belasterende werknemers**
$D_3 = (\lambda x.{*}\text{EMP}_{wt}(x) \wedge \text{Seo}(x)) \cap \text{EMP}_{wt}$
The set of single employees part of reciprocal slandering sums of employees
The intersection with $\mathbf{EMP_{wt}}$ is provided by the compositional Iceberg semantics.

Elk van de **drie elkaar belasterende werknemers**

$D_4 = D_3$

Elk van **de drie elkaar belasterende werknemers**

$D_5 = D_4$ $|D_5| = 3$

The set of single employees part of the sum of three reciprocal slandering sums of employees

Elk **van de drie elkaar belasterende werknemers**

$D_6 = D_5$

Elk distributes to D_6 : there is a sum of three employees that has the slandering-each-other property, and each of those three employees was interviewed.

Conclusion:
Counting, count comparison, distribution make reference to a notion of **disjoint distribution set**. There is need for a compositional theory of this notion.
This is what Iceberg semantics does.

2.2. Iceberg semantics

2.2.1 Icebergs: We interpret all nouns in a single complete Boolean algebra B.

NPs are interpreted as ***iceberg sets - i-sets***:

An *i-set* is a pair $X = \langle \mathbf{body}(X), \mathbf{base}(X) \rangle$ where $\mathbf{body}(X) \subseteq B$ and $\mathbf{base}(X) \subseteq B$
and $\mathbf{body}(X) \subseteq {}^*\mathbf{base}(X)$
the base generates the body under $\sqcup$.

DPs are interpreted (at the lowest type) a***s i-objects***

An *i-object* is a pair $X = \langle \mathbf{body}(X), \mathbf{base}(X) \rangle$ where $\mathbf{body}(X) \in B$ and $\mathbf{base}(X) \subseteq B$
and $\mathbf{body}(X) = \sqcup(\mathbf{base}(X))$

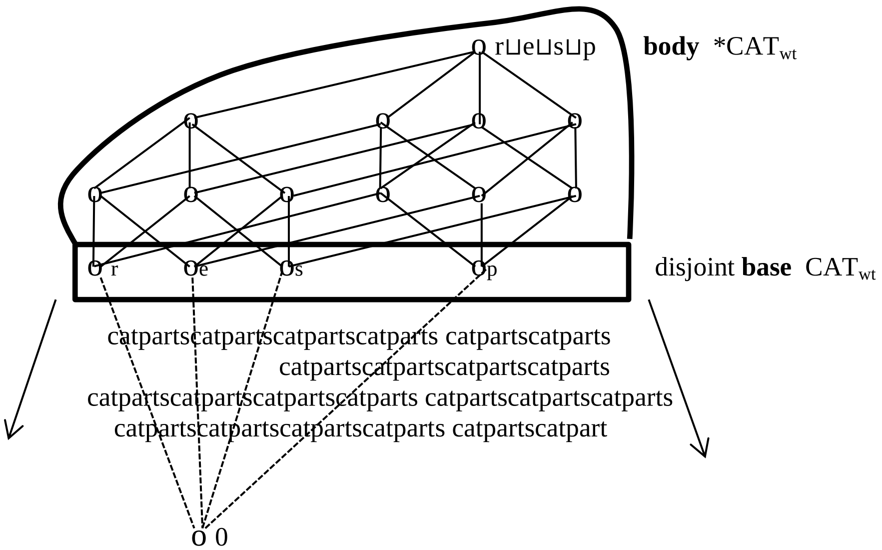
-body = what the Mountain semantics would give you.
-base = set in terms of which body elements are counted, count-compared, and to which distribution takes place.

Singular count nouns:
cat $\rightarrow CAT_{wt} = \langle\ CAT_{wt}, CAT_{wt} \rangle$ where CAT_{wt} is a **disjoint** set
Plural count nouns:
cats $\rightarrow \langle {}^*CAT_{wt}, CAT_{wt} \rangle$

Singular definite DP:
the cat $\rightarrow \langle \sigma(\ CAT_{wt}), CAT_{wt} \rangle$
the cats $\rightarrow \langle \sigma({}^*CAT_{wt}), CAT_{wt} \rangle$

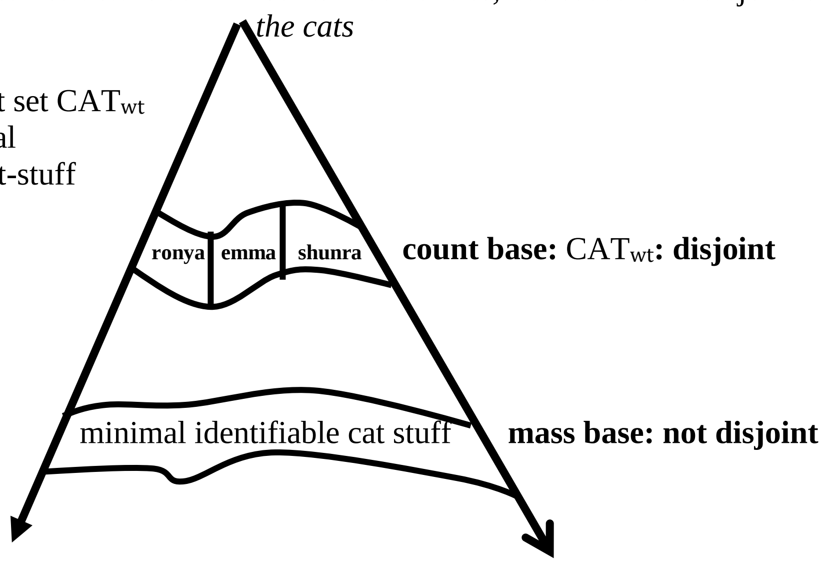
As in Mountain semantics, the denotation of a plural noun is a mountain rising up from the denotation of the singular noun.
But the denotation of the singular noun is no longer required to be a set of atoms:
the requirement of atomicity has been weakened to disjointness.
As a consequence the mountain is no longer securely attached to to bottom,
but, so to say, floats in a sea of parts. Like an iceberg:

