ICEBERG SEMANTICS FOR COUNT NOUNS AND MASS NOUNS: MESS MASS NOUNS AND MEASURES

Fred Landman
Tel Aviv University – Universität Tübingen Düsseldorf, June 2016

Iceberg semantics: meant as a useful framework for studying and developing theories of mass-count, singularity-plurality for lexical nouns, complex nouns (NPs) and noun phrases (DPs).
Main inspirations:
-Link 1983, Landman 1991, e.v.: Boolean semantics for plurality.
-Chierchia 1998 (following in part Pelletier and Schubert): mass nouns with minimal elements (*furniture*)– the supremum argument (*the furniture* = *the chairs and the tables*).
-Rothstein 2010, Landman 2011: mass-count distinction based on overlap-disjointness.
- Krifka 1989: Count nouns based on *natural units* rather than atoms.
- Barbara Partee p.c. [public comments, many times]: Central idea of Boolean semantics:
not: singular noun denotes a set of atoms; **but**: singuar noun denotes the set of minimal elements of the plural denotation.

1. Boolean background

Boolean semantics: Link 1983: Boolean domains of mass objects and of count objects.
Semantic plurality as closure under sum.
Boolean interpretation domain B: Boolean algebra with operations of complete join ⊔ and meet ⊓.

Boolean part set: $(x] = \{b \in B: b \sqsubseteq x\}$ **The set of all parts of x.**
$(X] = (\sqcup X]$

Closure under ⊔: $*Z = \{b \in B: \exists Y \subseteq Z: b = \sqcup Y\}$ **The set of all sums of elements of Z**

Generation: X **generates** Z **under** ⊔ iff $Z \subseteq *X$ **every x ∈ Z is a sum of elements of X**

Minimal elements: $\textbf{min}(X) = \{x \in X: \forall y \in X: \text{if } y \sqsubseteq x \text{ then } y=x\}$
Atoms in B: $\textbf{ATOM} = \textbf{min}(B-\{0\})$

Disjointness: a and b **overlap** iff $a \sqcap b \neq 0$ **a and b have a part in common**
a and b are **disjoint** iff **a and b do not overlap**

Z **overlaps** iff for some a,b ∈ Z: a and b overlap
Z is **disjoint** iff Z does not overlap

Definite operator (Sharvy 1980):

$$\sigma(Z) = \begin{cases} \sqcup Z & \text{if } \sqcup Z \in Z \\ \bot & \text{otherwise} \end{cases}$$

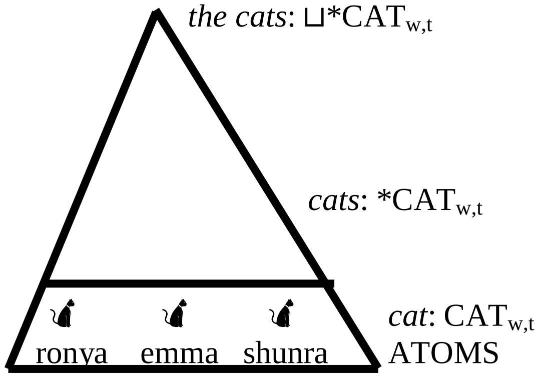
⊔Z, on the presupposition that ⊔Z is in Z

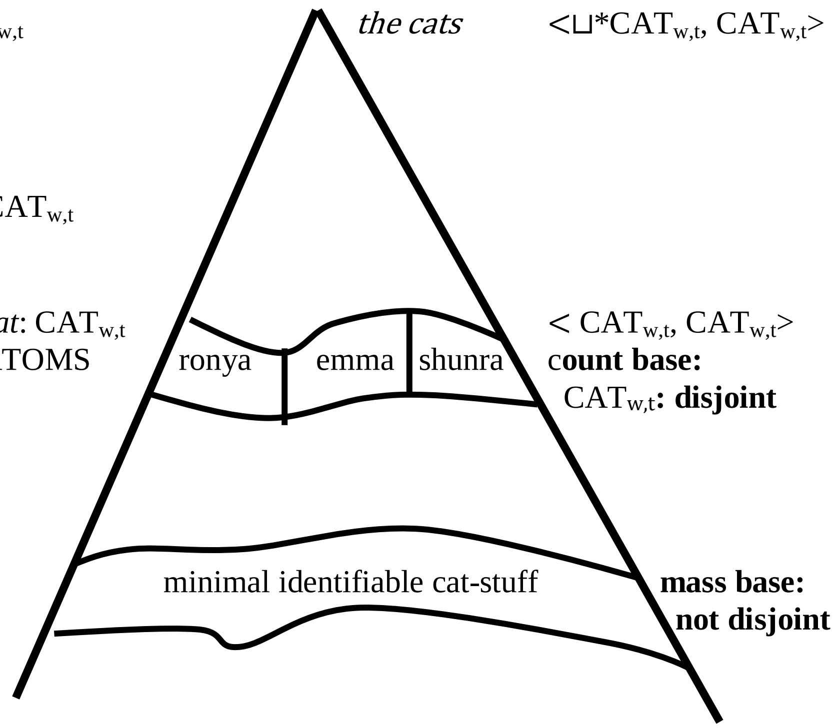
2. Mountain semantics and Iceberg semantics

Mountain semantics:
singular noun: sets of atoms

Iceberg semantics:
singular nouns: disjoint set

plural nouns: closure under sum of singular nouns.





Iceberg semantics: Following Chierchia's supremum argument:
the cats is a count sum of three cats relative to disjoint *base*: {ronya, emma, shunra}
a mass sum relative to a mass base, say, minimal identifiable cat-stuff

Iceberg semantics: NPs are interpreted as **iceberg sets [i-sets]**:

an **i-set** is a pair $X = <$ **body**(X), **base**(X) $>$ with **body**(X), **base**(X) $\subseteq$ B
and **body**(X) $\subseteq$ ***base**(X)

An i-set iceberg is a pair consisting of a **body** set and a **base** set with the **body generated by the base under** $\sqcup$.

1. Iceberg semantics stays as close to Mountain semantics as possible: body generated by the base.
2. Mass-count distinction is not based on atomicity but on disjointness of the base.
3. Compositionality: Iceberg interpretations keep track of the base:
   mass-count applies to complex NPs and DPs (details in Landman 2016).
4. Count characteristics: **Counting, distribution, count-comparison**:
   - you count sums in the body in terms of the base, but **only if** the base is disjoint.
   - you distribute a sum in the body to the base, but **only if** the base is disjoint.

Iceberg semantics: singular noun: *cat* $\rightarrow <$ $CAT_{w,t}$, $CAT_{w,t}>$ with $CAT_{w,t}$ a disjoint set.
Plural noun: *cats* $\rightarrow <$ *$CAT_{w,t}$. $CAT_{w,t}>$ closure under sum of $CAT_{w,t}$
Count nouns *cat* and *cats*: the same disjoint base $CAT_{w,t}$
Mass nouns (simplified): Let FURNITURE-ITEM$_{w,t}$ be a disjoint set.
furniture $\rightarrow$ <*FURNITURE-ITEM$_{w,t}$, *FURNITURE-ITEM$_{w,t}$>: base: not disjoint.
Idea: distinction between singular and plural is not articulated in the base.

3 Mass – count – neat – mess

3.1. Disjointness and counting

If Z is **disjoint** then *Z has the structure of a **complete atomic Boolean algebra** with Z as set of atoms. This allows correct counting in terms of Z.

Counting as presuppositional cardinality: Let $x \in B$ and let $Z \subseteq B$

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

.
The cardinality of x relative to Z is the cardinality of the set of Z-parts of x **presupposing** that **Z is disjoint.**

Counting: Lexical semantics of numericals and sorted count quantifiers makes reference to **card**, which **presupposes** disjointness:

Count versus mass:
1. Counting: ✓three cats - #three mud
2. Distribution: ✓each of the cats - #each of the mud
3. Comparison: *most* cats purr: only cardinality comparison
most mud is clay: only measure comparison

But what about:

Neat mass versus mess mass:
2. Distribution to items with adjectives:
The *big furniture* = the *big items of furniture*
The *big mud* ≠ the *big items of mud*
3. Comparison in terms of items possible:
most furniture is upstairs: both cardinality comparison and measure comparison

Semantics of neat mass nouns and reference to *items*: see: See: Landman 2011 and Landman [I-promised-Hana-I-write-it-this- month] and section 9.3.

