MESS MASS MEASURE AND NEAT MASS MEASURE

Fred Landman
Linguistics Colloquium
Tel Aviv University
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In memory of Susan Rothstein

**WHO DISCUSSED WITH ME THE WORK THAT THIS TALK IS PART OF
ON A DAY AND NIGHT BASIS FOR THE LAST 19 OF OUR 27 YEARS TOGETHER**

MESS MASS MEASURE AND NEAT MASS MEASURE

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1. AIM OF THIS PAPER

Neat mass nouns: mass nouns like *pottery*, *furniture*, *livestock*, *poultry*.

Bunt 1980, 2006 (following Quite 1960): Widespread assumption about neat mass nouns:
Neat mass nouns are *semantically* no different from count nouns.
The only difference is that neat mass nouns *grammatically* lack a feature +COUNT.

Against this: Rothstein 2011, Landman 2011, Grimm and Levin 2012:
Neat mass nouns are *semantically* different from count nouns in that they, unlike count nouns, allow *measure comparison* interpretations.

Snag: Also *singular count nouns* allow measure comparisons interpretations, when their interpretation is downshifted (= grinding).

Hence: If *neat mass nouns* allow measure comparison interpretations due to downshifting, Bunt may be right after all.

Argument in this paper:
Indeed, neat mass nouns allow measure comparison interpretations under downshifting.
But, neat mass nouns, unlike count nouns, *also* allow measure comparison interpretations that do *not* involve downshifting.

Conclusion: Neat mass nouns are *semantically* different from count nouns and from mess mass nouns (nouns like *time*, *meat*, *water*).

Strategy of the paper: ***Reculer pour mieux sauter*** [1]
The argument will be made in the context of a Guided Tour of Iceberg Semantics, as laid out in Landman 2019b.

[1] Draw back in order to jump forward better

2. BOOLEAN BACKGROUND

Boolean semantics: Link 1983:

-Boolean domains of mass objects and of singular and plural count objects.
-Semantic plurality as closure under sum.

Boolean interpretation domain **B**:
Boolean algebra with part-of relation $\sqsubseteq$, operations of supremum $\sqcup$ (sum) and infimum $\sqcap$.

Let **B** be a Boolean algebra and $a,b,x,y \in B$, $X,Y \subseteq B$.

▹ X^+ is the set of *non-null* elements of X: $X^+ = X - \{0\}$

▹ X is *disjoint* **iff** no two elements of X share a (non-null) part; otherwise X *overlaps*

▹ $(x]$ is the *Boolean part set* of x $\{y \in B: y \sqsubseteq x\}$
$(X]$ is the *Boolean part set* of X, $\{y \in B: y \sqsubseteq \sqcup X\}$
▹ *X is the *closure under sum of* X $*X = \{b \in B: \exists Y \subseteq X: b = \sqcup Y\}$

▹ X *generates* Y *under* $\sqcup$ **iff** $Y \subseteq *X$ and $\sqcup Y = \sqcup X$
Every element of Y is a sum of X-elements and X and Y have the same supremum

▹ X is a *partition* of b **iff** $X \neq \emptyset$ and $X \subseteq (b]^+$ and X is disjoint and $\sqcup X = b$
A partition of b is a disjoint set of parts of b whose sum is b

Notions of atoms generalized to subsets X of B:

▹ a is an X-*atom* **iff** a is a minimal element in X^+ ▹ $ATOM_X$ is the set of X-atoms.

▹ $ATOM_{X,b}$ is the set of *X-atomic parts of* $b \in X$: $ATOM_{X,b} = (b] \cap ATOM_X$

▹ X is *atomic* **iff** every element in X^+ has an X-atomic part
▹ X is *atomistic* **iff** every element in X^+ is the sum of its X-atomic parts
▹ X is *atomless* **iff** there are no X-atoms

You get the familiar Boolean atom related notions by setting X = B.

3. ICEBERG SEMANTICS

Iceberg semantics:
1. Nouns are interpreted as icebergs: their interpretation consist of a body and a base:
    -body = the interpretation in standard Boolean semantics.
    -base = the basic stuff that body objects are made of.

▹ An *i-set* is a pair X = <**body**(X), **base**(X)> where **body**(X) and **base**(X) are subsets of B and:
and **body**(X) $\subseteq$ ***base**(X) and $\sqcup$(**body**(X)) = $\sqcup$(**base**(X))

An i-set is a pair consisting of a body set and a base set, where the base generates the body under sum:

Classical Boolean semantics = Mountain semantics:
    The interpretation of the **plural** is a *mountain* rising up from the interpretation of the **singular** (a set of atoms).
Iceberg semantics: **Plural body** is a mountain rising up from the **singular base**.
    The base is not a set of atoms but floats in a sea of mass: an *iceberg*.

2. No sorting:
- the **same body** is mass or count depending on the base it is grounded in.
- the **same body** is singular or plural depending on the base it is grounded in.

3. *Classical Boolean semantics* (e.g. Link 1983, Landman 1991):
  count-mass is a vertical distinction:
  count: looking down, you see Boolean atoms, and every object is the sum of its Boolean atomic parts.
  mass: objects are not necessarily the sum of a set of Boolean atomic parts, or even: when you look down you don't see Boolean atoms.

Iceberg semantics: two distinctions: ***count-mass*** and ***neat-mess,*** both defined in terms of the base:

count-mass is a horizontal distinction on the base:
    Count: the base is conceptually (*cat*) or contextually (*fence*) disjoint
    Mass: the base overlaps (*pottery*, *meat*)

neat-mess is a vertical distinction on the base:
    Neat: looking down you see a disjoint set of base atoms and every object is the sum of its base atomic parts (*cat*, *pottery*)
    Mess: you don't (*meat*)

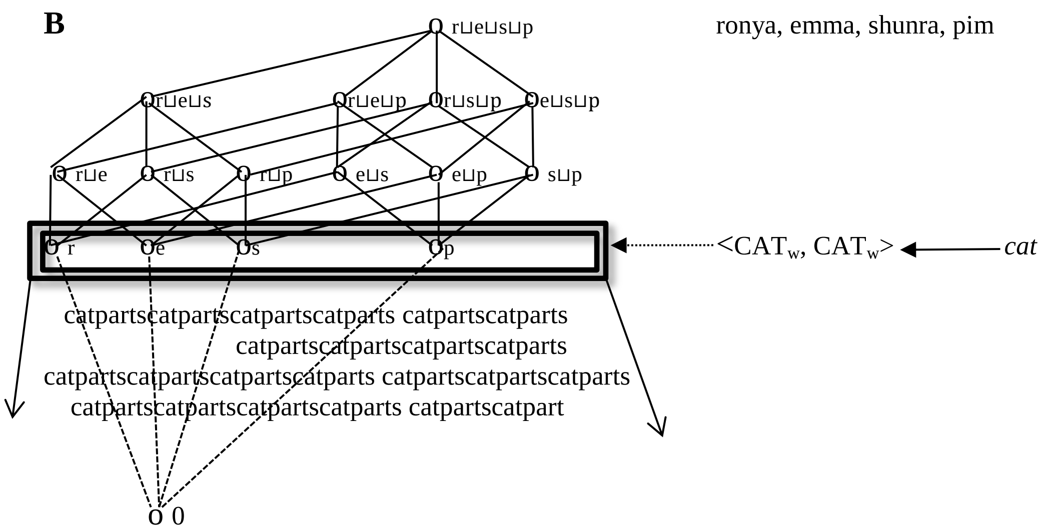
4. Compositional semantic: notions ***mass*** and ***count*** also apply to complex NPs and DPs.

