National Research University
Higher School of Economics
Moscow

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The Mass/Count Distinction: Three Recent Perspectives

Hana Filip
hana.filip@gmail.com

Department of Linguistics
Heinrich-Heine-University Düsseldorf

Main data: What is to be explained?

(1) English examples

	[–C]		[+C]	
1. Plural:	salt	#salts	boy	✓boys
	furniture	#furnitures		
2. Numerals	#one salt	#two salt(s)	✓one boy	✓two boys
	#one furniture	#two furniture(s)		
3. Quantifiers:	#every meat		✓every boy	
	#many meat(s)	#many furniture(s)		✓many boys
	✓much meat	✓much furniture	#much boy	#much boys

(examples adapted from Landman 2011)

- Signature grammatical property of count Ns: can be straightforwardly modified by numerals.
- Signature grammatical property of mass Ns: direct modifications with numerals are ungrammatical, highly marked, unless they can be reinterpreted as count (by coercion or type-shifting).

(2) Case agreement required in felicitous modifications with numerals

a.	kolme kissaa	b.	# kolme riisia	FINNISH
	three $cat_{PART.SG}$		three $rice_{PART.SG}$	

(3) Classifier required in modifications with numerals (classifier languages) MANDARIN

a.	wǔ	gè	píng guǒ	b.	* wǔ	gè	ní
	five	CL	apple		five	CL	mud
	'five apples'				'five mud'		

Note: Number marking may not be required even in languages which have a grammaticized singular/plural distinction, the singular is used with any number (Krifka 1995, p.407):

(4)	a.	üç	elma	b.	# üç	elmalar	TURKISH
		three	$apple_{SG}$		three	$apples_{PL}$	

Main questions

(1) **What grounds the mass/count distinction?**

Is the mass/count distinction linguistic (stemming from **grammar**) or extralinguistic (rooted in language **independent cognitive systems**)?

How do the grammatical manifestations of the mass/count distinction relate to the conceptual, pre-linguistic contrast 'undifferentiated stuff/individuated object'?

How does it relate to things in the real world?

No one-to-one correspondence between the linguistic mass/count distinction and the conceptual stuff/object distinction:

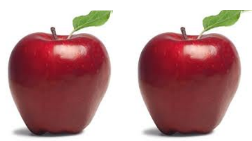
- In no language will the basic words for stuff like blood or air come out as count (also Chierchia 2010, p.105)

STUFF

→ MASS encoding: *air*

- While it is true that "Spelke-like" objects are encoded as count, they can also be encoded as mass: e.g., *furniture*. ("Spelke-like" objects = objects with discrete boundaries, move as wholes along continuous paths, retain their identity upon colliding with each other.)

INDIVIDUATED OBJECTS



→ COUNT encoding: *apple/s*

→ MASS encoding: *furniture*

Main questions

(2) How do we motivate **the variation in the mass/count encoding?** Mass or count terms can be and are used with reference to what seem to be the same entities in the real world, in a single language and across different languages.

This clearly indicates that the mass/count distinction is independent of the ‘structure of matter’ in the real world.

Some relevant cases (from Chierchia 1998)

(i) Entities that come in natural units of equal perceptual salience may differ in a single language as to whether they are mass or count.
For example, *rice* is mass, while *lentil/lentils* is count.

The mass/count distinction is independent of the 'structure of matter' in the real world.

(ii) Within a single language, there are lexical mass/count doublets (Quine 1960, p.91; also McCawley 1975) like

- *footware/shoes, foliage/leaves, change/coins* (no lexical relation between near synonyms)
- *carpeting/carpets (*two lexical items based on the same root are related by morphological operation; one has a mass use and the other has a count use)
- *hair/hairs, rope/ropes, stone/stones (*a single lexical item can be realized as mass or count)

Such (near-)synonyms) describe the same slice of reality, the choice of one or the other depends on our perspective, context of use, affordances of objects, etc.:

rake leaves into a pile
**rake foliage into a pile*
*Mediterranean herbs and alpines are prone to rotting in damp conditions so **rake foliage from plants** that like air around their growth in winter.*

The mass/count distinction is independent of the 'structure of matter' in the real world.

(iii) Mass expressions in one language have count near-synonyms in another:

горох [−C] RUSSIAN *pea/peas* [+C] ENGLISH
hrách [−C] CZECH

(iv) Some languages, such as Mandarin, do not seem to have a grammaticized mass/count distinction among nouns. Count uses (tend to) require classifiers.

wŭ gè píng guŏ MANDARIN
five CL apple
'five apples'

The mass/count distinction: Three recent perspectives

Chierchia, Gennaro (2010). Mass nouns, vagueness and semantic variation. *Synthese*, 174:99–149.

Landman, Fred (2011). Count nouns – mass nouns – neat nouns – mess nouns. *The Baltic International Yearbook of Cognition*, 6:1–67.

Rothstein, Susan (2010). Counting and the mass/count distinction. *Journal of Semantics*, 27(3):343–397.

Questions:

- Why can't we count mass nouns like *mud* (# /* *three muds*)?
  [Chierchia and Landman, focus on mass nouns]

- Why can count nouns be explicitly and straightforwardly counted by using numeral modifiers (*three cats*, *three fences*)?
  [Rothstein, focus on count nouns]

All three in the tradition of using part structures to model the nominal (and also verbal) domain.

... next: a brief introduction to classical extensional mereology

CLASSICAL EXTENSIONAL MEREOLOGY

- Mereology
- Core axioms and concepts
  - parthood
  - sum
- Higher order properties:
  - cumulativity
  - divisivity (aka divisiveness)
  - atomicity

CLASSICAL EXTENSIONAL MEREOLOGY

- Mereology
  - is the theory of parthood
  - derived from the Greek $\mu\acute{\epsilon}\rho o\varsigma$ (meros), meaning "part" (also "portion", "segment")
  - origins: the Pre-Socratics (6th and 5th century BC, see Varzi 2011), Leśniewski (1916), Leonard & Goodman (1940) and Goodman (1951)
  - formalized by means of mathematical structures: namely, Boolean algebras.

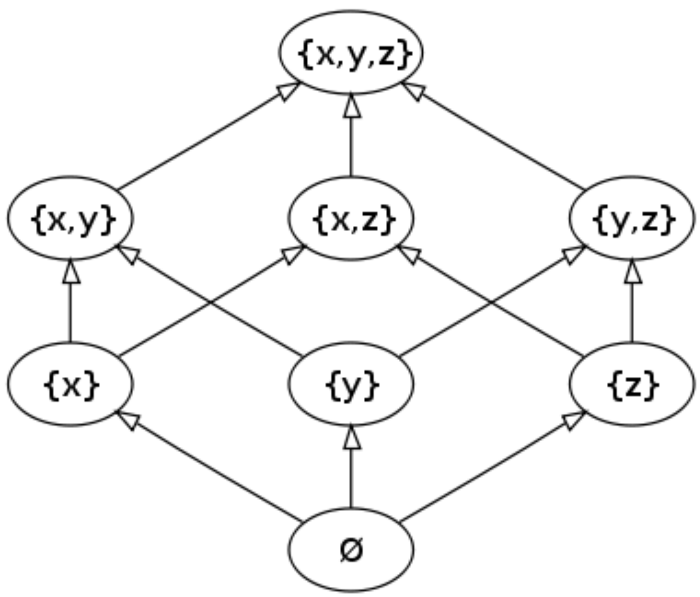
- Boolean algebra
  - uses variables like A, B, C, etc. The variables can take only two values TRUE and FALSE, or written as 1 and 0. *
  - The main operations are
    - conjunction (or meet) $\wedge$,
    - disjunction $\vee$, and
    - negation $\neg$.

* In elementary algebra, the values of variables are numbers and the main operations are addition and multiplication.

CLASSICAL EXTENSIONAL MEREOLOGY

A common way of defining a Boolean algebra is as a lattice structure, a type of algebraic structure.

Boolean lattice of subsets: e.g., $\{x,y\} \subset \{x, y, z\}$



CLASSICAL EXTENSIONAL MEREOLOGY

- Mereology
- **Core axioms and concepts**
  - **parthood**
  - **sum**
- Higher order properties:
  - cumulativity
  - divisivity (aka divisiveness)
  - atomicity

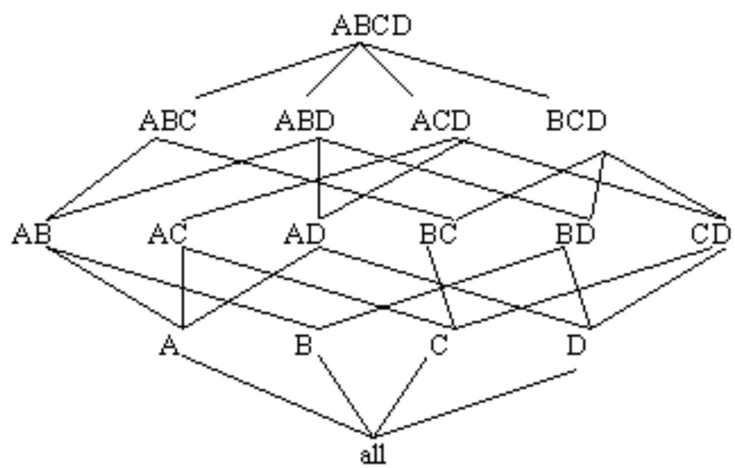
CLASSICAL EXTENSIONAL MEREOLOGY

- Classical Extensional Mereology (CEM) consists of
  - THREE AXIOMS and requires only
  - a SINGLE PRIMITIVE NOTION in terms of which the rest of the mereological system can be defined.