3.2. Defining mass-count-neat-mess for i-sets and for NPs

Noun phrases are interpreted as i-sets. We define **mass**, **count**, **neat**, **mess** for i-sets:

Let X = <**body**(X), **base**(X)> be an i-set iceberg.
X is **count** iff **base**(X) is disjoint, otherwise X is **mass**

X is **neat** iff **min**(**base**(X)) is disjoint and **min**(**base**(X)) generates **base**(X) under $\sqcup$, otherwise X is **mess**

Borderline cases:

X is **borderline mass** iff X is **borderline neat** iff X is count
X is **borderline mess** iff X is neat

Constraint on noun phrase interpretations:

- **count**/**mass**/**neat**/**mess** noun phrases are in **normal, standard** contexts interpreted as **count**/**mass**/**neat**/**mess** i-sets.
- **count**/**mass**/**neat**/**mess** noun phrases can be **borderline count**/**mass**/**neat**/**mess** in non-standard contexts.

-The point of this is **not** to characterize 'normality', but to allow the theory to be flexible: You cannot expect your definitions of count-mass in terms of overlap to apply unproblematically to interpretations of noun phrases in extreme situations, say, domains that have 0 or 1 elements.

Example: the empty i-set <Ø,Ø> is technically **count.**
We don't want to say that *mud* is not a mass noun because it allows count interpretation <Ø,Ø>. So we let <Ø,Ø> be **borderline mass**.

-**Mess mass noun** *meat* is interpreted in a normal context as a mess mass i-set.
Its generating base could be: all meat parts up to the smallest size that we can cut.
This base is not disjoint, nor need we think of it as itself generated by a disjoint set.

-**Neat mass noun** *furniture* is interpreted in a normal context as a neat mass i-set.
Its base is generated from a disjoint set, the minimal furniture items.
The distinction between singulars and plurals is not articulated in the base:
The ***two*** *folding chairs* and the **one** *folding table* form **one** garden set:
within *furniture* 2 + 1 = 3 and 2 + 1 = 1 hold simultaneously.
The base is not disjoint, but generated by the set of its minimal element: a disjoint set.

-**Plural count noun** *cats* is interpreted as a count i-set and in normal contexts as a plural i-set.
Its base is a disjoint set of individual cats, its body is the closure under sum of that set.

-**Singular count noun** *cat* is interpreted as a singular count i-set: an i-set where the body is the same as the base and disjoint.

3.3. Iceberg semantics for DPs

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

an i-object is a pair consisting of an object x in B and a set Z such that x = ⊔Z

Let $x = \langle \mathbf{body}(x), \mathbf{base}(x) \rangle$ be an i-object .

x is **count**/**mass**/**neat**/**mess** iff

i-set $\langle (\mathbf{body}(x)] \cap \mathbf{base}(x), \mathbf{base}(x) \rangle$ is **count**/**mass**/**neat**/**mess**

x is a **singular** iff $x = \langle \mathbf{body}(x), \{\mathbf{body}(x)\} \rangle$

Ronya $\rightarrow$ <ronya, {ronya}> **singular count object**

<ronya, {ronya}> is **count** because:

$\langle (\text{ronya}] \cap \{\text{ronya}\}, \{\text{ronya}\} \rangle = \langle \{\text{ronya}\},\{\text{ronya}\} \rangle$, which is count.

<ronya, {ronya}> is **singular** because the base {ronya} is a singleton.

Ronya and Emma $\rightarrow$ <ronya ⊔ emma, {ronya, emma}> **plural count object**

The cats $\rightarrow$ $\langle \sigma(^*CAT_{w,t}), CAT_{w,t} \rangle$

= <ronya ⊔ emma ⊔ shunra, {ronya, emma, shunra}>

Neat mass (simplified):

The furniture $\rightarrow$ <the dresser ⊔ the piano, {the dresser, the piano, the dresser ⊔ the piano}

Neat mass object: base is not disjoint, but generated by a disjoint set.

Collectivity = Semantic singularity

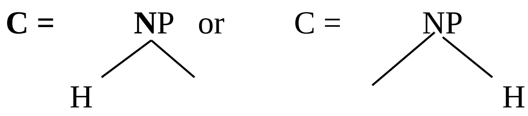
The cats $\rightarrow$ Semantically plural: $\langle \sigma(^*CAT_{w,t}), \mathbf{CAT_{w,t}} \rangle$ Plural base

Semantically singular: $\langle \sigma(^*CAT_{w,t}), \mathbf{\{\sigma(^*CAT_{w,t})\}} \rangle$ Singular base

See discussion in: Landman [I-promised-Hana-I-write-it-this- month].

4. Compositionality: The head principle [Landman 1016]

Head principle for NPs: Let C be a complex NP with **head** NP H:



and let: $C = <\mathbf{body}(C), \mathbf{base}(C)>$ $H = <\mathbf{body}(H), \mathbf{base}(H)>$

then: $\mathbf{base}(C) = (\mathbf{body}(C)] \cap \mathbf{base}(H)$
the **base of the complex** =
the **set of all parts of body**(C) **intersected** with the **base of the head**

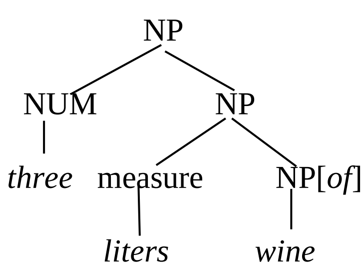
Head Principle for NPs:
Base information is passed up **from the head** NP **to the complex** NP
both for modification (adjuncts) or complementation (classifiers) structures.

Fact: If $\mathbf{base}(H)$ is **disjoint**, then $\mathbf{base}(C) = (\mathbf{body}(C)] \cap \mathbf{base}(H)$ is **disjoint**.

Corollary: Mass-count

The mass-count characteristics of the head inherit up to the complex:
Complex noun phrases are count if the head is count.
Complex noun phrases are mass if the head is mass.

5. classifiers interpretations of measures [Landman 1016, Khrizman et. al. 2015]



NP[*of*] *wine* $\rightarrow WINE_{w,t} = <\text{WINE}_{w,t}, \mathbf{base}(WINE_{w,t})>$
Measure: *liter* $\rightarrow LITER_{w,t} = <\mathbf{liter}_{w,t}, \mathbf{base}(LITER_{w,t})>$ [see below]

Classifier interpretations [for details see Khrizman et. al. 2015, Landman 2016]

5.1. Container classifier interpretation of measure *liter.*

(1) I broke a liter of milk.

-Function **contents** maps at w,t containers onto their contents.
Parametrized for context, container and contents properties:

$\mathbf{contents}_{\mathbf{c,glass,wine,}w,t}(x) = y$
the contents of glass x at w,t is body of wine y [discussion in Landman 2016]

-Property $\text{CONTAINER}_{\mathbf{c}}$ maps index w,t onto **disjoint** set of containers: $\text{CONTAINER}_{\mathbf{c,}w,t}$
What counts as a container in c is determined by context c.

We shift i-set ***LITER*** to i-set ***ONE-LITER-CONTAINER***

***ONE-LITER-CONTAINER* =** $<\mathbf{base}_P, \mathbf{base}_P>$

$\mathbf{base}_p = \lambda x.\ \text{CONTAINER}_{c,w,t}(x) \wedge \mathbf{body}(P)(\mathbf{contents}_{c,w,t}(x)) \wedge \mathbf{liter}_{w,t}(\mathbf{contents}_{c,w,t}(x))=1$
The set of containers whose contents is body(*P*) and whose contents measures one liter.

Fact: The classifier container interpretation of *liter* is **count**:
Reason: $\mathbf{base}_p$ is formed through **intersection with disjoint** set $\text{CONTAINER}_{c,w,t.}$

We form a **classifier interpretation** (abstracting over *P*): a function from i-sets to i-sets.
Details of the compositional derivation in Landman 2016. We derive:

liter of wine $\rightarrow <\mathbf{base}, \mathbf{base}>$
$\mathbf{base} =$
$\lambda x.\ \text{CONTAINER}_{c,w,t}(x) \wedge \text{WINE}_{w,t}(\mathbf{contents}_{c,w,t}(x)) \wedge \mathbf{liter}_{w,t}(\mathbf{contents}_{c,w,t}(x))=1$
The set of containers whose contents is *wine* and whose contents measures one liter.

Fact: *liter of wine* on the container-shifted interpretation is **singular count**.

5.2. Portion interpretation of measure *liter.*

Portion shift: *patat*-french fries is a mass noun in Dutch.