4. ICEBERG SEMANTICS FOR COUNT NOUNS

Singular count nouns: *cat* $\rightarrow$ CAT_w

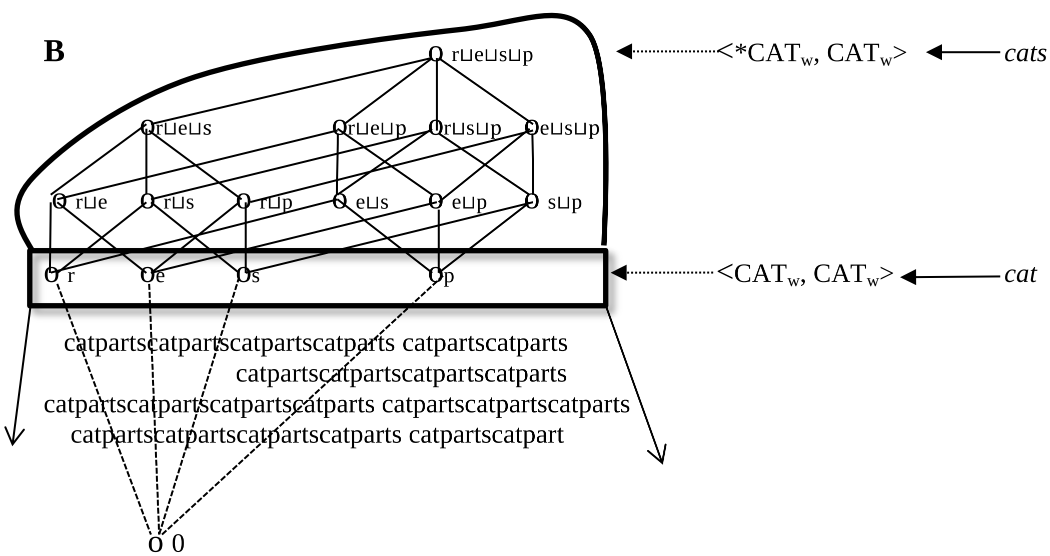
CAT_w = <**body**(CAT_w), **base**(CAT_w)> where **body**(CAT_w) = CAT_w
base(CAT_w) = CAT_w, **where $\mathbf{CAT_w}$ is a *disjoint* set**

Let $\mathrm{CAT}_w = \{r, e, s, p\}$



Plural count nouns: *cats* $\rightarrow$ $CATS_w$

$CATS_w$ = <**body**($CATS_w$), **base**($CATS_w$)> where **body**($CATS_w$) = $^*\mathrm{CAT}_w$, **the closure under sum**
base($CATS_w$) = CAT_w, **a disjoint set**



Complex plural count nouns: *three white cats* $\rightarrow$ $\mathit{3WH\text{-}CATS}_w$

$\mathit{3WH\text{-}CATS}_w$ = <**body**($\mathit{3WH\text{-}CATS}_w$), **base**($\mathit{3WH\text{-}CATS}_w$)> where:

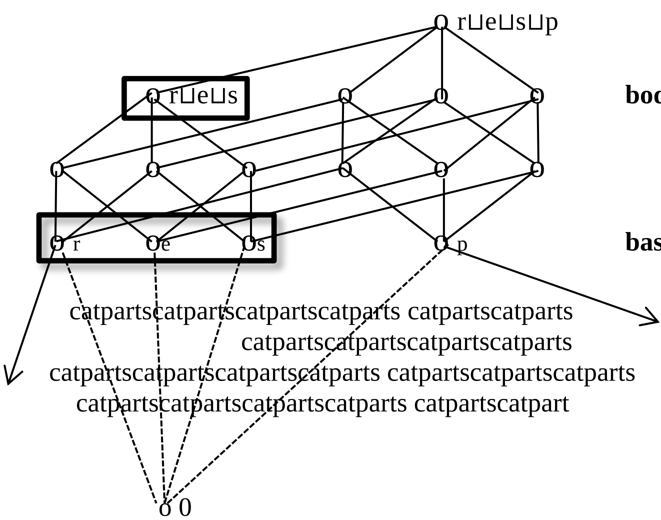
$$\mathbf{body}(\mathit{3WH\text{-}CATS}_w) = \lambda x.\ {*}(\text{WHITE}_w \cap \text{CAT}_w)(x) \wedge |(x] \cap \text{WHITE}_w \cap \text{CAT}_w| = 3$$

The set of sums of white cats that each have three single white cats as part

$$\mathbf{base}(\mathit{3WH\text{-}CATS}_w) = \text{WHITE}_w \cap \text{CAT}_w \text{, a disjoint set}$$

The set of single white cats

Let $\text{WHITE}_w \cap \text{CAT}_w$ be {r, e, s}



body = {r⊔e⊔s} set of objects with three base parts

base = $\text{WHITE}_w \cap \text{CAT}_w$ = {r, e, s}, a disjoint set

Basic compositional principle:

Head principle: The **base** of the interpretation of the complex **NP** is:
the **part set of the body** of the interpretation of the complex **NP**
intersected with
the **base** of the interpretation of the **head** of the complex NP.

$$\mathbf{base}(\text{NP}) = (\mathbf{body}(\text{NP})] \cap \mathbf{base}(\text{HEAD}_{\text{NP}})$$

-This is how in the above example the base $\text{WHITE}_w \cap \text{CAT}_w$ is derived.
-Later we will derive the fact that measure phrases pattern with mass nouns from this.

5. ICEBERG SEMANTICS FOR NEAT MASS NOUNS

▹ X is *count* iff **base**(X) is disjoint. For i-set X
▹ X is *mass* iff (if X is non-null then) X is *not count*.

▹ X is *neat* iff **base**(X) is atomistic and $\text{ATOM}_{\mathbf{base}(X)}$ is disjoint.
▹ X is *mess* iff (if X is non-null then) X is *not neat*.

Group-neutral neat mass nouns
▹ The i-set denotation of a neat mass noun is *group neutral* if the distinction between individuals and groups, *aggregates*, conglomerates of individuals, is neutralized in the **base**.

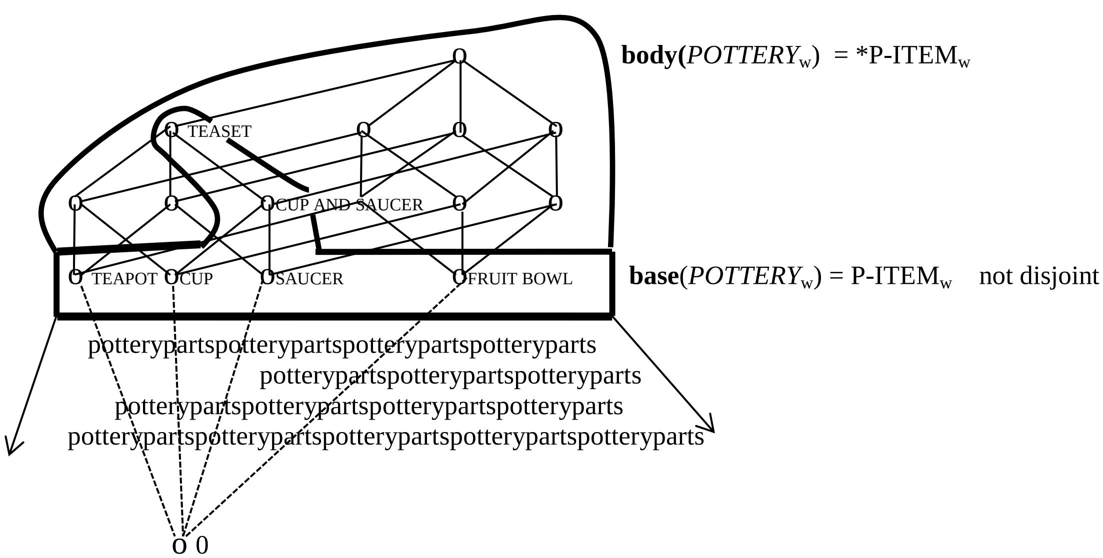
-Count nouns keep individuals in the **base** and groups of such base individuals separate:
a group of cats is not itself a cat.
-Neat mass nouns like *pottery* do not adhere to that distinction: a group of pottery items can count in the right context as *one* wrt. the denotation of *pottery*, ***alongside*** its parts that also count as *one*.

