ICEBERG SEMANTICS FOR COUNT NOUNS AND MASS NOUNS: THE EVIDENCE FROM PORTIONS

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PART 1 ICEBERG SEMANTICS

1.1. Boolean background

Boolean semantics: Link 1983: Boolean domains of mass objects and of count objects.
Singular objects as atoms.
Semantic plurality as closure under sum.

Boolean interpretation domain B:
B is a Boolean algebra with operations of complete join and meet: ⊔ and ⊓.

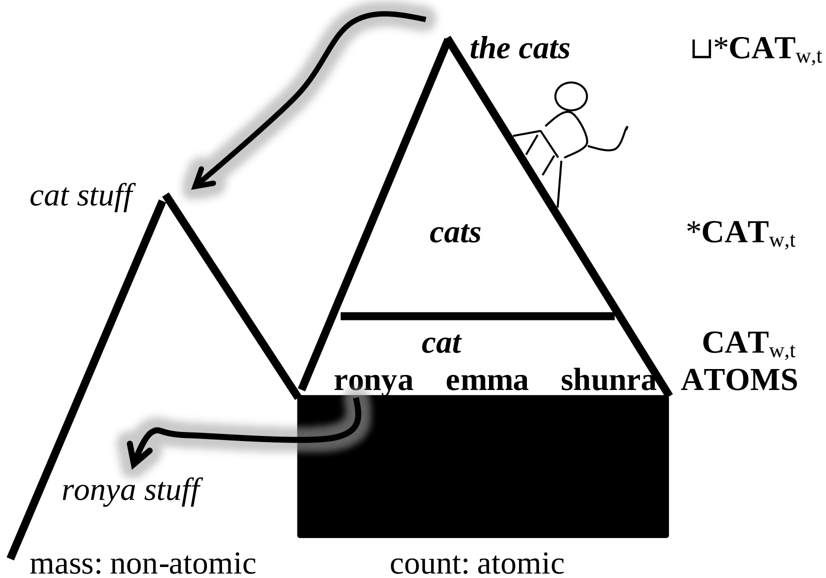
Boolean part set:	**(**x**]** = {b ∈ B: b ⊑ x} **(**X**]** = **(**⊔X**]**	The set of all parts of x.
Closure under ⊔:	*Z = {b ∈ B: ∃Y ⊆ Z: b = ⊔Y}	The set of all sums of elements of Z
Generation:	X **generates** Z **under** ⊔ iff Z ⊆ *X	all elements of Z are sums of elements of X

Minimal elements: **min**(X) = {x ∈ X: ∀y ∈ X: if y ⊑ x then y=x}
Atoms in B: **ATOM** = **min**(B–{0})

Disjointness:	a and b **overlap**	iff a ⊓ b ≠ 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	

1.2. Mountain semantics

plural nouns are mountains rising up from singular nouns
singular nouns are sets of atoms



-**counting** in terms of atoms: x *is three cats* = x has three atomic cat parts
-**distribution** in terms of atoms: *each of the cats* = each of the atomic cat parts

> **Correctness of counting atoms:**
> If A is a set of atoms then *A has the structure of a **complete atomic Boolean algebra** with A as set of atoms. This allows correct counting.

Consequence of sorted domains (Landman 1989, 1991):

1. Basically no relation between ⊑ and intuitive lexical part-of relations:
   Ronya, **Ronya's front leg**, **Ronya's paw** are all atoms, no part-of relation
   The stuff making up Ronya is not part of **Ronya** Ronya is an atom
2. **The problem of portions:** portions are countable mass

(1) a. The ***coffee*** in the pot and the ***coffee*** in the cup *were **each** spiked with strychnine*.
b. I drank t*wo **cups of coffee***
I didn't ingest the cups, so I drank *two **portions of coffee***

Problem: *coffee* is uncountable stuff, each portion of coffee is coffee
mass + mass = mass, so how can you count portions of coffee?
Landman 1991: **portion shift** shifts mass stuff to count atoms.
Iceberg semantics: different view on mass-count, not relying on atoms.

1.3 Iceberg semantics

1. Nouns are interpreted as icebergs: they consist of a **body** and a **base** and the body is **grounded** in the base. But the base floats (not a set of atoms).
2. -***mass*** - ***count*****: disjointness of the base** instead of **atomicity.**
   -***singularity*****:** body $\subseteq$ base; singular-plural characterized in terms of the base.
   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. Compositional semantic: notions ***mass*** and ***count*** apply to lexical nouns and NPs and DPs.

Correctness of counting is not to do with atomicity itself but with **disjointness:**

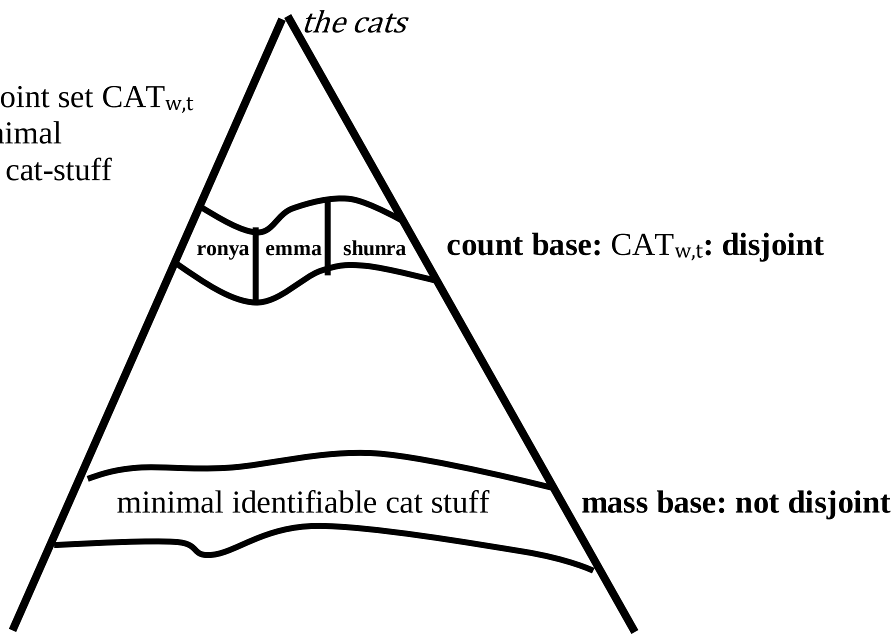
> **Correctness of counting:**
> If Z is **disjoint** then *Z has the structure of a **complete atomic Boolean algebra** with Z as set of atoms. This allows correct counting.