(2) [Ordering french fries in Amsterdam]:
Drie *patat*, alstublieft, één met, één zonder, en één met satésaus.
Three *french fries*[mass], please, one with mayonnaise, one without sauce and one with peanut sauce.

-Property PORTION$_c$ maps index w,t onto **disjoint** set of portions: PORTION$_{\mathbf{c},w,t}$
What counts as a portion in c is determined by context c.

Mass: *patat* $\rightarrow$ <PATAT$_{w,t}$, **base**(*PATAT*$_{w,t}$)>

Singular count: *patat* $\rightarrow$ < **base**, **base** >
base = $\lambda x.PORTION_{c,w,t}(x) \wedge PATAT_{w,t}(x)$
The set of portions of french fries

(3) He drank *three **liters** of Soda pop*, one in the morning, one in the afternoon, one in the evening.

We shift ***LITER*** to ***ONE-LITER-PORTION***:

***ONE-LITER-PORTION* =** <**base**$_P$, **base**$_P$>

base$_p$ = $\lambda x.$ PORTION$_{\mathbf{c},w,t}(x) \wedge$ **body**$(P)(x) \wedge$ **liter**$_{w,t}(x)=1$
The set of body(*P*)-portions that measure one liter.

Fact: The classifier portion interpretation of *liter* is **count**:
Reason: base$_p$ is formed through intersection with **disjoint** set PORTION$_{c,w,t}$

The same compositional derivation as above derives:

liter of wine $\rightarrow$ <**base**, **base**>
base = $\lambda x.$ PORTION$_{c,w,t}(x) \wedge$ WINE$_{w,t}(x) \wedge$ **liter**$_{w,t}(x)=1$
The set of portions of wine that measure one liter.

Fact: *liter of wine* on the portion shifted interpretation is **singular count**.

6 Measure interpretations are mass [Rothstein 2011, Landman 2016]

Background: Partitives with singular DPs patterns with partitives with mass DPs:

(4) a. ✓*much*/#*each* of the wine
b. ✓*much*/#*one* of the cat

Landman 2015ms: if we assume that the semantics of partitives disallows singular i-objects, then partitives with singular DPs become felicitous by *shifting* the singular object to a mass object (by changing the base): *opening up* internal structure:

(5) After the kindergarten party, ***much of my daughter*** was covered with paint.
(shift opening up the surface area of my daughter + *much* – area measure)

This shift is obligatory for partitives with singular DPs. Plural cases *can* be found:

(6) While our current sensibilities are accustomed to the tans, taupes, grays and browns, in their time ***much of the rooms*** as well as the cathedral proper would have been beautifully painted. [γ] [γ] means: googled

But plural cases are rare, and not everybody (e.g. Susan Rothstein) accepts cases like (6).
Crucial here: sharp contrasts between plural opening up (7b) and measure phrases (7c):

(7) a. #*Much* ball bearings was sold this month.
b. #?*Much* of the ball bearings was sold this month.
c. ✓*Much* of the ten *kilos* of ball bearings was sold this month.

So: the felicity of (7c) is not to do with *opening up* (as in (7b), but with the measure phrase.
Cf. also (8) (based on examples from Rothstein 2011):

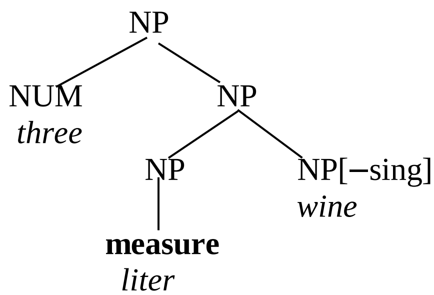
(8) a. **Many** *of the twenty kilos of potatoes* that we sampled at the food show were prepared in special ways. **20 one kilo-size portions - count**
b. **Much** *of the three kilos of potatoes* that I ate had an interesting taste.
potatoes to the amount of 3 kilos - mass

So partitive NPs with measure phrases pattern with mass nouns.

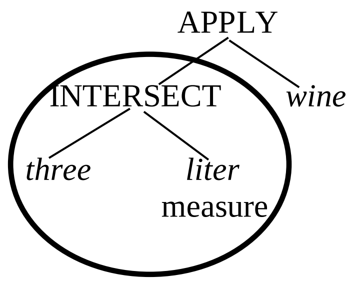
7. Semantics of measures [Landman 2016]

7.1. The body of the measure and the body of the measure phrase

Classifier structure:



Measure interpretation:



body of the measure phrase: interpretation with **function composition**:

(**numerical** ∘ **measure**) ∩ **complement**.
three *liter* *wine*

three composes with *liter*, the result intersects with *wine*

base of the measure phrase: head principle base(*C*) = **(body**(*C*)**]** ∩ **base**(*H*)

three → $\lambda n.n{=}3$ number predicate
liter → $LITER_{w,t}$ = <**liter**$_{w,t}$, **base**($LITER_{w,t}$)> (see below)
wine → $WINE_{w,t}$ = <$\text{WINE}_{w,t}$, **base**($WINE_{w,t}$)>

(**numerical** ∘ **measure**) ∩ **complement**.
($\lambda n.n{=}3$ ∘ **liter**$_{w,t}$) ∩ $\text{WINE}_{w,t}$ =
$\lambda x.$ **liter**$_{w,t}(x){=}3 \wedge \text{WINE}_{w,t}(x)$
The set of objects that are wine and measure three liters

three liters of wine → <**body**, **base**>
body = $\lambda x.$ **liter**$_{w,t}(x){=}3 \wedge \text{WINE}_{w,t}(x)$
Wine to the amount of three liters

7.2. The base of the measure and the base of the measure phrase

Body of the measure: measure function $\textbf{liter}_{w,t}$: $B \rightarrow R^{+}$
function from objects to positive real numbers = **set of object-number pairs**

We lift the Boolean structure from **B** to the relevant domain of object-number pairs.

- $\textbf{dom}(\textbf{liter}_{w,t}) = \{b \in B: \textbf{liter}_{w,t}(b) \neq \bot\}$, the set of objects for which $\textbf{liter}_{w,t}$ is defined.
- $\sqcup\textbf{dom}(\textbf{liter}_{w,t})$ is the maximal object for which $\textbf{liter}_{w,t}$ is defined.
- $(\sqcup\textbf{dom}(\textbf{liter}_{w,t})]$ is the set of all its parts.
- $B_{\textbf{liter},w,t}$ is the set pairs consisting of all objects in that set plus their $\textbf{liter}_{w,t}$ value:

$$B_{\textbf{liter},w,t} = \{<b,r>: b \in (\sqcup\textbf{dom}(\textbf{liter}_{w,t})] \text{ and } r \in R^{+} \cup \{\bot\} \text{ and } \textbf{liter}_{w,t}(b)=r\}$$

The relations and operations are given by:

$$<x,n> \sqsubseteq_{B_{\textbf{liter},w,t}} <y,m> \quad \text{iff} \quad x \sqsubseteq_{B} y \qquad (n,m \in R^{+} \cup \{\bot\})$$
$$<x, \textbf{liter}_{w,t}(x)> \sqcup_{B_{\textbf{liter},w,t}} <y, \textbf{liter}_{w,t}(y)> \quad = \quad <x \sqcup_{B} y, \textbf{liter}_{w,t}(x \sqcup y)>$$

We add operation $\uparrow$ and $\downarrow$ that shift between sets of objects and sets of object-measure value pairs in the obvious way:

$$\text{For } X \subseteq B: \quad {}^{\uparrow}X = \{<x,r>: x \in X \text{ and } \textbf{liter}_{w,t}(x) = r\} \qquad (r \in R^{+} \cup \{\bot\})$$
$$\text{For } Z \subseteq B_{\textbf{liter}.w,t}: \quad {}^{\downarrow}Z = \{x \in B: \exists r[\ <x,r> \in Z \text{ and } \textbf{liter}_{w,t}(x) = r]\}$$

Iceberg semantics of measures: **idea:** we follow Iceberg semantics **literally**:

The **body of the measure** is a set of object-measure value pairs: $\textbf{liter}_{w,t}$
The **base of the measure** is a set of object-measure value pairs that **generates the body of the measure under sum $\sqcup_{B_{\textbf{liter}}}$:**
$\textbf{base}(LITER_{w,t}) \subseteq \textbf{liter}_{w,t}$ and $\textbf{liter}_{w,t} \subseteq {}^{*}\textbf{base}(LITER_{w,t})$.