CLASSICAL EXTENSIONAL MEREOLOGY

- AXIOM I (**Unrestricted Composition**): Whenever there are some objects, then there exists a mereological sum of those objects.
- Suppose the entire universe consists of
  - Ann (*A*),
  - Bill (*B*),
  - one car (*C*) and
  - one dog (*D*).

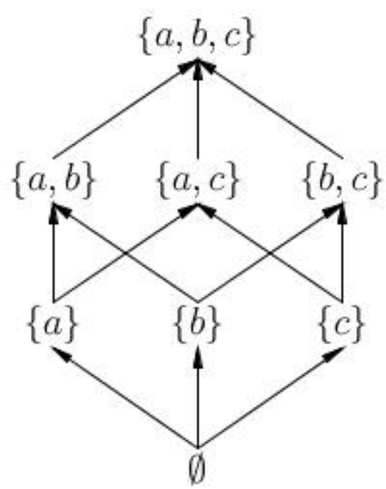
Then we may need represent all of their combinations, among which is Ann together with Bill (*AB*), which corresponds to the meaning of the conjunction *Ann and Bill*:

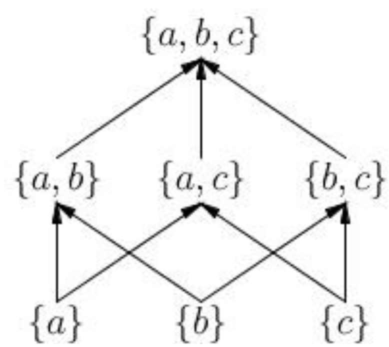


CLASSICAL EXTENSIONAL MEREOLOGY

No "null individual"

- The standard versions of CEM used in philosophy and semantic theory restrict the admissible algebraic structures to those that have no "null individual", i.e., an individual which belongs to ALL other individuals in the way that the empty set is a member of all other sets in set theory.
- The existence of such a null individual is taken to be counterintuitive.
- Consequently, the structures that are assumed are a special type of lattice, a **SEMILATTICE.** an UPPER SEMILATTICE.





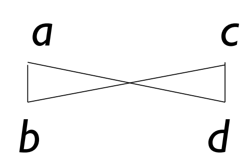
SEMILATTICE: Boolean algebra structure with the bottom null element removed

CLASSICAL EXTENSIONAL MEREOLOGY

- AXIOM 2 (**Uniqueness of Composition**) excludes (1) and (2), because not every two elements have a unique sum.

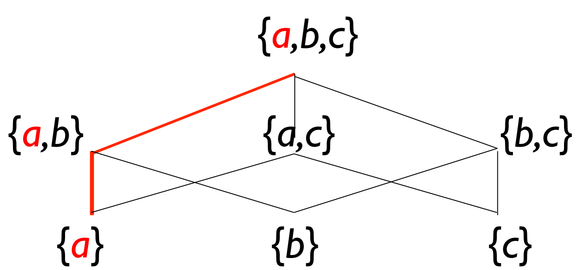
(1)

(2)



- AXIOM 3 (**Transitivity**): {*a*} is a part of {*a*,*b*,*c*}, because it is a part of one its parts {*a*,*b*}.

(3)



CLASSICAL EXTENSIONAL MEREOLOGY

- The single primitive can be chosen to be
  - **proper parthood** $<$,
  - **proper-or-improper parthood** $\leq$,
  - **sum** $\oplus$,
  - **overlap** $\otimes$
  - **disjointness**.

  The other notions are definable in terms of whichever one is taken as primitive.

- The two most commonly used primitive notions are:
  - the **part $\leq$ relation** and the sum operation defined from it (Tarski 1929, 1956), or
  - the **sum $\oplus$ operation** and the part relation defined from it (e.g., Krifka 1986 and elsewhere).

CLASSICAL EXTENSIONAL MEREOLOGY

The sum operation ‘ $\oplus$ ’ as the primitive notion and the part relation ‘ $\leq$ ’ defined from it.

Krifka (1998, p.199): Definition of a part structure *P*

$P = \langle U_P, \oplus_P, \leq_P, <_P, \otimes_P \rangle$ is a part structure, iff

a. 'U_P' is a set of entities: individuals, eventualities and times

$$I_P \cup E_P \cup T_P \subset U_P$$

b. '$\oplus_P$' is a binary **sum operation**, it is a function from $U_P \times U_P$ to U_P.
It is idempotent, commutative, associative:
$\forall x,y,z \in U_P[x \oplus_P x = x \wedge x \oplus_P y = y \oplus_P x \wedge x \oplus_P (y \oplus_P z) = (x \oplus_P y) \oplus_P z]$

c. '$\leq_P$' is the **part relation**: $\forall x,y \in U_P\ [x \leq_P y \leftrightarrow x \oplus_P y = y]$

d. '$<_P$' is the **proper part relation**: $\forall x,y \in U_P\ [x <_P y \leftrightarrow x \leq_P y \wedge x \neq y]$

e. '$\otimes_P$' is the **overlap relation**: $\forall x,y,z \in U_P\ [x \otimes_P y \leftrightarrow \exists z \in U_P[z \leq_P x \wedge z \leq_P y]]$

f. **remainder principle**: $\forall x,y,z \in U_P\ [x <_P y \rightarrow \exists! z[\neg\ [z \otimes_P x] \wedge z \oplus_P x = y\ ]]$

CLASSICAL EXTENSIONAL MEREOLOGY

'$\leq_P$' is the **part relation**: $\forall x,y \in U_P\ [x \leq_P y \leftrightarrow x \oplus_P y = y]$

'$<_P$' is the **proper part relation**: $\forall x,y \in U_P\ [x <_P y \leftrightarrow x \leq_P y \wedge x \neq y]$

'$\otimes_P$' is the **overlap relation**: $\forall x,y,z \in U_P\ [x \otimes_P y \leftrightarrow \exists z \in U_P [z \leq_P x \wedge z \leq_P y]]$

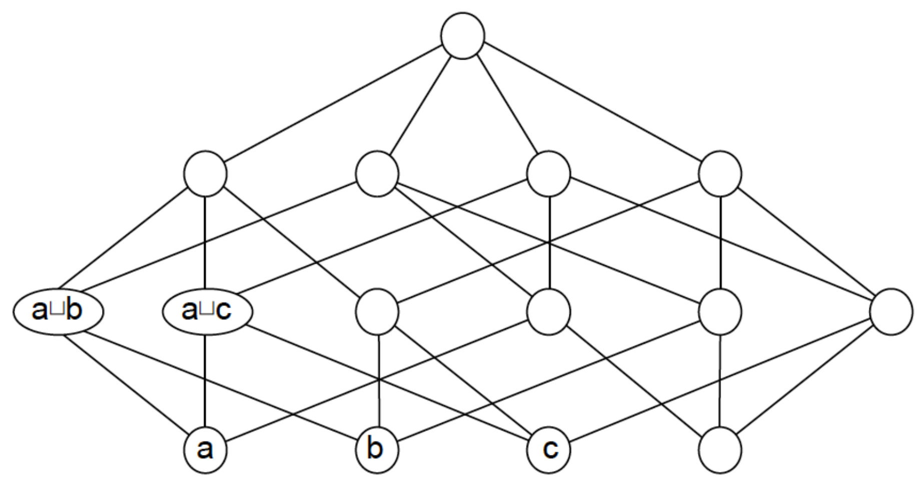
Examples:

$a \leq a \oplus b$

$a \leq a$

$a < a \oplus b$

$a \oplus b \otimes a \oplus c$



Exaples taken from Krifka 2007

CLASSICAL EXTENSIONAL MEREOLOGY

- An axiom known as the **REMAINDER PRINCIPLE** or SUPPLEMENTATION is used in order to ensure that the following structures be excluded.

  The object *a* has a solitary proper part *b*:

$$\begin{array}{c} a \\ | \\ b \end{array}$$

- **REMAINDER PRINCIPLE**: $\forall x,y,z \in U_P\ [x <_P y \rightarrow \exists! z[\neg [z \otimes_P x] \wedge z \oplus_P x = y]]$
  Whenever *x* is a proper part of *y*, there is exactly one "remainder" *z* that does not overlap with *x* such that the sum of *z* and *x* is *y* (Krifka 1998).