Example: *pottery*
So: 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 fruit bowl* is not an item sold as one in our shop.

Set of pottery items ***building blocks***:
P-ATOM_w = {THE TEAPOT, THE CUP, THE SAUCER, THE FRUIT BOWL}, **a disjoint set**.

Set of pottery items sold as one:
P-ITM_w = {THE TEAPOT, THE CUP, THE SAUCER, THE FRUIT BOWL, THE CUP AND SAUCER, THE TEASET}, **not disjoint**

$POTTERY_w = \langle \mathbf{body}(POTTERY_w), \mathbf{base}(POTTERY_w)\rangle$
where $\mathbf{body}(POTTERY_w) = {}^*\text{P-ITEM}_w$ and $\mathbf{base}(POTTERY_w) = \text{P-ITEM}_w$



Fact: $POTTERY_w$ is a neat mass i-set.

Sum-neutral neat mass nouns

▹ The i-set denotation of a neat mass noun is *sum neutral* if the distinction between the **base** and the **body** is neutralized.

▹ X is *sum neutral* iff for some disjoint set $\mathrm{X} \subseteq \mathrm{B}$: $X = \langle {}^*\mathrm{X}, {}^*\mathrm{X} \rangle$

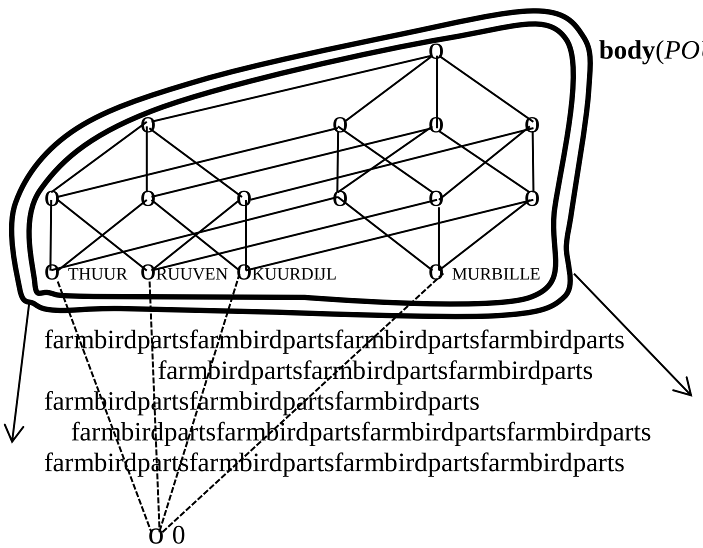
Natural cases that are sum neutral are mass nouns for natural kinds, like *livestock* and *poultry*:

Example: *poultry*

Assume that in w we are at a turkey farm, and all the relevant farm birds are turkeys.

$\mathrm{ATOM}_{\mathbf{base}(POULTRY_{\mathrm{w}})}$ = FARM BIRD$_{\mathrm{w}}$= {THUUR, RUUVEN, KUURDIJL, MURBILLE}, a disjoint set.

farm bird $\rightarrow$ *FARM-BIRD*$_{\mathrm{w}}$ = < FARM BIRD$_{\mathrm{w}}$, FARM BIRD$_{\mathrm{w}}$ >
poultry $\rightarrow$ *POULTRY*$_{\mathrm{w}}$ = < *FARM BIRD$_{\mathrm{w}}$, *FARM BIRD$_{\mathrm{w}}$ >



body(*POULTRY*$_{\mathrm{w}}$) = **base**(*POULTRY*$_{\mathrm{w}}$), not disjoint

***FARM BIRD$_{w}$* is a singular count i-set.**
***POULTRY*$_{\mathrm{w}}$ is a *sum neutral neat mass* i-set.**

Within neat denotations, *plural count* (<*X,X>) and *sum neutral* (<*X,*X>) are the extreme cases. *Group neutrality* is an in-between case.
Sum neutral neat mass nouns allow count comparison only with respect to the set of **base** atoms.
Group neutral neat mass nouns allow contextual variation.

[Landman 2019b identifies sum neutrality and group neutrality for neat mass nouns with Rothstein's *conceptual atomicity* and *contextual atomicity* and accounts for the semantic differences between the two classes that are discussed in Landman 2011 and 2019b (i.e. *different distributivity behaviour*).
See Landman 2019b for discussion concerning the subtleties of linking the notions of count/mass/neat mess *noun phrases* to count/mass/neat/mess *i-sets via* count/mass/neat/mess *intensions*.]

6. COUNT COMPARISON AND MEASURE COMPARISON

Neat mass nouns pattern with (plural) count nouns with respect to:
-Atomicity tests (Quine 1960, Chierchia 1998)
-Individual classifiers like *stuk(s)* in Dutch (Doetjes 1997)
-Distributive adjectives (Bunt 1980, 2006, Schwarzschild 2009, Rothstein 2011)
-Count comparison (Barner and Snedeker 2005)

Barner and Snedeker 2005: neat mass nouns, like count nouns, allow count-comparison interpretations:

(1) a. Most *farm animals* are outside in summer.
 b. Most *livestock* is outside in summer.

Example: On our neighbor's farm there is large livestock: 10 cows, weighing all together 700 kg.,
 and *poultry* (feathered livestock): 100 chickens, weighing all together 60 kg.
 On this farm, the chickens are inside all year through, but the cows are outside in summer.
Both (1a) and (1b) allow a reading on which what is asserted is false = count comparison

Bunt 1982, 2005 **(following Quite 1960): Widespread assumption about neat mass nouns:**
 Neat mass nouns are *semantically* no different from count nouns.
 The only difference is that neat mass nouns *grammatically* lack a feature +COUNT.

Against this: **Rothstein 2011, Landman 2011, Grimm and Levin 2012:**
 Neat mass nouns are *semantically* different from count nouns in that they, unlike count nouns, allow *measure comparison* interpretations: e.g. example (2):

(2) a. ✓Although more farm animals are inside than outside, as concerns biomass, *most livestock* is outside in summer. Also in terms of volume, *most livestock* is outside.
 b. # Although more livestock is inside than outside, as concerns biomass, *most farm animals* are outside in summer. Also in terms of volume, *most farm animals* are outside.

Count nouns do not allow measure comparison with *most*,
Hence: neat mass nouns do differ *semantically* from count nouns.

