COUNT NOUNS - MASS NOUNS
NEAT NOUNS - MESS NOUNS

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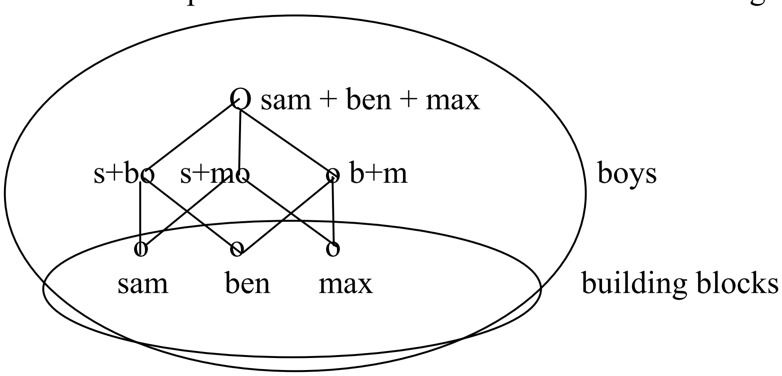
1. ...OR NOT TO COUNT

Count nouns can be counted: ✓one *boy*/✓two *boys*/✓three *boys*,…
Mass nouns cannot be counted: # one *salt*/# two *salt*/ # three *salt*,…

We count in a Boolean counting structure:
-The denotation of *boys* is a structure of singular and plural objects.
-The singular objects are the **semantic building blocks** of the structure.
-We count pluralities in terms of their semantic building blocks.



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Why can't we similarly count mass objects like *meat* and *salt*?
Apparently something is wrong with the building blocks of mass nouns.

NOT COUNT 1: Count noun denotations have minimal elements, mass nouns do not have minimal elements.

Very common assumption: ter Meulen 1980, Bunt 1985, Link 1983, etc.
discrepancy between semantics and the physical world. Representative example:

"What are the minimal parts of water? Chemistry tells us that they are the water molecules. But water molecules can be counted, while water cannot be counted. This shows that natural language semantics does not incorporate the insights of chemistry in its models: in our semantic domains, the water molecules are not the minimal parts of water. In fact, the real semantic question is: is there any evidence, semantic evidence, to assume that mass entities like water are built from minimal parts at all, either from minimal parts that are water, or from minimal parts that aren't water? If there is no such semantic evidence, it is theoretically better to assume that the semantic system does not impose a requirement of minimal parts.

Since there is no semantic evidence for minimal parts, we should assume non-atomic structures for the mass domain. That has the added bonus that we can nicely explain why we cannot count mass entities, because counting is counting of atoms."

(Authorized paraphrase of Landman 1991, pp 312-313)

Problems:

1. **Chierchia 1998:** nouns like *furniture* are mass, but seem to have minimal parts:
   Furniture consists of *pieces of furniture*, and *parts of pieces of furniture* are not necessarily themselves *furniture*.
2. **The problem of homeopathic semantics:**
   Look at (1):

   (1) There is *salt* on the viewing plate of the microscope, one molecule's worth.
   [−COUNT]

Problem: mass noun *salt* in (1) is felicitous, though intuitively, what is on the viewing plate doesn't have any parts that are themselves salt.
The theory is forced to **invent** here an infinite structure of non-existent salt parts that are themselves *salt*.
-Homeopathic semantics: postulate arcane semantics structures solely to avoid counting:
-we "dilute" the *salt* so far that **not a single molecule remains**, yet it will be *salt* all the way down, because the *Spirit of Salt* hovers over the waters.
-Reasonable counterintuition: whenever you go down into substance α to smaller and smaller parts, you always reach a point where what you have is too small to count as α: a minimal α-part.
Hence: what is in the microscope is *salt*, but has no parts that are themselves *salt*:
a minimal *salt* part.

NOT COUNT 2. Vagueness (suggested in Chierchia 1998)

-The set of minimal elements in a count denotation is sharp: when you look down in a count denotation you see the set of minimal elements sharply outlined.
-The set of minimal elements in a mass denotation is vague: when you look down in a mass denotation, you have a blurred picture.

Problems: What kind of vagueness is involved, and why is this different from what we find with count predicates?

NOT COUNT 2.1 Cardinal vagueness?

(2) How many *quarks* are there in the water in this cup?
[+COUNT]

We don't know, and it may even be truly undetermined (because of quantum mechanics). But that doesn't prevent *quarks* from being count.

NOT COUNT 2.2 Borderline vagueness?
Idea: the denotation of mass nouns like *salt* is generated from building blocks that are not salt, nor non-salt, but **borderline** salt.

Problem: Borderline vagueness is classically found with **classifier nouns, count nouns that include a quantitative size dimension** in their meaning, like *grain* and *heap*:
-you have to have the right size to be a grain, and the right size to be a heap, and what is the right size is vague:

> **Sorites paradox (Eubulides):**
> Take away a ***grain*** *of salt* from a ***heap*** *of* salt: what remains is a ***heap*** *of salt*.
> Take another ***grain*** away…
> *Ergo*: A ***grain*** *of salt* is itself a ***heap*** *of salt.*

Again: borderline vagueness is not typical for mass nouns as opposed to count nouns.

NOT COUNT 2.3. Higher-order vagueness?
If you like you can interpret my proposal as an analysis in terms of higher order vagueness.

NOT COUNT 3. Italian sculpture (Chierchia 1998**)**
-The minimal elements are sitting inside the mass denotation as a Michelangelo sculpture is already sitting in the block of marble.
-Singular count predicates sculpt out the minimal elements, and plural count predicates store access to them. In Chierchia's proposal, mass = singular ∪ plural.

Problem 1: The denotation of the mass noun and the plural noun are so close that we can trivially recover the one from the other.
-But then, why don't we? We would **expect** contextual recovering of minimal elements, hence contextual shift from a mass reading to a count reading, picking out the minimal elements. We don't find that at all:
-we find in context shifts from mass readings to count readings, but the minimal elements of the **count predicate** are parcelings at a **macro-size**, they are **never** Chierchia's minimal elements: (2a) is infelicitous, (2b) is fine:

(3) a. #There are far more than a billion *waters* in this cup of water.
b. I would like two coffees, two cognacs and two *waters*, please.

Problem 2: If the mass-count distinction is this small, why do languages have it at all?

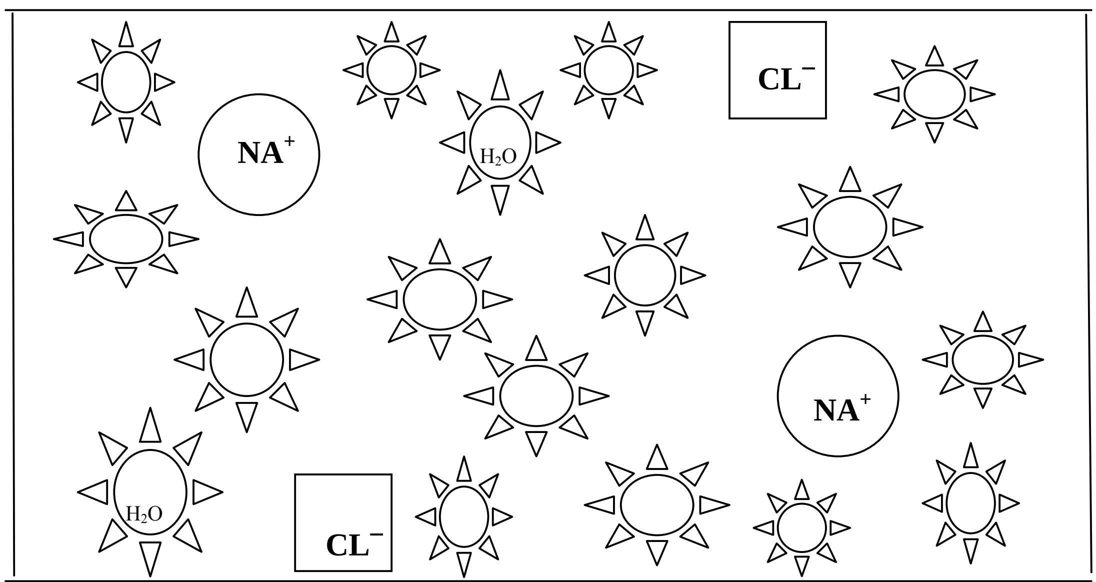
Diagnosis: Chierchia Sculpture is not sculpturing, but just cutting the domain following the dotted line, so easy, a child can do it.
And the problem is: the child doesn't do it.

2. VARIANTS

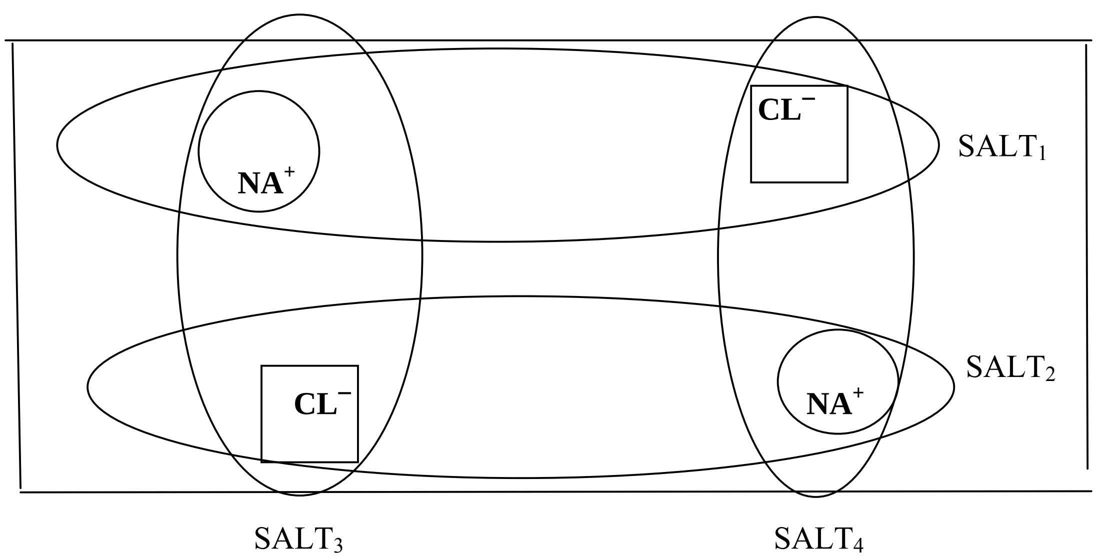
All these proposals are formulated in terms of **underspecification**:
-Mass is mass because, looking down in the mass denotation, you don't see any building blocks, or don't see them well, (or you see them but cannot get them out).