  Alternative definition: $\forall x,y,z \in U_P\ [x <_P y \rightarrow \exists z[\neg[z \otimes_P x] \wedge z \leq_P y]$

CLASSICAL EXTENSIONAL MEREOLOGY

The part relation as the primitive notion and the sum operation defined from it.

- The **"part-of"** relation is reflexive, transitive and antisymmetric:

Axiom of reflexivity: $\forall x[x \leq x]$
Everything is part of itself.

Axiom of transitivity: $\forall x \forall y \forall z[x \leq y \wedge y \leq z \rightarrow x \leq z]$
Any part of any part of a thing is itself part of that thing.

Axiom of antisymmetry: $\forall x \forall y[x \leq y \wedge y \leq x \rightarrow x = y]$
Two distinct things cannot both be part of each other.

- Tarski (1929, 1956)
- Taking reflexivity (and antisymmetry) as constitutive of the meaning of 'part' simply amounts to regarding identity as a limit (improper) case of parthood.

CLASSICAL EXTENSIONAL MEREOLOGY

The part '≤' relation is reflexive, which is at variance with how English *part* is used. It is distinguished from the proper part relation, which is irreflexive '<'. The relation of proper-part can be defined based on the part relation '≤':

- **proper-part-of relation <**
  The "proper-part-of" relation restricts parthood to nonequal pairs:
  $x < y =\text{def } x \leq y \wedge x \neq y$
  A proper part of a thing is a part of it that is distinct from it.

  or

  $x < y =\text{def } x \leq y \wedge \neg(y \leq x)$
  x is a proper part of a thing if it is a part of a thing which itself is not part of x.

The relation of overlap can be also defined based on the part relation '≤' :

- **overlap relation ⊗**
  $x \otimes y =\text{def } \exists z[z \leq x \wedge z \leq y]$
  Two things overlap if and only if they have a part in common.

CLASSICAL EXTENSIONAL MEREOLOGY

The sum operation $\oplus$

- The classical definition is due to Tarski (1929, 1956). (For other definitions, see Sharvy 1979, 1980, for instance.)

  $$sum(x,P) =_{def} \forall y[P(y) \rightarrow y \leq x] \wedge \forall z[z \leq x \rightarrow \exists z'[P(z') \wedge z \otimes z']]$$

  - A sum of a set P is a thing that contains everything in *P* and whose parts each overlap with something in P.
  - "sum(x,P)" means "x is a sum of (the things in) P".

Tarski (1956) (see Betti and Loeb 2012 "On Tarski's Foundations of the Geometry of Solids", *The Bulletin of Symbolic Logic*):

"Definition I. An individual *X* is called a proper part of an individual *Y* if *X* is a part of *Y* and *X* is not identical with *Y*.

Definition II. An individual *X* is said to be disjoint from an individual *Y* if no individual *Z* is part of both *X* and *Y* .

Definition III. An individual *X* is called a sum of all elements of a class α of individuals if every element of α is a part of *X* and if no part of *X* is disjoint from all elements of α. ([Tarski, 1956a], p. 25)

PostulateI. IfX isapartofY andY isapartofZ,thenX isa part of *Z*.

Postulate II. For every non-empty class α of individuals there ex- ists exactly one individual *X* which is the sum of all elements of α.([Tarski, 1956a], p. 25)"

CLASSICAL EXTENSIONAL MEREOLOGY - SUMMARY

- Classical Extensional Mereology (CEM) consists of
  - THREE AXIOMS and requires only
  - a SINGLE PRIMITIVE NOTION in terms of which the rest of the mereological system can be defined.
- The three basic axioms are given in Lewis (1991) informally as follows:
  - AXIOM 1 (Unrestricted Composition): Whenever there are some objects, then there exists a mereological sum of those objects.
  - AXIOM 2 (Uniqueness of Composition): It never happens that the same objects have two different mereological sums.
  - AXIOM 3 (Transitivity): If x is part of some part of y, then x is part of y.
- The single primitive can be chosen to be
  - proper parthood $<$,
  - proper-or-improper parthood $\leq$,
  - sum $\oplus$,
  - overlap $\otimes$
  - disjointness.

  Other notions are definable in terms of whichever one is taken as primitive.

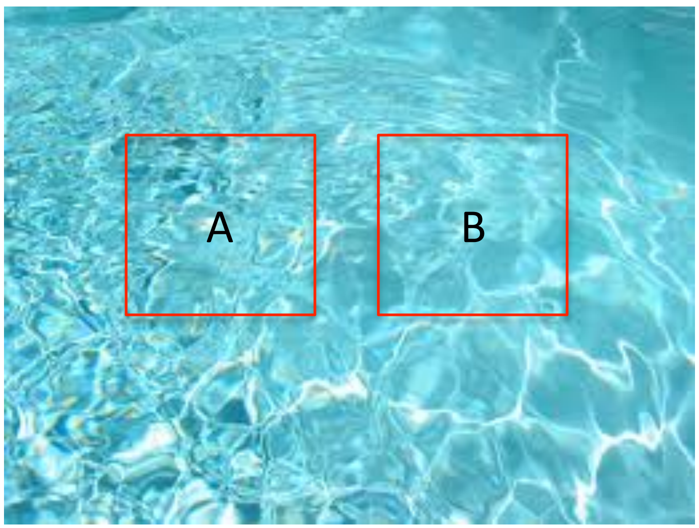
CLASSICAL EXTENSIONAL MEREOLOGY

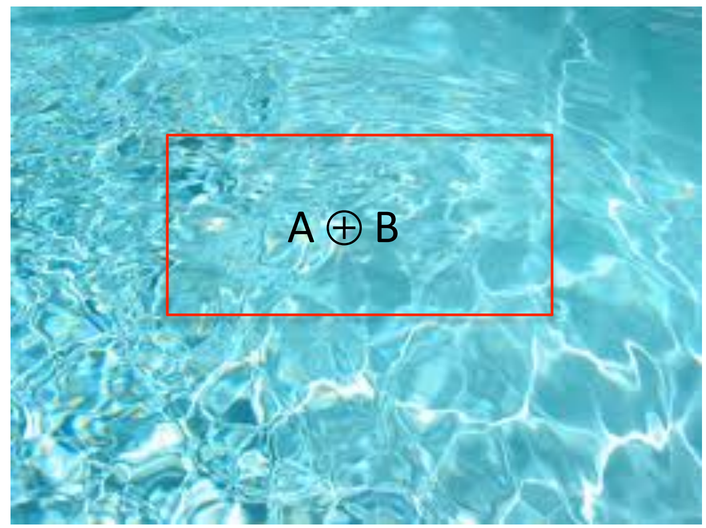
- Mereology
- Core axioms and concepts
  - parthood
  - sum
- **Higher order properties (lattice-theoretic perspective):**
  - **cumulativity**
  - **divisivity (aka divisiveness)**
  - **atomicity**

Cumulativity

- Mass nouns have the property of CUMULATIVE REFERENCE, as Quine (1960, p. 91) proposes: “any sum of parts which are water is water.” (Quine attributes this property to Goodman (1951).)

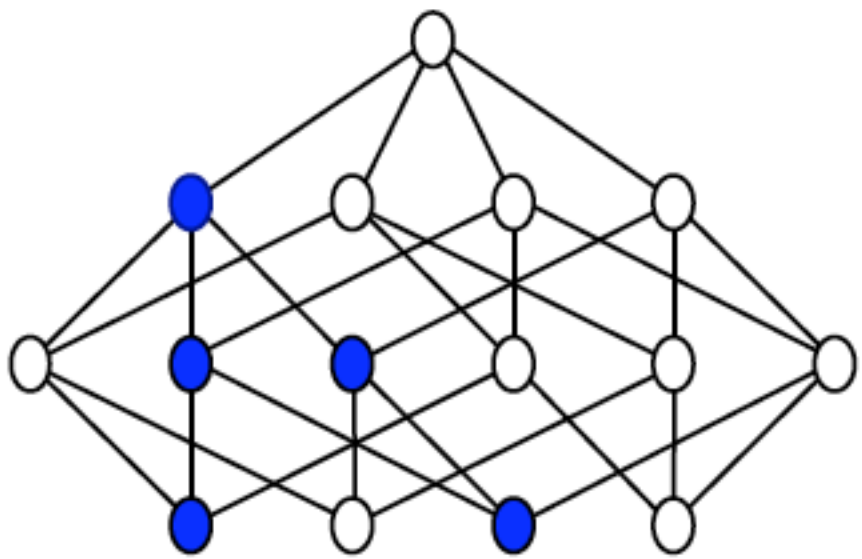
A is water and B is water. $\Rightarrow$ A and B together is water.





Cumulativity

CUMULATIVE(P) $\leftrightarrow \forall x,y[P(x) \wedge P(y) \rightarrow P(x \oplus y)]$
A predicate *P* is *cumulative* if and only if, whenever *P* applies to any *x* and *y*, it also applies to the sum of *x* and *y* (assuming that *x* and *y* to which *P* applies are two distinct entities).