In context, we choose CAT_{wt} = {*ronya*, *shunra*, *emma*, *pim*} **disjoint:**
cats → $CATS_{wt}$ **= <body**($CATS_{wt}$), **base**($CATS_{wt}$)> = <$^*\text{CAT}_{wt}$, CAT_{wt}>



We get the same Boolean structure as in Mountain semantics, but based on a disjoint set.

the cats:
count: sum of disjoint set CAT_{wt}
mass: sum of minimal identifiable cat-stuff



No sorting: -mass entities and count entities stand in the same part-of relation
-sets of 'mass' portions can be count if the grammar makes them disjoint.
-count entities can shift to mass entities if we shift the base.

2.2.2 Compositional base semantics for adjectives (and numericals).

The Head principle.

NP <**body**(*NP*), **base**(*NP*)>

ADJ NP$_{HEAD}$ <**body**(*HEAD*), **base**(*HEAD*)>

λ*Z*.**<** **adj**(**body**(*Z*), **adj**(**base**(*Z*)) **>**

body(*NP*) = **adj**(**body**(*NP*))

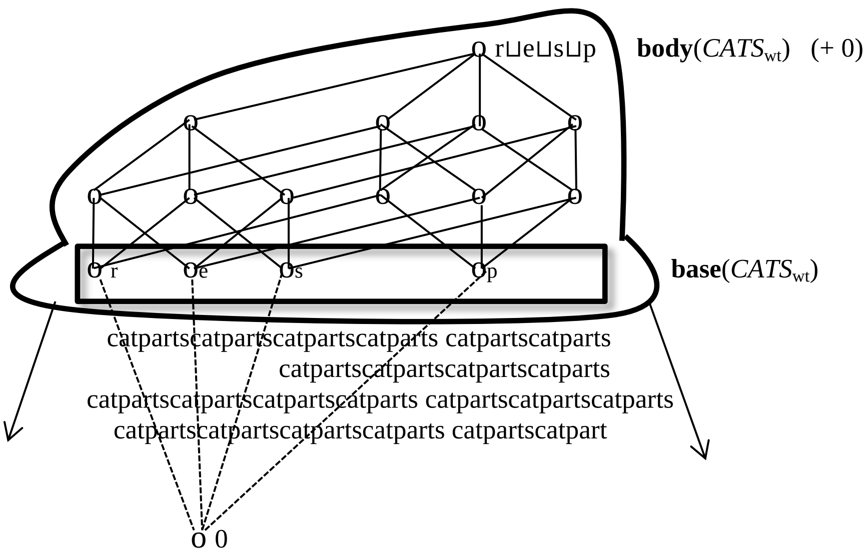
base(*NP*) = **⦇body**(*NP*)**⦈** ∩ **base**(*HEAD*)

Example: ***white cats***

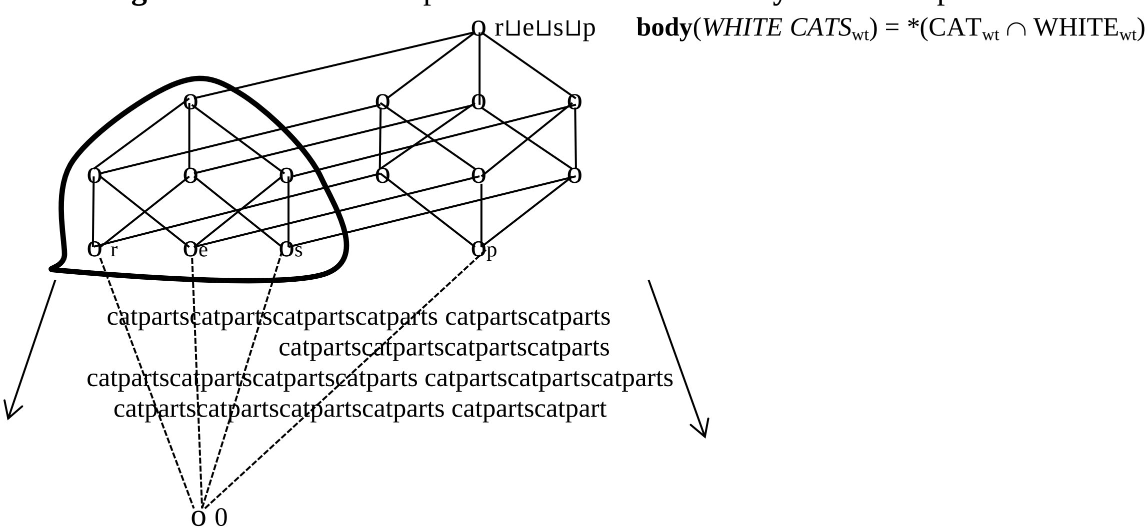
Stage 1: The interpretation of plural noun *cats*:

cats → $CATS_{wt}$ = <$^*CAT_{wt}$, CAT_{wt}>

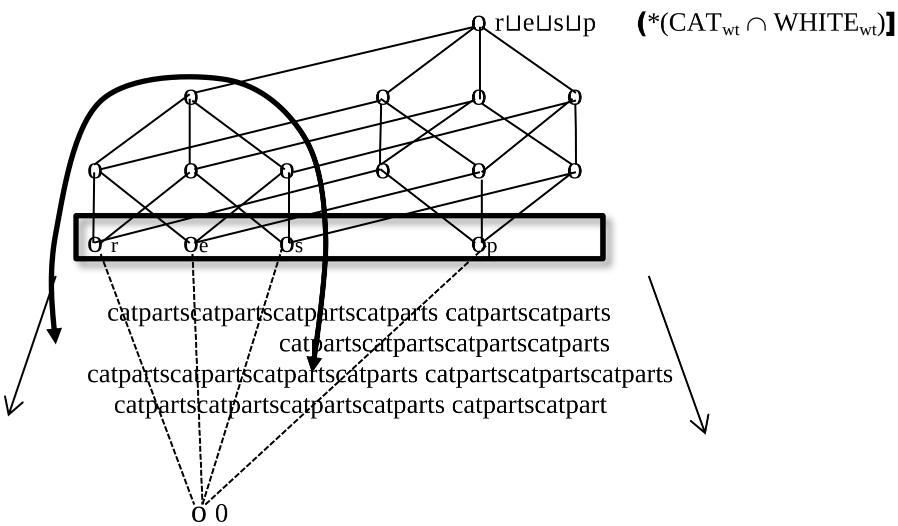
CAT_{wt} = {r, e, s, p}, a disjoint set. p is pim



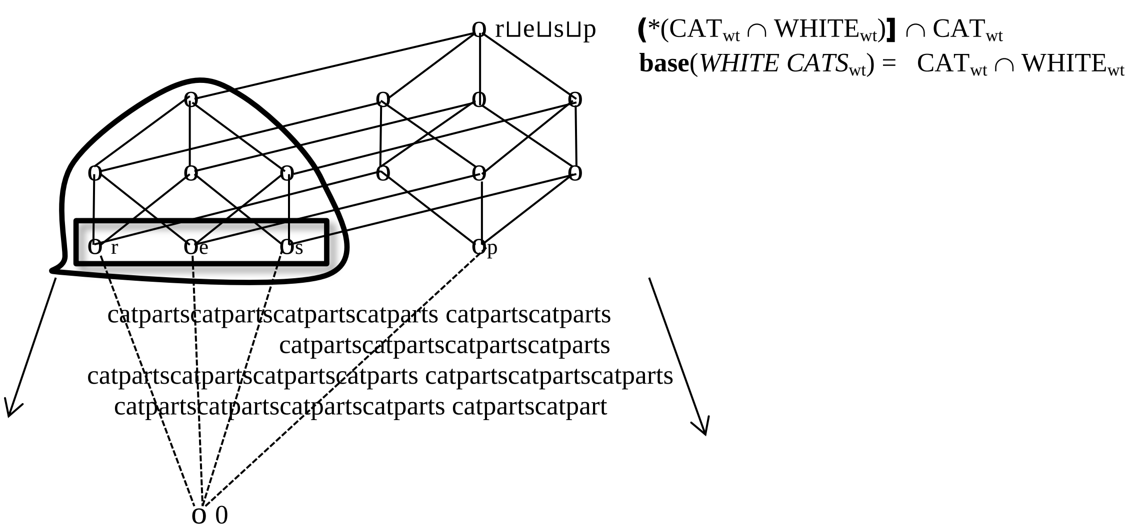
Stage 2: Distributive interpretation of *white*: the **body** of the interpretation of *white cats* is:



Stage 3-1: Deriving the **base** of the interpretation of *white cats*:
take the Boolean part set of **body**(*WHITE CATS*$_{wt}$):



Stage 2-2: Intersect this with **base**(*CATS*$_{wt}$)**:**



Head Principle: base(*NP*) = (**body**(*NP*)] ∩ **base**(*HEAD*)
The base information of the head constrains the base information of the complex.

Prediction (given a reasonably semantics for reciprocals)
[$_{NP}$ *van de drie elkaar belasterende werknemers*]
base(*NP*) = the set of those individuals in EMP$_{wt}$ that are part of sum x, where x is a sum of three employees and x is the maximal sum of employees that has the S-eo property.

Thus: In Iceberg semantics the semantic derivation keeps track of the correct distribution set.

2.3. Count and mass and neat and mess.

Mountain semantics: mass-count distinction is a vertical distinction:

look down in the Boolean part set of an object $r \sqcup e \sqcup s$ in the denotation *CAT of count NP *cats*:
you see a set of atomic parts {r, e, s} $\subseteq$ $ATOM_B$ in terms of which the object is counted.

look down in the Boolean part set of an object w in the denotation $WINE_{wt}$ of mass NP *wine*:
you see no atoms, counting is impossible.

Two problems, discussed in Landman 2011:
1. Chierchia 1997: *Poultry*, *furniture* are mass but have atomic denotations.
2. Landman 2016: Proper interpretation of divisibility:

(3) There is ***salt*** on the objective of the microscope, one molecule's worth.

We do not want to assume that parts of a molecule of salt are in the denotation of *salt*, simply ***because*** *salt* is a mass noun and divisible. If you don't see atoms in (3), you must be clear about ***what*** it is that you do see.