7.3 Continuous additive measures are mass

$\mathbf{liter}_{w,t}$ is an additive and continuous measure.

Additivity:
$\mathbf{liter}_{w,t}(x \sqcup y) = \mathbf{liter}_{w,t}(x - y) + \mathbf{liter}_{w,t}(y - x) + \mathbf{liter}_{w,t}(x \sqcap y)$

This has the consequence that if x and y are disjoint, $\mathbf{liter}_{w,t}(x \sqcup y) = \mathbf{liter}_{w,t}(x) + \mathbf{liter}_{w,t}(y)$

For our purposes I will formulate continuity as follows:

Continuity:
if $x \sqsubseteq y$ and $\mathbf{liter}_{w,t}(x) < \mathbf{liter}_{w,t}(y)$ then for every $r \in \mathbf{R}^+$:
if $\mathbf{liter}_{w,t}(x) < r < \mathbf{liter}_{w,t}(y)$ then $\exists z \in D$: $x \sqsubseteq z \sqsubseteq y$ and $\mathbf{liter}_{w,t}(z) = r$

When a body grows from x with volume n to y with volume m, its volume passes through *all* intermediate values.

This has direct consequences for the base:

Let $x \sqsubseteq y$ and $\mathbf{liter}_{w,t}(y) = \mathbf{liter}_{w,t}(x) + \mu$, where μ is tiny. Then, by additivity $\mathbf{liter}_{w,t}(y - x) = \mu$

Hence, given additivity, continuity entails:

If $\mathbf{liter}_{w,t}(x)= m$ then for **all** $n \in R^+$: if $n < m$ there is **some part** $z \sqsubseteq x$: $\mathbf{liter}_{w,t}(x)=n$
Body x with volume m has parts with volume n for every $n \in \mathbf{R}^+$ with n < m.

This has the consequence that:

Fact: If $\mathbf{base}(LITER_{w,t})$ is disjoint and $\mathbf{liter}_{w,t}(x)=m$ then $\langle x,m\rangle \notin \mathbf{base}(LITER_{w,t})$.
A *disjoint* base for a continuous measure can only contain pairs of the form $\langle x,\perp\rangle$.

Proof: Assume $\mathbf{base}(LITER_{w,t})$ is disjoint and $\mathbf{liter}_{w,t}(x)=m$, $m \in R^+$ and $\langle x,m\rangle \in \mathbf{base}(LITER_{w,t})$.
Take $n \in R^+$ such that $n < m$. There is some part $y \sqsubseteq x$ with $\mathbf{liter}_{w,t}(y)=n$.
$\langle y,n\rangle$ must be generated under $\sqcup$ by $\mathbf{base}(LITER_{w,t})$.
But this can only be from parts of x and those parts overlap x.
Thus $\mathbf{base}(LITER_{w,t})$ won't be disjoint. Contradiction.

Does this show that the base of the measure cannot be disjoint? Not by itself.

-The theory does not disallow '**infinitesimal point objects**':
atoms (points) such that volume is undefined for *them* and for their *finite* sums, but *is* defined for *infinite* sums.

-Think of models for space and time (e.g. Tarski's algebra of solids for Euclidian geometry).
As is well know, we can represent time intervals and space solids as infinite sets of point: regular open sets of **points.**

-If we were to generalize this to matter, and allow infinitesimal matter points, we might be able to generate all measure values from a disjoint set of points just with $\sqcup$.

But note: these would not be points of time, space, space-time,
they would be **points of matter**: Demokritos resurrected.

Origins of Iceberg semantics: Seminar I taught in 2001 at Tel Aviv University (Landman 2001$\rightarrow$)
Inspired by concerns about **homogeneity for mass nouns** in the earlier literature.

Homogeneity for mass nouns gives simultaneously not enough parts and too many parts.
Reason: homogeneity is defined vertically (down).

Not enough parts: Lønning 1987.
Homogeneity: all parts of water are water: $\text{WATER}_{w,t} = (\text{WATER}_{w,t}]$
-all parts of yellow water are yellow water:

$$\text{YELLOW}_{w,t} \cap \text{WATER}_{w,t} = (\text{WATER}_{w,t} \cap \text{YELLOW}_{w,t}]$$

Observation: Homogeneity forces you to **disregard natural parts** in the domain:
-parts of water that are too small to count as water do not stand in relation $\sqsubseteq$ to *the water*
-parts of yellow water that are too small to count as yellow do not stand in $\sqsubseteq$ to *the yellow water*.

Too many parts: Bunt, ter Meulen, Landman 1991 (and many others).
Divisibility: **Semantically**, all parts of water are water, and semantics is not committed to atoms (semantics $\neq$ physics)
Observation: Homeopathic semantics: divisibility leads assuming **non-natural parts:**

(9) There is salt on the objective of the microscope, *[one molecule worth]* [Landman 2011]

Divisibility requires that the denotation of mass noun *salt* **also in (9)** divides into **parts that are salt:** it's salt all the way down. But nature doesn't have such parts (Homeopathic semantics).

Iceberg semantics:
Try to develop the semantics of mass nouns and count nouns in naturalistic structures
Try not to *disregard* natural parts and structure. Try not to *include* non-natural structure.

Iceberg semantics *rejects* vertical notions of homogeneity for mass nouns.
Iceberg semantics: noun denotations are icebergs:

the denotation of *cats* **floats** on parts of cats that are too small to count as *cat*.
the denotation of *water* **floats** on parts of water that are too small to count as *water*.
the denotation of *yellow water* **floats** on parts that are too small to count as *yellow water*.

(cf. similar discussion about incremental homogeneity in the aspectual domain for *activities* in Landman and Rothstein 2012.)

If iceberg semantics includes in the domain naturalistic parts of water than are not themselves water, then Iceberg semantics has no place for non-naturalistic parts like matter points:

Iceberg semantics *rejects* Democritian atoms of matter.

Conclusion: In iceberg semantics the base of a continuous additive measure is not disjoint.
Hence: Continuous additive measures are mess mass.

What is **base**($LITER_{w,t}$)?
Suggestion (Landman 2016):

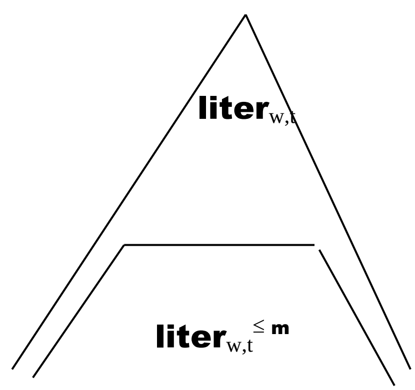
Let $\mathbf{m}_{\mathbf{liter},w,t}$ ($\mathbf{m}$ for short) be a **contextually** given measure value.

For instance, think of $\mathbf{m}$ as the lowest volume that our experimental precision weighing scales can measure (but not the lowest value defined).

$\mathbf{liter}_{w,t}^{\leq \mathbf{m}} = \{\langle x,n\rangle: \mathbf{liter}_{w,t}(x) = n \text{ and } n \leq \mathbf{m}\}$ (r,m $\in$ R^+)
The set of object-liter value pairs where the liter value is less than or equal to $\mathbf{m}$

We set: $\mathbf{base}(LITER_{w,t}) = \mathbf{liter}_{w,t}^{\leq \mathbf{m}}$

$\mathbf{liter}_{w,t}^{\leq \mathbf{m}}$ is closed downward and hence a heavily overlapping base.
Since ***all*** pairs <d,n> with $n \leq \mathbf{m}$ are in $\mathbf{liter}_{w,t}^{\leq \mathbf{m}}$, $\mathbf{base}(LITER_{w,t})$ has no problem generating all elements with higher volume value as (infinite) sums of base elements with ⊔:
$\mathbf{liter}_{w,t} \subseteq {}^*\mathbf{base}(LITER_{w,t})$.



7.4. Measure phrases

We keep track of the measure in the base of the measure phrase, so that we can access it later.

This means: **base** of the measure phrase: **set of object-measure value pairs.**
body of the measure phrase: **set of objects**.
Measure phrases are **$i^{\downarrow}$-sets**: $^{\downarrow}$**base** generates **body** under $\sqcup$.

three liters of wine :
body = $\lambda x.\mathbf{liter}_{w,t}(x)=3 \wedge WINE_{w,t}(x)$
Objects *that are wine* and have volume three liters
base = $\{<y,n>: \exists x[WINE_{w,t}(x) \wedge y \sqsubseteq x \wedge n \leq \mathbf{m}_{\mathbf{liter},w,t}]\}$
$^{\downarrow}$**base**: **objects *that are part of wine* and have volume at most $\mathbf{m}_{\mathbf{liter},w,t}$**

Fact: *three liters of wine* on the measure interpretation is **mess mass**.