The definition and lattice structure taken from Krifka 2007

Cumulativity

- The property of cumulative reference holds true for
  - mass nouns (*water*),
  - aggregate mass nouns (*furniture*) (Quine (1960) and
  - bare plurals (*horses*) (Link 1983): "If the animals in this camp are horses, and the animals in that camp are horses, then the animals in both camps are horses" (Link 1983, p.303).

(1) A is *water* and B is *water*. $\Rightarrow$ A and B together (A$\oplus$B) is *water*.

(2) A are *apples* and B are *apples*. $\Rightarrow$ A and B together (A$\oplus$B) are *apples*.

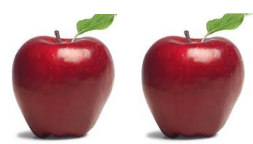
A B $\Rightarrow$ A$\oplus$B



- The property of cumulative reference does **NOT** hold for singular count nouns (*apple*):

(3) A is *an apple* and B is *an apple*. $\not\Rightarrow$ A$\oplus$B (A and B together) is *an apple*.





Divisivity (aka divisiveness)

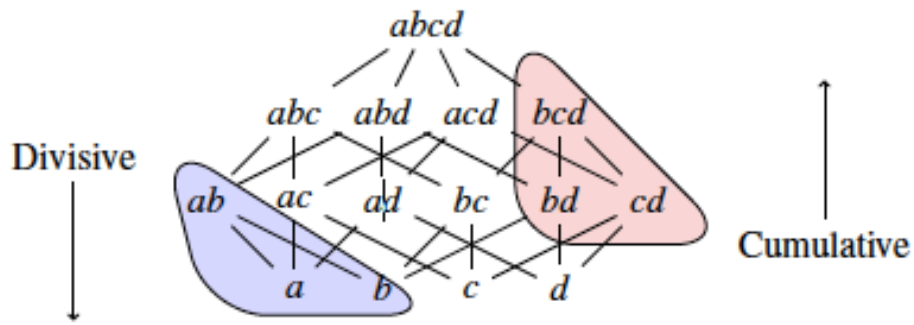
- Count (sortal) terms are never divisive in their reference, while mass terms may be.

- Mereological definition of DIVISIVE predicates:
  DIVISIVE(P) $\leftrightarrow \forall x \forall y\ [P(x) \wedge y \leq x \rightarrow P(y)]$ Krifka 2013 (and elsewhere)
  A predicate *P* is *divisive* if and only if, whenever *P* applies to *x*, then for all *y* such that *y* is a part of *x*, *P* applies to *y*.
  Or, simpler: If *P* applies to *x*, and if *y* is a part of *x*, then *P* applies to *y*.

- Some notable precursors:
  - sortal vs. non-sortal terms in Frege 1884, p.66 (cited in Pelletier 1975, p.453):
    "Only a concept which isolates what falls under it in a definite manner, and which does not permit any arbitrary division of it into parts, can be a unit relative to a finite number.
  - *Cheng's condition* (Cheng 1973): "any part of the whole of the mass object which is *W* is *W*" (see Bunt 1979)

- The divisivity property is often assumed to hold for prototypical mass nouns like *water* (this is controversial, see already Quine 1960, p.98).
- The divisivity property does not hold for singular count nouns (*apple, boy*), plurals (*apples*) and for aggregate/collective mass nouns (*furniture*).

Cumulativity and Divisivity



(The representation taken from Grimm 2012, p. 113, Figure 4.4)

- If a predicate is cumulative, it permits "going upwards" in the semilattice, and if it is divisive, it permits "going downwards" in the semilattice.

Atomicity

- The property of atomicity characterizes discrete individuals.
  An atom is an individual which has no proper parts:

  $\text{Atom}(x) \leftrightarrow \neg\exists y(y < x)$
  An atom is an individual which has no proper parts.

- Atomicity is a restriction on the part relation. It differs from cumulativity and divisivity in so far as it is not a closure condition.

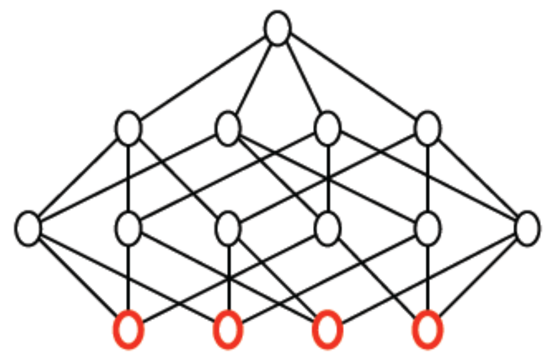
Atomicity

- Atomicity relative to a domain: Some approaches have models that are atomistic (Chierchia 1998). I.e., they have an additional axiom requiring for everything in the domain to be composed of atoms:

  $\text{ATOM}(x) = \forall x \exists y[y \leq x \wedge \neg\exists z(z < y)]$ absolute atoms

  For any element, there is a part

  for which there does not exist a proper part.



- Atoms are also defined relative to a property:

  $\text{ATOM}(x,P) = P(x) \wedge \neg\exists y[y < x \wedge P(y)]$ atom relative to a property

  P applies to *x*, but not to a proper part of *x*.

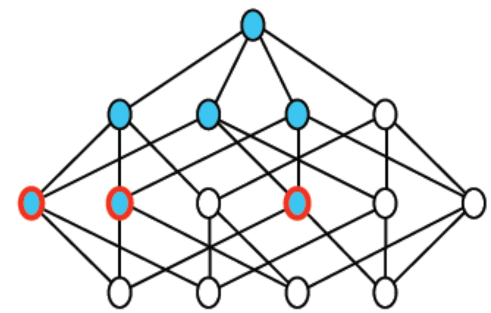
Krifka 2007

Atomicity

- Given the definition of an atom relative to a property *ATOM(x,P)*, we can define what it means for a predicate to be atomic (taken from Krifka 1989):

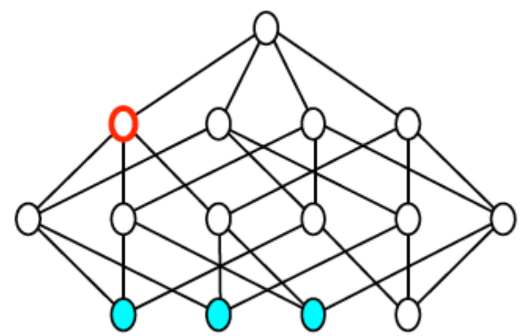
- atomic relative to a predicate P: ATOMIC(P):

  ATOMIC(P) = $\forall x[P(x) \rightarrow \exists P'\forall y[P'(y) \rightarrow ATOM(y, P) \wedge x = \sqcup P'$
  P is atomic iff every *x* that is *P* contains a *P*-atom.



$\sqcup$P: the smallest individual x such that $\forall y[P(y) \rightarrow y \leq x]$

generalized join $\sqcup$P



Krifka 2007

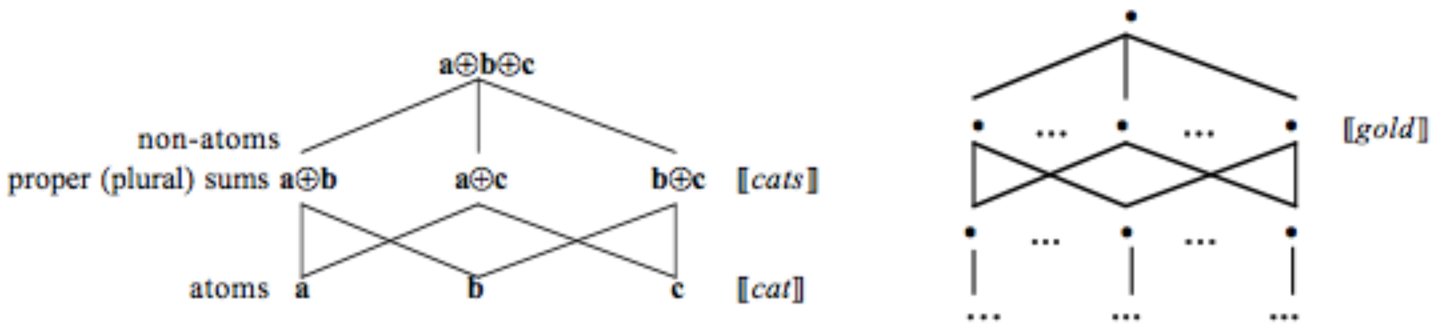
Atomicity

- Singular count nouns (*cat*), bare plurals (*cats*), aggregate mass nouns (*furniture*) express atomic predicates.
- Sometimes also assumed for true mass nouns (*water*), e.g. Chierchia (1998).

Link (1983): Atomic and non-atomic semilattices for mass/count/plural

- Key assumption: A sortal distinction between mass and count nouns (see also Quine 1960).

  COUNT NOUNS (*cat/s*) take their denotation from the domain that has an atomic structure, while MASS NOUNS (*gold*) from the domain that has a NON-ATOMIC structure, which is disjoint from the ATOMIC structure.