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

> **i-set** An i-set iceberg is a pair consisting of a **body** set and a **base** set with **the body generated by the base** under $\sqcup$.
>
> **iceberg** X = < **body**(X) **base**(X) >
> with **body**(X), **base**(X) $\subseteq$ B and **body**(X) $\subseteq$ ***base**(X)

Iceberg semantics: singular noun *cat* and plural noun *cats* are counted in terms of the same base: *cat* $\rightarrow$ < $CAT_{w,t}$, $CAT_{w,t}$>, with $CAT_{w,t}$ a disjoint set.
cats $\rightarrow$ <*$CAT_{w,t}$. $CAT_{w,t}$>

the cats:
count: sum of disjoint set $CAT_{w,t}$
mass: sum of minimal identifable cat-stuff



1.4 The mass-count distinction

Let X = <**body**(X), **base**(X)> be an i-set iceberg.

X is **count** iff **base**(X) is **disjoint**, otherwise X is **mass**

count nouns are interpreted as i-sets with **base disjoint.**
mass nouns are interpreted as i-sets with **base overlapping**.

Refinement to deal with borderline situations:
Problem: We want to allow mass nouns to denote the null i-set <Ø,Ø.> in certain worlds, but <Ø, Ø> is technically count. , but should be allowed as borderline mass.
Solution: We allow count as borderline mass. [definitions given in the appendix]
N**ormality:** In normal contexts mass nouns denote i-sets that are mass but not borderline mass.

Infelicity condition:
Let α be a **mass noun** and β an NP-**modifier**
If βα is **only borderline mass when defined,** then βα is **infelicitous**

Counting as presuppositional cardinality:

Let $x \in B$ and let $Z \subseteq B$

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

.

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

Fact: The semantics of **numericals** below is defined in terms of **card**
Corollary: Numerical predicates cannot felicitously modify mass nouns

Grammar with bases

1. **Bases** are used for distinguishing count nouns (***base disjoint***) from mass nouns.
2. Count nouns: **Bases** are used for counting, count-comparison and distribution.
With Rothstein 2010: ***base disjoint*** is a grammatical property, cannot be reduced to conceptual disjointness, because of count nouns like *fences.* These are contextually coerced into disjointness by ***base disjoint***. [Discussion in Landman 2015 ms.]
3. **Bases** are used for distinguishing neat mass nouns (**base generated under ⊔ from a disjoint subset**) (like *kitchenware*) from mess mass nouns (like *meat*, *wine*, *mud*).
4. Neat mass nouns: **Bases** are used for count-comparison and distribution.
Landman 2015 ms. : the neat/mess distinction is a grammatical distinction, because of neat mass nouns like *fencing*. [Discussion in Landman 2015 ms.]

1.5 Iceberg semantics for numerical modifiers

Head principle for NPs: (Compositionality)

Let C be a complex NP with NP head H   Both denote i-sets:

H = <**body**(H), **base**(H)>

C = <**body**(C), **base**(C)>

then:

base(C) = (**body**(C)] ∩ **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.

Semantics for numerical modifiers [following Landman 2004]

three	→ 3	number	
at least	→ ≥	relations between numbers	$\lambda m\lambda n.\ n \geq m$
–	→ =		$\lambda m\lambda n.\ n = m$

Number predicates: Apply the number relation to the number:

at least three → $\lambda n.n \geq 3$ ({3,4,5,…})   set of numbers

– three → $\lambda n.\ n = 3$ ({3})

Numerical predicates: Compose the number relation with **card**:

at least three → $\lambda n.n \geq 3 \circ$ **card** = $\lambda X\lambda x.$ **card**[x,X] ≥ 3

Numerical modifiers: functions from i-sets to i-sets

at least three → $\lambda P.$ { <**body**$_P$, **base**$_P$ > if **pres**$_P$; ⊥ otherwise }

with: **body**$_P$ = $\lambda x.$ **body**(P)(x) ∧ **card**[x,**base**(P)] ≥ 3
the set of **body**(P)-sums that count as at least 3 **base**(P) objects

base$_P$ = (**body**$_P$] ∩ **base**(P) >   Head principle

pres$_P$ = **base**(P) is **disjoint**

Fact: ***At least three*** only felicitously modifies NPs whose base is disjoint.
This means, indeed, that *at least three* + mass noun is infelicitous.