Reason: $^{\downarrow}\mathbf{base}(LITER_{w,t})$. $= \lambda x.\ \mathbf{liter}_{w,t}(x) \leq \mathbf{m}$ is not disjoint..
When we intersect, we intersect this base with **the Boolean part set of** the stuff that is wine and has volume three liters. This intersection is, of course, not disjoint either, and, in fact, closed downwards, so it doesn't have a set of minimal elements (above 0).

three kilos of potatoes:
body: $\lambda x.\mathbf{kilo}_{w,t}(x)=3 \wedge {}^{*}POTATO_{w,t}(x)$
***sums of potatoes* that weigh 3 kilos.**
$^{\downarrow}$**base**: $\lambda y.y \sqsubseteq \sqcup(\lambda x.{}^{*}POTATO_{w,t}(x) \wedge \mathbf{kilo}_{w,t}(x)=3]) \wedge \mathbf{kilo}_{w,t}(y) \leq \mathbf{m}_{\mathbf{kilo},w,t}]\}$
***Parts* of the sum of potatoes that weigh less than m kilo.**

three kilos of potatoes is mass: the body – a sum of potatoes – is **mass** relative to this base: the set of **potato-parts** that measure up to value $\mathbf{m}_{\mathbf{kilo},w,t}$, is not disjoint.

This is so, **despite the fact**, that the body consists of sums of (whole) potatoes.

Example from Landman 2016: Dutch count noun *bonbon* in (10):

(10) *[at Neuhaus in the Galerie de la Reine in Brussels]*
Customer: Ik wou graag 500 gram bonbons. *Shop assistant:* Eén meer or één minder?
I would like 500 grams of pralines. One more or one less?

💣Ah, just squeeze enough into the box so that it weights exactly 500 grams.
(💣 = *faux pas*)

Rothstein's observation: measure phrases are mass.
Semantics of partitive *of the three kilos of potatoes*, access the measure function $\mathbf{kilo}_{w,t}$ via the base.
Mass measure reading of the partitive is accessed via the measure base of the partitive.

8 Mass and count – Measuring and counting

8.1 Mess mass nouns

Count nouns: body generated from a disjoint base.
Neat mass nouns: body generated from a base which is itself generated from a disjoint subset.
Mess mass nouns: body generated from an overlapping base which is not itself generated from a disjoint subset.

This means: different ways in which mess mass nouns can be mess mass.

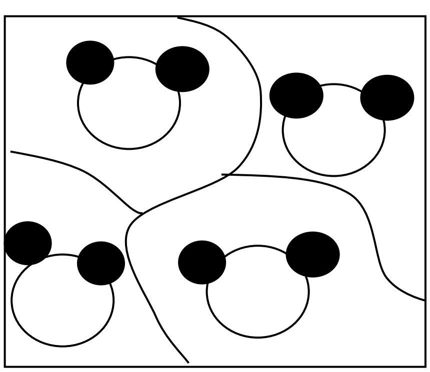
Link 1983: mass = non-atomic Landman 1992: mass = atomless
Chierchia 1998: neat mass nouns are atomic
Landman 2001→: **mass-count distinction:**
not vertical (atomic versus atomless), **but horizontal** (disjointness versus overlap)
Landman 2011: try to stay close to Chierchia 1988 also for mess mass nouns:
count: **base** disjoint
neat mass: **base** overlaps but **min**(**base**) disjoint
mess mass: **min**(**base**) overlaps

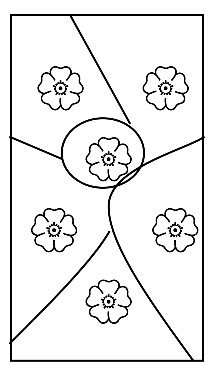
Problem: this presupposes that for all noun denotations **min**(**base**) is defined.

-OK for certain examples, cf. discussion of contextual minimal parts of *meat* in Landman 2011.
– Not OK as a theory for all mess mass nouns.
e.g. continuous additive measures are mess mass, but **min**(**base**) is not defined.

Change from Landman 2011: Now that the theory is safely grounded in the horizontal distinction (overlap versus disjointness), there **is not reason to disallow** atomless structures or atomless denotations for mess mass nouns.

Re-assessment of the discussion of mess mass nouns like *bloemetjes behang- flower patterned wallpaper* and *water*. **fig 1** **fig 2**





Water

Landman 2001→, 2011: Semantic domains are postulated to **share** a reality with physics: it is extravagant to postulate semantic models that are **actually incompatible** with physics, incompatible with molecule based structures.

Natural perspective of mess mass stuff : repeating the same building blocks on and on *bloemetjes behang*: built from repeating the same building block.

Landman 2011: the denotation of **water** is not a set of water molecules, but a **structure of water molecules and space** (around and inside) the water molecules.

Building blocks: Form a partition of the water into blocks that each contains exactly one water molecule, as in **figure 1** above.

> **BB**(π,x): **π is a partitioning of** x **into building blocks:**
> **BB**(π, $\sqcup$(WATER$_{w,t}$)) iff π is a partition of $\sqcup$(WATER$_{w,t}$) and each block of π consists of one water molecule and space.
>
> **base**(*WATER*$_{w,t}$) = $\lambda x.\exists\pi$[**BB**(π, $\sqcup$(WATER$_{w,t}$)) $\wedge$ x $\in \pi$]
> **The union of all the partionings of the water into building blocks.**

Similar for *bloemetjes behang*: we can identify the generating base objects easily: they consist of one flower and space.

Landman 2011 suggested that this set could be taken as the minimal set generating *water*. However:

Fact: **base**(*WATER*$_{w,t}$) does not have minimal elements.
Proof: This just follows from the continuity and density of space:

> Let x $\in$ **base**(*WATER*$_{w,t}$). Then x $\in \pi_1$, and x consists of space and one molecule **h$_2$o.**
> Clearly there is another partition π_2 that reduce the space around (or inside) **h$_2$o** a little and adds the space taken away to some other block.
> This gives y $\in \pi_2$ with y $\sqsubseteq$ x and y consists of space and one molecule **h$_2$o**
> hence y $\in$ **base**(*WATER*$_{w,t}$).
> The continuity and density of space tells us that we can always reduce elements in the base, hence there is no set **min**(**base**(*WATER*$_{w,t}$))

This is not a problem in the present version of Iceberg semantics, where we derive:

Fact: If *water* → <WATER$_{w,t}$, **base**(WATER$_{w,t}$)>, *water* is **mess mass.**

Iceberg semantics: mass and count are or can be **different perspectives** on the same concrete objects (say, water molecules).

Count, or neat mass perspective:
Fixes a disjoint base (individual water molecules), and **ignores in the generation set** the spatial setting [or counts water molecule + space-objects relative to *one* presupposed partition].

Mess mass perspective:
Mess mass base gives **the different ways** you can regard the concrete object as made up from molecules and space: the space subdivisions **enter into the part-of structure and the calculation of the whole.**

The latter perspective is necessary if you want to **measure**, say, the volume of the whole.

8.2 Domains for measuring

Continuous additive measures look, by definition, at continuous aspects of concrete objects.
We showed that these measure are mess mass in Iceberg semantics.

How do we apply measures to noun phrase denotations?

We have a set of knives, spoons, and forks with medallions on the handle. They look silver, but …

(11) a. *Not much* of the spoons is silver, only the medallions are.
b. *Not much* of the flatware is silver, only the medallions are.

-The body and base of the denotation of *spoons* and *flatware* contain flatware items and their sums. Out of the blue, the same is true for the denotations of the partitive noun phrases *of the spoons* and *of the flatware*.

The measure quantifier *not much* in (11) picks out the maximal element in the noun phrase denotation that is silver (ignoring an irrelevant non-conservative reading).

Problem: that object is the sum of the medallions on the handles, and it is not in the noun phrase denotation.

Conclusion: when partitive noun phrases combine with measures their denotation shift to a **measurable denotation** which is mess mass.