Snag: **Also *singular count nouns* allow measure comparisons interpretations, when their interpretation is downshifted (= grinding).**
Hence: **If *neat mass nouns* allow measure comparison interpretations due to downshifting, Bunt may be right after all.**

In (2) we compare neat mass nouns with *plural* count nouns in the context of determiner *most*.
But what about *singular* count nouns?
The standard wisdom is that we don't need to worry about *singular* count nouns in these contexts, because they are infelicitous.

(3) much mud/much pottery/#much cat
 most mud/most pottery/#most cat

Problem: the ***true*** standard wisdom is that singular nouns are *only felicitous on a mass interpretation*. In (4) *hippopotamus* has a (mess) mass interpretation, and (4) accordingly has a felicitous measure interpretation:

(4) a. Most *hippopotamus* is eaten in Africa.
b. Much *hippopotamus* is eaten in Congo.

For singular count nouns the measure interpretation involves a shift to mass.
Argument for shift: Dutch diminutive–*tje* produces a noun which is *always* neuter and count.
This +COUNT requirement cannot be overridden. Shift is impossible for independent reasons. Nice contrast in (5) and (6):

(5) a. ✓Het meeste *lam* wordt met Pasen gegeten
most lamb is with Easter eaten — Most lamb is eaten with Easter
b. #Het meeste *lammetje* wordt met Pasen gegeten
most lamb$_{[diminutive]}$ is with Easter eaten — Most little lam is eaten with Easter.

(6) a. ✓Er is gewoon te veel *auto* op de weg
There is as a matter of fact too much automobile on the road
b. #Er is gewoon te veel *autootje* op de weg
There is as a matter of fact too much automobile$_{[diminutive]}$ on the road

(5): the count interpretation is eliminated in favour of the mess mass interpretation.
(6): count noun *auto* shifts to (mess) mass.

This shift is known in the literature as *grinding*. I follow Landman 2019b to use the more general term ***downshifting***.
Observation: singular nouns *do* allow measure comparison under downshifting.

So what about the measure interpretations of neat mass nouns?

Hence: **If *neat mass nouns* allow measure comparison interpretations due to downshifting, Bunt may be right after all.**

The problem is particularly urgent, since I will show below that downshifting is indeed possible for neat mass nouns.

Argument in this paper:

Indeed, neat mass nouns allow measure comparison interpretations under downshifting.
But, neat mass nouns, unlike count nouns, *also* allow measure comparison interpretations that do *not* involve downshifting.

Strategy: once more, ***reculer pour mieux sauter***

I will now discuss mess mass nouns and downshifting.

7. TYPES OF MESS MASS i-SETS

▻ *X* is *mess mass* iff *X* is *mass* and *X* is *mess*
iff **base**(*X*) is not disjoint and *either* **base**(*X*) is not atomistic
or **base**(*X*) is atomistic but $\mathbf{ATOM}_{\mathbf{base}(X)}$ is not disjoint.

The disjunctive definition of mess mass i-sets allows a range of different types of i-sets that all count as mess mass, from completely homogenous i-sets to heterogeneous i-sets.
I discuss three types here. More in Landman 2019b.

7.1. TYPE 1: HOMOGENEOUS i-SETS: example: ***time***

Mess mass noun *time* as in (7):

(7) Much *time* had passed.

time $\rightarrow$ $TIME_w = <\mathbf{body}(TIME_w), \mathbf{base}(TIME_w)>$

$\mathbf{body}(TIME_w)$: set of periods of time.

Period structure of time: $\mathbb{P}$ set of regular open subsets of $\mathbb{R}$

The notion of a period is a generalization of the notion of an open interval. Example: the picture shows the period where the traffic light is green:

green green green green green
p = (——) (——) (——) (——) (——)

- $p_w \in \mathbb{P}$ is the contextually maximal period in $\mathbf{body}(TIME_w)$, and (for ease) an interval.
- **duration** is a measure function from open subintervals of p_w to $\mathbb{R}$.
- δ be a contextually given number in $\mathbb{R}$, such that we cannot in the context distinguish between intervals of size r and subintervals of smaller sizes.

- *Moments of time* in p_w*:* M_{p_w} is a set of open sub-intervals intervals of size δ that *partitions* p_w.

Fact: $\cup M_{p_w}$ is a set with single points missing between its maximal subintervals:

(——————— p_w ———————)
δ δ δ δ δ δ δ δ δ δ δ δ
(—).(—).(—).(—).(—).(—).(—).(—).(—).(—).(—).(—)

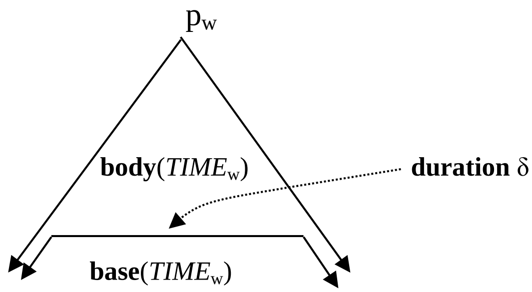
$\mathbf{body}(TIME_w) = (p_w]$ the set of all subperiods of p_w

What is $\mathbf{base}(TIME_w)$? Here is a suggestion.
$\mathbf{base}(TIME_w) = \{p \in (p_w]^+ : \mathbf{duration}(p) \leq \delta\}$
the set of subperiods with duration up to δ

So we get:

time $\rightarrow$ $TIME_w = <$ $\boldsymbol{(}p_w\boldsymbol{]}$, $\{p \in \boldsymbol{(}p_w\boldsymbol{]}^+$: **duration**$(p) \leq \delta\} >$

base($TIME_w$) forms the *bottom* of the **body**($TIME_w$):



Fact 1: The interpretation of *time, TIME*$_w$ is a *mess mass* i-set.

Let *moment of time* $\rightarrow$ $M_{p_w} = \ < \mathrm{M}_{p_w}, \mathrm{M}_{p_w} >$

Fact 2: The interpretation of *moment of time* M_{p_w} is a *singular count* i-set.

Homogeneous mess mass: it's *time* all the way down.

7.2. TYPE 2: CONTEXTUALLY CHOSEN OVERLAPPING MINIMAL PARTS: example: ***meat***

Landman 2011 (paraphrase): Take a big juicy slab of meat. We can think of this as being built from minimal parts, without having to assume that there are 'natural minimal meat parts'; think of the meat as built from parts that are appropriately minimal in the context. For instance, they are the pieces as small as a skilled butcher, or our special fine-grained meat-cutting machine can cut them. Suppose the meat cutting machine consists of a horizontal sheet knife and a vertical lattice knife that cut the meat into tiny cubes: snap – snap. This will partition the meat into many tiny meat cubes, which we can see as contextual minimal parts.

Now, if we move the sheet-knife or the lattice-knife a little bit, we get a *different* partition of the meat into minimal meat cubes. And there are many ways of moving the sheet knife and the lattice knife, each giving a different partition. None of these partitions has a privileged status (as providing 'natural' or 'real' minimal parts); the meat can be seen as built from all of them. This provides an i-set that is mess mass.

Boolean structure of *regions of space*: $\mathbb{III}$, set of regular open subsets of $\mathbb{R}^3$.
π_w: $B \rightarrow \mathbb{III}$ maps objects onto the region of space they occupy (eigenplace).[2]
We take again a top down perspective: Let m_w be the sum of the meat in w.
The meat cutter would, with the current position of its blades, cut m_w into a ***variant***, a set of parts of m_w that are little cubes.