Iceberg semantics: *two* distinctions, one vertical, and one horizontal.
In Iceberg semantics the ***count-mass*** distinction is a ***horizontal*** distinction.
The ***vertical*** distinction is called the ***neat-mess** distinction*.

> ***Count and mass i-sets*** Let *X* = <**body**(*X*), **base**(*X*)> be an i-set
> *X* is ***count*** iff **base**(*X*) is disjoint; otherwise *X* is ***mass***

[Details of the subtleties of the semantics of count and mass intensions and count and mass nouns in Landman 2016 and Landman, ms.]

Iceberg semantics: use the base of the NP interpretation for distinguishing:
count nouns (***disjoint base***) from mass nouns (***overlapping base***).

Similar to Rothstein 2010: ***disjoint base*** is a grammatical property,
a requirement on the semantics interpretation of count nouns (in normal contexts).

Rothstein: The denotation of count nouns like *fence* is not conceptually disjoint.
But *fence* is a count noun, and that makes its denotation ***contextually disjoint***:
in context we choose or force an interpretation for *fence* that is disjoint.
The reason is that count nouns are required or expected to have a disjoint base.

[Iceberg semantics assumes pragmatic strategies for eliminating overlap in context - normally contextual restriction will do. In extreme cases ***pragmagic*** can be used: change the ontology as a give and take between speech participants. Pragmagic allows you to decide where events start and end, whether something counts as one even or two, and whether a part where a and b overlap, is really one overlapping part p, or can be reanalyzed as two indiscernable disjoint objects: $p_{\text{as part of } \mathbf{a}}$ and $p_{\text{as part of } \mathbf{b}}$.]

Mass-count distinction: ***horizontal*** notion on the bases of i-sets:
wat matters for mass-count is whether the base elements have parts in common or not.

Neat-mess distinction is a ***vertical*** distinction. But it doesn't relate to an absolute set of atoms ATOM_B, but to the set of base-atoms. I repeat:

$\mathrm{ATOM}_{\mathbf{base}(X)}$ is the set of minimal elements in $\mathbf{base}(X)^+$
$\mathbf{base}(X)$ is *atomic* iff for every $x \in \mathbf{base}(X)^+$: $\mathrm{ATOM}_{\mathbf{base}(X),x} \neq \emptyset$

Neat and mess i-sets
X is ***neat*** iff $\mathrm{ATOM}_{\mathbf{base}(X)}$ is disjoint and $\mathbf{base}(X)$ is atomic; otherwise *X* is ***mess***

Neat and mess i-objects Let $x = \langle\mathbf{body}(x), \mathbf{base}(x)\rangle$ be an i-object
x is ***neat*** iff $\mathrm{ATOM}_{\mathbf{base}(x)}$ is disjoint and $\mathbf{base}(x)$ is atomic; otherwise *x* is ***mess***

Count i-sets are *neat* i-sets *X* where $\mathbf{base}(X) = \mathrm{ATOM}_{\mathbf{base}(X)}$

A natural class of neat mass nouns are ***super neat mass*** nouns:

Super neat mass i-sets
X is ***super neat mass*** iff for some disjoint set X, $X = \langle {}^*X, {}^*X \rangle$.

2.4. The typology of count and mass and neat and mess

2.4.1. Count nouns and cardinality

We introduce the cardinality function via the notion of a *distribution set* which *presupposes* disjointness:

Presuppositional distribution: $\mathbf{D}_Z(x)$

$$\mathbf{D} = \lambda Z \lambda x. \begin{cases} (x] \cap Z & \text{if Z is } \textbf{disjoint} \\ \bot & \text{otherwise} \end{cases}$$

.

$\mathbf{D}_Z(x)$, the distribution set of x relative to Z is the set of Z-parts of x,
presupposing that Z is disjoint.

Presuppositional cardinality: $\mathbf{card} = \lambda Z \lambda x. |\mathbf{D}_Z(x)|$

Hence: $\mathbf{card}_Z(x) = |\mathbf{D}_Z(x)| = |(x] \cap Z|$, presupposing that Z is disjoint.
The cardinality of the set of Z-parts of x, presupposing that Z is disjoint.

Example: let $\mathrm{CAT}_{wt} = \{r, e, s, p\}$, a disjoint set.
$r \sqcup e \sqcup s \in {}^*\mathrm{CAT}_{wt}$
$\mathbf{card}_{\mathrm{CAT}_{wt}}(r \sqcup e \sqcup s) = |\mathbf{D}_{\{r, e, s, p\}}(r \sqcup e \sqcup s)| = |(r \sqcup e \sqcup s] \cap \{r, e, s, p\}| = |\{r, e, s\}| = 3$

2.4.2. Neat mass nouns

1. Itemized neat mass nouns.

In our shop we sell *kitchenware*. This includes *basic* kitchenware items:

BKW_{wt} = {teapot, cup, saucer, pan}, a disjoint set.