My proposal is formulated in terms of **overspecification**:
-Looking down in the mass denotation you see **too many building blocks.**
Hence when you count building blocks in a mass denotation, you will count them wrong.

(4) There is *salt*[−C] in the water, two molecules worth.



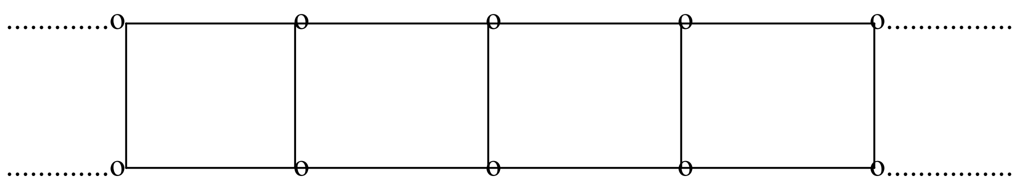
Two molecules worth. But which two molecules? $SALT_1$+$SALT_2$ or $SALT_3$+$SALT_4$?



-The countable perspective gives you two **variants** of salt each with two non-overlapping building blocks (in the example, the molecules). 1+2 versus 3+4
-The mass perspective **merges** all variants into one part-of structure, scrambles them and gives (in the example) four **overlapping** building blocks.
-Counting is counting of building blocks. If you insist on counting mass salt, you will count overlapping building blocks (four, in the example), **and you are guaranteed to count wrong!** Mass cannot be counted because counting goes wrong!

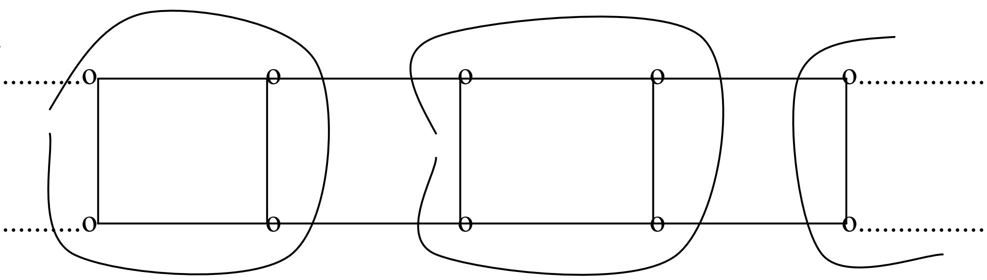
In general, we get variants by dividing an objects into parts in different ways, without making a choice between these different ways of division.

How do we get alternative variants:
-Think of an organic molecule built op from minimal molecules:



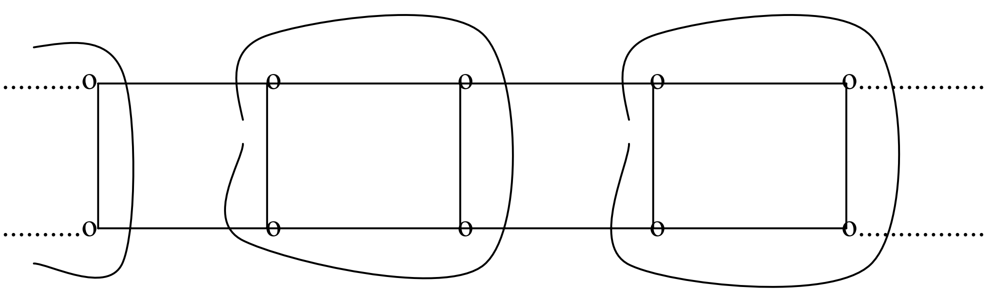
Since the structure will involve chemical bonds, we can regard it as build up as in A:

A



But the variant in **B** is equally 'real':

B



-Mass perspective: mass noun denotations are built from overlapping building blocks coming **simultaneously** from a multiplicity of variants, different ways of dividing the things into parts.
-Count perspective: (in agreement with Rothstein 2010) count nouns are built from building blocks that are, **in context,** non-overlapping. This means that, in context, in a count denotation, we ignore for the sake of counting the internal part-of structure of the building blocks.

-What if the mass predicate consists of a single salt molecule?
You still have variants as to which electrons the salt molecule forms a molecule with.

-What about a chemically inactive metal like *gold*? Because *gold* is a metal, it has lots of 'freely wandering' electrones, and physics doesn't tell you for those **which electron** belongs to which gold atom, but it tells you **how many** belong, since the gold **is** chemically inactive because of its complete set of electrons. Hence there are variants available here too.

-Note that, if in the *salt* example we replace the variants for single NaCL molecules by variants which vary according to which electrons they form single N-Cl molecules with, we move to a perspective on which in a sense **there are no** single NaCl molecules, but only multiplicities of variants.
-Indeed, in quantum mechanics asking whether a photon at place-time 1 in a reaction is **the same identical** photon as a photon at place-time 2 is irrelevant: **count** in physics is a **measure:** we can know how many photons are involved in the reaction (with a certain probability), and the photon itself can be seen as a set, a multiplicity of particles with a probability, with a set of **invariants induced by physical law** that determine that it is a multiplicity **worth one photon**. (i.e. count as a measure).

-I am claiming that this perspective inspired by physics is appropriate as an inspiration for the semantics of mass nouns.
-I am also claiming that it is **wrong** as an inspiration for the semantics of count nouns.
Counting is not measuring, counting is (in context) **selecting a variant**:
-In context we either make a **choice** which variant for the mass worth one NaCl-molecule we include in our count denotation of, say, *salt molecule*, or we associate with the sum of the variants for NaCl a count object $NaCl^c$, with its internal part-of structure made inaccessible (and hence not formally overlapping anything).

-**Important**: examples from physics are the inspiration for the analysis, not the analysis itself. Once we got the idea, we think of the mass nouns *salt*, *gold* and *meat* as built from minimal *salt*-parts, *gold*-parts, *meat*-parts:
-what counts as minimal parts?

    -Maybe determined in part naturalistically for some predicates (like *salt* and *gold*)
    -Determined lexically and contextually for others, like *meat*.

Characteristic feature of the bulding blocks of these mass nouns:

    The building blocks form a multiplicity of variants, which, taken together, overlap.

Generalize from count denotations to mass denotations: **regular sets**:
-**Count:** The parts of an object d in a count denotation like *boys*:
a Boolean algebra of parts with d as maximum,
generated by a set of non-overlapping minimal elements, a single variant.
-**Mass:** The parts of an object m in a mass denotation like *meat*:
a simultaneous multiplicity of Boolean algebras, each with d as maximum (and 0 as minimum), each generated under sum by its single variant of minimal elements.
Since the variants are different ways of cutting up d, taking all these variants together, gives a set of overlapping minimal elements

3. REGULAR SETS

I will assume as domain a complete atomic Boolean algebra **BOOL** = <BOOL,$\sqsubseteq$,$\neg$,$\sqcup$,$\sqcap$,0,1>.

►*X = {y $\in$ BOOL: for some Y $\subseteq$ X: y = $\sqcup$Y} (X $\subseteq$ BOOL)
*X is the **closure of** X **under** (complete) **sum**

►x and y are **disjoint** iff x $\sqcap$ y = 0 (x,y $\in$ BOOL–{0})
Two elements are disjoint if they have no part in common.
►X is **disjoint** iff any two x, y $\in$ X are disjoint.
►X is **maximally disjoint in** Y iff X is disjoint and X $\subseteq$ Y and
for every Z $\subseteq$ Y: If Z is disjoint and Z $\supseteq$ X then X = Z

►x is a **minimal element of** X iff x $\in$ X–{0} and for every y $\in$ X – {0}: if y $\sqsubseteq$ x then y = x
►**min**(X) is the set of minimal elements of X

►A **generating set for** X is a set gen(X) $\subseteq$ X–{0} such that $\forall$x $\in$ X: $\exists$Y $\subseteq$ gen(X): x = $\sqcup$Y
Every element of X is generated as the sum of elements in gen(X).

Fact: If gen(X) is a generating set for X then min(X) $\subseteq$ gen(X) (since generation is under $\sqcup$).

►A **generated set** is a pair *X* = <X,gen(X)>, with gen(X) a generating set for X.
►A generated set X is **bounded** if 0, $\sqcup$X $\in$ X.

►V is an **variant for** *X* iff (*X* a bounded generated set)
1. V is a maximally disjoint subset of gen(X).
2. V* is a subset of X such that $\sqcup$X $\in$ V*.

►*X* is **generated by variants** iff (*X* a bounded generated set)
1. For every x $\in$ X there is some variant V for *X* such that x $\in$ *V.
2. Every disjoint subset of gen(X) is part of some variant for *X*.

Fact 1: If V is a variant for *X*, *V is a Boolean algebra with top $\sqcup$X and atoms V.
Fact 2: If *X* is generated by variants and Y is a disjoint subset of gen(X) then $\sqcup$Y $\in$ X:
Namely: by the second condition of *generated by variants* Y is part of a variant V. By the second condition of *variant* this means that $\sqcup$Y $\in$ X.

►The **ideal generated by** x: (x] = {y $\in$ BOOL: y $\sqsubseteq$ x} (x $\in$ BOOL)
The ideal generated by x is the set of all its **Boolean** parts.
►The **part set of** x **in** X , **ps$_{\mathbf{X}}$**(x) = (x] $\cap$ X (x $\in$ X)
The part set of x in X is the set of x's X-parts.
► **ps**$_X$(x) = <ps$_X$(x) , gen(X) $\cap$ ps$_X$(x)> (*X* a generated set)

► *X* is **closed under variants** iff for every x $\in$ X: **ps**$_X$(x) is generated by variants.
(*X* a bounded generated set)

Idea: every element x of X is the sum of variants. These variants consist of non-overlapping elements only and each generates a Boolean algebra of parts of x. These variants are, so to say, scrambled together, and this means that, the regular set itself is not necessarily closed under sum, intuitively since its elements may come from different variants.