We define two categories:

Let X = <**body**(X), **base**(X)> be an i-set.
X is **measurable** if continuous additive measures are defined for X (without shift).
Fact: measurable i-sets are mess.

X is **countable** if **card** is defined on X (without shift).
X is countable if the cardinality function is defined for X.
Fact: countable i-sets is are count.

On this perspective: **measurable nouns** are a subclass of mess nouns
countable nouns are a subclass of neat nouns

Rothstein 2016 suggests a stronger connection:

Count is a perspective on which concrete objects can be counted, not measured.
Mass is a perspective on which concrete objects can be measured, not counted.

Rothstein: This means that count comparison for neat mass nouns must be distinguished from count comparison for count nouns: e.g. count comparison measure that isn't **card**.

Iceberg semantics allows this identification, but is not committed to it:
I give a different account of count-comparison for mass nouns in section 9.3.

Still two conceptual bases:

-conceptual distinction between *stuff* and *things*.
-conceptual distinction between *measurable* and *countable*.

We usually take the first distinction to feed into the linguistic mass-count distinction
(Languages decide to yes or no distinguish between stuff and things.)
But, Susi Lima's findings about Yudja suggest that languages can tie in to the second distinction
(Languages decide to yes or no distinguish between measurable or countable):
In Yudya all nouns are countable, and Yudja does provide any means for measuring.

9 Mess mass, grids and portions

9.1. Portion shift for mass nouns

Portion shift: *patat*-french fries is a mass noun in Dutch.

(2) [Ordering french fries in Amsterdam]:
Drie *patat*, alstublieft, één met, één zonder, en één met satésaus.
Three *french fries*[mass], please, one with mayonnaise, one without sauce and one with peanut sauce.

Thus, mess mass noun *patat* is shifted in context to a singular count noun *patat*:

Mess mass:
patat $\rightarrow$ <$\text{PATAT}_{w,t}$, **base**($PATAT_{w,t}$)>
Portion shift: singular count
patat $\rightarrow$ <**base**, **base**>
where: **base** = $\lambda x.\text{PORTION}_{c,w,t}(x) \wedge \text{PATAT}_{w,t}(x$
the set of portions of french fries.

(There may be complex syntactic structure involved as well: no plural marking ends up on the lexical item *patat.*)

Fact: $\lambda x.\text{PORTION}_{c,w,t}(x) \wedge \text{PATAT}_{w,t}(x)$ is a **partition** on $\sqcup(\lambda x.\text{PORTION}_{c,w,t}(x) \wedge \text{PATAT}_{w,t}(x))$

-Portioning french fries goes into portions of contextually determined size:
small – medium – large.
-Portioning does not need to partition all of the french fries: not all french fries comes in portions.

Grids for mess mass nouns

Let P be a mess mass i-set.

Property $\text{GRID}_{\mathbf{c},P}$ maps index w,t onto **disjoint** set of portions: $\text{GRID}_{\mathbf{c},P,w,t}$
where the portions are **prototypical, naturalistic** units (with respect to a single set of criteria).

A grid divides a mess mass denotation α into units that are all prototypical for α, and prototypical in the same way.

$\mathbf{grid_c} = \lambda P.$ <$\mathbf{base}_{\mathbf{c},P}$, $\mathbf{base}_{\mathbf{c},P}$>
where: $\mathbf{base}_{\mathbf{c},P} = \lambda x.\text{GRID}_{\mathbf{c},P,w,t}(x) \wedge \mathbf{body}(P)(x)$

Not a grid: The portioning of *french fries mass* into portions in a drench fries shop.
The portions **are not** prototypical, naturalistic for french fries.
Yes a grid: A portioning of *french fries* mass into *individual sticks*:
The portions **are** prototypical naturalistic for french fries.

In fact, in Dutch, *patat* is ambiguous between a mass noun and a singular count noun:

(12) a. Ik heb te veel patat gegeten.
I have eaten too much patat[mass]
b. Mag ik een patat proeven, één patat?
Can I taste one single french fry stick.

Many nouns, and especially food stuff nouns, are ambiguous between **mess mass** and **count**:

$[_{noun}\ \alpha] \rightarrow$	X = < **body**(X), **base**(X)>	**mess mass**
	$\mathbf{grid_c}(X)$	**singular count**

To allow the theory to be neutral about the direction of the connection I formulate the inverse relation as well. [I formulate connections between **mess mass** and **count**, this is easily reformulated as a connection between **mess mass** and **neat**].
To avoid the term **grind,** I will use the term **ungrid** to refer to the inverse of a particular grid:

ungrid: Let P be a mess mass i-set and let Q be the singular count i-set: $\mathbf{grid_c}(P)$
$\mathbf{ungrid_c}(Q)$ = P

[This is, of course, assumed to be disambiguated by the context]

Thus, the ambiguity between **mess mass** and **count** can also be expressed as:

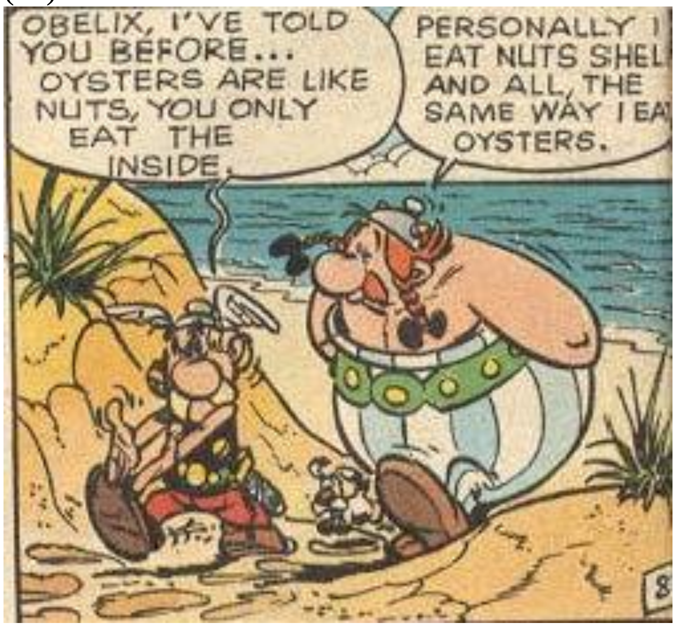
$[_{noun}\ \alpha] \rightarrow$	X = < **base**(X), **base**(X)>	**singular count**
	$\mathbf{ungrid_c}(X)$	**mess mass**

Many mess mass nouns come with natural grids,
Many singular count nouns come with natural ungrids.

So*: Banana* means *banana stuff* or *singular banana*, the guy that comes in a yellow peel.
The theory does not force a perspective on which is basic and which is derived.

[The theory actually **does** include the **peel** in the banana stuff: the fact that we don't eat the peel is a matter of contextual restriction, as suggested in (13) from Goscinny and Uderzo 1966:

(13)



]

The theory does not **force** lexicalization to go one way or the other:

rice (mass) grows on pants in the form of grid ***grains of rice*** (count)
-ungrid ***peanut*** (mass) grows on plants in the form of ***peanuts*** (count)
[where one can count the pod as one peanut – when you pick the peanuts off the plant - but also each seed]
pasta (mass) is shaped in the form of ***noodles*** (count).

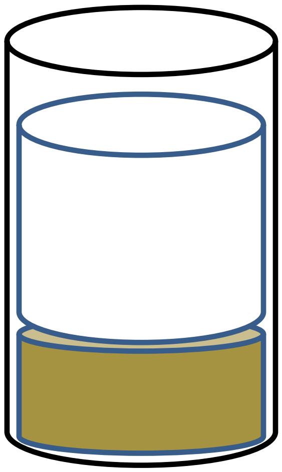
But, it is not an accident that grids of **rice/pasta mass** are lexically or productively accessible.

No reduction: the categories mass and count are **not defined** in terms of the other via grid or ungrid

-It is reasonable that **some** count nouns **are** defined as **grids** in mess mass nouns:
the diminutive in Dutch maps mass nouns onto count nouns, often grids:
een kaasje is a very small wheel of kaas-cheese.
-It is not reasonable to assume that **all** count nouns are defined that way: a *cat* is not a portion of cat-stuff, with underlying mass noun *cat*. There is no **underlying** mass noun.
-It is reasonable that **some** mess mass nouns are defined as **ungrids** of neat mass nouns – say, foodstuffs, where the mushed meaning is not very common, like *pear*.
-It is not reasonable that **all** mess nouns are defined this way.