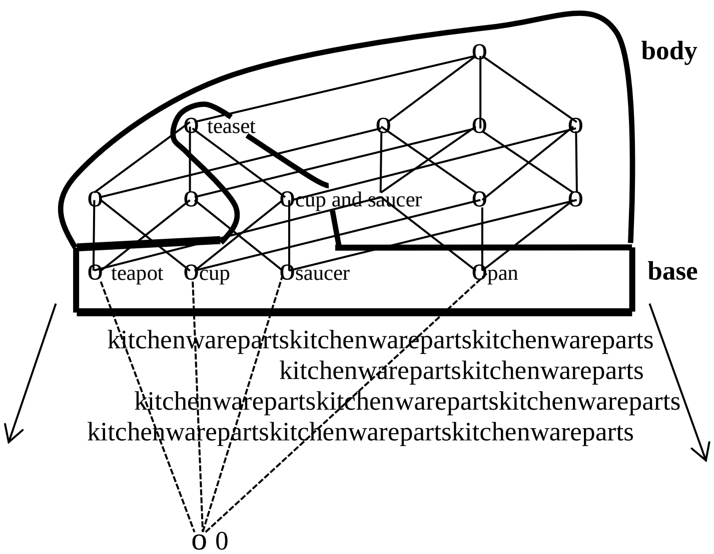
In our shop you can buy *cups* and *saucers* independently,
but you can also buy a *cup and saucer* (for a different price),
and you can but a one-person *teaset* for a very good price.
But a *saucer and pan* is not an item sold independently in our shop.

KW_{wt} is the set of goods that are sold in our shop as one:

KW_{wt} = {teapot, cup, saucer, pan, cup and saucer, teaset} =
{teapot, cup, saucer, pan, cup $\sqcup$ saucer, cup $\sqcup$ saucer $\sqcup$ teapot}

Obviously, $\text{ATOM}_{KW_{wt}} = BKW_{wt}$, and also obviously: $\forall x \in KW_{wt}\ \exists a \sqsubseteq x$: $a \in BKW_{wt}$.
Hence KW_{wt} is an *atomic* set with a *disjoint* set of atoms.

kitchenware $\rightarrow$ KW_{wt} = <**body**(KW_{wt}), **base**(KW_{wt})> = <$^*KW_{wt}$, KW_{wt}>



The *grammatical* requirement is that KW_{wt} is a neat mass i-set.

KW_{wt} is an i-set (since **body**(KW_{wt}) = ***base**(KW_{wt}))/

KW_{wt} is neat, because the base, KW_{wt}, is atomic with a disjoint set of atoms BKW_{wt}.
KW_{wt} is mass because the base KW_{wt} is not itself disjoint.

Hence: if x ∈ **body**(KW_{wt}): $\mathbf{D}_{\mathbf{base}(KW_{wt})}$(x) and $\mathbf{card}_{\mathbf{base}(KW_{wt})}$(x) are undefined.

$\mathbf{card}_{\mathbf{base}(KW_{wt})}$(**teaset**) = ⊥

There is **no unique count** for **teaset** in terms of the base:

teaset counts as one and two and three simultaneously.

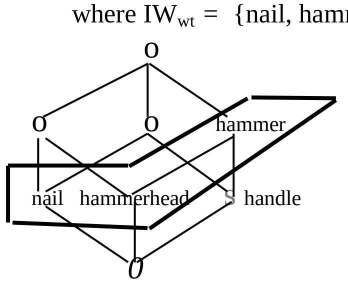
In ***itemized neat mass nouns*** like *kitchenware* the distinction between plurals and contextual groups (pluralities treated as singular objects in their own right) is blurred:
-Groups of kitchenware items count themselves as kitchenware (and can be in the base).
-Groups of cats do not themselves count as cats (they are not in **base**(CAT_{wt}).

Kitchenware does not make a distinction between:
-plurals that count as **many**
and -plurals as **groups** that count as **one**.

[The denotation of *kitchenware* here is actually not just atomic, but atomistic:
every element of the base (KW_{wt}) is the sum of atoms (BKW_{wt}). This need not be the case.

For that we go one floor up in our shop which has wooden items and ironware.
One of the items we sell is a hammer which consists of a metal hammerhead and a wooden handle.
We also sell the hammerheads and the handles separately.
Arguably, the hammer and the hammerhead are *ironware*, but the handle is wood:
the kind where you stick the stem through the hole in the hammer head and it sticks.

ironware → IW_{wt} = <**body**(IW_{wt}), **base**(IW_{wt})> = <$*IW_{wt}$, IW_{wt}>
where IW_{wt} = {nail, hammerhead, hammer}>:



While **body**(IW_{wt}) *is* generated by IW_{wt} under sum, it is not generated by $ATOM_{Iwwt}$ (= {nail, hammerhead}) under sum. Thus this neat mass i-set is atomic, but not atomistic.]

2.4.3. Super neat mass nouns

Typical cases of super neat mass nouns are *sortal mass nouns* corresponding to natural kinds and subordinates or superordinates of natural kinds (in particual animate kinds).
These are neat mass nouns like *poultry* and *livestock*.
It is appropriate to think of these as ***number neutral*** in the following sense**.**

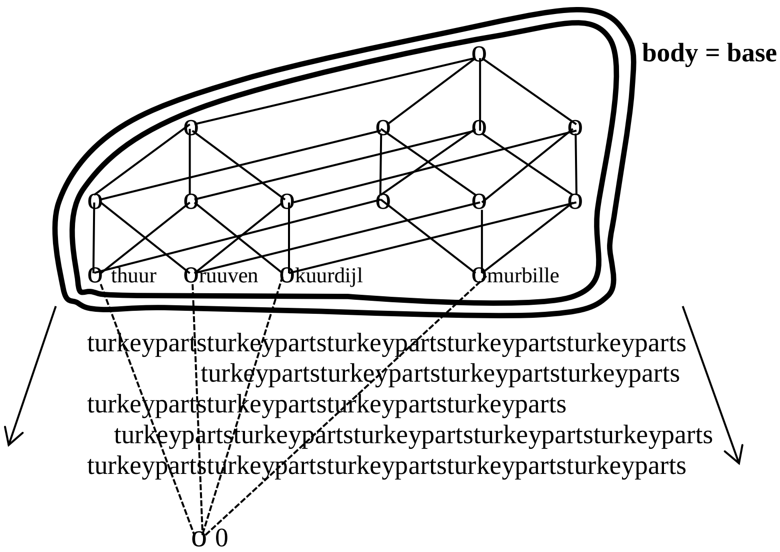
Suppose that in wt the relevant *poultry* is *turkeys*:
Let TURKEY_{wt} = {Thuur, Ruuven, Kuurdijl, Murbille}, a disjoint set.