[2] For technical details, see Landman 2019b

▹ a *variant* for m_w is a set $\mathbf{var}_{m_{w},\delta}$ which satisfies the conditions $V_1 – V_5$:
V_1. A variant is a partition of the meat m_w
V_2. A variant also partitions the space of the meat m_w
V_3. The variant cuts the meat into little blocks
V_4. The little blocks have the same volume
V_{5a}. Each block in the variant is the maximal part of the meat occupying the space of that block
V_{5b}. Contextual volume value δ is *big enough* so that we recognize the *maximal parts of* m_w that go on at the regions of volume δ as *meat*: contextual mimimal parts that are meat.

▹ $\mathbf{V}_{m_{w},\delta}$ is the set of all variants for m_w.

▹ $MEAT_w$ is the union of all the meat variants: $MEAT_w = \cup\mathbf{V}_{m_{w},\delta}$

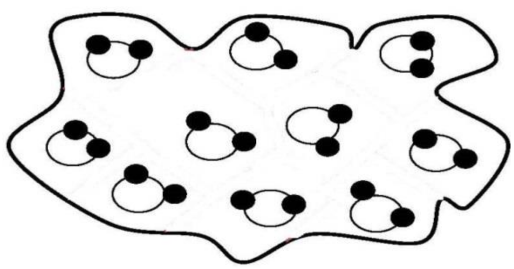
meat → $MEAT_w$ = <*$MEAT_w$, $MEAT_w$>

We take as the **base** of the i-set $MEAT_w$ the union of the variants, and as **body** the closure of this set under sum.

Fact: $MEAT_w$ is a mess mass i-set.

7.3. TYPE 3: HETEROGENEOUS I-SETS: example: ***water***

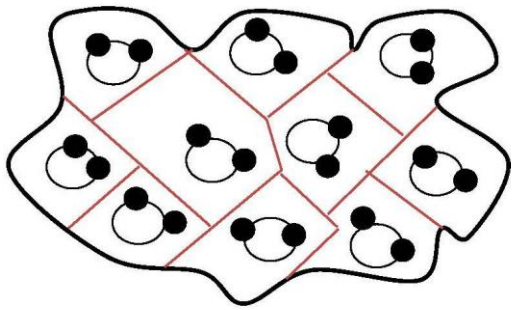
Landman 2011: (Paraphrase) Here is a puddle of water. Look down into the water of the puddle:



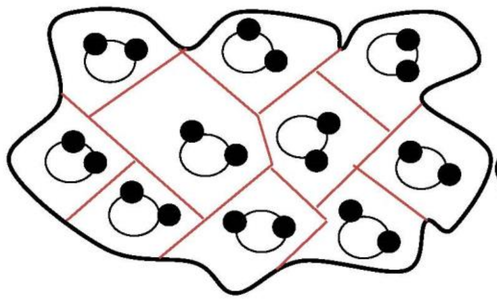
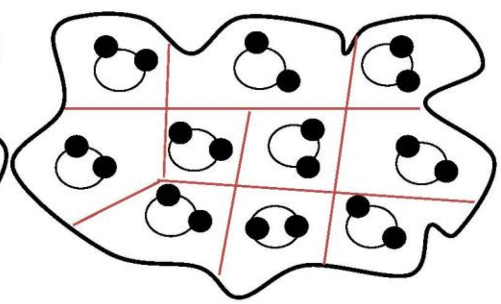
Count perspective: The water is built from a disjoint set of water molecules. There is only one variant. Hence it is reasonable to regard the water as just the sum of the water molecules.
Mass perspective: The puddle as a spatio-temporal object: when you look down into the puddle, you don't just see a set of water molecules, you see these objects in their spatio-temporal configurations and the relations between them. More in particular, you see what is a conglomeration of objects in space. When you divide up what you see in front of you, you cannot pick and choose: you're dividing up the puddle into sets of water molecules *and space.*

So you *can*, if you so want, pick the cherries out of the pie, pick the disjoint individual molecules out of the space, but that is imposing a count perspective. On the mass perspective, you pick the molecules out, by dividing the puddle into a disjoint set of water molecule-space pairs, which means that you simultaneously divide up the set of molecules and the space they are in.

Spatio temporal count perspective: It is perfectly reasonable to regard the puddle as the sum of disjoint building blocks. say, blocks that have exactly one water molecule in them, blocks that partition the sum of water molecules *and* its space:



But, again, such partitions are not unique, they are variants, and on the mass perspective such a variant does not have a special status:

So, even though the set of water molecules would not itself give rise to an overlapping **base**, water molecules *cum* space, do.

Idea: body(*WATER*$_w$) consists of sums of water molecules plus regions of space containing these, making up in total the water molecules in the puddle and the space of the puddle.

base(*WATER*$_w$) is a set of water molecule-space pairs that *that contain a single water molecule.*

Intuition: a subregion of the water that contains one water molecule may well counts itself as *water*, but a subregion that only contains, say, half a molecule does not itself count as *water*.

We assume that all the (contextually relevant) water in w is the water making up the puddle. E_w is the set of all water molecules in w, $e_w = \sqcup E_w$ and $\mathbf{e}_w = \langle e_w, \pi_w(e_w) \rangle$.

▹ We construct **base**(*WATER*$_w$) and **body**(*WATER*$_w$) as sets of pairs $\langle e,\pi \rangle$, where e is a sum of water molecules and π is a region that $\pi_w(e)$ is a *proper part* of, i.e. $\pi_w(e) \subset \pi$

▹ A variant for $\mathbf{e}_w$ is a set $\mathbf{var}_{e_w}$ is a set of molecule-space pairs $\langle e,\pi \rangle$ as described above where **dom**($\mathbf{var}_{e_w}$) is a partition of e_w and **ran**($\mathbf{var}_{e_w}$) is a partition of $\pi_w(e_w)$.

▹ $\mathbf{V}_{e_w}$ is the set of all variants of water.

As before, we let the **base** of *WATER*$_w$ be the union of variants:

$water \rightarrow WATER_w = \langle {}^*\mathrm{WATER}_w, \mathrm{WATER}_w \rangle$, where $\mathrm{WATER}_w = \cup \mathbf{V}_{e_w}$

Fact: base(*WATER*$_w$) is an atomless mess mass i-set.

7.4. THE SUPREMUM ARGUMENT

Two different choices for the interpretation of the NP *water molecule*:

Interpretation 1: the base of *water molecule* is a variant in the base of *water*:
water molecule $\rightarrow$ WM_w = <$\mathrm{WM_w}$, $\mathrm{WM_w}$>, where $\mathrm{WM_w} \in \mathbf{V}_{e_w}$

Interpretation 1*: Water molecule* denote a variant of *water*, a partition of the water and its space in w

Fact: WM_w is a singular count i-set such that $\sqcup$body(WM_w) = $\sqcup$body($WATER_w$)

-On interpretation 1, the mass DP *the water* and the count DP *the water molecules* have the same body-denotation: the mass supremum and the count supremum are identified.

Interpretation 2: the base of *water molecule* is a set of water molecules:
water molecule $\rightarrow$ E_w = <$\mathrm{E_w}$, $\mathrm{E_w}$>, where $\mathrm{E_w}$ is disjoint.