- "Non-atomic" means "not necessarily atomic", or unmarked with respect to atomicity (Partee 1999); no commitment as to whether it is atomless or not ("non-atomic" does not mean "atomless"!)

  The problem with **downward closure** ("What are the minimal parts of water?") led Link to remain agnostic as to whether the structures representing the mass domain were atomless or merely non-atomic.

Link (1983): Atomic and non-atomic semilattices for mass/count/plural

- Goal: to provide an analysis of mass terms and plurals, capturing both the similarities between MASS and PLURAL and differences between MASS and COUNT. *

- Mass nouns have the property of CUMULATIVE REFERENCE, as Quine (1960, p. 91) proposes: "any sum of parts which are water is water." (Quine attributes this property to Goodman (1951).)

- The same holds for plurals: "If the animals in this camp are horses, and the animals in that camp are horses, then the animals in both camps are horses" (Link 1983, p.303).

- In setting up his system, Link takes as basic the sum operation '$\oplus$', and derives the part relation '$\leq$' from it (see also Krifka 1989, and elsewhere). This means that we set out with the notion of a lattice, or more precisely, a join semi-lattice.

* Massey (1976): another theory of plurals and mass nouns formulated in a mereological framework. Early approaches to plural semantics adopted set theory (Hausser, 1974; Bennett, 1974).

Link (1983): Atomic and non-atomic semilattices for mass/count/plural

Main innovation: the domain of entities from which nouns take their denotations is not an unstructured set, but has the algebraic structure of a JOIN SEMILATTICES that capture the mereological part-whole relations (whereby the 'join' corresponds to the mereological sum operation).

Example: a domain consisting of three cats

sums
- the maximal sum individual a⊕b⊕c ⟦*the cats*⟧
- proper (plural) sums a⊕b a⊕c b⊕c ⟦*cats*⟧

part relation ≤

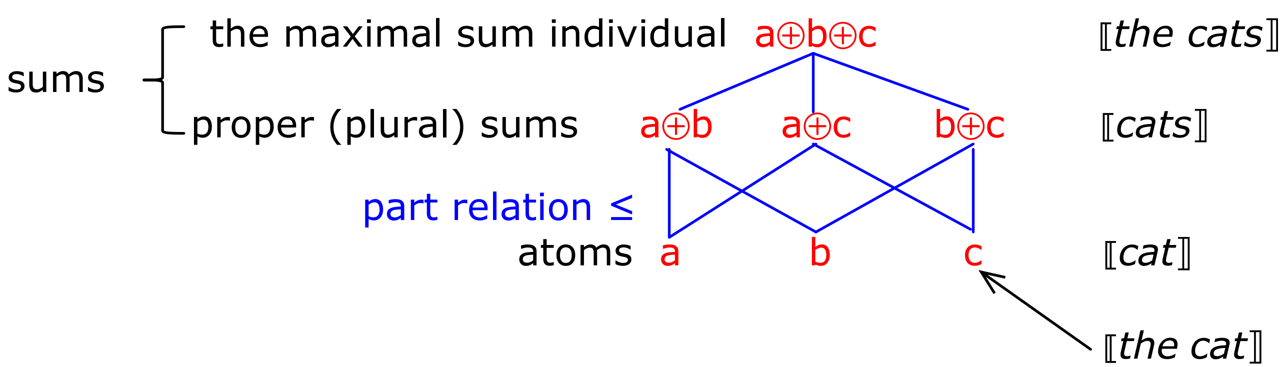
atoms a b c ⟦*cat*⟧

a ≤ a⊕b

⟦*the cat*⟧ is undefined in this situation

Link (1983): Atomic and non-atomic semilattices for mass/count/plural

- Only (sortal) **COUNT NOUNS** like *cat* refer to individuals or "atoms", and the sets of atoms in their denotation are structured by ATOMIC join semilattices, (partially) ordered by the mereological binary part relation '≤'.
- Atoms, or the smallest, minimal parts, correspond to the meanings of singular forms (eg., *the/ one cat*), and non-atomic elements or the plural/sum individuals model the meanings of plural forms (e.g., *cats, two cats*).
- In this sense, the ATOMIC join semilattice is a plurality structure, on which a counting operation is defined.



Link (1983): Atomic and non-atomic semilattices for mass/count/plural

Algebraic closure used to model the meaning of plural terms.

- Definition: Algebraic closure (Link 1983)
  The algebraic closure *P of a set P is defined as
  $\{x \mid \exists P' \subseteq P[x = \oplus P']\}$

- Algebraic closure closes any predicate (or set) P under **sum** formation: Algebraic closure extends a predicate P so that whenever it applies to a set of things individually, it also applies to their sum. The algebraic closure of a set *P*, written as **P*, is the set that contains any sum of things taken from (the domain of denotation of) *P*, all the individual sums of members of the extension of *P*.

- Such a starred predicate **P* has the same cumulative reference property as a mass predicate, it is closed under sum formation: any sum of parts which are **P* is again **P*.

Link (1983): Atomic and non-atomic semilattices for mass/count/plural

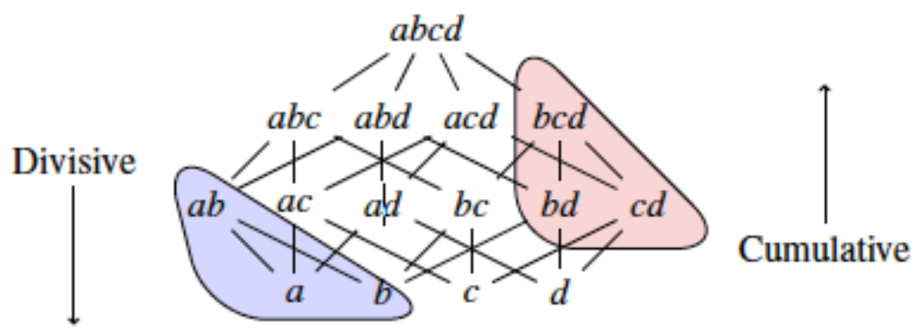
- Algebraic closure used to model the meaning of plural terms.

(1) a. John is **a boy**. boy(j)
b. Bill is **a boy**. boy(b)
c. ⇒ John and Bill are **boys**. ⇒ *boy($j \oplus b$)

- Link translates the argument in (1) as follows:

(2) boy(j) ∧ boy(b) ⇒ *boy($j \oplus b$)

Cumulativity and Divisivity as Closure Properties



(The representation taken from Grimm 2012, p. 113, Figure 4.4)

- In terms of the part structure, cumulativity is closure under sum formation, while divisivity is closure under part-taking.

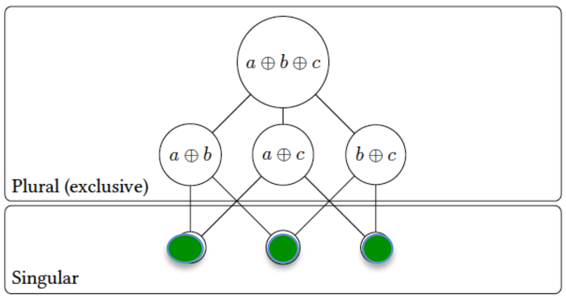
Exclusive plural: Link 1983 (also Chierchia 1998)

the plural form N*pl* means the same as *two or more N*

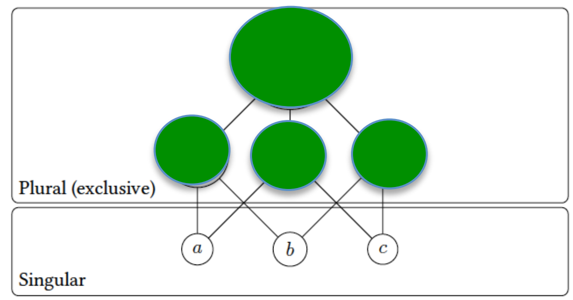
(1) $[\![N\mathit{pl}]\!] = {}^*[\![N\mathit{sg}]\!] - [\![N\mathit{sg}]\!]$

(2) a. $[\![\mathit{boy}]\!] = \{a, b, c\}$

b. $[\![\mathit{boys}]\!] = {}^*[\![\mathit{boy}]\!] - [\![\mathit{boy}]\!] = \{a \oplus b, b \oplus c, a \oplus c, a \oplus b \oplus c\}$



$[\![\mathit{boy}]\!]$



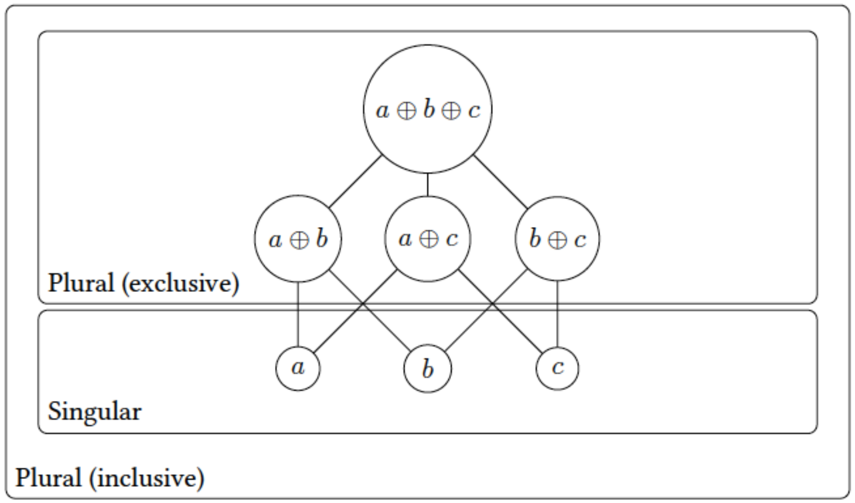
$[\![\mathit{boys}]\!]$

(3) a. Mary saw a horse.

b. Mary saw horses.