► $\neg_x y = \sqcup\{z \in (x]: z \sqcap y = 0\}$ $(y \sqsubseteq x)$

The **relative complement of** y **in** (x]

►X is **relatively complemented** iff for every x,y ∈ X: if $y \sqsubseteq x$ then $\neg_x y \in X$.

This means that for every x ∈ X, $ps_X(x)$ is closed under relative complement.

►Bounded generated set *X* is **regular iff**

X is **closed under variants** and *X* is **relatively complemented**.

CONSTRAINT ON MASS AND COUNT NOUNS:
Mass and Count nouns denote regular sets.

Example:
Let BOOL be a Boolean algebra with set of Boolean atoms NA ∪ CL, where NA is a set of sodium ions and CL a set of chloride ions. Then the set of elements of B which are built from the same number of Na ions as Cl ions is a regular set generated by the set of all single salt molecules (and as we will see, one that is not count).

Intuition: in regular set *X*, the set of generators gen(X) is the set of **building blocks**. They are the things we are tempted to count as *one*.

4. THE BOOLEAN INTUITIONS

1. Cumulativity: if x and y are salt then $x \sqcup y$ is salt

-Cumulativity is **not** valid since regular sets are not necessarily closed under sum.
-And it **shouldn't** be valid for salt with overlapping building blocks:
Example: **Na**CL_1 ⊔ **Na**Cl_2 = **Na** ⊔ Cl_1 ⊔ Cl_2 with more chloride than sodium is not salt (on the strict definition we adhere to here for the sake of the example).

-Regular sets **do** satisfy what is intuitively valid:

If x and y are salt and x and y are **disjoint** then $x \sqcup y$ is salt.

(cf. Krifka 1989)

2. Remainder: Take some, but not all of the salt away. What is left is salt.
This is valid for regular sets, since it is closure under relative complement.

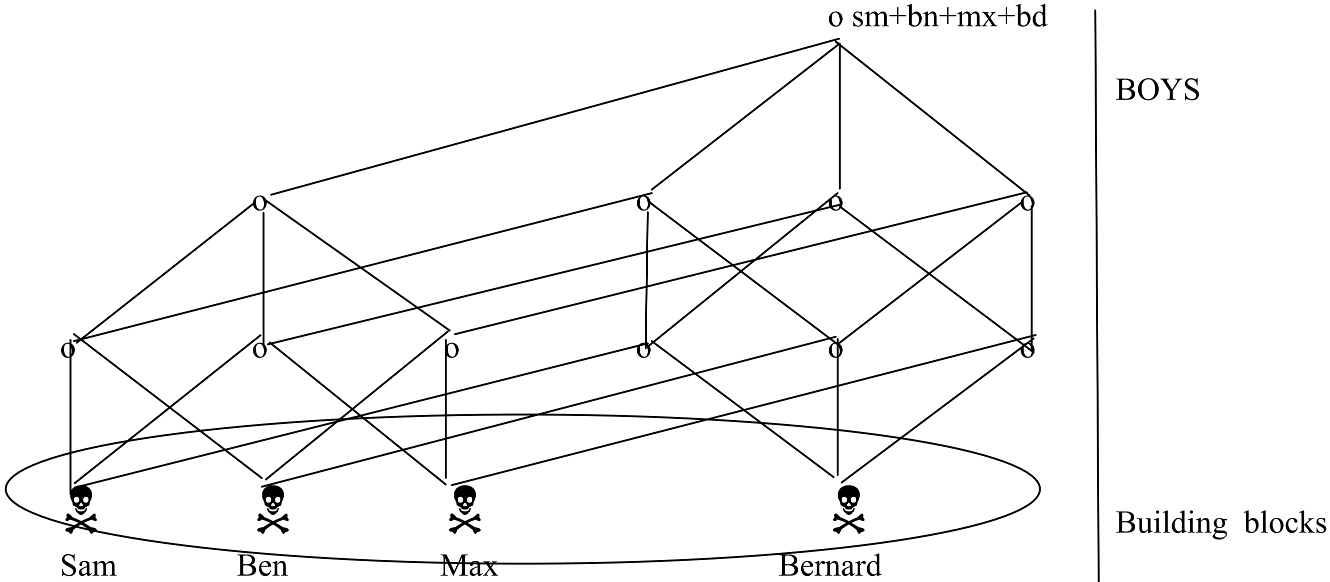
5. COUNTING GENERATORS

We define the relation **COUNT** between *X*, elements of X, and natural numbers:

COUNT:
`
1. 0 has **COUNT** 0
2. Each generator of X has **COUNT** 1
3. The **COUNT** of x equals the addition of the **COUNT**s of the generators x is built from.
4. If Y is a variant for x, the **COUNT** of x equals the addition of the **COUNT**s of the elements of Y.

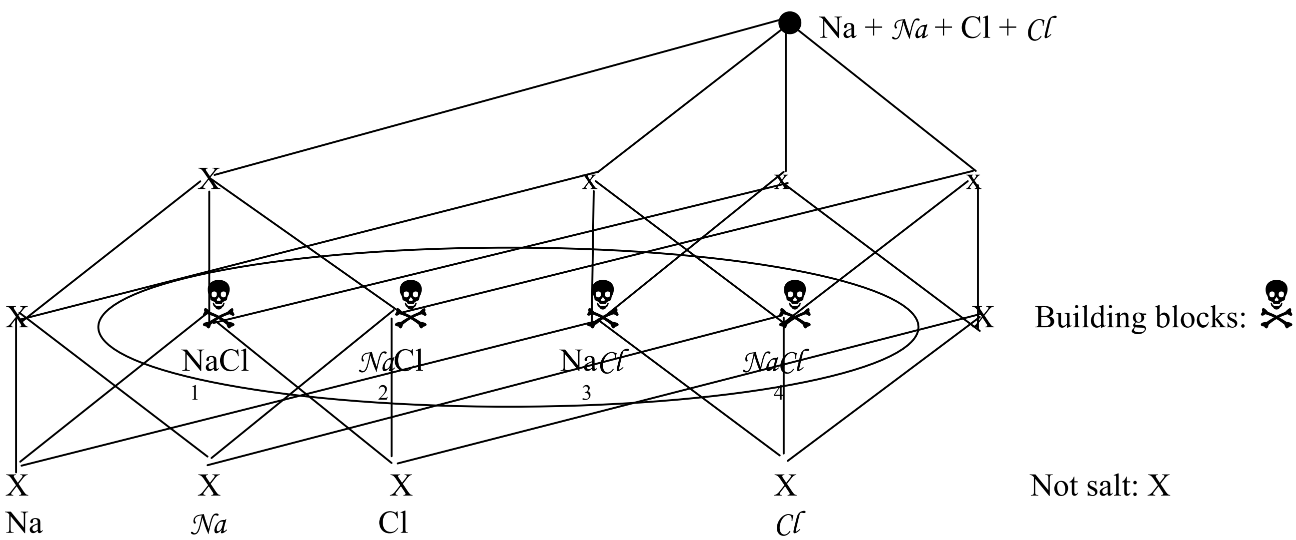
Correctness criterion: COUNT is correct on *X* iff COUNT is a function from X into N.

Countable: *boys*



Built (in context) from non-overlapping building blocks (the minimal elements)
COUNT is a function: the COUNT of sm+bm+mx+bd is 4.

Mass: *salt*



The denotation of *salt* is {0, NaCl, $\mathcal{N}a\mathcal{C}\ell$, $\mathcal{N}a$Cl, Na$\mathcal{C}\ell$, Na + $\mathcal{N}a$ + Cl + $\mathcal{C}\ell$}
Variants: NaCl + $\mathcal{N}a\mathcal{C}\ell$ and $\mathcal{N}a$Cl + Na$\mathcal{C}\ell$ (1 + 4 - 2 + 3)
Overlap: NaCl + Na$\mathcal{C}\ell$ and $\mathcal{N}a\mathcal{C}\ell$ + Na$\mathcal{C}\ell$

Built from overlapping building blocks: the generators are the minimal elements of the denotation of salt, but they overlap.
COUNT is incorrect: COUNT$_{SALT}$(Na + $\mathcal{N}a$ + Cl + $\mathcal{C}\ell$) = {4,2}:
4 for the generators (by condition 3 of COUNT), and 2 for each variant (by condition 4 of count).

6. COUNT AND MASS – NEAT AND MESS

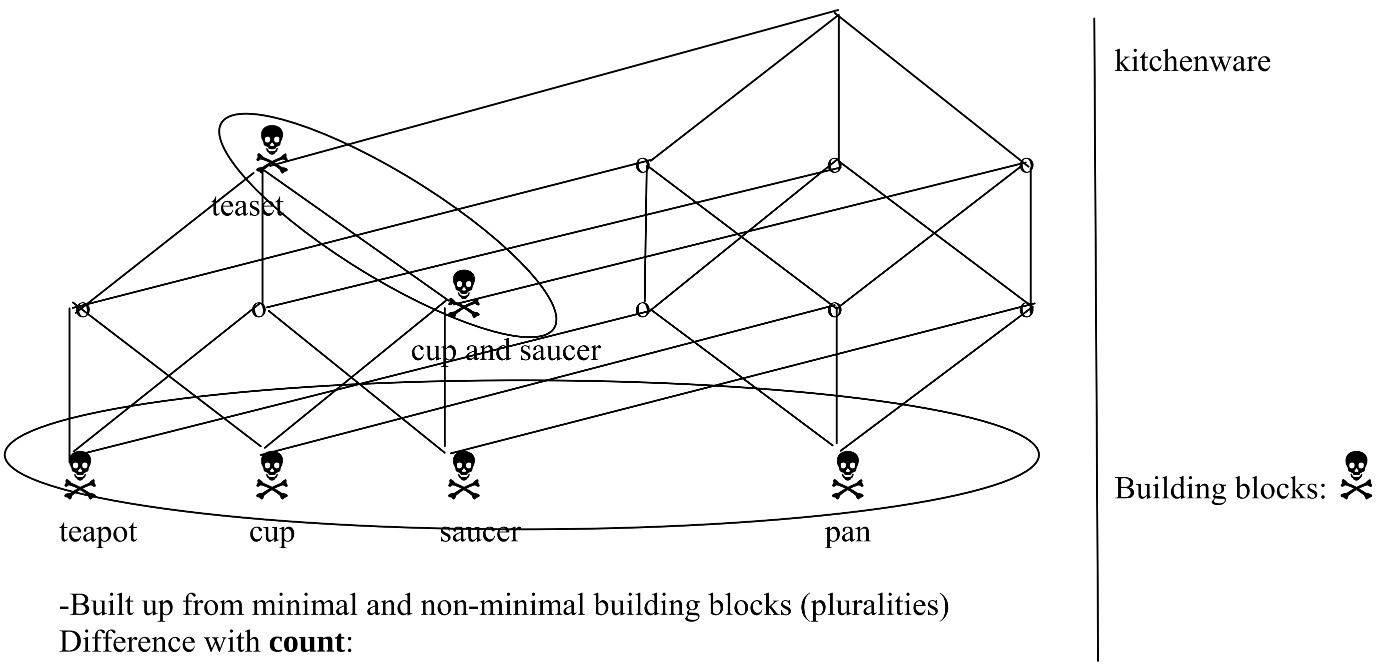
X is [+C], **count,** iff the generators of X do not overlap (**gen**(X) is disjoint)
X is [–C], **mass** iff the generators of X overlap.