cats $\rightarrow$ $CATS_{w,t}$ = < $*CAT_{w,t}$, $CAT_{w,t}$>, with $CAT_{w,t} \subseteq B$ and **disjoint**($CAT_{w,t}$)
We derive:

at least three cats $\rightarrow$ < **body**, **base** >
: **body** = $\lambda x.\ *CAT_{w,t}(x) \wedge$ **card**$[x, CAT_{w,t}] \geq 3$
base = **(body]** $\cap\ CAT_{w,t}$

which simplifies as:

at least three cats $\rightarrow$ < **body**, **base** >
body = $\lambda x.\ *CAT_{w,t}(x) \wedge$ **card**$[x, CAT_{w,t}] \geq 3$ the set of sums consisting of at least 3 cats
base = $CAT_{w,t}$ disjoint set

Example: $CAT_{w,t}$ = { r, e, s, m }
at least three cats: **body** = { r⊔e⊔s, r⊔e⊔m, r⊔s⊔m, e⊔s⊔m, r⊔e⊔s⊔m }
set of strict pluralities
base = { r, e, s, m } note: base is not the set of minimal elements of the body

Base is the set used for **counting** and for **distribution,** e.g. with *each*:

In (2) a sum of cats in the denotation of *three pet cats* counts as a sum of *three* in relation to the base of the subject denotation $PET_{w,t} \cap CAT_{w,t}$. *Each* in the VP distributes the VP property to the elements of this set:

(2) *Three pet cats* should *each* have their own basket.

Segue to the Part II: Head principle for NPs:
base(C) = **(body**(C)**]** $\cap$ **base**(H)
base of complex = part set of body restricted by base of head

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

PART 2: CLASSIFIERS, MEASURES AND THE HEAD PRINCIPLE

2.1. Classifiers and measures in English and Dutch.

[Note: I follow the usage of Larry Horn and use [γ] to indicate examples found on the web.]

Classifiers and measures take mass or plural complements:

One pack of *rice*	One kilo of *ballbearings*	#One kilo of *ballbearing*
Eén pak *rijst*	Eén kilo *kogellagers*	#Eén kilo *kogellager*

Classifiers agree in number with modifiers in English and Dutch

Two packs of rice *Two kilos* of rice *Twee pakken* rijst

Measures in Dutch are not specified for number (Doetjes 1997)

Twee ***kilo*** rijst	number not specified	measure interpretation
Twee ***kilos*** rijst	plural specified	classifier interpretation

Most remarkable: cheerful shifting between measure and classifiers interpretations:

(3) Joha's mother said to him: "Go and buy me ***two liters of milk***." So Joha went to buy her ***two liters of milk***. He arrived home and knocked on the door with ***one liter of milk***. His mother said to him: "I asked you for two liters. Where is the second one?" Her son said to her: "It broke, mother." [γ] **measure → classifier**

(4) a. There was also the historic moment when I accidentally flushed a ***bottle of lotion*** down the toilet. That one took a plumber a few hours of manhandling every pipe in the house to fix. [γ] **classifier**

b. This is one of the few drain cleaners that says it's safe for toilet use, so I flushed a ***bottle of it*** down the toilet and waited overnight. [γ] **measure**

Semantic interpretation: Rothstein 2011 (following among others Landman 2004)

Classifier interpretation:	**Measure interpretation:**
three bottles of wine	*three liters of wine*
three ∩ [**bottle (wine)**]	[**three** ∘ **liter**] ∩ **wine**

Classifier interpretation: **bottle** applies to **wine,** the result intersects with **three**
The **semantic head** is the **classifier *bottle*:**

three ***bottles*** of wine = three ***bottles*** filled with wine
three ***liters*** of milk = three ***liter bottles*** filled with milk

Other classifier interpretations (discussed below) follow the same semantic composition.

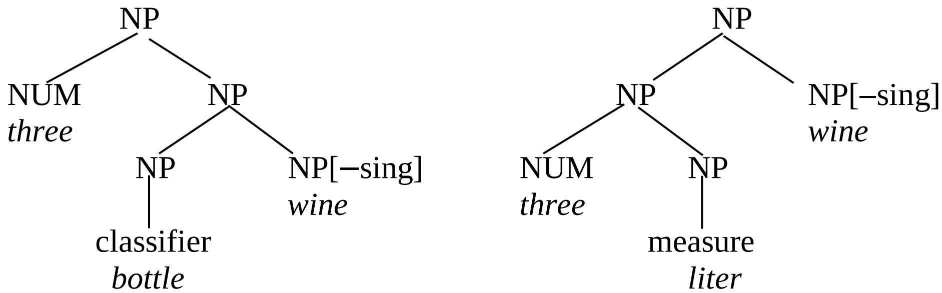
Measure interpretation: **three** composes with **liter,** the result intersects with **wine**
the **semantic head** is the **non-measure *wine*:**

three ***liters*** of wine = ***wine*** to the amount of three liters
three ***boxes*** of books = ***books*** to the amount of three boxfuls

The syntactic head: Landman v. Rothstein

Rothstein 2011, 2016: Measure and classifier interpretations have different syntactic structures. Evidence from Mandarin Chinese, Modern Hebrew, and Hungarian.

Classifier structure: | **Measure structure:**



Syntactic head: classifier | **Syntactic head:** NP[–sing]

Rothstein: 1. **Measure phrases** have the **measure structure** and a measure interpretation. Syntax and semantics are **matched**.
2. **Syntactic head** of the measure phrase is **NP[–sing].**
3. **Semantics** of this head: **mass** or **plural reinterpreted as mass.**

Consequence: Measure phrases come out as mass.

I claim, for English and Dutch:
1. No evidence that NP[–sing] in the measure phrase is the syntactic head.
2. No evidence that NP[plur] is reinterpreted as mass in the measure phrase:
3. Rothstein's modifier evidence is evidence for the semantics of measures.

ad 1: classifier phrases and measure phrases do not show the differences with respect to number and gender agreement (the latter in Dutch) that you would expect if measure phrases have the measure structure (see Landman 2015).
ad 2: There is no evidence for the systematic reinterpretation of the complement in measure phrases as a mass noun.