(3b) is interpreted as claiming that Mary saw more than one horse.

There are different views on the meaning of the plural



(Fig. taken from Champollion 2012)

Exclusive: the plural form means *two or more N* (Link 1983, Chierchia 1998) singular and plural forms of a count noun denote disjoint sets

Inclusive: the plural form means *one or more N* (Krifka 1986, Sauerland 2003, Sauerland, Anderssen and Yatsushiro 2005, Chierchia 2010)

Mixed: the plural form is ambiguous between *one or more N* and *two or more N* (Farkas and de Swart 2010)

Inclusive plural: Krifka 1986, Sauerland 2003, Sauerland, Anderssen and Yatsushiro 2005, Chierchia 2010

(1) $[\![\text{N}pl]\!] = *[\![\text{N}sg]\!]$

(2) a. $[\![boy]\!] = \{a, b, c\}$

b. $[\![boys]\!] = *[\![boy]\!] = \{a, b, c, a\oplus b, b\oplus c, a\oplus c, a\oplus b\oplus c\}$

the plural form N*pl* means the same as *one or more N*

- Argument: plural forms whose interpretation appears to be indifferent to the atom/sum divide in that the plural nominal is allowed to range over both atoms and sums. "The main argument in favour of the view that plurals are number neutral has to do with the semantics of plural negative quantified Determiner Phrases (DPs) like *no cats*" (Chierchia 2010; originally proposed by Schwarzschild, 1996, p. 5).

(3) Suppose there is exactly one cat in the room.

There are no cats in the room is false.

If the meaning of *cats* excluded singularities, it would be true in a situation where there is one cat in the room. This sentence would assert that there is no group of cats (empty set) in the room. To get sentences of this sort right, singularities have to be included. On the exclusive theory of plurals we cannot derive the meanings of sentences like (3) compositionally without resorting to intensionality.

Inclusive plural: Krifka 1986, Sauerland 2003, Sauerland, Anderssen and Yatsushiro 2005, Chierchia 2010

Exluding atoms from plurals is problematic – further arguments:

A: Do you have children?
B: Yes, one. / *No, (just) one.

A: Do you have more than one child?
B: *Yes, one. / No, (just) one.

Inclusive plural: Krifka 1986, Sauerland 2003, Sauerland, Anderssen and Yatsushiro 2005, Chierchia 2010

Question: Why cannot positive sentences like *there are cats on the mat* be used to describe a situation in which there is only one cat on the mat?

- Krifka (1986) argues that the singular form blocks the plural form via competition: On the inclusive view of plurals, when singular reference is intended, singular and plural forms are in pragmatic competition, and the more specific singular form blocks the plural form.
- Chierchia (2010) suggests that that this effect might be due to a scalar implicature.

... end of the introduction to classical extensional mereology

The mass/count distinction: Three recent perspectives

Chierchia, Gennaro (2010). Mass nouns, vagueness and semantic variation. *Synthese*, 174:99–149.

Landman, Fred (2011). Count nouns – mass nouns – neat nouns – mess nouns. *The Baltic International Yearbook of Cognition*, 6:1–67.

Rothstein, Susan (2010). Counting and the mass/count distinction. *Journal of Semantics*, 27(3):343–397.

Questions:

- Why can't we count mass nouns like *mud* (# /* *three muds*)?
  [Chierchia and Landman, focus on mass nouns]
- Why can count nouns be explicitly and straightforwardly counted by using numeral modifiers (*three cats*, *three fences*)?
  [Rothstein, focus on count nouns]

The mass/count distinction is a matter of vagueness

Chierchia, Gennaro, 2010. Mass nouns, vagueness and semantic variation. *Synthese* 174, 99-149.

- Theoretical background: mereology, supervaluationism
- Counting is subject to two laws:
  (i) we count the minimal elements ("atoms") to which a property applies, and
  (ii) the property used for counting must have stable minimal entities ("stable atoms"), i.e., the same ones in every precisification (p.122).

  [Precisification = a way of making things more precise, removing disagreements about the application of properties to things, e.g., the application of the property of 'heap' to some quantity of sand; or deciding whether mature cat embryos count as cats.]

- The entire domain of discourse is atomic (having the structure of an atomic lattice), *everything* in the domain is composed of atoms (also Chierchia 1998):
  All nouns have minimal, atomic elements in their denotation, also prototypical mass nouns (*water*) denote atoms.
- Inclusive view of the semantics of plurals:
  Plural nouns (like *cats*) include singularities in their extension (contrary to Chierchia 1998), and hence are number neutral: e.g., CAT is used to refer to the number neutral cat-property.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

- **Main claim**: If we enrich singular/plural lattice structures with **VAGUENESS**, we can provide the grounding for the mass/count distinction.
  The mass/count distinction is explained in terms of independently needed notions needed to account for vagueness in language.

- ***Count nouns have "stable atoms".***
  We always know what counts as 'one' across all admissible precisifications (ways of making things more precise).
  For instance, know with reasonable certainty what qualifies as a (more or less 'whole') cat.

- ***Mass nouns have "unstable individuals"***.
  Mass noun denotations consist of minimal atomic elements, but lack stable atoms.
  Elements may be split into components more than one way, consequently, it is VAGUE what to count as one or two or many. If you do not know of your minimal elements which ones to count as 'one', you cannot count them.

"While every noun/concept may in a sense be vague, mass nouns/concepts are vague in a way that systematically impairs their use in counting" (p.99).

The mass/count distinction is a matter of vagueness (Chierchia 2010)

Parallels to vagueness in the meaning of adjectives

- **count** nouns like *cat* ≈ absolute gradable adjectives like ***dry***

  - There is a natural cut off point that separates dry things from non dry things (even though its exact characterization might still be vague) (Kennedy 2007, and elsewhere).
  - “In considering smaller and smaller instances of the property CAT, there is a cut off point such that if you go smaller, you won’t have a cat anymore (even though where such a cut off point lies may be somewhat vague); ...” (p.118).

- **mass** nouns like *rice* ≈ relative gradable adjectives like ***tall***

  - for adjectives like *tall,* a natural cut off point separating, say, tall people from non tall ones is much more elusive.
  - In considering ever smaller rice samples the cut off point that separates rice from non rice remains way more elusive.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

- We know with reasonable certainty what qualifies as a (more or less 'whole') cat (atom), but there is no systematic basis for deciding which rice amounts qualify as rice atoms

rice

rice flour a half of a grain of rice a single grain of rice a few grains a bowl of rice

sometimes TRUE always TRUE

- "*rice* has contextually supplied smallest parts, but lacks stable atoms (because the vagueness of the smallest rice parts will be resolved differently in different precisifications)" (p. 123).

  "For some (...) purposes, we might consider a grain of rice, rice [allergy testing, cereal cultivation, HF]. But, then that applies to half grains as well. And to quarters of grains. In certain cases, we may regard rice flour as rice (as when we say 'there is rice in this cake'). The point is that there is no systematic basis for deciding which rice amounts qualify as **rice atoms** [emphasis, HF]" (p.117-8).

The mass/count distinction is a matter of vagueness (Chierchia 2010)

We don't have any rice.

FALSE

TRUE

Cooking a paella dish:
A: "Do we have any rice?"
B: "We don't have any rice."
is felicitous if one grain of rice is left, or a few grains.

FALSE

For some purposes, like rice allergy testing, cereal cultivation, a grain of rice qualifies as *rice*.

In this cooking context, a single grain of rice or a few grains is/are not enough to reach the threshold of significance to qualify as *RICE*.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

Argument: the semantics of plural quantified Determiner Phrases (DPs) that are indifferent to the atom/sum divide (i.e., the plural CN they contain is allowed to range over both atoms and sums).

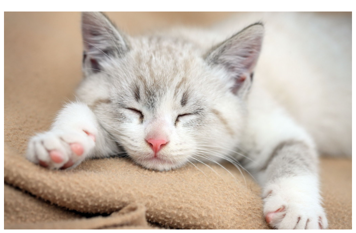
- Rice consists of single grains of rice, but a single grain of rice **is not** always enough to reach the threshold of significance to qualify as *RICE*.

a single grain of rice

We don't have any rice

may be TRUE in some contexts: for instance, when what is at issue is having enough rice to cook paella for dinner.