Interpretation 2: We ignore the spatio-temporal setting of the water, and fish the molecules out of the space, treat them as abstract objects on their own merit, and distance them in that way from the denotation of *the water*.

Fact: E_w is a singular count i-set such that: $\sqcup$body(E_w) $\neq$ $\sqcup$body($WATER_w$)

-On interpretation 2, the mass DP *the water* and the count DP *the water molecules* *do not* have the same body-denotation: the mass supremum and the count supremum are not identified.

Thus, Iceberg semantics does not have to take a stand on Chierchia 1998's Supremum Argument (in favor of interpretation 1). Iceberg semantics can allow both perspectives.
Landman 2019b argues that this is a Good Thing.

8. TYPES OF DOWNSHIFTS

8.1. TYPE 2: GRINDING: like *meat*

Downshifting: standard case: a bare singular NP occurs in a position where mass NPs are felicitous, but bare singular NPs are not: the bare singular gets a mess mass interpretation:

(8) a. Some people eat *chiwawa* when they get hungry [γ][3]
  b. The Thai restaurant was advertised as the award winning restaurant from two consecutive years, so we decided to try Thai food for the first time in our lives...and there was *COCKROACH* IN THE SOUP!!!! [γ]
  c. The main course today will be *yellow curried Muppet with plum chutney*! [γ]
  d .In Finland 700 million kilos of *potato* is produced a year. Nearly half of the amount is poorly utilized waste, invalid potatoes, peels and cell water. [γ]

Downshifting: **body** of the count noun *shifts down* from a set generated from a disjoint set of objects to include stuff making up those objects.
base of the count noun *shifts* to a set generating the downshifted body under ⊔, to provide a ***mess mass perspective*** on the down shifted body.

Grinding: **a count i-set is mapped onto an i-set that is much like the i-set interpretation of *meat*** (i.e. it is indeed messy.)

8.2. TYPE 1: MEASURING: like *time*.

Downshifting that isn't grinding:

(9) a. Positive is especially the price. The box is OK and it's much *book* for little money. [γ]
  b. At first glance much of the *book* may appear unstructured and chaotic. [γ]
  c. The Welshie is a lot of *dog* in a medium-size package [γ]

(10) After the kindergarten party, *most of my daughter was* covered with paint.

The term grinding is not appropriate for the examples in (9) and (10): there is no grinding involved. But there *is* down shifting: in (9) and (10) the part-of structure of the objects involved is *opened up* and made accessible for measuring:

(9a) The weight structure of the parts of the book (e.g., 1 euro per 100 grams)
(9b) The full text of the book.
(9c) The volume of the dog
(10) The surface of my daughter's body.

[3] [γ] means that the example comes from the web. *Chiwawa* is of course *Chihuahua*

Natural assumption: the measure is defined for x on the *part set* (x] of the object x involved, or a contextual restriction of that (like the set of parts of the surface area of my daughter's body).

Thus the **body** shifts down to the part set, i.e. a set closed downwards.

Adding an appropriate **base** makes the downshifted interpretation homogenously mess mass, like *time*.

8.3. TYPE 3: HETEROGENEOUS DOWNSHIFTING: like *water*.

Rothstein 2011, 2017: the shift in (11) seems at first sight to be from count noun *bicycle* to count noun *bicycle part*. It is not clear how that helps to make the example felicitous, despite a bare singular noun occurring in argument position.

(11) In the repair shop there was *bicycle* all over the ground.

Landman 2019b argues that the downshifted interpretation is actually *mess mass* after all:

(12) a. There was *bicycle* all over the ground.
[When we counted there were actually more items on the right side, since that was where they had put the little things, like the screws and the balls from the ball bearings, etc..]
b. *Most bicycle* was on the left side of the room.

The intuition is that (12b) is true in this context. If *bicycle* in (12a) is downshifted to either a count or a neat mass interpretation, (12b) should, in this context, allow for a count comparison interpretation. But it doesn't, it only allows for a measure comparison interpretation.
Hence, despite appearances, bicycle in (12a) and (12b) is mess mass.

How can you get a mess mass perspective from a disjoint set of bicycle parts BP_w?
Answer: by regarding the denotation of *bicycle* as an i-set generated from variants of pairs of bicycle parts in BP_w and space around them.

Thus, the denotation of downshifted *bicycle* can be analyzed on the model we gave for *water*, and *most* in (12b) accesses the volume projection of the objects in the i-set, in the same way as it would for *water*.

8.4. DOWNSHIFTING FOR NEAT MASS NOUNS

Cheng, Doetjes and Sybesma 2008 and Rothstein 2017: Downshifting is a last resort operation. Landman 2019b argues that this is not always the case. Here: downshifting for neat mass nouns.

(13) The hotel is undergoing renovations and there was *furniture* all over the hall ways. [γ]

Not downshifted: **base**($FURNITURE_w$) = set of *furniture items*:

In context: down-shifting of *furniture* to mess mass:

[After the explosion:]
(14) The entire building had collapsed from the back. (…) There was *furniture* all over the back lawn where it had fallen after the back gave way. [γ]

To bring out the salient mess mass features I modify the example as in (15):

[After the explosion:]
(15) There was furniture all over the back lawn where it had fallen after the back gave way. It clearly had been a powerful explosion, since *most of the furniture* was found on the outer side of lawn, far away from the house.

furniture shifts to *furniture debris*: piles of pieces, chips, rubble, bigger items, some possibly still whole.
The mass measure compares furniture debris (15): the volume of the debris on the outer side of the lawn is bigger than the volume of the debris on the inner side = mess mass.

Because of examples like this, we must take the possibility that neat mass nouns get a measure interpretation via downshifting seriously.

Central Question: are there measure comparison readings of neat mass nouns that are not downshifted?

Answer: ***reculer pour mieux sauter***

In order to see what exactly we are looking for, I discuss some aspects of the Iceberg semantics analysis of measure phrases like *three liters of wine* and *three kilos of potatoes*.

9. SEMANTICS FOR MEASURE PHRASES

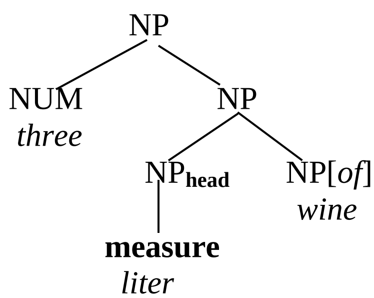
Rothstein's Observation: The i-set denotations of measure phrases are mass. (Rothstein 2011)

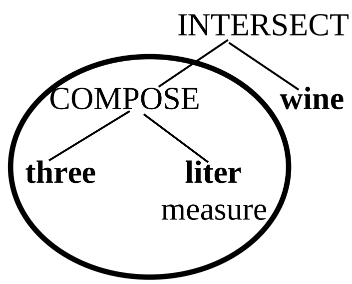
(16) a. #?*Much* of the *ball bearings* was sold this month. **#? count**
b. ✓*Much* of the *ten kilos of ball bearings* was sold this month. ✓ **mass**

(17) 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 - *kilo* as a classifier - count**
b. **Much** of the *three kilos of potatoes* that I ate had an interesting taste.
potatoes to the amount of 3 kilos - *kilo* as a measure - mass

Landman 2016: measure phrase: *three **liters** of wine*

Classifier structure: mismatched with: **Measure interpretation:**





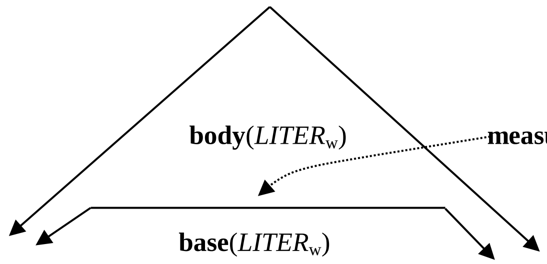
Head: measure *liter*
liter → $LITER_w$ = <**body**($LITER_w$), **base**($LITER_w$)>

body($LITER_w$) = $\mathbf{liter}_w$, continuous, additive measure function
base($LITER_w$) is a function that generates $\mathbf{liter}_w$ under ⊔.