(5) a. 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]
b. In Finland 700 million kilos of **potatoes** are produced a year.
#Nearly half of the amount is poorly utilized waste, invalid potatoes, peels and cell water.

If **potatoes** in (5b) is reanalyzed as a mass noun, (5b) should be as felicitous as (5a), but it isn't.

(6) The truck toppled over and five hundred **boxes** of **marbles were** rolling over the highway, causing a major traffic jam.

Classifier interpretation - *five hundred boxes rolled over the highway*
Measure interpretation - *marbles to the amount of 500 boxfuls rolled over the highway*
Marbles in (6) does not shift to a mass interpretation on either reading.

ad 3: Rothstein uses the contrast in (7) as evidence for the syntactic distinction:

(7) a. ✓One expensive glass of wine classifier structure
b. #One expensive liter of wine measure structure

Idea: -(7b): *expensive* does not modify just *liter*;
the measure structure makes [*one liter*] a constituent;
hence, expensive cannot occur there **and** modify *wine*.
-(7a): *expensive* can modify *glass of wine*.

However, look at (7c) on the classifier interpretation, and the natural interpretation where the cup is not itself melted (searching for [γ]-variants strongly confirms the judgement):

(7) c. #Eén gesmolten beker ijs. #One melted cup of icecream.

Observation for (7c): Context disallows: ((**melted(cup))** (icecream)
(melted **(cup(icecream)**)
Infelicity of (7c) shows: Semantics disallows: (cup **(melted(icecream))**)

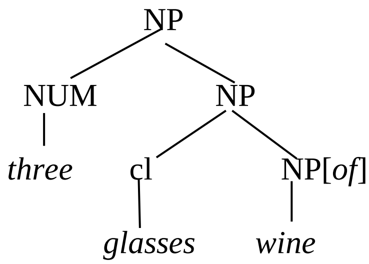
Apply this to (7b): Context disallows: ((**expensive(liter))** (wine)
Observation for (7c): Semantics disallows: (liter **(expensive(wine))**)
Measure semantics disallows: (expensive **(liter(wine)**)
(liter(wine)) is not a semantic unit in the derviation.

Conclusion: the modification facts in Dutch and English are evidence for the measure semantics, but not for the proposed measure syntax.

This talk: 1. **Measure phrases** have the **classifier structure** and a measure interpretation.
Mismatch between syntax and semantics.
2. **Syntactic head** of the measure phrase is the **measure**.
3. **Semantics** of the measure: the measure itself is **mass.**
Consequence: By the Head principle, the measure phrase comes out as mass.
Hence we will derive Rothstein's result with a standard syntax.

2.2. Semantics of classifiers.

Classifier structure:



semantics interpretation

three(**plur**([**classifier[**$GLASS_{w,t}$**]** ($WINE_{w,t}$)])))

mass noun [$_{NP}$ *wine*] $\rightarrow$ $WINE_{w,t}$ = <$\text{WINE}_{w,t}$, **base**($\text{WINE}_{w,t}$)>
count noun [$_{NP}$ *glass*] $\rightarrow$ $GLASS_{w,t}$ = <$\text{GLASS}_{w,t}$, $\text{GLASS}_{w,t}$> with **disjoint**($\text{GLASS}_{w,t}$)

Classifier interpretation:	$GLASS_{w,t}$ shifts to a classifier interpretation,
[$_{cl}$ *glass*] $\rightarrow$ **classifier**[$GLASS_{w,t}$]	a function from i-sets to i-sets

General interpretation schema for classifiers:

classifier[$GLASS_{w,t}$] = function from i-sets to i-sets

$$\lambda P. \begin{cases} \langle \textbf{body}_P, \textbf{base}_P \rangle & \text{if } P \text{ is mass or plural and } \textbf{pres}_P \\ \bot & \text{otherwise} \end{cases}$$

with: **body**$_P$ = **...**
base$_P$ = **(** **body**$_P$ **]** $\cap$ $\text{GLASS}_{w,t}$ Head principle
pres$_P$ = **...** Possible further presuppositions

Note 1: $\text{GLASS}_{w,t}$ is the base of the NP interpretation of *glass*
If we shift the NP interpretation of *glass* **before classifier interpretation** we get a different base [$\rightarrow$ contents classifiers]
Note 2: Further presuppositions specified: [$\rightarrow$ contents classifiers]

With this schema, we only need to specify the variable parameters for different classifier interpretations.

2.3. Container classifiers.

Container interpretation:
body$_P$ = $\lambda x.\text{GLASS}_{w,t}(x) \wedge$ **body**(P)(**contents**$_{[\text{GLASS, P,c}],w,t}$(x))
the set of glasses containing **body**(P)

Basis of container interpretation: **contents function:**

contents$_{[\text{GLASS, WINE,c}],w,t}$: B $\rightarrow$ B
-specifies for a container its **relevant contents:** the relevant stuff that is in the container
-indexed for: container **glass**, contents **wine** and **context** c

Constraints on contents:
1. **contents**$_{[\text{GLASS, WINE,c}],w,t}$(x) = y presupposes that x is a glass and requires that y is wine.
2. **Relevant contents:**
-for glasses and wine: *liquid contents* and not the *gaseous contents* (ignores the air in the glass)
-contents requires the amount of wine to be within a certain range:

(8) *[Next to Susan is a wineglass with less than a centimeter wine left in it. Susan to Fred:]*
a. You see that ***wineglass***? Can you fill it up please?
b. #You see that ***glass of wine***? Can you fill it up please?