- A single (whole) cat **is** always enough to reach the threshold of significance to qualify as *CAT*.



We don't have any cats

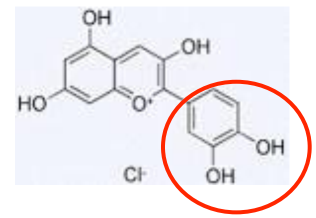
is always FALSE (if there is one cat in the domain of discourse)

The mass/count distinction is a matter of vagueness (Chierchia 2010)

- The positive extension of *rice* (RICE+) contains entities to which RICE clearly applies.
- The negative extension of *rice* (RICE−) contains entities to which RICE clearly does not apply.
- The vagueness band of *rice* contains entities that are neither clearly rice nor not rice.

RICE+

RICE−



positive extension

gap

RICE's vagueness band

negative extension

"If in counting directly with a property P, we count P-atoms, and such atoms happen to be all vaguely specified, as all fall outside of the 'safe' boundaries of the relevant property, we are stuck. We don't know what to count, not even in principle (although we will of course be able to measure)." (p. 118)

Mass is a matter of vagueness: Mass Ns are VAGUE i.e., their denotation lacks "stable atoms", stable minimal stable units in every precisification, and so cannot be counted.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

- The positive extension of *cat* (CAT+) contains entities to which CAT clearly applies.
- The negative extension of *cat* (CAT−) contains entities to which CAT clearly does not apply.

CAT+

positive extension

cat embryos

gap
CAT's vagueness band

CAT−

negative extension

Any **count N** has stable atoms in its denotation, a noun is count if there are at least some things it applies to that are clearly atomic, "stable atoms", across all admissible precisifications (ways of making things more precise).

The mass/count distinction is a matter of vagueness (Chierchia 2010)

- SUPERVALUATIONS AND ATOMICITY: Chierchia's central insight is that **stable atomicity** differentiates count from mass nouns.
- On supervaluationist theories of vagueness, whenever a predicate is vague, there are ways of making it more precise in compliance with our intuitions about how it is used.
- For count Ns like *cat* "we have a reasonably clear idea of what qualifies as a (more or less 'whole') cat atom" (p.117).
  - For count nouns, the ground context chooses the level of vagueness for each lexical entry (deciding, e.g. whether mature cat embryos count as cats, as non cats or whether they fall in the truth value gap), admissible precisifications (successive sharpenings of the ground context) make things more precise.
  - N is count if there are at least some things it applies to that are clearly atomic, "stable atoms", across all admissible precisifications.
- No mass N has "stable atoms" (stable minimal entities) in its denotation relative to every context.
  - In the ground context, they are treated as $\cup$-closed sets of unstable entities (closure of union of sets).
  - "While every noun/concept may in a sense be vague, mass nouns/concepts are vague in a way that systematically impairs their use in counting" (p.99).

The mass/count distinction is a matter of vagueness (Chierchia 2010)

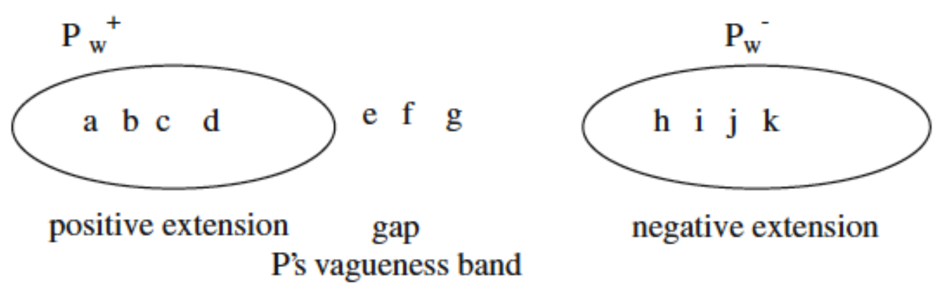
Mass nouns are treated as singleton properties of SUMS ("cannot be true of more than one individual").

- They are singleton properties like proper names - key similarity: singular morphology:
  - the lack of pluralisation, singular agreement, the impossibility of combining them with numbers (but not with "one", HF)
  - singular morphology of mass nouns rather is 'real', rather than defective (p.139)
- Mass nouns are singleton properties of *sums*; proper names are singleton properties of absolute *atoms*. Key difference: distributional properties with quantifiers
  - Proper names cannot freely co-occur with quantifiers; from singleton properties we cannot extract properties that are good quantifier restrictions by looking at their parts, as atoms have no parts in the relevant sense.
  - Mass nouns can co-occur with quantifiers, namely those like *most, some*, *all* that measure parts (in the sense relevant to the singular/plural distinction; called "part-quantifiers"). Mass properties are never good as restrictions for "atomic quantifiers" (like numbers, *every*) ; but they maybe good as restrictions for part-quantifiers. From singleton properties of sums we can extract properties that are good quantifier restrictions, by looking at their parts.in the relevant sense).

The mass/count distinction is a matter of vagueness (Chierchia 2010)

A Note on Supervaluationism

- Supervaluationism: a theory of vagueness, in Chierchia (2010) inspired by Veltman (1985)
- Vague predicates *P* are interpreted by partial functions from individuals into truth values (relative to a context *c* that fixes any context dependent parameter *P* may have).
  - In virtue of such partiality, a property *Pw* of type <*e*,*t*> (one-place predicate, denoting sets of individuals) is going to be associated with
    - a **positive extension** Pw^+ (the set of all things for which it yields 1 or true) and
    - a **negative extension** Pw^- (the set of all things for which it takes value 0 or false);
    - things for which *Pw* is undefined are said to fall into *Pw*'s truth value gap, which represents *P*'s **vagueness band**.



The mass/count distinction is a matter of vagueness (Chierchia 2010)

A Note on Supervaluationism (cont.)

- The positive extension of *heap* (HEAP+) contains entities that are clearly a heap.
- The negative extension of *heap* (HEAP−) contains entities that are not a heap.
- The vagueness band of *heap* contains entities that are neither clearly a heap nor not a heap.

HEAP+ HEAP−



positive extension gap negative extension

HEAP's vagueness band

(a) (c) (b)

- So if *a* is determinately a heap, *b* is determinately not a heap and *c* is neither determinately a heap nor determinately not a heap, then every precisification must make '*a* is a heap' true and '*b* is a heap' false, but some make '*c* is a heap' true and others make it false.
- To a first approximation, to be admissible a precisification must assign all the determinate heaps to the extension of 'heap' and assign none of the determinate non-heaps to its extension, but it is free to assign or not assign things in the gap ['penumbra'] between these groups to the extension of 'heap'.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

A Note on Supervaluationism (cont.)

- The positive extension of *green* (GREEN+) contains entities that are clearly green.
- The negative extension of *green* (GREEN^{-}) contains entities that are not green.
- The vagueness band of *green* contains entities that are neither clearly green nor not green.

- One way to analyze the vagueness of green is to assume that its negative and positive extensions can be given with different degrees of precision. At the lowest degree of precision *c*, the vagueness band of GREEN is as large as it can be. At a higher degree of precision c', the vagueness band of GREEN has been shrunk. At the highest degrees of precision, there are no individuals in the vagueness band of GREEN. There are of course several ways of reducing the vagueness band of GREEN, i.e. several different highest degrees of precisions.
- *The degrees of precisions are commonly called 'valuations' of a predicate*. Instead of 'valuations' Chierchia uses contexts. Ground contexts are contexts in which predicates are evaluated at the lowest degree of precision. (Adaptation of Guillaume Thomas's example.)

The mass/count distinction is a matter of vagueness (Chierchia 2010)

A Note on Supervaluationism (cont.)

- **Precisification**: we can sharpen our criteria for being *Pw* by shifting from the ground context *c* to a different context *c'* in which fewer things fall within the vagueness band.
- Through successive sharpenings (i.e. through further context changes) we may reach a point in which *Pw* becomes total.
- There is no single way of making *Pw* total. But the things that are in *P*'s positive extension relative to the ground context *c* will remain stable no matter how we make *c* more precise. We can represent this by ordering contexts as follows: we say that

  c $\propto$ c' "c is a precisification of c' "
  iff for every *P* and every world *w*, *Pw*'s vagueness band relative to *c'*
  is smaller or equal to *Pw*'s vagueness band relative to *c*.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

A Note on Supervaluationism (cont.)

- We can then say that a formula ϕ of type *t* (a sentence type, denotes a truth value) is **definitely true** (in symbols **D** ϕ) relative to a context *c* iff ϕ is true relative to every total precisification *c'* of *c*.

- This has the usual effect of supervaluations: tautologies like $\neg[P(a) \wedge \neg P(a)]$ are definitely true and contradictions as definitely false even if *P(a)* does not have a stable value relative to every context.