Interestingly enough, the theory of regular sets allows a second kind of mass structure, which is mass, but in several ways closer to count:

X is [+N], **neat,** iff the minimal elements of X do not overlap (**min**(X) is disjoint)
X is [–N], **mess**, iff the minimal elements of X overlap.

By definition **count** entails **neat**, equivalently, **mess** entails **mass**
([−N] ⇒ [−C] , equivalently, [+C] ⇒ [+N])
The mass structure given above is **mess mass** [−C, −N].
But the theory allows structures that **neat mass:** [−C, +N].
The claim is that these structures are precisely suited for mass nouns like *furniture* and *kitchenware*:

Mass: Kitchenware



-Built up from minimal and non-minimal building blocks (pluralities)
Difference with **count**:
-a *plurality of boys* does not itself count as *one boy*
-a *plurality of kitchenware (cup and saucer)* can count itself as kitchenware, and can also count as one (on an inventory listing everything that is sold as one item that has its own price)
- **COUNT is incorrect: COUNT$_{\textit{KITCHENWARE}}$**(*teaset*) = {1,2,3,5}

-Difference with **mess mass** like *salt* and *meat*: the **minimal** building blocks are non-overlapping, **the overlap is only vertical:** a sum and its parts count as one simultaneously.
In other words: these are sets in which the distinction between **singular individuals** and **plural individuals** is not properly articulated.

Contextually count: (Rothstein 2010) count nouns like *line, highway, mirror*
-A line divides into lines, a highway into highways, a mirror breaks into mirrors.
But **before** the mirror breaks, we do not, in a normal context, count the mirror and its parts that would count as mirrors when broken as **more than one**: only the maximal mirror counts: i.e. the mirrors that we **do** count don't overlap (or we **make** them not overlap by parceling).
Neat mass:
-The teapot, the cup, the saucer, the cup and saucer all count as kitchenware and can all count as one simultaneously.

7. INDIVIDUATED SETS

Rothstein 2010: neat mass noun *furniture, kitchenware* are like count noun *boys, marbles* in that their minimal elements are **individuated**.

I will propose the following formalization of Rothstein's notion:

Let X be a regular set.

A **dimension set** D_X is a set of properties like Form, Size, Weight, Color,… that are natural properties for the building blocks of X, the elements of **gen**(X), to have.

The **extensional dimension set** E_X is:
$E_X = \{ \lambda x \in \mathbf{gen}(X){:}\ \forall y \in \mathbf{gen}(X)-\{x\}{:}\ x \sqcap y = 0 \}$
Dimension : the property that a building block has if it is disjoint from all other building blocks.

X is **individuated by dimension set** D_X if each property in D_X is a bi-partition on **gen**(X), and the properties in D_X jointly determine the partition into singletons: $\{\{x\}{:}\ x \in \mathbf{gen}(X)\}$.

X is [+I], **individuated,** iff X is individuated by a salient dimension set
X is [–I], **non-individuated,** otherwise

We assume that E_X, the extensional dimension set, is always salient.

Intuition: you can tell the building blocks apart, individuate them, with the help of natural properties in D_X.
Individuation is not counting: you can individuate the building blocks of nouns with natural properties, partition them into finegrained natural units down to the level of singletons, without ending up with non-overlapping objects. This is what happens with *furniture* and *kitchenware*.
But counting is itself individuating: building blocks that are made non-overlapping in context (count) are *ipse facto* individuated:

Facts: - X is individuated by E_X iff X is count.
-**count** entails **individuated** ([+C] $\Rightarrow$ [+I])

8. THE TWO FEATURE SYSTEM

In the two-feature system, we assume that the structural notion of neatness (no overlapping minimal elements) and the more intensional notion of individuatedness coincide:

Strong Mess Mass assumption: [+N] ⇔ [+I]

-1. **mess mass assumption: [–N] ⇒ [–I]**:
The generators of mess mass nouns are non-individuated.
-2. **[+N] ⇒ [+I]**
The generators of neat sets are individuated.

This gives the following system of features, which we assume to be **lexically specified on nouns in English:**

~~[+C, –N]~~	Because [+C] ⇒ [+N]		
[+C, +N]	= [+C]	count:	*marbles, boys*
[−C,−N]	= [−C, −N]	mess mass:	*meat, cheese*
[−C,+N]	= [−C, +N]	neat mass:	*furniture, kitchenware*

The theory makes the following natural distinctions:

[−C]		[+C]
Meat/salt	*furniture/kitchenware*	*boys/marbles*

[−N]	[+N]	
Meat/salt	*furniture/kitchenware*	*boys/marbles*

Hypothesis: These contrasts are semantically robust.

[±C]:

1. Plural:	*salt/#salts*	versus	*boy/boys*
	furniture/#furnitures		
2. Numericals	*#one salt/# two salt*	versus	*one boy/two boys*
	#one furniture/# two furniture		
3. Quantifiers:	*#Every meat/#many meat*	versus	*Every boy/many boys*
	#Many furniture	versus	*Many boys*
	Much furniture	versus	*#Much boys*

9. THE ROBUSTNESS OF THE FEATURE [±N]

9.1 Counting in Chinese (cf. Rothstein 2010)

Assumption 1: [± N] is a **lexical** feature on nouns, [± C] is a **grammatical** feature.
ròu [−N] (meat) versus *níu* [+N] (cow)

Assumption 2: Counting modifiers require a [+C] input:
Liăng denotes **2**:

2 is a partial function from generated sets to generated sets such that:

$$\mathbf{2}(X) = \begin{cases} \langle\{x \in X: \mathbf{COUNT}_X(x)=2\}, \text{gen}(X)\rangle & \textbf{if } \boldsymbol{X} \textbf{ is [+C]} \\ \text{undefined otherwise} & \end{cases}$$

2 has its standard interpretation **if X is count**

Assumption 3: General unspecific count-classifier *ge* maps individuated nouns onto count nouns. We specify the meaning of *ge* as $\mathbf{ge}_k$ (for context k):

For context k, let $\mathbf{var}_k$ be a function that maps *X* onto a **variant** for *X*:
$\mathbf{var}_k(X) \in \text{VAR}_X$.

$$\mathbf{ge}_k(X) = \begin{cases} \langle {}^*\mathbf{var}_k(X), \mathbf{var}_k(X)\rangle & \textbf{if } \boldsymbol{X} \textbf{ is [+N]} \\ \text{undefined otherwise} & \end{cases}$$

ge picks a variant in X, and takes its Boolean closure **if X is neat**

Fact: when defined, $\mathbf{ge}_k(X)$ is [+C].

Predictions:

#Liăng níu	*✓Liăng ge níu*
two cow$_{[+N]}$	two [CL cow$_{[+N]}$] $_{[+C]}$
#Liăng ròu	*#Liăng ge ròu*
two meat$_{[-N]}$	two CL meat

9.2 Strongly distributive adjectives (cf. Rothstein 2010, Schwarzschild 2009)

Schwarzschild 2009 and Rothstein 2010 point at a class of adjectives that strongly prefer distributive interpretations, let's call them **strongly distributive adjectives**:
Strongly distributive: *Small, big, large, round, square,…*
Not strongly distributive: *noisy, successful,…*

(5) a. The boys are *noisy/successful* - The *noisy/succesful* boys
Either: The boys are noisy/successful individually
Or: The boys are noisy/successful as a group
b. The boys are *small/big* - The *small/big* boys
Only: the individual boys are small/big

(5b) only allows a reading where *small/big* distributes to the building blocks. Schwarzschild and Rothstein (independently) observe that [+N] mass nouns like *furniture* and *kitchenware* **pattern with count nouns** when it comes to strongly distributive adjectives, and they pattern **distinctly** from [−N] mass nouns:

(6) a. The *furniture* is big.
 b. The *big furniture* is exhibited on the third floor.
(7) a. The *meat* is big.
 b. The *big meat* is in the other fridge.

For *furniture* in (6) we find exactly what we found for **count** nouns:
-(6a) expresses that the furniture building blocks, the pieces of furniture, are big. The big furniture consists of the pieces of furniture that are individually big, like the sofa's and the pianolas.

This kind of reading is absent for [−N] mass nouns like *meat* in (7):
- (7a) does not mean that the meat-building blocks are big, (7b) does not mean that all big meat-building blocks are in the other fridge: for one thing, it is plausible to assume that all meat-building blocks are **small** (and that's why (7a) is a bit funny).