What counts as *a glass of wine*: relative to what is standard for **glass** and **wine** and the **context.**
-*a glass of wine* versus a *glass of Lagavulin single malt.*
-*a glass of wine now* versus *a glass of wine for Susan when Susan was pregnant*

-The wine may be mixed with non-wine but only to a certain extent:
Some drinks allow water, an olive, a piece of lemon, a grape pit, a worm, without affecting the contents:
It's still *a glass of mescal*, even if it has a worm in it; but if you pour diesel oil in my glass of *Chassagne Montrachet* it is no longer *a glass of wine* and the end of a beautiful friendship.

We feed the container interpretation for *glass* into the classifier interpretation schema, apply the result to the i-set interpretation of *wine* and derive:

[$_{\text{NP}}$ *glass of wine*] $\rightarrow$ <**base**, **base**>
with **base** = $\lambda x.\text{GLASS}_{w,t}(x) \wedge \text{WINE}_{w,t}$(**contents**$_{w,t}$(x))
the set of glasses whose contents is wine

[Note: for readability: index $_{[\text{GLASS, WINE,c}]}$ on contents suppresed; extensional property variables, instead of the proper intensional ones, see Landman 2015 ms. for discussion.]

Fact: ***glass of wine,*** with ***glass*** a **container classifier**, is a **singular count** NP

Reason: *glass* is a count noun, hence $\text{GLASS}_{w,t}$ is disjoint.
Hence **the set of glasses containing wine** is also disjoint.

2.4. Portion and measures interpretations.

2.4.1. Portion classifiers interpretations are count.

Two ***glasses*** of wine two **sacks** of potatoes two **spoons** of sugar

Container classifiers: two ***glasses*** containing wine
Measure reading: **wine** to the amount of **two glasses**
Contents classifiers: two **wine portions** each of which is the contents of a *glass* of wine

Portion readings: denote stuff, like mass nouns, but are count.

(9) I have put sixteen glasses of wine ready in a row, of different size, as you can see. We are going to put all of it into the brew in the course of two hours. As you will see, ***most of the sixteen glasses of wine are*** put into the soup during the first half an hour of brewing.

-Container reading is not relevant: we are not going to put the glasses in the brew.
-most in (9): compares the **number of portions of wine**. Count reading, no measure reading: the portions are specified to be of different sizes.

Other portion classifiers: ***shape classifiers*:**

Shape classifiers (portion classifiers): *hunk, slice, stack (of hay), strand (of hair)*

A ***hunk*** of meat = meat in the shape of a ***hunk***
A ***slice*** of meat = meat in the shape of a ***slice***

Shape classifiers: a hunk of meat is *meat*. Similar to measures: a kilo of meat is meat.
But shape classifiers are count:

(10)	a. I don't eat ✓**much** ***/#many meat*** sliced nowadays.	mass
	b. I don't eat **#much /✓ many *slices of meat*** nowadays	count
	c. Most of the slices of meat are pork	count comparison

i.e. (10c) comparison concerns **the number of slices** of meat; **no mass comparison**.

[Partee and Borschev 2012 discuss portion readings (tentatively) as a subcase of measure readings. Schvarcz 2014 argues with Hungarian data that portion readings are count. Khrizman, Landman, Lima, Rothstein and Schvarcz 2015 argue that portion readings differ systematically from measure readings, and they offer cross-linguistic evidence to this effect.]

2.4.2 Measure interpretations are mass (Rothstein 2011)

Partitives with singular DPs patterns with partitves with mass DPs:

(11) 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 changingf the base): *opening up* internal structure:

(12) 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 singualar DPs. Plural cases can be found:

(13) 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]

But plural cases are rare, and not everybody (e.g. Susan Rothstein) accepts cases like (13).
Crucial here: sharp contrasts between plural opening up (14b) and measure phrases (14c):

(14) 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 (14c) is not to do with *opening up* (as in (14b), but with the measure phrase.
Cf. also (15):

(15) 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 patterns with mass nouns.

Note: 'the very same thing' may count as *much of the six boxes of ball bearings*, which is mass, and count as *many of the ball bearings* , which is count.
In Iceberg semantics, the difference will be located in the base: the base of the first, but not that of the second involves the measure *boxful* in its derivation.

2.5 Portion classifiers 1: Shape classifiers

Shape classifiers, *hunk, slice, heap, strand,…*

count noun [$_{NP}$ *hunk*] → $HUNK_{w,t}$ = <$HUNK_{w,t}$, $HUNK_{w,t}$> with **disjoint**($HUNK_{w,t}$)

Portion interpretation: Simply intersection

body$_P$ = λx. **body**(P)(x) $\wedge$ $HUNK_{w,t}$(x)
stuff that is **body**(P) and hunk

We feed the portion interpretation for *hunk* into the classifier interpretation schema and apply to the interpretation of *meat* and derive:

hunk of meat → <**base**, **base** > with **base** = $\lambda x.MEAT_{w,t}(x) \wedge HUNK_{w,t}(x)$
stuff that is meat and hunk

Fact: ***hunk of meat*** with ***hunk*** a **shape portion classifier**, is a **singular count** NP

Shape classifiers; based on count nouns, hence **disjoint** base.
Actually, shape classifiers satisfy a stronger property:

Contextual separateness:
If $HUNK_{w,t}$(x) and $HUNK_{w,t}$(y) and x≠y then x and y are **contextually separated**:
They behave in the context as separate single bodies under environmental transformations.

Two disjoint parts of one hunk of meat only become themselves hunks when they are separated and we can pick them up separately.
Two disjoint parts of the soup become portions of soup when we put them in separate bowls.
Two segments of one hair are not two strands of hair.