Think of the kind **turkey**. **turkey** is be instantiated in wt.
Assume that the instantiation can be done in a count (= singular) was, or in a number neutral (= plural) way:

$$\textbf{inst}_{\textbf{count},\,wt}(\textbf{turkey}) = \text{TURKEY}_{wt} \qquad \textbf{inst}_{c}$$
$$\textbf{inst}_{\textbf{number neutral},wt}(\textbf{turkey}) = {}^*\text{TURKEY}_{wt} \qquad \textbf{inst}_{nn}$$

With this, we can set:

$$\textit{turkey} \rightarrow \textit{TURKEY}_{wt} = \langle \textbf{inst}_{\textbf{c},\,wt}(\textbf{turkey}), \textbf{inst}_{\textbf{c},\,wt}(\textbf{turkey})\rangle = \langle \text{TURKEY}_{wt}, \text{TURKEY}_{wt}\rangle$$
$$\textit{poultry} \rightarrow \textit{POULTRY}_{wt} = \langle \textbf{inst}_{\textbf{nn},wt}(\textbf{turkey}), \textbf{inst}_{\textbf{nn},wt}(\textbf{turkey})\rangle = \langle {}^*\text{TURKEY}_{wt}, {}^*\text{TURKEY}_{wt}\rangle$$



$\textit{POULTRY}_{wt}$ is a **super neat mass** i-set:
$\text{ATOM}_{\text{base}(\textit{POULTRY}_{wt})} = \text{TURKEY}_{wt}$, which is disjoint and generates the **base** $^*\text{TURKEY}_{wt}$.
Of course, the **base** trivially generates the **body**, since **base** and **body** are identical.
$\textit{POULTRY}_{wt}$ is **mass**, because the **base** is not disjoint.

The idea is that ***number neutral*** neat mass nouns do not make the distinction ***in the base*** between pluralities that count as **many** and pluralities that count as as **one**.

2.4.4. Distribution sets for neat mass nouns.

In lecture 1, we discussed diagnostics for count nouns. What we find, for English, is:

English count and mass nouns:

1. Count nouns but not mass nouns combine with counting phrases:
   seven, less than five, at least three
2. Count nouns but not mass nouns combine with count distributors: *both, neither, each*
3. *most* + count noun allows count comparison.
4. *m*ost + count noun does not allow measure comparison.
   most + mass nouns allows measure comparison.

while *neat mass nouns* are genuine mass nouns, they pattern in certain ways with count nouns.

English neat mass nouns:

1 **neat ~ mass** nouns: no combination with counting phrases: *seven, less than five, at least three*
2_a **neat ~ mass** nouns: no combination with distributors: *both, neither, each*
2_b **Neat ~ count** nouns: both combine with distributive adjectives: *small, big*
3. **Neat** ~ **count** nouns: *most* + neat mass noun allows count comparison
4. **Neat** ~ **mass** nouns: *most* + neat mass noun allows measure comparison

Distributivity for neat mass nouns (Rothstein 2011, Schwarzschild 2009)

Schwarzschild: *big* is stubbornly distributive

(4)	The *noisy* boys	✓ = the boys that are noisy	✓= the noisy group of boys
	The *big* chairs	✓ = the chairs that are big	× = the big group of chairs

Rothstein: neat mass noun *furniture* combines with *big*, and *big* **is distributive** (like *each*):

(5) The *big* furniture ✓= the items of furniture that are big
×= the big group of furniture items

Count comparison for neat mass nouns:

Barner and Snedeker 2005 discuss *more than*, Landman 2011 discusses *most*.
Observation: B&S 2005 : Speakers readily get count comparison for neat mass nouns.
Landman 2011: But also measure comparison.

(6) a. Most *farm animals* are outside in summer. [*count*] [Landman 2011]
b. Most *livestock* is outside in summer. [*neat*]
c. Most *manure* is outside in summer. [*mess*]

(6a) only allows count comparison, (6c) only allows measure comparison.
But (6b) allows both: count comparison and comparison, say, in terms of volume or biomass.

Dutch individual classifier *stuks*

Doetjes 1997: Dutch classifier *stuks*: *stuks* + count noun; *stuks* + neat mass noun
not: *stuks* + mess mass noun (Caveats in Landman 2011)

(7) a. Ik moet *drie stuks* ***hemden*** ophalen van de stomerij [***count***]
I must collect *three items of* ***shirts*** from the dry cleaner
b. Kan je z*es stuks* ***croquetten*** halen bij slager?
Can you get *six items of* ***meat rolls*** at the butcher?

(8) a. Ik heb acht stuks ***keukenwaar*** aangekruist in the catalogus. [***neat***]
I checked *eight items of* ***kitchenware*** in the catalogue.
b. Ik heb *drie stuks* ***vee*** verkocht, twee schapen en een koe.
I sold *three items of* ***livestock***, two sheep and a cow.