The strongly distributive adjectives are precisely the ones that are naturally used to **individuate.**

We assume that their distributive interpretation of *big*, **d-big**, requires [+N] sets as input:

$$(\textbf{d-})\textbf{big}(X) = \begin{cases} \langle{}^{*}(\text{gen}(X) \cap \textbf{\textit{big}}),\ \text{gen}(X) \cap \textbf{\textit{big}}\rangle \textbf{ if } \textbf{\textit{X}} \textbf{ is [+N]} \\ \text{undefined otherwise} \end{cases}$$

big has its distributive interpretation **if X is neat**

9.3. The classifier *stuks* (Doetjes 1997)

Dutch has a classifier *stuks* with a meaning similar to the English *head* (as in *head of cattle*) but with a much wider use. And, as Doetjes observes, it applies to count nouns and individuated mass nouns, but not mess mass nouns: in other words *stuks* applies to [+N] nouns and turns them into [+C] noun phrases (just like Chinese *ge*):

(8) a. Hoeveel *hemden* neem je mee op vakantie? Drie *stuks*. **[+C]**
 How-many *shirts* take you with on vacation Three CL

I b. Hoeveel *meubilair* heb je besteld? Drie *stuks* **[−C,+N]**
 How-much *furniture* have you ordered? Three CL
 c. Hoeveel *vee* heb je gekocht? Drie *stuks*, twee schapen en een koe. **[−C,+N]**
 How-much *cattle* have you bought Three CL two sheep and a cow

 d. Hoeveel *vlees/kaas* heb je gekocht? #Drie *stuks*. **[−N]**
 How-much *meat/cheese* have you bought? #Three CL

9.4. Neat comparisons.

I will use Dutch examples, because the mass noun *vee* (cattle) illustrates the phenomenon so well (unlike *cattle*, which is plural), but the facts are the same in English.

We look at available readings for ***de meeste*** **(*most*)**

(9) Het meeste *vlees* wordt gegeten op zon – en feestdagen **[−N]**
Most *meat* is eaten on (sun and holi)-days

This means:

Meer vlees wordt gegeten op zon- en feestdagen dan op andere dagen
More meat is eaten on (sun and holi)-days than on other days.

more = more in volume/more in weight…. (mass measures)

but not:

more = more building blocks, more minimal building blocks... (count)

The reason is clear:
-when you count building blocks or minimal building blocks of [−N]-sets, you count wrong.
-mass measures only add up values for non-overlapping elements (cf. Krifka 1989).

(10) De meeste *koeien* zijn buiten in de zomer. **[+C,+N]**
Most *cows* are outside in the summer

This means:

Meer koeien zijn buiten in de zomer dan binnen
More cows are outside in summer than inside.

more = more building blocks = **more minimal building blocks**, i.e. individual cows

(11) Het meeste *vee* is buiten in de zomer. **[−C,+N]**
Most cattle is outside in the summer

This means:

Meer vee is buiten in de zomer dan binnen
More cattle is outside in the summer than inside

more = more in weight/more in volume….
more in building blocks …

but the most prominent reading is:

more = **more in minimal building blocks** (like [+C]) i.e. on the most prominent reading, (11) is equivalent to (12) (and, if the cattle consists only of cows, to (10)).

(12) De meeste **stuks** vee zijn buiten in de zomer.
Most heads of cattle are outside in summer

[Example of **more** counting building blocks, rather than minimal building blocks:

(13) In this shop, most kitchenware costs over 5 euros.

The cup is 3 euros, the saucer is 3 euros, you pay 5.50 for the cup and saucer, the tea-pot is 6 euros, the tea-set is 11 euros. So three items cost more than 5 euros and 2 items less.]

Observation:
-Neat nouns have non-overlapping minimal generators, like count nouns.
-Neat nouns **cannot be counted** in terms of minimal generators, (because counters grammatically require nouns that are [+C]).
-But neat nouns **can be compared** in terms of minimal generators: **neat comparison**

The neat-comparison meaning of **most** applies to count and neat mass nouns:

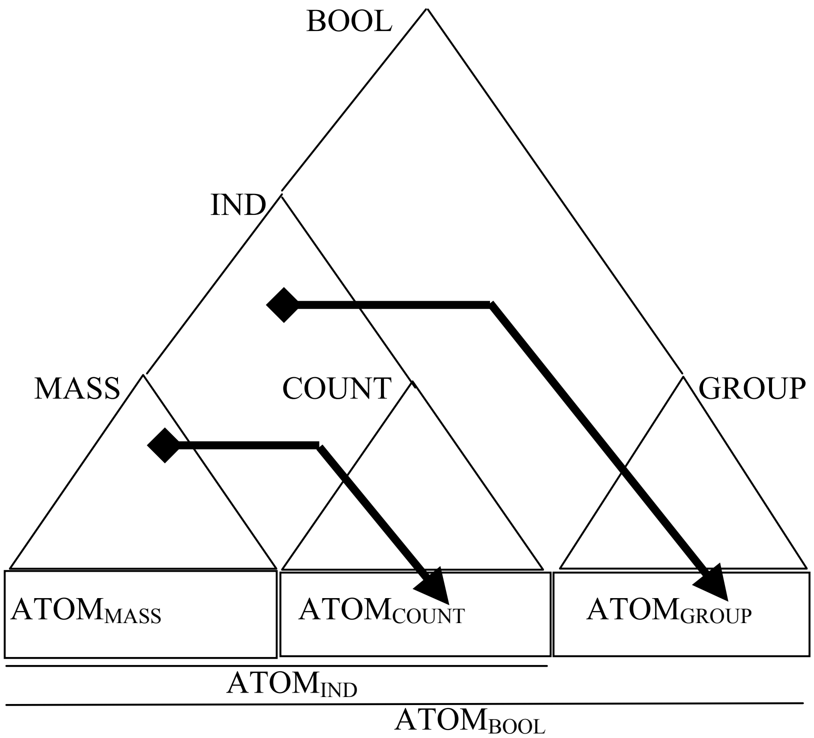
$$\mathrm{MOST}^{\mathbf{N}}(X, \mathbf{P}) = \begin{cases} 1 \text{ if } X \text{ is [+N] and } |(\,\sigma(X\cap\mathbf{P})] \cap \mathbf{min}(X)| > |(\,\neg_{\sigma(X)}\,\sigma(X\cap\mathbf{P})] \cap \mathbf{min}(X)| \\ 0 \text{ if } X \text{ is [+N] and } |(\,\sigma(X\cap\mathbf{P})] \cap \mathbf{min}(X)| \leq |(\,\neg_{\sigma(X)}\,\sigma(X\cap\mathbf{P})] \cap \mathbf{min}(X)| \\ \textbf{undefined if } \boldsymbol{X} \textbf{ is [–N]} \quad \textbf{Not defined for mess nouns} \end{cases}$$

Let **cow** be the set of individual cows.

(10) De meeste *koeien* zijn buiten in de zomer. **[+C,+N]**
Most *cows* are outside in the summer
$\mathrm{MOST}^{\mathrm{N}}(cows, outside)$ iff $|\,\mathbf{cow} \cap \mathbf{outside}\,| > |\,\mathbf{cow} - \mathbf{outside}\,|$

(11) Het meeste *vee* is buiten in de zomer. **[−C,+N]**
$\mathrm{MOST}^{\mathrm{N}}(vee, outside)$ iff $|\,\mathbf{min}(\boldsymbol{vee}) \cap \mathbf{outside}\,| > |\,\mathbf{min}(\boldsymbol{vee}) - \mathbf{outside}\,|$

10. REGULAR SETS EQUIPPED WITH NUCLEAR POWER



GRINDING AND PARCELING
-Count objects can be **ground** into mass
-Mass can be **parceled** into count objects

-Parceling is the same operation as **group formation** (cf. Landman 1992):
A (mass or count) sum is treated as count atom, more than the sum of its parts.

Fusion: a plurality is **fused** into a new atom:
$\uparrow$: MASS–$ATOM_{MASS} \rightarrow ATOM_{COUNT}$ is a one-one function into $ATOM_{COUNT}$
$\uparrow$: IND – (MASS $\cup$ $ATOM_{IND}$) $\rightarrow$ $ATOM_{GROUP}$ is a one-one function into $ATOM_{GROUP}$
$\uparrow$: $ATOM_{BOOL} \rightarrow ATOM_{BOOL} = \{<a,a>: a \in ATOM_{BOOL}\}$
$\uparrow^{+} = \uparrow - \{<a,a>: a \in ATOM_{BOOL}\}$

-Relating me to my mass parts:
I am not a parceling of anything, but I assume there is an equivalence relation which relates me uniquely to the parceling of all my mass parts.

$\approx$ is an equivalence relation on $ATOM_{BOOL}$ such that:
1. if $a \in ATOM_{\alpha}$ then $[a]_{\approx} \subseteq ATOM_{\alpha}$, where $\alpha \in$ {MASS,COUNT,IND,GROUP}
2. if $a \in ATOM_{MASS}$ then$[a]_{\approx}$ is a singleton
3. if $a \in ATOM_{BOOL} - ATOM_{MASS}$ then there is exactly one $b \in [a]\approx$ such that $b \in$ **ran**$(\uparrow^{+})$
we call this b: $a_{\approx}$

-With this, we can define the **inverse** of the fusion operation, which (of course) is the operation of **splitting the atom**:

-If you are a sum of atoms, we split you as follows: We go down to your atoms:
-for each one that is a parcel, we go back with $\uparrow^{+\,-1}$ (we split the atom into a mass sum),
-for each that isn't a parcel, we go with ≈ to the equivalent parcel and from there back with $\uparrow^{+\,-1}$.
Split maps you onto the sum of the resulting mass sums.