9.2. Count comparison for mass nouns

Look at the following container:



Cf. (14):

(14) a. Most rice is brown.
b. Most of the rice is brown.

Judgement: Out of the blue, (14) is false.
Mass comparison in terms of volume, not count comparison.

But: If we set up the context carefully, we can trigger count readings.
[Susan Rothstein, Peter Sutton p.c.] Example adapted from an example by Peter Sutton:

For the game we hid very small grains of brown rice and very large grains of white rice (to make it not too difficult for the children).
Winner was the one who found the largest number of grains.
Peter was very good at the game, in fact:

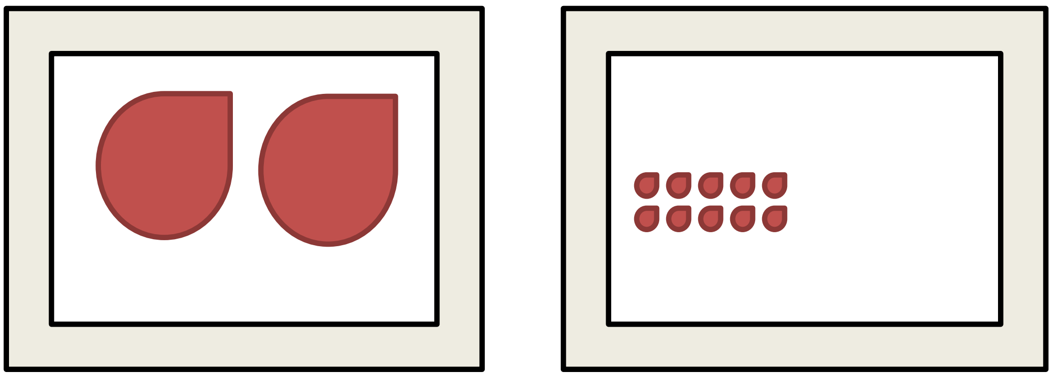
(15) *Most rice* was found by Peter.

Judgement: In this context, (15) is true.
Count comparison in terms of number of grains.

Count readings via portions.
[Note: one may expect the possibility of the shifts discussed in this section to vary across languages. Since at the workshop, the examples in question did not come easily to several of the native speakers of English, I will for the paper use Dutch examples. Searches on the web show that the judgements reported here are quite unproblematic for Dutch. For the points that I am making this is sufficient: I am not here trying to explain why you don't get the readings in question, if you don't; I am trying to explain what you do get, if you do get anything.]

Out of the blue. Below are the display compartments of our butcher shop.

Left compartment: hunks of veal **Right compartment:** hunks of baby duck.



(16) a. Most meat is in the right hand side compartment.
b. Most of the meat is in the right hand side compartment.

Judgement: Out of the blue in this context (16) is false.
Mass comparison in terms of volume, not count comparison.

But, again, we can create a context for **count comparison via hunks (portions).**

You have ordered the above hunks for the Festive Dinner for your Traditional Family of the Father, the Mother, and the ten children.
However, I have to call you with the disaster message:
The hunks of baby duck were found out to be infected and can't be sold.

(17) There is a problem with your order, ***most of the meat*** had worms in it, we had to throw it out and we can't order new in time.

Judgement: In this context, (17) is true.
Count comparison in terms of number of hunks.

Count readings for neat mass nouns versus mess mass nouns:
Neat mass nouns:
Count-comparison is normal and easy for neat mass nouns [Barner and Snedeker 2005]
Mass-comparison requires context [shift to measure structure] .

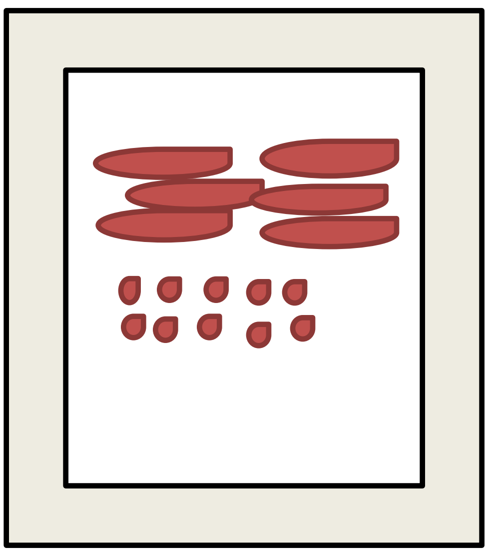
Mess mass nouns:
Mass-comparison is normal
Count-comparison requires context [portion shift] .

Additional evidence for portion shift: stubbornly distributive adjectives
[Rothstein 2011, Schwarzschild 2009]

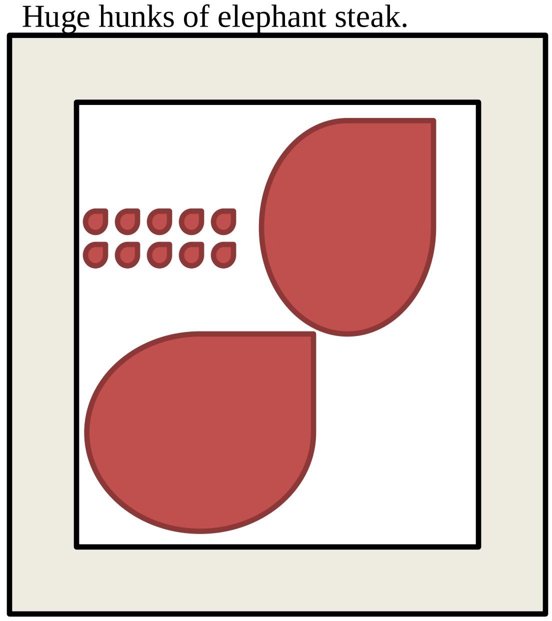
Stubbornly distributive adjectives: *big*

(18) a. The *noisy* boys = ✓the boys that are noisy | ✓the noisy group of boys
b. The *big* chairs = ✓the chairs that are big | ×the big group of chairs
c. The *big* furniture = ✓the pieces of furniture that are big
d. #The big meat **out of the blue infelicitous**

Left compartment:
Small hunks of baby duck
Big hunks of pork



Right compartment: Exotic meant
Small hunks of baby penguin
Huge hunks of elephant steak.



(19) a. Most big meat is in the left hand compartment.
b. Most of the big meat is the left hand compartment.

Judgement: In this context, (19) is true.
Count comparison in terms of number of big hunks.

Difference with (17-18) versus (19):
-(18) is felicitous because we created a context in which counting hunks was relevant.
-(19) is felicitous **without a counting context.**

Explanation:
big requires a count or neat mass noun complement, but is given a mess mass complement.

Portion shift must take place to make *big* felicitous.
The portion shift that makes *big* felicitous, makes counting accessible, and (19) is true.
No further counting context is needed.

9.3 The challenge of distribution and count comparison for mass nouns

(2) [Ordering french fries in Amsterdam]:
Drie *patat*, alstublieft, één met, één zonder, en één met satésaus.
Three *french fries*[mass], please, one with mayonnaise, one without sauce and one with peanut sauce.

In (2) portion shift turns a **mass noun** *patat* into a **count noun** *patat*.

-This is **not** what happens when distributive adjectives combine with mass nouns:
-Mass nouns modified by distributive adjectives stay mass.
-This is **not** what happens in count comparison of mass nouns:
-Mass nouns in contexts of count comparison stay mass.

(20) a. The big meat is in the left hand compartment, the small meat in the right hand compartment.
b. #Three big meat/#many big meat/#three big meats
c. ✓Much of the big meat is camel /#many of the big meat is camel.

(20) shows:

Despite the distribution required by *big, big meat* is as much a mass noun phrase as *meat.*

Explanation in Iceberg semantics:
the head principle: base(C) = **(body**(C)**]** $\cap$ **base**(H)

The head in *big meat* is mass noun *meat*. The head principle predicts that *big meat* is a mass noun.

Hence: In (2), **portion shift affects both body and base.**
In (20) **portion shift only affects the body.**

Proposal: [following in essence Landman 2011]
It is not *meat* that shifts from mass to count,
but *big* shifts from an interpretation that distributes to base-elements to an interpretation that distributes to portions.

[Details in Landman 2015ms, and for neat nouns in Landman [I-promised-Hana-I-write-it-this-month.]