Relates to: topological considerations in the semantics of mass and count nouns in Grimm 2012.

2.6 Portion classifiers 2: Contents classifiers

Central in the analysis of contents readings: we assume that function **contents** is **normal on** relevant indices w,t:

> **contents** is **normal on** w,t iff
> $\forall y_1,y_2$[if $y_1 \neq y_2$ then **disjoint**[$\mathbf{contents}_{w,t}(y_1)$, $\mathbf{contents}_{w,t}(y_2)$]
> In a normal context, distinct containers have non-overlapping contents.

One consequence: for normal w,t $\mathbf{contents}_{w,t}$ is one-one, and hence inverse function $\mathbf{contents}_{w,t}^{-1}$ is defined.

container classifiers: glasses **containing** wine
contents classifiers: wine **contained in** glasses

> **Contents interpretation:**
> We shift the NP *glass* from **container** to **contents**, relative to *P,w,t*:
>
> $[_{NP}\ glass] \rightarrow <\mathbf{base}_{P,w,t}, \mathbf{base}_{P,w,t}>$
> with $\mathbf{base}_{P,w,t} = \lambda x.\text{GLASS}_{w,t}(\mathbf{contents}_{(P),w,t}^{-1}(x))$
> set of portions that are *P*-contents in w,t of glasses
>
> We use this as base in the classifier interpretation schema, with the corresponding body:
> $\mathbf{body}_{P,w,t} = \lambda x.\ \mathbf{body}(P)(x) \wedge \text{GLASS}_{w,t}(\mathbf{contents}_{w,t}^{-1}(x))$
> set of **body**(*P*) portions that are contents in w,t of glasses
>
> We add an additional presupposition: $\mathbf{pres}_{P,w,t}$ = **contents is normal on context** w,t

We feed the interpretation derived into the classifier schema and apply to *wine*:

> *glass of wine* $\rightarrow <\mathbf{base}, \mathbf{base}>$
> with **base** = $\lambda x.\text{WINE}_{w,t}(x) \wedge \text{GLASS}_{w,t}(\mathbf{contents}_{w,t}^{-1}(x))$
> the set of wine portions that are glass-contents in w,t

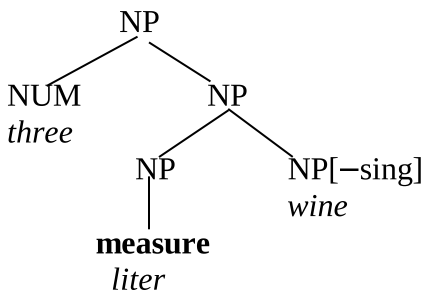
If x_1, x_2 are in this set and $x \neq y$ then they are contents of **different glasses** (because $\mathbf{contents}_{w,t}$ is a function), hence, by the normality presupposition, x_1 and x_2 are disjoint:

Hence:

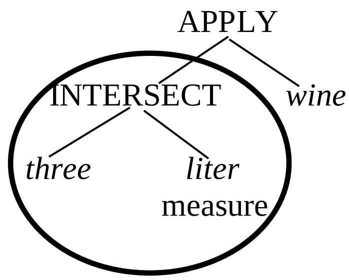
> **Fact:** ***glass of wine***, with ***glass*** a **contents portion classifier**, is a **singular count** NP

2.7. Semantics of measures

Classifier structure:



Measure interpretation:



Semantics: ***three liter*** is a semantic unit [but not a syntactic unit in this syntax]]

Iceberg semantics: interpretation with **function composition**:

(**measure** ∘ **numerical**) ∩ **complement**. — *liter* composes with *three*

liter *three* *wine* — the result intersects with *wine*

General schema for the measure interpretation:

measure[$LITER_{w,t}$] = function from i-sets to i-sets

$\lambda \mathbf{N} \lambda P. \begin{cases} <\mathbf{body}_{P,N}, \mathbf{base}_{P,N,}> & \text{if } \mathbf{pres}_{P,N} \\ \perp & \text{otherwise} \end{cases}$

with: $\mathbf{body}_{P,N}$ = ($\mathbf{body}(LITER_{w,t}) \circ$ N) ∩ $\mathbf{body}(P)$ — Function conposition

$\mathbf{base}_{P,N}$ = $^{\uparrow}$($\mathbf{body}_P$] ∩ $\mathbf{base}(LITER_{w,t})$ — Head principle

$\mathbf{pres}_{P,N}$ = N is a number predicate (like λn.n=3) and P is mass or plural

Iceberg semantics for the measure

Basic idea:

1. The body of the measure *liter* is the measure function $\mathbf{liter}_{w,t}$, which is a function from objects to real numbers, and hence a set of object-number pairs.

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

[The relevant domain is: $\mathbf{liter}_{w,t} \cup \{<b,\perp>: \mathbf{liter}_{w,t}(b) = \perp\}$, ⊔ is lifted in the obvious way.
Operations ↑ and ↓ shift between sets of objects and sets of object-measure value pairs:
$^{\uparrow}X = \{<X,\mathbf{r}>: \mathbf{liter}_{w,t}(x) = \mathbf{r}\}$ $^{\downarrow}Z = \{x: \exists \mathbf{r} \in \mathbf{R}: <x,\mathbf{r}> \in Z \text{ and } \mathbf{liter}_{w,t}(x) = \mathbf{r}]\}$ **]**

3. We follow Iceberg semantics: base of the measure *liter* must be a set of object-value pairs that generates $\mathbf{liter}_{w,t}$ under ⊔.