(9) a. #Ik heb *drie* ***stuks kaas*** gekocht. ✓Ik heb *drie* ***stukken kaas*** gekocht. [***mess***]
\# I bought *three* ***items*** *of* ***cheese*** ✓ I bought *three* ***pieces*** *of* ***cheese***
b. #Ik heb *drie* ***stuks vlees*** gegeten. ✓Ik heb *drie* ***stukken vlees*** gegeten.
\# I ate *three* ***items*** *of* ***meat****.* ✓I ate *three* ***pieces*** *of* ***meat***

s*tuks* and *items*:

gevogelte-**poulty** is in Dutch and English ambiguous between mess mass [bird meat] and neat mass [bird item]:

(10) a. *vlees, vis, wild en* ***gevogelte*** [γ] [***mess***]
meat, fish, game and poultry
b. Het houden van kostbaar sierpluimvee en ***exotisch gevogelte*** maakte deel uit van de cultuur van de buitenhuizen van de zeventiende-eeuwse Nederlandse welgestelden. [γ]
Keeping expensive ornamental bird-livestock and exotic poultry was part of the culture of country houses of the seventeenth century Dutch well-to-do. [***neat***]

English ***item*** applies to both interpretations:

(11) a. As a general principle all ***items of poultry*** whether raw or pre-cooked, such as croquettes, need to be coated before deep frying. [γ] [***item + mess***]
b. From 12 to 14 June 2008, the Worcester Show Grounds were a cacophony of cackle and crow. A total of 1523 ***items of poultry*** was exhibited by 45 exhibitors. [γ] [***item + neat***]

Dutch ***stuks*** only applies to the neat interpretation:

(12) Het is verboden pluimveestallen met gezamelijk meer dan 10.000 ***stuks gevogelte*** te exploiteren die gelegen zijn in een gebied anders dan agrarische gebieden. [γ]
[From a Belgian law text]
It is forbidden to exploit bird live stock stables with alltogether more than 10.000 ***items of poultry*** that are located in areas other than agricultural areas.

Distribution for neat mass nouns = Interpretation possibilities of *stuks* + neat mass noun

1. ***Super neat*** mass nouns only allow ***distribution to minimal elements*** (= individuals)
Stuks + super neat mass noun ***picks out minimal elements*** (individuals)

groot vee = vee dat bestaat uit grote stuks vee
big livestock = livestock that consists of big livestock individuals

What counts as ***10.000 stuks gevogelte*** in (8) is unambiguously 10.000 birds.

-If the 10.000 birds are love birds that are kept in cages of two and are only sold in pairs
there is a sense in which there are 5.000 items for sale,
but this cannot be described as *5.000 stuks gevogelte*-5000 items of poultry.

2. ***Itemized neat*** allow ***distribution*** to ***contextually selected*** disjoint set of base elements.
Stuks + itemized neat picks out ***contextually*** selected disjoint set of base elements.

Rothstein: what counts as *big furniture* depends on the context.
Context 1: ***small furniture:*** the kitchen chairs, the dining chairs, the table
Context 2: ***small furniture:*** the kitchen chairs ***big furniture***: the dining set

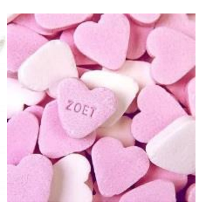
Context dependency of *stuks* + itemized neat:

(13) Thee servies uit Tunesie bestaande uit 12 stuks - 8 euros
Tea set from Tunesia consisting of 12 stuks – 8 euros

-If you find a shop that will sell you three of them, how many ***stuks keukenwaar*** have you bought?
36 or 3? Either answer is reasonable, depending on the context.

Nice contrast: 
count noun *snoepjes*-**candies** versus itemized neat mass noun *snoepgoed*-**candy**

Candyshops in Holland sell what is called an ***uitdeeldoos***-hand out box :
a box of sweets for kids to hand out in class on their birthday.
The following items any typically found in an *uitdeeldoos*:



(14) a. Een uitdeeldoos bevat ca. 70 snoepjes [***count***]
A hand out box contains ca. 90 candies
b. Een uitdeeldoos bevat ca. 70 stuks snoepgoed [***neat mass***]
A hand out box contains ca. 70 items of candy

(14a) counts snoepjes, candies. Here you count individual smarties and love hearts.
(14b) counts items of candy, here a box of smarties and a role of love hearts can count as 1.

2.5. The analysis for count nouns and neat mass nouns

1. Semantics of counting phrases like *less than three*
counting distributors like *each*

less than three $\rightarrow$ $\lambda Z.\langle$**less than three**(**body**(Z)), **less than three**(**base**(Z))$\rangle$
(Z a variable over i-sets)

$\textbf{less than three}(\textbf{body}(Z)) = \lambda x.\textbf{body}(Z)(x) \wedge \textbf{card}_{\textbf{base}(Z)}(x) < 3$

$\textbf{less than three}(\textbf{base}(Z)) = (\textbf{less than three}(\textbf{body}(Z))] \cap \textbf{base}(Z)$

Let Z = *CATS* = $\langle {}^*\text{CAT}_{wt}, \text{CAT}_{wt}\rangle$

less than three cats $\rightarrow \langle\lambda x.{}^*\text{CAT}_{wt}(x) \wedge \textbf{card}_{\text{CAT}_{wt}}(x) < 3,\ \text{CAT}_{wt}\rangle$

1. The base of **less than three**(*CATS*) is disjoint, so *less than three cats* is ***count***.
2. The body of **less than three**(*CATS*) makes reference to **base**(*CATS*).
   This requires that **the head of** *less than three cats* **be count**.

each $\rightarrow \lambda\alpha\lambda\mathbf{z}.\forall a \in D_{\textbf{base}(\mathbf{z})}: \alpha(\mathbf{z})$ (**z** a variable over i-objects)

This requires the subject to be a **count** i-object.