Split is the operation $\downarrow_o$

$$\begin{array}{ll}\forall a \in \text{ATOM}_{\text{BOOL}}: \downarrow_o a = \uparrow^{+\,-1}(a) & \text{if } a \in \mathbf{ran}(\uparrow^{+}) \\ \qquad \downarrow_o a = \uparrow^{+\,-1}(a_{\approx}) & \text{if } a \notin \mathbf{ran}(\uparrow^{+}) \text{ and } a \in \text{ATOM}_{\text{BOOL}} - \text{ATOM}_{\text{MASS}} \\ \qquad \downarrow_o(a) = a & \text{if } a \in \text{ATOM}_{\text{MASS}} \\ \forall x \in \text{BOOL} - \text{ATOM}_{\text{BOOL}}: \downarrow_o x = \sqcup(\{\downarrow_o a: a \in \text{ATOM}(x)\} & \\ \qquad \text{where ATOM}(x) = \{a \in \text{ATOM}_{\text{BOOL}}: a \sqsubseteq x\} & \end{array}$$

-If you are a sum of groups or a group of groups, splitting you may not bring you to a homogeneous mass sum, but, (as we know) splitting sets into motion a chain reaction of **fission**:

Fission is the operation $\downarrow$ of recursive split: continue to split till you have only mass left

$$\downarrow(x) = \begin{cases} \downarrow_o(x) & \text{if } \downarrow_o\downarrow_o(x) = \downarrow_o(x) \\ \downarrow(\downarrow_o(x)) & \text{otherwise} \end{cases}$$

The fission of **fido**, $\downarrow$(**fido**) is the sum of fido's mass parts.
The fission of a set (like ***dog)*** is the set of all Boolean parts of the fission of its sum:

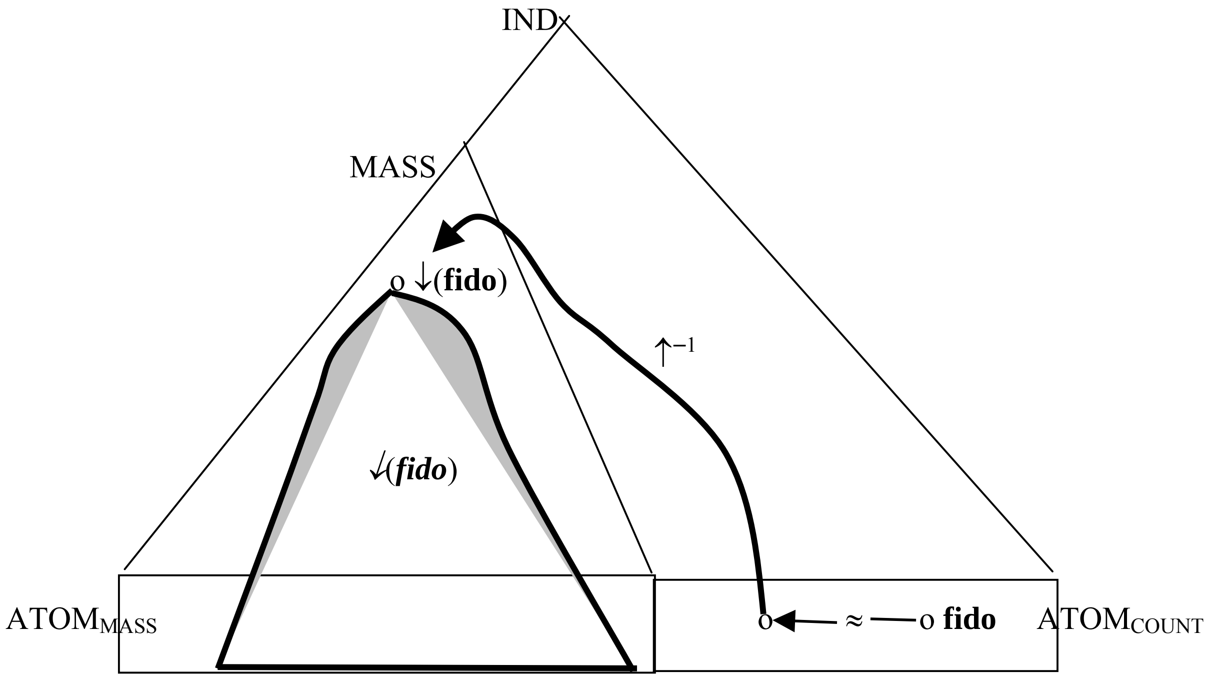
Let $X \subseteq \text{BOOL}$
$\downarrow(X) = (\downarrow\sqcup X]$

Thus: the fission of *dog*, $\downarrow$(***dog***), is the set of all Boolean parts of the fission of the sum of all dogs.

$\downarrow$(*dog*) is a complete atomic Boolean algebra, we grind $\sqcup$(***dog***) **all the way down**:
that is, we grind it so finely, that the structure becomes **neat**.

Since we want the fission to be mass, we choose the set of generators to be bigger than the set of atoms (for instance, everything, except 0):

Let $\mathit{X} = \langle X, \text{gen}(X)\rangle$ be a regular set.
$\downarrow(\mathit{X}) = \langle\downarrow(X), \downarrow(X) - \{0\}\rangle$



In the picture we see

- **fido**
- the parcel of fido's mass parts
- ↓(**fido**), the sum of fido's mass parts
- √(***fido***) the regular set of fido's mass parts, (where ***fido*** = {**fido**})

Note that the fission of *fido* is, what I will call, **homeopathic**: closed **all the way** down under mass parts.
That is, unlike prototypical mass nouns like *salt*, fissions have no bound on what is too small to be included.

11. FISSION READINGS

☠ WARNING ☠:
THE FOLLOWING SECTION CONTAINS MATERIAL THAT MAY BE NOT SUITABLE FOR PERSONS ACCOMPANIED BY SMALL DOGS

11.1. Rothstein's last resort account

(14) a. Zeus: (*shocked*): There is *human* in the soup.
b. The fan and the Chiwawa: There was *dog* all over the wall.

Classical assumption: (14) involves **fission**:
a [+C] noun is given a [−C] interpretation.
Rothstein 2010: Cross-linguistic evidence that fission of nouns is only possible as a **last resort mechanism** to resolve grammatical mismatch.

Rothstein's account for English:
-The singular verb in (14b) is followed by a bare noun.
-There are no bare singulars in English, only bare mass nouns.
-The bare noun *dog* is lexically count in English.
This conflict is resolved by **fission:** *dog*[+C] ⇒ √(*dog*)[−C]

Chinese:
Cheng, Doetjes and Sybesma 2008 point out: (15) has **no fission reading**, but only a plural, wall-paper reading (wall paper with doggies):

(15) qiáng-shang dōu shì gǒu
wall- top all COP dog
There is *dog* all over the wall.

Rothstein's account for Chinese:
-Chinese nouns are not specified for number, so (15) **allows** a plural interpretation.
Since there is no grammatical conflict, the last resort mechanism isn't available.
Hence there is no fission reading.

Hebrew: (examples in Rothstein 2009)
-like Chinese: in general no grammatical conflict and no fission readings.
-but a special construction with **gender** mismatch **does** get the fission reading.

11.2 The problem of food-stuff

Cheng, Doetjes and Sybesma 2008 point out that natural foodstuff nouns in Chinese **do** have mass interpretations: (here ^{X} means: fission reading absent)

(16) shālā lĭ yǒu píngguǒ/^{X}zhū
salad inside have apple ^{X}pig
There is ✓apple/^{X} pig in the salad.

(16) does not require whole apples in the salad, but **does** require a whole pig (the kind that has an apple in its mouth).

Natural explanation: ambiguity for foodstuff nouns

Ambiguity Assumption:			**AMBIGUOUS**	
English:	*dog* [+C],	*meat* [−N],	*apple*[−N],	*apple*[+C]
Chinese:	*gǒu* [+N],	*ròu* [−N],	*píngguǒ*[−N],	*píngguǒ*[+N]

Prediction:

Food-stuff nouns in English and Chinese have [−N] mass readings, but no fission readings.

-Fission readings are homeopathic, closed under all mass parts
-Lexical mass readings are not homeopathic: the stuff in a proton in a particular Na atom does not itself count as *salt*.

(17) a. There is *fido* in the salad.
b. There is *dog* in the salad.
✓$\exists x \in \downarrow(\boldsymbol{dog})$: **in the salad**(x)

(17a,b) are homeopathic.

(17a,b) is true if **some mass part** that has been extracted from fido can be detected in the salad. (i.e. I may not been able to taste it, but Zeus **knows** it!).
-There is no further constraints on this, because there is no [−N] mass noun ***fido*** or ***dog*** to put further semantic constrains on variable x.

(18b) is not homeopathic.

(18) a. There is *E470* in the salad, which is extracted from meat.
b. There is *meat* in the salad.
✓$\exists x \in$ ***meat***: **in the salad**(x)
$^{X}\exists x \in \downarrow$(***meat***): **in the salad**(x)

Suppose (18a) is true.
E470 is a salt of fatty acids used as an anti-caking agent. Industrially it is extracted either from meat or from a vegetable source. But E470 extracted from meat and E470 extracted from a vegetable source is the same E470.

Many vegetarians regard the salad in (18a) as not suited for vegetarians, because animals have been killed to make the salad; kashrut regards a salad with cheese and E470 derived from meat as not allowed.
However, this is not because (18a) entails (18b), because it doesn't!
Neither for the vegetarian, nor for the rabbi does E470 derived from meat **count itself as** meat (for either, you're just not allowed to use things **derived** from meat in your food).

The lexically mess mass noun ***meat*** puts lexical constraints on what counts as meat and what doesn't:

(18b) **does not mean** that some mass part thing **extracted from meat** is in the salad,
but **only means** that some mass part that **is meat** is in the salad.

Similarly (19) is not homeopathic.

(19) a**.** There is *E470* in the salad, which is extracted from apple.
b. There is *apple* in the salad.
✓$\exists x \in$ ***apple*[−N]**: **in the salad**(x)
$^{X}\exists x \in \downarrow$(***apple***): **in the salad**(x)

(19) patterns with (18) and not with (17): (19a) does not entail (19b): for (19b) to be true what there is in the salad has to be not just a mass part derived from an apple, but has to be itself apple-mass. The situation is the same for *píngguǒ* in (16) in Chinese (Xu Ping Li, p.c.).

The Ambiguity Assumption + Rothstein's Last Resort Assumption accounts for this:
English:
-*apple* in (19) can be interpreted as *apple*[−N] without grammatical conflict
Hence (19b) has only a normal mass interpretation, no fission interpretation.
Chinese:
- *píngguǒ* in (16) allows a [−N] and [+N] interpretation, without grammatical conflict.
Hence we expect to find a plural and a normal mass reading, but no fission reading.

11.3 The Chiwawa, the Doberman and the Belle de Boskoop

(20a,b) are felicitous, (21) is funny:

(20) a. The salad and the Chiwawa: There is *small* *dog* in the salad.
Er zit *kleine hond* in de salade
b. The salad and the Doberman: There is *big* *dog* in the salad.
Er zit *grote hond* in de salade
(21) The salad and the huge Belle de Boskoop (Goudreinet):
#There is *big* *apple* in the salad.
#Er zit grote appel in de salade.