Count:

$big_P = \lambda z.\ \mathbf{body}(P)(z) \wedge \forall a \in (z] \cap \mathbf{base}(P)\text{: } BIG_{w,t}(a)$

Portion shifted mass:

$big_P = \lambda z.\ \mathbf{body}(P)(z) \wedge \forall a \in (z] \cap [\boldsymbol{\lambda x.PORTION_{w,t}(x)} \wedge \mathbf{body}(P)(x)]\text{: } BIG_{w,t}(a)$

So, in the count-meaning of *big*, distribution is to **disjoint** set: **base**(P),
in the portion-shifted meaning of *big*, distribution is to **disjoint** set:
$[\boldsymbol{\lambda x.PORTION_{w,t}(x)} \wedge \mathbf{body}(P)(x)]$

For the **base** of *big meat* we follow the head principle:

big meat → <**body**, **base**>

$\mathbf{body} = \lambda z.MEAT_{w,t}(z) \wedge \forall a \in (z] \cap [\lambda x.PORTION_{c,w,t}(x) \wedge MEAT_{w,t}(x)]\text{: } BIG_{w,t}(a)$
The objects that are meat and the sum of portions of meat.

$\mathbf{base} = (\mathbf{body}] \cap \mathbf{base}(MEAT_{w,t})$

base = **the part set of the sum of all the meat that comes in portions of meat, intersected with the base of meat.**

-This gets the body interpretation correct with *big* distributing to portions.
-This gets the base interpretation correct: *big meat* is mess mass like *meat*.

-*each* distributes to the base and requires the base to be disjoint (hence requires count)
-*big* distributes to a disjoint set.
Count noun: the base
Neat mass noun: contextually relevant set, for instance **min**(**base**).
Mess mass noun: disjoint set introduced via contextual portioning.
Head principle: this does not affect the head of the complex noun phrase:
big boys is count, *big furniture*, *big meat* are mass.

More precisely:
The semantics of $\mathbf{card}_Z$ given above presupposes that Z is a disjoint set. This, by itself, does not make $\mathbf{card}_Z$ an operation that only applies to count i-sets.
The additional assumption about the semantics of *numericals* is that their semantics accesses $\mathbf{card}_{\mathbf{base}(H)}$ and *this* requires the head to be count.
Similarly, we assume the semantics of *big* is formulated in terms of a distributive operator $\mathbf{D}_Z$ which accesses a set Z that is required to be disjoint. This, by itself, does not make $\mathbf{D}_Z$ an operation that only applies to count i-sets. But we assume that *each* and the implicit distributive

operator on count predicates accesses $\mathbf{D}_{\mathbf{base}(H)}$, and this is what brings in the restriction to count predicates.
We make a similar assumption for cardinal comparison: cardinal *most* accesses $\mathbf{card}_Z$, with $_Z$ a disjoint set; for count predicates what is accessed is again $\mathbf{card}_{\mathbf{base}(H)}$.
When we move to the mass domain, what is clear that the settings with Z = **base**(*H*) are not accessible, because **base**(*H*) is not disjoint. This means that. if these operations are accessed in the mass domain, this can *only* be by making some other disjoint set accessible.
In the case of neat mass nouns, various disjoint sets may be accessible in context. One that is always there, by definition of neat mass nouns is: Z = **min**(**base**(*H*)), which *is* disjoint. We expect this to be a natural choice for Z, and we expect that distribution and count comparison relative to **min**(**base**(*H*)) is natural for neat mass nouns. This is, of course, correct.

For mess mass nouns no such natural disjoint set is availble. This meas that *if* distribution and count comparison are available *at all* for mess mass nouns, this only possible to sets that are introduced with contextual care via portion shift.

In sum:
Iceberg semantics, with its compositional analysis of the mass-count distinction in terms of the head principle, is a natural framework to analyze dual mass-count behavior of complex noun phrases, as seen in distributive adjectives and count comparison.

References

Barner, David and Jesse Snedeker, 2005, 'Quantity judgements and individuation: evidence that mass nouns count,' in: *Cognition*, 97**,** pp. 41-66.

Bunt, Harry, 1985, *Mass Terms and Model Theoretic Semantics*, Cambridge University Press.

Chierchia, Genaro, 1998, 'Plurality of mass nouns and the notion of *semantic parameter*,' in: Susan Rothstein (ed.), *Events and Grammar*, p. 52-103, Springer[Kluwer], Berlin.

Krifka, Manfred, 1989, 'Nominal reference, temporal constitution and quantification in event semantics,' in: Renate Bartusch, Johan van Bentham and Peter van Emden Boas (eds.) *Semantics and Contextuel Expression*, pp. 75-115, Foris, Dordrecht.

Khrizman, Keren, Fred Landman, Suzi Lima, Susan Rothstein and Brigitta R. Schvarcz, 2015, 'Portion readings are count readings, not measure readings,' in: Thomas Brochhagen, Floris Roelofsen and Nadine Theiler (eds.), *Proceedings of the 20th Amsterdam Colloquium*, ILLC, Amsterdam.

Landman, Fred, 1991, *Structures for Semantics*, Springer [Kluwer], Berlin.

Landman, Fred [2001→] TAU Seminar, ms., *On the mass-count distinction* – various stages - 2007-version at tau.ac.il/~landman/

Landman, Fred, 2011, 'Count nouns – mass nouns – neat nouns – mess nouns,' in: Michael Glanzberg, Barbara H. Partee and Jurģis Šķilters (eds.), *Formal Semantics and Pragmatics: Discourse, Context and Models. The Baltic International Yearbook of Cognition, Logic and Communication* 6, 2010, http://thebalticyearbook.org/journals/baltic/issue/current

Landman, Fred, 2015ms, *Iceberg Semantics for Mass Nouns and Count Nouns*, accepted, Springer, Berlin.

Landman, Fred, 2016, 'Iceberg semantics for count nouns and mass nouns: classifiers, measures and portions,' submitted to: *The Baltic International Yearbook of Cognition, Logic and Communication*.

Landman, Fred, [I-promised-Hana-I-write-it-this- month], 'Iceberg semantics for count nouns and mass nouns,' promised to: Hana Filip (ed.), *Counting and Measuring in Natural Language*, Cambridge University Press, Cambridge.

Landman, Fred and Susan Rothstein, 2012a,b, 'The felicity of aspectual *for*-phrases Part I and II,' in: *Language and Linguistics Compass* 6/2 pp 85–96 and pp 97–112.

Lima, Suzi, 2014, *The Grammar of Individuation and Counting*, Ph.D. Dissertation, University of Massachusetts, Amherst.

Link, Godehard, 1983, 'The logical analysis of plurals and mass terms: a lattice-theoretic approach,' in: Rainer Bäuerle, Urs Egli and Arnim von Stechow (eds.), *Meaning, Use and the Interpretation of Language*, pp. 303-323, de Gruyter, Berlin.

Lønning, Jan-Tore, 1987, 'Mass terms and quantification,' in: *Linguistics and Philosophy* 10, p. 1-52.

ter Meulen, Alice, 1983, 'Homogeneous and individuated quantifiers in natural language,' in G. Dorn and P. Weingartner (eds.), *Foundations of Logic and Linguistics. Problems and their Solutions*, Springer, Berlin.

Pelletier, Francis Jeffry and Leonard Schubert, 1989/2002, 'Mass Expressions,' in Dov Gabbay and Franz Guenthner (eds.), *The Handbook of Philosophical Logic*, Springer[Kluwer], Berlin.

Rothstein, Susan, 2010, 'Counting and the mass-count distinction,' in: *Journal of Semantics* 27.

Rothstein, Susan, 2011, 'Counting, measuring, and the semantics of classifiers,' in: Michael Glanzberg, Barbara H. Partee and Jurģis Šķilters (eds.), *Formal Semantics and Pragmatics: Discourse, Context and Models. The Baltic International Yearbook of Cognition, Logic and Communication* 6, 2010, http://thebalticyearbook.org/journals/baltic/issue/current

Rothstein, Susan, 2016 in press, *Semantics for Counting and Measuring,* Cambridge University Press, Cambridge.

Schwarzschild, Roger, 2009, 'Stubborn distributivity, multiparticipant nouns and the count/mass distinction,' in: *Proceedings of NELS 39*, GLSA, University of Massachusetts, Amherst.

Sharvy, Richard, 1980, 'A more general theory of definite descriptions,' in: *Philosophical Review* 89, pp. 607-624.

Tarski, Alfred, 1927, 'Foundations of the geometry of solids,' translated in: Tarski, Alfred, 1956, *Logic, Semantics, Metamathematics*, first edition, Oxford University .