2. Lack of measure interpretations for count nouns

We will see in lecture 3 how we deal with measure phrases like *three kilos of candies*.
Here we deal with the constraint on the measure interpretation of *most*.

Idea:
-Measures are defined on Boolean domains.
-The ***measure interpretation*** of *most* requires a noun interpretation of which ***the base can be regularized into a Boolean domain*****:**.

Let X = $\langle$**body**(X), **base**(X)$\rangle$ be an i-set of type α where α ∈ {count, neat, mess}
The ***regularization of*** X within type α, $\textbf{reg}_{\alpha}(X) = \langle\textbf{body}(X), {}^*\textbf{base}(X)\rangle$,
if this is an i-set of type α.

Fact: Regularization is possible for mass nouns (mess or neat), but not for count nouns.
Hence: Mess mass nouns and neat mass nouns allow measure interpretations for *most*,
count nouns do not.

3. Distribution and count-comparison for neat mass nouns.

Presuppositional distribution: $\mathbf{D}_Z(x)$

$$\mathbf{D} = \lambda Z \lambda x. \begin{cases} (x] \cap Z & \text{if } Z \text{ is } \mathbf{disjoint} \\ \perp & \text{otherwise} \end{cases}$$

$\mathbf{D}_Z(x)$, the distribution set of x relative to Z is the set of Z-parts of x, presupposing that Z is disjoint.

Crucial observation: Iceberg semantics:

The basic operation is not $\mathbf{D}_{\mathbf{base}(\textit{HEAD})}$ but $D_{\mathbf{Y}}$, where $\mathbf{Y}$ is a disjoint set.

Hence: if the semantics of a phrase involves $\mathbf{D}_{\mathbf{Y}}$, it must provide a ***disjoint*** set,
but this set doesn't have to be **base**(*HEAD*)

3.1. Distributive adjectives: *groot-big*

big $\rightarrow$ $\lambda Z.\langle \mathbf{big}(\mathbf{body}(Z)), \mathbf{big}(\mathbf{base}(Z))\rangle$ (Z a variable over i-sets)

$\mathbf{big}(\mathbf{body}(Z)) = \lambda x.\mathbf{body}(Z)(x) \wedge \forall a \in \mathbf{D}_{\mathbf{Y}(Z)}\text{: BIG}_{wt}(a)$ where $\mathbf{D}_{\mathbf{Y}(Z)}$ is a disjoint set
$\mathbf{big}(\mathbf{base}(Z)) = (\mathbf{big}(\mathbf{body}(Z))] \cap \mathbf{base}(Z)$

Fact : if α is a count NP, then *big α* is count NP.
if α is a neat mass NP, then *big* α is neat mass NP.

This follows from the Head principle:
The mess/neat/count characteristics of the head determines
The mess/neat/count characteristics of the complex.

Disjoint sets:
-In the case of ***count noun*** or ***super neat mass nouns*** *Z*,
there is only one reasonable choice for disjoint set $\mathbf{D}_{\mathbf{Y}(Z)}$, namely: $\mathbf{D}_{\mathbf{Y}(Z)} = \text{ATOM}_{\mathbf{base}(Z)}$.
(in the case of the count noun this ***is*** **base**(*Z*)).
Hence: the body denotation of *big farm animals* and of *big livestock* consists of sums of farm animals that are individually big.

-In the case of **itemized neat mass noun** *Z*, the context can provide natural choices for $\mathbf{D}_{\mathbf{Y}(Z)}$ of disjoint subsets of **base**(Z), not just $\text{ATOM}_{\mathbf{base}(Z)}$.
Hence: the body denotation of *big furniture* consists of sums of big furniture items, but what counts as furniture items varies with the context.
-In the case of **mess mass noun** *Z* the context does not provide a choice of a disjoint set for $\mathbf{D}_{\mathbf{Y}(Z)}$, and modification of *Z* by distributive **big** is infelicitous.
[But see lecture 3 for the Dutch and German exceptions that confirm the analysis!]

3.2. Count-comparison with *most*.

Semantics of ***most***: defined in terms of $\mathbf{card}_{\mathbf{Y}(Z)} = |\mathbf{D}_{\mathbf{Y}(Z)}|$, where $\mathbf{D}_{\mathbf{Y}(Z)}$ is a disjoint set

Hence: we expect to find the same facts as for *big*:

-**Count comparison** is possible with ***count nouns*** and ***neat mass nouns***, but not with mess mass nouns
[But see lecture 3 for the Dutch and German exceptions that confirm the analysis!]

-**Count comparison** with ***count noun*** *Z* or ***super neat mass noun*** *Z* compares in terms of $\text{ATOM}_{\mathbf{base}(Z)}$

-**Count comparison** with ***itemized neat mass noun*** *Z* compares in terms of a contextually provided disjoint subset of **base**(*Z*).

I have discussed the typology of count, super neat mass nouns and itemized neat mass nouns. What is left to discuss is mess mass nouns.

Tune in next time to Lecture 3 on mess mass nouns,measures and portions.