4. Let **m** be a **contextually** given measure value. For instance, think of **m** as the lowest volume that our experimental precision weighing scales can measure (but not the lowest value defined).

We set: $\mathbf{m}_{\mathbf{liter},w,t} = \mathbf{m}$

$\mathbf{m}_{\mathbf{liter},w,t}{}^{\alpha}$ = {<x,**r**>: $\mathbf{liter}_{w,t}(x) = \mathbf{r}$ and $\alpha(\mathbf{r},\mathbf{m})$ } for α ∈ { =, <, ≤, >, ≥,…}
the set of object-value pairs where the liter value stands in numerical relation α to value **m**

We observe that $\mathbf{m}_{\mathbf{liter},w,t}{}^{=}$, the set of object-value pairs with liter value **m**, cannot generate $\mathbf{liter}_{w,t}$ under ⊔, simply because it cannot generate $\mathbf{m}_{\mathbf{liter},w,t}{}^{<}$, the set of object-value pairs with liter value **below m**, under ⊔ .

5. This means that, if we want to stand a chance of generating $\mathbf{liter}_{w,t}$ under ⊔ we **must** include in our base $\mathbf{m}_{\mathbf{liter},w,t}{}^{\leq}$**,** the set of object-value pairs with liter value **up to m**. Since $\mathbf{liter}_{w,t}$ is an additive measure, it is reasonable to assume that $\mathbf{m}_{\mathbf{liter},w,t}{}^{\leq}$ **does** indeed generate $\mathbf{liter}_{w,t}$ under ⊔ (when $\mathbf{m}_{\mathbf{liter},w,t}$ is chosen as suggested).

[$_{\text{measure}}$ *liter*] → $LITER_{w,t}$ = <**body**($LITER_{w,t}$), **base**($LITER_{w,t}$)>

where:	**body**($LITER_{w,t}$) = $\mathbf{liter}_{w,t}$	the measure function
and:	**base**($LITER_{w,t}$) = $\mathbf{m}_{\mathbf{liter},w,t}{}^{\leq}$	pairs with value up to $\mathbf{m}_{\mathbf{liter},w,t}$
and:	$\mathbf{m}_{\mathbf{liter},w,t}{}^{\leq}$ generates $\mathbf{liter}_{w,t}$ under ⊔	

Fact: measure *liter* is mass

Reason: base $\mathbf{m}_{\mathbf{liter},w,t}{}^{\leq}$ is not disjoint (in fact, already $\mathbf{m}_{\mathbf{liter},w,t}{}^{=}$ is not disjoint).

This fact really follows from the basic architecture of Iceberg semantics, the assumption that the base must generate the body **under ⊔**:

- If you **don't include** $\mathbf{m}_{\mathbf{liter},w,t}{}^{\leq}$ in the base, you will **not generate** $\mathbf{liter}_{w,t}$ **under** ⊔
- If you **do include** $\mathbf{m}_{\mathbf{liter},w,t}{}^{\leq}$ in the base, then (except in abnormal contexts) the **base is not disjoint.**

General concern:
-If you want to generate the set of object-measure value pairs that is the measure function $\mathbf{liter}_{w,t}$ from a disjoint base, you must generate all liter measure values from the values in that base, using only addition of values, +.
-In normal contexts generating the measure function requires (pervasive) overlap in the base.

Measures and sets in the measure phrase:
base of the measure phrase is a **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 $\sqcup$.

We apply the measure schema to measure *liter*, number predicate *three* and complement *wine* and derive:

three liters of wine :
$\mathbf{body} = \lambda x.\mathbf{liter}_{w,t}(x)=3 \wedge \text{WINE}_{w,t}(x)$
$\mathbf{base} = \{\langle y,\mathbf{r}\rangle: \exists x[\text{WINE}_{w,t}(x) \wedge y \sqsubseteq x \wedge \mathbf{r} \leq \mathbf{m}_{\mathbf{liter},w,t}\}$

body: stuff that is wine and has volume three liters
$^{\downarrow}$**base**: stuff that is part of wine and has volume at most $\mathbf{m}_{\mathbf{liter},w,t}$.

Fact: **measure** phrase ***three liters of wine*** is a **mass** NP

Reason: $^{\downarrow}\mathbf{base}(LITER_{w,t}) = \lambda x.\ \mathbf{liter}_{w,t}(x) \leq \mathbf{m}_{\mathbf{liter},w,t}$ 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.

Similar semantics for *three kilos of potatoes* and *three boxes of books*:
three kilos of potatoes: $\lambda x.\mathbf{kilo}_{w,t}(x)=3 \wedge {}^*\text{POTATO}_{w,t}(x)$
three boxes of books: $\lambda x.\mathbf{box}_{w,t}(x)=3 \wedge {}^*\text{BOOK}_{w,t}(x)$

three kilos of potatoes is mass, because the base that Iceberg semantics derives is the set of **potatoe-parts** that measure up to value $\mathbf{m}_{\mathbf{kilo},w,t}$, and this set is not disjoint.

Important to note:
- the element of the **base** are **parts** of sums of potatoes measuring three kilos; they are not themselves required to be in the denotation of *POTATO (with POTATO disjoint).
- but the elements of the **body are** required to be in *POTATO.

Nice example showing the latter: Dutch count noun *bonbon* in (16):

(16) *[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?