Derived Fission Assumption: *small N, big N* derives its fission behavior from *N:*

Account of (20): *dog* in (17b) has a fission interpretation.
Derived Fission Assumption: *big dog* and *small dog* in (20) also have fission interpretations: mass stuff derived from big/small dogs.

(20) a. There is *small* *dog* in the salad.
$\checkmark \exists x \in {\downarrow}(\boldsymbol{dog} \cap \textbf{small})$: **in the salad**(x)

Account of (21): *apple* in (19b) does not have a fission interpretation, only a [−N] mass interpretation.
Derived Fission Assumption: *big apple* in (21) does not have a fission interpretation either.
This means that *big apple* in (21) can only be *big* (*apple*[−N]).
But, as we know, strongly distributive adjectives are not very felicitous with [−N] nouns.
Hence (21a) is not great:

(21) #There is *big* *apple* in the salad.
$\#\exists x \in {\downarrow}\mathbf{(}\mathit{apple}\mathbf{)} \cap {}^*\textbf{big}$: in the salad**(x)**

12. THE NEATNESS OF FISSION READINGS

12.1 The problem

-The fission interpretation of *dog* is **mass, but neat:** $\boldsymbol{\downarrow}$***(dog)*** is [−C,+N].
-In the two-feature system, where [+N] ⇔ [+I], it follows that the fission interpretation of *dog* $\downarrow$(*dog*) is **individuated**.
-But that means that such interpretations should allow strongly distributive adjectives like *small* and *big*, with interpretations that distribute to the neat (individuated) building blocks.

In other words, we predict that (20a) has an alternative analysis:

(20) a. There is *small* *dog* in the salad.
$\exists x \in {\downarrow}(\boldsymbol{dog}) \cap {}^*\textbf{small}$: **in the salad**(x)

There is stuff derived from *dog* in the salad, and that stuff is built from small building blocks.
-If the minimal elements are individuated, this interpretation should be felicitous.
Problem: (20) doesn't allow such an interpretation.

Diagnosis: the fission $\downarrow$(*dog*) should be [−I].

Three ways of solving the problem:

12.2. The three-feature system

In the three feature system, we do not make the assumption that in neat sets the generators must be interpreted as individuated. We **do** continue to make the mess mass assumption:

> **Mess mass assumption: [–N] ⇒ [–I]**
> **Mess is non-individuated**

Here are all possible feature combinations and their realization in English:
~~[+C +N –I]~~ Because [+C] ⇒ [+I]
~~[+C –N –I]~~ Because [+C] ⇒ [+N]
~~[+C –N –I]~~ Because [+C] ⇒ [+N],[+I]
~~[¡C –N –I]~~ Because [–C –N] ⇒ [–I]

[+C +N +I]	= [+C]	count:	*marbles,boys*
[−C −N −I]	= [−N]	mess mass:	*meat*, *cheese*
[−C +N +I]	= [−C, +I]	individuated mass:	*furniture, kitchenware*
[−G +N −I]	= [−C, +N, −I]	fission mass:	$\downarrow$(*dog*)

Meat $\downarrow$*(dog)* *kitchenware*	*dog*
[−C]	[+C]

Meat $\downarrow$*(dog)*	*kitchenware* *dog*
[−I]	[+I]

Meat	$\downarrow$*(dog)* *kitchenware* *dog*
[−N]	[+N]

In this theory, we have room for sets of category [+N,−I], with neat minimal generators that are not individuated. The category [+N,−I] is not lexically realized.

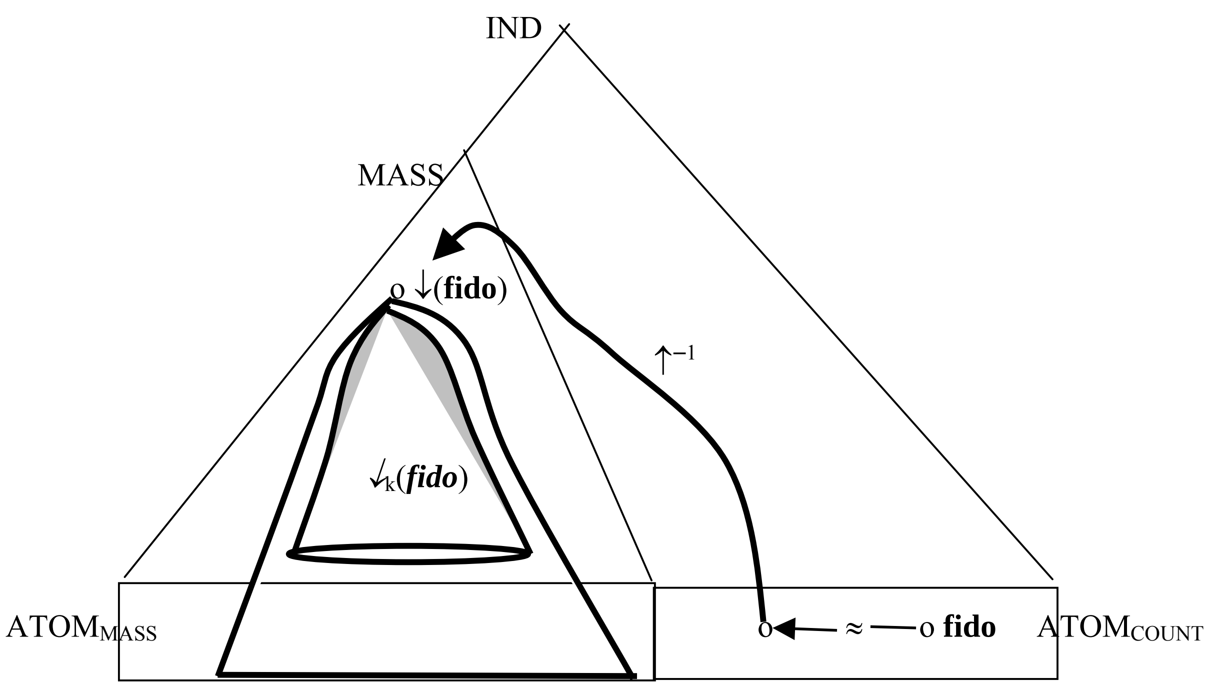
Problem:
-The two-feature theory only uses features defined in terms of the conceptual algebra of part-of structures: part-of, minimal element, generator, overlap, sum, remainder,…
-It does this by postulating a structural equivalence: neatness and individuated are not the same thing, but in the structures used in the theory we identify the two extensionally: we postulate that neat sets are individuated.
This allows us to do without the feature that has the more complex definition ([±I])
Hence, there is a conceptual elegance that gets lost in the three-feature theory.
-Also: why aren't there languages where the category [−C, +N, −I] is lexically inhabited?

12.3. Fission$_k$

An obvious alternative is to change the fission operation which gives a neat output to an operation whose output is mess, not neat.
This is simply enough to do: let context k select a subset of fission $\downarrow_k(X)$ of $\downarrow(X)$:

Fission$_k$: $\downarrow_k(X) = \langle \downarrow_k(X), gen(\downarrow_k(X)) \rangle$

where: 1. $\downarrow_k(X)$ is a regular set
2. $\downarrow_k(X)$ is a **subset** of $\downarrow(X)$
3. $\sqcup(\downarrow_k(X)) = \sqcup(\downarrow(X))$
4. $gen(\downarrow_k(X))$ is a set of **overlapping generators** for $\downarrow_k(X)$



Problem:
This makes $\downarrow_k$(***dog***) not really different from prototypical [−N] mass nouns.
It is not so clear how to elegantly express the homeopathy differences discussed above.