Which function? Take mess mass i-set $TIME_w$ as a model:

Fix a small value $\mathbf{m}_{\mathbf{liter}_w}$. We set:

⊳ **base**($LITER_w$) = $\mathbf{liter}_w^{\leq \mathbf{m}_{\mathbf{liter}_w}}$, the set of object-measure value pairs where the measure value is less than or equal to $\mathbf{m}_{\mathbf{liter}_w}$.



Fact: *LITER*$_w$ is a mess mass measure i-set (given conditions discussed in landman 2019a, 2019b). The compositional semantic analysis based on the *Head Principle* derives:

three liters of wine $\rightarrow$ *3L-WINE*$_w$ = < **body**(*3L-WINE*$_w$), **base**(*3L-WINE*$_w$)>

where: **body**(*3L-WINE*$_w$) = $\lambda x.{*}\text{WINE}_w(x) \wedge \mathbf{liter}_w(x) = 3$

The wine that measures three liters, wine to the amount of three liters

base(*3L-WINE*$_w$) = $\lambda x.x \sqsubseteq \sqcup(\text{WINE}_w) \wedge \mathbf{liter}_w(x) \leq \mathbf{m}_{\mathbf{liter}_w}$

The parts of the wine that measure at most $\mathbf{m}_{\mathbf{liter}_w}$liters.

Fact: *3L-WINE*$_w$ is a mess mass i-set.

So we derive Rothstein's Observation.

The same analysis derives:

three kilos of potatoes $\rightarrow$ *3K-P-OES*$_w$ = < **body**(*3K-P-OES*$_w$), **base**(*3K-P-OES*$_w$)>

where: **body**(*3K-P-OES*$_w$) = $\lambda x.{*}\text{POTATO}_w(x) \wedge \mathbf{kilo}_w(x) = 3$
base(*3K-P-OES*$_w$) = $\lambda x.x \sqsubseteq \sqcup(\text{POTATO}_w) \wedge \mathbf{kilo}_w(x) \leq \mathbf{m}_{\mathbf{kilo}_w}$

Three kilos of potatoes is mess mass, because the **base** that we derive is the set of **all** parts of the sum of the potatoes that weigh at most $\mathbf{m}_{\mathbf{kilo}_w}$ kilos, and this set is closed downwards.

Fact 1: The elements of this base are potato parts, not potatoes.
The semantics of the measure phrase downshifts the **base** with respect to the **base** of *POTATOES*$_w$ (= <*POTATO$_w$, POTATO$_w$>)

Fact 2: No shifting takes place in the body:
three kilos of potatoes is mess mass *despite the fact that* the **body** is just the set of sums of potatoes (rather than potato parts).

10. MEASURES DOWNSHIFT THE BASE BUT NOT THE BODY

Look at (18):

[at Neuhaus in the Galerie de la Reine in Brussels]
(18) a. *Customer:* I would like 500 grams of pralines. *Shop assistant:* One more or one less?
b. ☠Ah, just squeeze enough into the box so that it weights exactly 500 grams.

The continuation (18b) would be a terrible *faux pas* at this particular location.
This suggests that, though *500 grams of pralines* is mass, the **body** stays a sum of singular pralines.

Example (19) shows that 500 grams of pralines is indeed *mass*:

(19) a. ✓Much of the 500 grams of pralines
b. #Many of the 500 grams of pralines ≠ ✓Many of the pralines

Example (20) shows that *500 grams of pralines* is in fact mess mass:

[We got (given) 500 grams of pralines, and they consisted of six huge 50 grams pralines and ten 20 grams pralines. The big ones were Fred's favorites, and he ate them, the small ones were the ones that Susan really liked, and she ate *them*:]
(20) Most of the 500 grams of pralines was eaten by Susan.

We judge (20) as false. This means that (20) does not (naturally) have a count-comparison reading.
So, the reading on which (20) is false is a measure reading.

But note: the relevant measure reading is still defined, in this example, on **body**($PRALINES_w$):
(20) partitions the sum of the pralines into two parts: the sum of the pralines that Fred ate, and the sum of the pralines that Susan ate, ***both of which are in*** $*\mathrm{PRALINE}_w$.

This is not a *necessary* feature of the reading: the example stays false if Fred ate half of one of the small ones as well. But this example helps up to determine what we are looking for:
We have overlooked one more feature of the measure comparison in (20): it takes place in the context of a *partitive*: *most* ***of the*** *500 grams of pralines*.

Obviously even if the **body** of the interpretation of *500 grams of pralines* is just a set of sums of pralines, this is *obviously not* case for the partitive NP *of the 500 grams of pralines*, because obviously partitives ***semantically*** downshift (add parts).

We are now in a position to formulate what it is that we are looking for:

Question: Is there a semantic difference with respect to measure comparison interpretations in the context of *most*, between neat mass nouns and partitives of neat mass nouns?

I will argue that there is. Before that, we need one more step: the measure comparison semantics of *most*.

11. MEASURE *MOST*

We specify the semantics for measure ***most***. The semantics is based on a comparison relation between subsets of B: **(**where $\mathbf{measure}_w$ is a measure function).[4]

$$\mathbf{more}_w = \lambda X \lambda Y.\mathbf{measure}_w(\sigma(X) \sqcap \sqcup Y) > \mathbf{measure}_w(\sigma(X) - \sqcup Y)$$

X is more than Y iff
the measure of the X that is Y is bigger than the measure of the X that is not Y.

We cannot use this directly as the semantics for *most*, because the relation $\mathbf{more}_w$ is not appropriately conservative. The form of conservativity I will incorporate in Iceberg semantics is that in *most*[NP, VP], the VP interpretation must live on ***base(*NP*):**

$$most \to \lambda P \lambda Q.\mathbf{more}_w[\mathbf{body}(P), Q \cap {}^*\mathbf{base}(P)]$$

In all the examples discussed here **body**(*NP*) = ***base**(*NP*), so we simplify accordingly.

Non-downshifted NPs:
Let *NP* be the neat mass i-set interpretation of NP, and VP the interpretation of the VP.
The measure semantics for *most*(NP, VP) compares the measure values of:

$\sigma(\mathbf{body}(NP)) \sqcap \sqcup(\mathrm{VP} \cap \mathbf{body}(NP))$
The body(*NP*) element that is the sum of the body(*NP*) elements that have the VP property
and
$\sigma(\mathbf{body}(NP)) - \sqcup(\mathrm{VP} \cap \mathbf{body}(NP))$
The body(*NP*) element that is the relative complement in σ(body(*NP*)) of the latter object.

Fact: These two objects are both in body(*NP*).

Downshifted NPs:
Let $\downarrow(NP)$ be the downshifted i-set interpretation, and VP the interpretation of the VP.