2.8. Shifting measures to classifiers:

Khrizman, Landman, Lima, Rothstein and Schvarcz 2015 discuss operations that shift measures to portion classifiers and show that these interpretations are **count**.
See KLLRS 2015 for details. In all the following cases we derive $\lambda P.\langle$**base**$_P$,**base**$_P\rangle$

Measure shift to a container interpretation:

(17) I broke a liter of milk

Shift *LITER* to *ONE-LITER-CONTAINER*, with property CONTAINER_c the nature of which is contextually provided, with for all w,t, $\text{CONTAINER}_{c,w,t}$ disjoint:

base$_P = \lambda x.\text{CONTAINER}_{c,w,t}(x) \wedge$ **body**$(P)($**contents**$_{w,t}(x)) \wedge$ **liter**$_{w,t}(x)=1$
Countable containers containing one liter of body(P) disjoint

Measure shift to a portion interpretation: free portion interpretations

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

Shift *LITER* to *ONE-LITER-PORTION*, with property PORTION_c the nature of which is contextually provided, with for all w,t, $\text{PORTION}_{c,w,t}$ disjoint:

base$_P = \lambda x.$ **body**$(P)(x) \wedge \text{PORTION}_{c,w,t}(x) \wedge$ **liter**$_{w,t}(x)=1$
Countable portions of body(P) of one liter disjoint

Free portion interpretations for container classifiers:

Measure interpretation of classifiers like *bottle, glass, cup* involves measure functions **bottle**$_{w,t}$, **glass**$_{w,t}$, **cup**$_{w,t}$. These can shift to free portion interpretations:

Shift $CUP_{measure}$ to *ONE-CUP-SIZE-PORTION*:
base$_P = \lambda x.$ **body**$(P)(x) \wedge \text{PORTION}_{c,w,t}(x) \wedge$ **cup**$_{w,t}(x)=1$
Countable cup-size portions of body(P). disjoint

(19) Pour three cups of soy sauce in the brew, the **first** after 5 minutes , the **second** after 10 minutes, the **third** after 15 minutes. I have a good eye and a very steady hand, so I pour **them** straight from the bottle.

-I don't add the cups to the brew.
-The soy sauce is never in a cup when I pour, so it is not the contents of any real cup.
-But I count what I pour in: **cup-size portions** = **free portion interpretation.**

2.9 In sum

Readings for classifiers and measures:

three bottles of wine		
container interpretation	**count**	three bottles filled with wine
contents interpretation	**count**	three portions of wine, each the contents of one bottle
measure interpretation	**mass**	wine to the amount of three bottle-fuls
portion interpretation	**count**	three bottle-amount size portions
three liters of wine		
measure interpretation	**mass**	wine to the amount of three liters
portion interpretation	**count**	three liter-amount size portions
container interpretation	**count**	three liter-containers filled with wine
contents interpretation	**count**	three portions of wine, each the contents of one liter-container

Compositionality: Systematic account of classifier and measure interpretations of complex noun phrases (pseudo partitives).
Possible because mass-count applies not just nouns, but noun phrases, and because of the Head Principle: compositional definition of bases for complex noun phrases.

Iceberg semantics:
Mass-count distinction: based on **disjointness**, not on atomicity

three glasses of wine

	Mass measure reading		**Count portion reading**
	wine measuring 3 glassfuls		three glass-size portions
the body:		**the wine**	
generated by			
the base:	wine parts below a minimal measure		three disjoint portions
	mass		**count**

Proost

Appendix: Definitions of count, mass, neat, mess

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**

More subtle definitions taking into account **borderline situations**.
-technically, i-set <Ø,Ø> is trivially **count** and **not mass.**
But we want to allow the denotation of mass nouns to be empty in some worlds (contexts).
count i-set <Ø,Ø> should count as **borderline mass**
-Intuition for neat mass nouns: distinction between singular and plural is not properly articulated in the base: **min(base)** $\subseteq$ **base** $\subseteq$ ***min(base).**
But the borderline case is: **min(base)** = **base. Count** should count as **borderline neat**.

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

With this we define notions of mass, neat and mess i-sets that include borderline cases:
X is **mass**$^{\textbf{inclusive}}$ iff X is mass or borderline mass
X is **neat**$^{\textbf{inclusive}}$ iff X is neat or borderline neat
X is **mess**$^{\textbf{inclusive}}$ iff X is mess or borderline mess

These notions are only useful in that they allow us to be explicit about borderline cases in the following definitions of count, mass, neat, mess NPs:

Let α be an NP.
α is **count** iff for every $w \in W$: $[\![\alpha]\!]_w$ is **count**
α is **mass** iff for every $w \in W$: $[\![\alpha]\!]_w$ is **mass**$^{\textbf{inclusive}}$ and not for every $w \in W$: $[\![\alpha]\!]_w$ is **borderline mass (count)**
α is **neat** iff for every $w \in W$: $[\![\alpha]\!]_w$ is **neat**$^{\textbf{inclusive}}$ and not for every $w \in W$: $[\![\alpha]\!]_w$ is **borderline neat (count)**
α is **mess** iff for every $w \in W$: $[\![\alpha]\!]_w$ is **mess**$^{\textbf{inclusive}}$ and not for every $w \in W$: $[\![\alpha]\!]_w$ is **borderline mess (neat)**

In **normal contexts** the interpretation of α is , *ceteris paribus* assumed to be not borderline.

Summary: In all contexts: **Count** nouns are interpreted as **count** i-sets
In normal contexts: **Mass** nouns are interpreted as **mass** i-sets
Neat nouns are interpreted as **neat mass** i-sets
Mess nouns are interpreted as **mess mass** i-sets

Important note: Mess mass nouns in normal contexts are generated under $\sqcup$ by a base which is not disjoint, nor itself generated by a disjoint set of minimal elements.
With Landman 2011: present theory is based on generation under $\sqcup$ and disjointness.
Against Landman 2011: present theory allows different sources for **mess** mass (including even sets with atomless bases, which **come out** as mess mass).

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