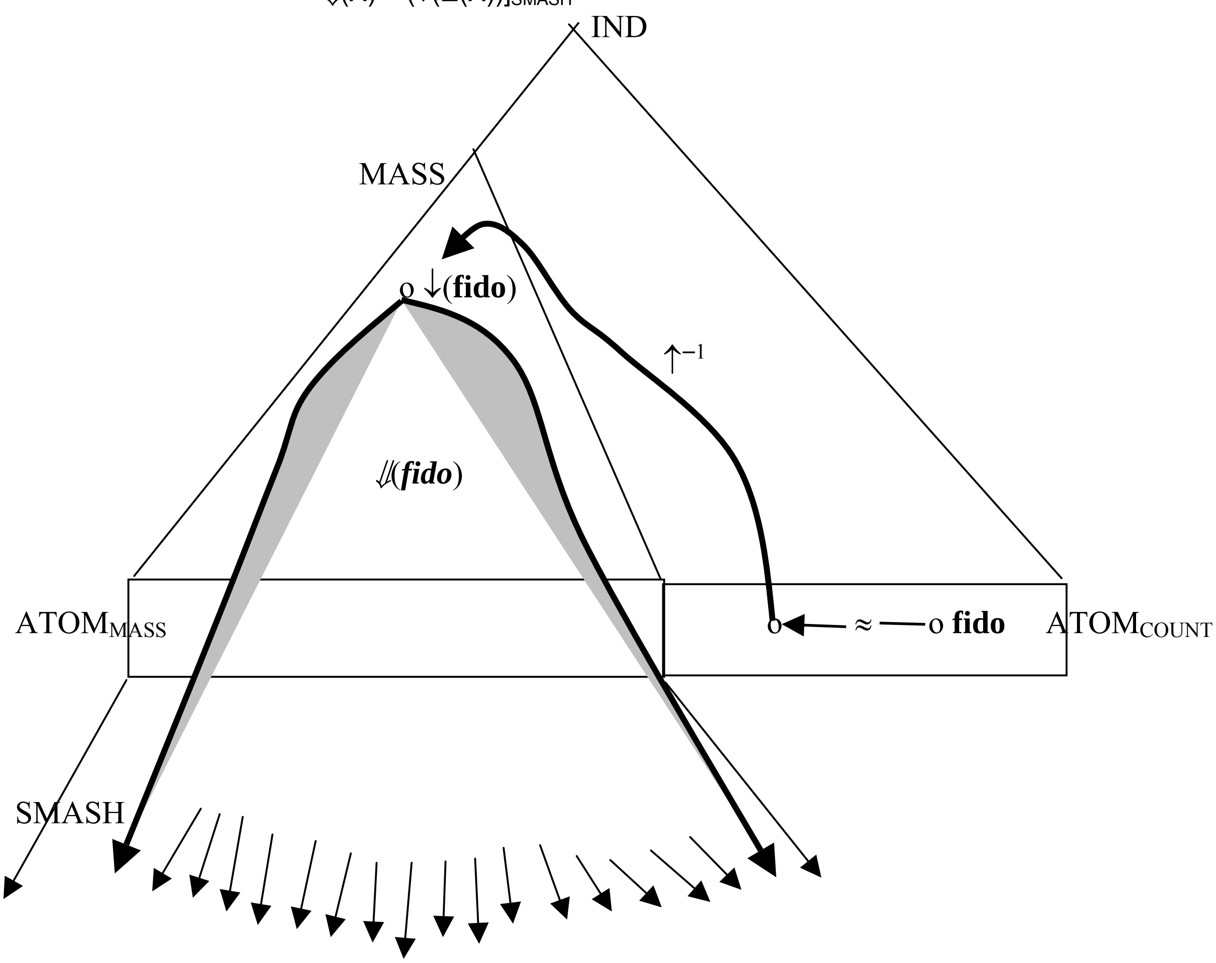
12.4. Super fission

Fission breaks down an object into its homeopathic mass set, a neat Boolean algebra. The atoms of that Boolean algebra are the ultimate minimal parts in the mass structure MASS, according to the background Boolean algebra BOOL.
But what is the status of those postulated minimal parts in MASS?
And why aren't these minimal parts in MASS themselves ground by fission?
After all, with fission we are not looking for the minimal parts **with a certain, lexically induced property**, like ***being salt***, but minimal mass parts ***an sich***.

Super fission is fission that doesn't stop at the contextually provided postulated minimal mass parts in MASS, but breaks open any such atoms.

We extend out interpretation domain BOOL to an interpretation domain UNIVERSE:

> UNIVERSE = <BOOL,SMASH> where
> 1. BOOL is, as before, a complete **atomic** Boolean algebra with atoms sorted into mass-atoms, count-atoms, group-atoms, and hence BOOL includes mass structure MASS.
> 2. SMASH is a complete **atomless** Boolean algebra such that
> 1. BOOL $\cap$ SMASH = MASS
>   2. for all m $\in$ MASS: $(m]_{BOOL} \subseteq (m]_{SMASH}$
>
> SMASH IS AN ATOMLESS BOOLEAN ALGEBRA WITH MASS AS ITS TOP PART
>
> **Super fission:** $\Downarrow\!\!\Downarrow(X) = \langle \Downarrow(X), \Downarrow(X) - \{0\} \rangle$
> $\Downarrow(X) = (\downarrow(\sqcup(X))]_{SMASH}$



The feature N now has three values:

neat:	[+N]	minimal generators do not overlap
mess:	[–N]	minimal generators overlap
superfine:	[# N]	minimal generators absent

The analysis changes only minimally from the two-feature theory:

-The fission $\Downarrow$(***dog***) is superfine, which is homeopathic, and neither neat nor mess.

-We assume that for count nouns, neat nouns and concrete mass nouns, like *meat* and *salt*, interpretation takes place in BOOL, where only the values [±N] are available, so lexically the features [±C] [±N] are available, but [#N] is not.

-For abstract mass nouns like *love* we will want to think about their lexical specification and their place in the structure. Tarski, for one, would make a case that the mass interpretations of the abstract nouns *space* and *time* should be **superfine,** because for Tarski, SMASH is the natural background structure for models of geometry.

Atomless Boolean algebra's were first studied by Tarski in the Nineteen twenties and thirties.
-Mostowski and Tarski introduced standard techniques for constructing such Boolean algebras from intervals of real numbers. A variant of this technique can be found in Bunt 1985.
-The smallest atomless Boolean algebra is countable, and in fact there is only one countable atomless Boolean algebra. It has the elegant property that it is homogenous: each Boolean sub-algebra is isomorphic to the whole (if you leave out 0 and 1, then wherever you stand and look up, the sky looks the same, and what you see when you look down is also same as what you see when you look up).
-The countable atomless Boolean algebra has a unique **completion** which only differs from the countable atomless one in that it supplies the infinite joins and meets that don't all exist in the countable structure. The completion stands in the same relation to the countable atomless Boolean algebra as the set of real numbers stands to the set or rational numbers.
-The completion of the countable atomless Boolean algebra is itself a complete atomless Boolean algebra of cardinality $2^{\aleph_0}$, and it is also continuous.
Tarski was particularly interested in this structure as an underlying model for geometry.
-With Tarski, I would propose this structure as the right structure for SMASH.

12.5 Superfission$_k$

Homeopathic analysis of (21a,b) as opposed to (21c):

(21) a. There is *fido* in the salad.
b. There is *dog* in the salad.
c. There is *dog meat* in the salad

Reason: no lexical mass interpretations for *fido* and *dog*
no independent criterion to determine what counts as too small to be *mass-fido* or *mass-dog*

No lexical bound. Do we want a contextual bounds?

My judgement (for Dutch):

-(21c) expresses that there is dog tissue of the right kind in the salad.
-For (21a) I go with Zeus: to take anything out of *pelops* or our beloved *fido* and put it in the salad is an abberation punishable down the generations.
-But maybe (21b) is somewhere in between.

Cf. (22):

(22) There is *E470* in the salad, which is taken out of fido's muscle tissue.

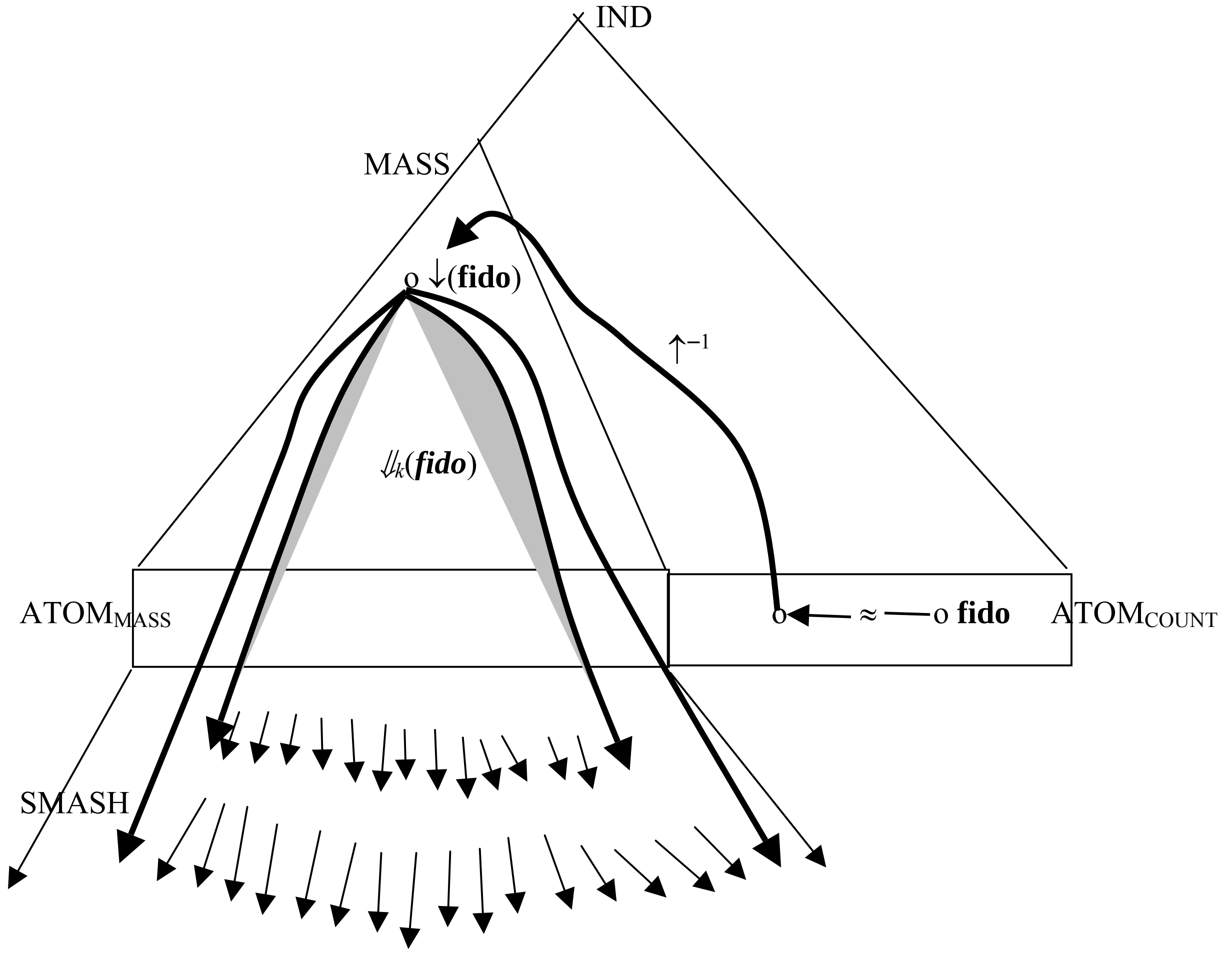
My judgement (for similar cases in Dutch):
-(22) entails (21a)
-(22) does not entail (21c).
-Does (22) entail (21b)? I hesitate.

If we want to allow (22) **not** to entail (21b), we can combine the two last analyses and introduce **super fission$_k$**,

Super Fission$_k$: $\Swarrow_k(X) = <\Downarrow_k(X), \mathrm{gen}(\Downarrow_k(X))>$

where: 1. $\Swarrow_k(X)$ is a regular set
2. $\Downarrow_k(X)$ is an SMASH-substructure of $\Downarrow(X)$
3. $\sqcup(\Downarrow_k(X)) = \sqcup(\Downarrow(X))$

Superfission$_k$ does not take all mass parts all the way down, but is superfine, so it takes the mass parts far enough down so as to distinguish the denotation from neat nouns and mess nouns.
- shifted proper name *fido*: $\Swarrow(fido)$
- shifted count nouns *dog*: $\Swarrow_k(dog)$
-(22) entails (21a)
-(22) does not necessarily entail (21b).


IND
MASS
o ↓(fido)
↑⁻¹
⇓k(fido)
ATOM MASS
o ≈ o fido
ATOM COUNT
SMASH

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