The measure semantics for *most*(NP, VP) compares the measure values of:
$\sigma(\mathbf{body}(\downarrow(NP))) \sqcap \sqcup(\mathrm{VP} \cap \mathbf{body}(\downarrow(NP)))$
The body(↓(*NP*)) element that is the sum of the body(↓(*NP*)) elements that have the VP property
and
$\sigma(\mathbf{body}(\downarrow(NP))) - \sqcup(\mathrm{VP} \cap \mathbf{body}(\downarrow(NP)))$
The body(↓(*NP*)) element that is the relative complement in σ(body(↓(*NP*))) of the latter object.

Fact: These two objects both in body(↓(*NP*)), but, of course, not necessarily in body(*NP*).

[4] I choose the interpretation of *most* familiar from van Benthem 1984, but the argument doesn't depend on the particular reading of *most*.

12. NON-DOWNSHIFTED MEASURE READINGS FOR NEAT MASS NOUNS

-Downshifting for *singular* DPs in partitives with a measure comparison reading:

(10) After the kindergarten party, most *of my daughter* was covered with paint.

-Also possible with *plural* DPs, (though not everybody gets these as easily).

(21) a. 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]
b. Most *of the rooms* would have been painted in bright colours.

The natural reading for (21b) is a measure reading, comparing the surface of the rooms painted in bright colours with the surface not so painted.

-Compare (21b) with (22), a non-partitive:

(22) Most rooms would have been beautifully painted.

We find: No downshifted measure interpretation, only count comparison
comparing the number of rooms that would have been beautifully painted with the number of rooms that would not have been beautifully painted.

-Partitives with neat mass nouns: downshifting with measure interpretation in (15):

[After the explosion:]
(15) Most *of the furniture* was found on the outer side of lawn, far away from the house.
[of the furniture = furniture debris]

-We now discuss readings for neat mass nouns that are *not* downshifted.

Look at (23) with partitive *of the confectionary*, based on neat mass noun *confectionary*:

[Scenario: Fred and Susan bought pralines and other candies for 10 euros.
Fred paid 7 euros, Susan paid 3 euros. No combination of candies actually cost 7 euros and no combination of candies cost 3 euros.]
(23) Most of the confectionary was paid for by Fred.

(23) is perfectly true in this context. This can only be if the reading is downshifted.

Reason: the confectionary that Fred paid for and the confectionary that Susan paid for are in this context not objects ***in*** **body**($CONF_w$).
This means that the measure reading of (23) cannot be true on a *non-downshifted* interpretation in this context.

If we downshift confectionary to, say, $\llparenthesis\sigma(\mathrm{CONF}_w)\rrbracket$, and add a measure function based on say, *prize per kilo*, then we can partition $\sigma(\mathrm{CONF}_w)$ into two parts ***in*** $\llparenthesis\sigma(\mathrm{CONF}_w)\rrbracket$ that can stand for what Fred paid for and what Susan paid for.
(Of course, if they were to quarrel and insist of dividing the loot accordingly, they would have to use a knife.)

Compare (23) with (24) in the same context:

> [Same scenario: Fred and Susan bought pralines and other candies for 10 euros.
> Fred paid 7 euros, Susan paid 3 euros. No combination of candies actually cost 7 euros and no combination of candies cost 3 euros.]

(24) Most confectionary was paid for by Fred.

This time, the judgement is that the reading we have in (23) is actually very hard to get for (24).
(24), of course, *does* allow for a count reading, which is irrelevant here.
But, crucially, (24) ***does*** naturally allows for *another measure* reading, as in context (25):

> [Scenario: Fred bought four big 50 grams pralines, and he paid 4 euros, while Susan bought 10 little 10 grams pralines and she paid 5 euro (Susan's pralines contained expensive ingredients like Crunchy Frog).]

(25) Most confectionary was paid for by Fred.

The count-comparison reading is false here. The above downshifted measure reading is also false here.

But there *is* a measure reading which is true:

> The weight/volume of the confectionary that Fred bought was bigger than the weight/volume of the confectionary that Susan bought.

This measure reading is similar to the measure phrase *500 grams of pralines* discussed earlier, in that there is no downshifting of the **body**: In *500 grams of pralines* the **body** was just the set $^*\mathrm{PRALINE}_w$. It was the **base** derived from *grams* that derived the mess mass interpretation.

Similarly in (25), if the confectionary is all pralines, the comparison is:

$$\mathbf{more}_w[\mathbf{body}(\mathit{CONF}_w), \mathbf{body}(\mathit{CONF}_w) \cap \mathrm{PAIDforbyFRED}_w]$$

which is:

$$\mathbf{more}_w[{}^{\mathbf{*}}\mathrm{PRALINE}_w, {}^{\mathbf{*}}\mathrm{PRALINE}_w \cap \mathrm{PAIDforbyFRED}_w]$$

i.e.

$$\mathbf{measure}_w(\sigma({}^{\mathbf{*}}\mathrm{PRALINE}_w,) \sqcap \sqcup({}^{\mathbf{*}}\mathrm{PRALINE}_w \cap \mathrm{PAIDforbyFRED}_w)$$
$$>$$
$$\mathbf{measure}\ _w(\sigma({}^{\mathbf{*}}\mathrm{PRALINE}_w,) - \sqcup({}^{\mathbf{*}}\mathrm{PRALINE}_w \cap \mathrm{PAIDforbyFRED}_w)$$

The measure of the pralines that Fred paid for is bigger than the measure of the pralines that Fred didn't pay for.

This is, as it should be, a measure comparison between two sums of pralines, i.e. two elements in **body**(CONF_w).

The present case differs from the case of *most of the 500 grams of pralines* in that the latter example involved a partitive, and hence the example didn't distinguish between non-downshifted and downshifted interpretations.

That is different here: the downshifted interpretation is not available in (24)-(25), but the non-downshifted interpretation is.

This means that the measure comparison interpretation in (25) is not derived via downshifting.

Another example that shows the same is (26):

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

(26) a. Not much of the cutlery is silver, only the medallions are.

b. Not much cutlery is silver.

(26a) easily gets a downshifted measure interpretation: the cutlery stuff that is silver (the medallions) is much smaller in weight/volume than the cutlery stuff that is not (the rest).
This reading is hard to get for (26b). But (26b) can nevertheless be given a measure interpretation: If the cutlery is one huge silver knife and one huge silver fork and ten tiny metal teaspoons, one can easily regard (26b) as false, even though the count-comparison reading would be true.

13. CONCLUSION

Neat mass nouns, like count nouns and unlike mess mass nouns, allow count-comparison interpretations.
Neat mass nouns, like mess mass nouns and unlike count nouns, allow non-downshifted measure interpretations.

Hence: Neat mass nouns are *semantically* different from count nouns and from mess mass nouns.

Hence the theory of Bunt et. al. that semantically neat mass nouns are just the same as count nouns is untenable.

More generally, Rothstein 2017 tentatively links the notion of measuring to the mass domain and counting to the count domain: you can only measure in the mass domain and only count in the count domain.
I do not hold with this for counting: I argue in Landman 2019a, 2019b that in Dutch and German, count comparison readings *are* possible, under contextual conditions, in the mass domain *also* for mess mass nouns.
But I *do* agree with Rothstein's suggestion for measuring:

> Count nouns never allow measure comparison
> Mess mass nouns and neat mass nouns always allow measure comparison.

Hence measure comparison may well be possible for these, just because measure comparison is what is possible in the mass domain.

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