- An essential part of theories of vagueness in terms of super-valuations is that truth of a sentence is relative to valuations: a formula is super-true (or super-false) iff it is true (or false) at all valuations. (A sentence that is true on all precisifications is said to be **supertrue**, and a sentence that is false on all precisifications is said to be **superfalse**.)

The mass/count distinction is a matter of vagueness (Chierchia 2010)

Summary

- ***Count nouns have "stable atoms".***
  We always know what counts as 'one' across all admissible precisifications (ways of making things more precise).
  Any count N has stable atoms in its denotation; a noun is count if there are at least some things it applies to that are clearly atomic, "stable atoms", across all admissible precisifications.

- ***Mass nouns have "unstable individuals"***.
  "While every noun/concept may in a sense be vague, mass nouns/concepts are vague in a way that systematically impairs their use in counting" (p.99)
  Mass Ns are VAGUE in so far as while their denotations consist of minimal atomic elements, that are "unstable individuals".
  No mass N has "stable atoms" (stable minimal entities) in its denotation.

  The VAGUENESS of the minimal elements may be resolved in more than one way, depending on how we want to make things more precise. Elements that are atomic on one way of making things more precise, may not be atomic on another.

  Elements may be split into components more than one way, consequently, it is VAGUE what to count as one or two or many. If you do not know of your minimal elements which ones to count as 'one', you cannot count them.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

Problems 1: "fake" mass nouns like *furniture, footware, kitchenware, headgear, ...*

- **pattern with mass nouns** (singular agreement, no plural marking, combination with "part-quantifiers" like *most*, hence they are treated in the way in which number marking languages treat unstably atomic nouns, i.e., singleton properties of sums)
- However, **"fake" mass nouns like *furniture* are not any vaguer than count nouns like *table* or *chair*, and tables and chairs are furniture** (as Chierchia (2010, p.140, 144), observes).
  It follows then
  (i) "since furniture is not inherently vaguer than table, we know right off the bat that ***furniture* cannot be treated on a par with *water***" (p.144);
  (ii) "Hence, it seems highly implausible that nouns like *furniture* are any vaguer than *table* or *chair*. It follows, that **the mass like behaviour of nouns like *furniture* must come from a totally different source**" (p.140).

"even if listed as singleton properties, nouns like *furniture* do retain their atomic structure. Such structure can be extracted from their denotation (in fact, it has to be extracted by quantifiers like *some*, *all*, *most*,…). And such structure will be undistinguishable from that of plurals. This would explain why in some cases, fake mass nouns do pattern with count plural nouns and unlike core mass nouns, as with the 'Stubbornly Distributive Predicates', discussed in Schwarzschild (2007)" (p.139).

The mass/count distinction is a matter of vagueness (Chierchia 2010)

Problem 2: *Rice* versus *mud*

Chierchia's claim: "the basic components of core mass nouns **are not accessible to our perception** and not worth our while dwelling too much over. This won't impair an effective use of the noun, but it will impair using it for counting" (Chierchia 2010, p.123)

- *cat* versus *rice* / *mud* (agreement with Chierchia (2010))
  - It is non-vague what the counting base for *cat* is.
  - It is vague what the counting base for *rice* / *mud* is.

We don't have any cats.
(always false)

I've eaten (all) my rice.
(sometimes true)

I've cleaned (all) the mud off my boots.
(sometimes true)

The mass/count distinction is a matter of vagueness (Chierchia 2010)

Problem 2: *Rice* versus *mud*

- *rice* versus *mud* (departure from Chierchia (2010))

We CAN and DO perceptually distinguish minimal salient elements in the denotation of rice, which is not true for *mud*.

Nouns for GRANULAR substances like *rice* are not vague in the same way as nouns for subtances like *mud, meat* are, the denotations of nouns for granular and fibrous substances is built from non-overlapping individuals, minimal salient elements that we perceptually distinguish: e.g., individual rice grains.

Core mass nouns (in English) are not uniform in having minimal elements in their denotation equally not accessible to our perception.
Some core mass Ns may be less vague than others, in so far as a notion of the minimal element can be more readily available (see similar observation in Chierchia 2010, p.140).

The mass/count distinction is a matter of vagueness (Chierchia 2010)

Problem 3: Cross-linguistic variation

- Ns describing GRANULAR substances like rice, lentils, and also FIBROUS entities like hair(s) manifest cross-linguistic variation in their encoding as count or mass:

[+C]	[–C]	[+C]	[–C]
bean/s English	*fasole* Rumanian	*hair* English	*vlas/y* Czech
fagiolo/i Italian			

- Were the denotation of the mass noun *fasole* ('bean', Rumanian) vague (built from "unstable individuals"), then the same should hold of the English *lentil(s)*, which is count, leaving unexplained the [−C]/[+C] variation.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

Problem 4: Intralinguistic variation

Entities that come in natural units of equal or similar perceptual salience may differ in a single language as to whether they are mass or count. For example, *rice* is mass, while *bean(s)*is count in

rýže [-C] Czech

čočka [-C] (Czech)

fazole [+C] Czech

- Were the denotation of the mass noun čočka ('lentil', Czech) vague (built from "unstable individuals"), then the same should hold of fazole ('bean/s"), which is count, leaving unexplained the [−C]/[+C] variation.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

Problem 5: Chierchia's "unstable individual" conflates two notions of vagueness:

(i) vagueness qua extensional variation across precisifications and
(ii) vagueness with respect to lacking clearly individuated units.

(i) Vagueness qua extensional variation across precisification (what is in the positive extension of a predicate)

- Count Ns are not vague: A single cat counts as one cat across all precisifications.
- Mass Ns are vague: A single grain of rice does not always reach the threshold of significance to qualify as *rice*.

(ii) Vagueness with respect to lacking clearly individuated units across all precisifications (related to the inherent nature of substances)

- Count Ns (*cat*) and granular mass Ns (*rice*) and fibrous Ns (*hair*) are not vague: "We have a reasonably clear idea of what qualifies as a (more or less 'whole') cat atom" (Chierchia 2010, p. 117) and also a whole rice grain.
- Mass Ns like *mud* are vague: We do not have a clear idea of what qualifies as one whole mud atom.

Chierchia's (2010, p.117-8) basic examples with *cat* and *rice* revolve around the quantitative question "How much rice is enough to be felicitously described as *rice* or *cat* [in a given context for a purpose *x*]?", which is orthogonal to atomicity – what counts as "one whole entitity" in the denotation of *P*.

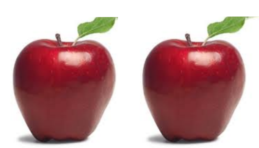
The mass/count distinction is a matter of non-overlap

Landman, Fred, 2011. Count nouns, Mass nouns, Neat nouns, Mess nouns. *The Baltic International Yearbook of Cognition*, Vol. 6. pp. 1-67.

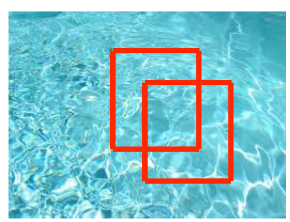
- **Main thesis:** "count means non-overlap, or overlap made irrelevant" (p.17)
  Counting is counting of non-overlapping GENERATORS ("things that we would count as one"; "semantic building blocks" that count as 'one').
  The problem with counting in the mass domain: It fails, because its generators overlap, and their overlap cannot be *made irrelevant.*

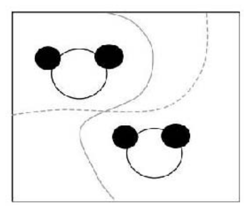
- Count noun denotations (*apple*) are built from non-overlapping generators.
- Mass noun denotations (*water, kitchenware*) are built from overlapping generators.

non-overlapping generators



H20: overlapping minimal generators





overlapping generators

- **Main data**: "fake" mass nouns, Landman's NEAT mass nouns, like *kitchenware*

The mass/count distinction is a matter of non-overlap (Landman 2011)

- Two kinds of mass nouns:
  - MESS mass nouns (prototypical mass nouns like *water, meat, salt, mud*): denotations built from overlapping minimal generators
  - NEAT mass nouns (mass nouns like *furniture* and *kitchenware):* denotations built from overlapping generators, where the overlap is not located in the minimal generators.

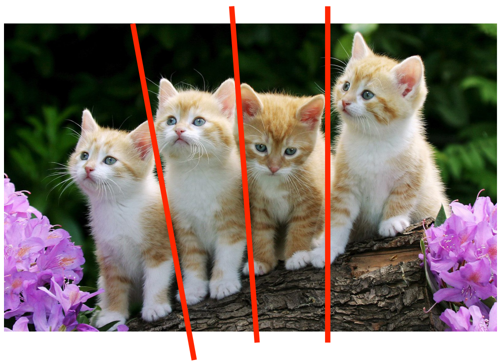
- 3 denotation types for nouns:

non-overlapping generators	overlapping generators	
COUNT [+C]	MASS [- C]	
boys, peas	non-overlapping minimal generators	overlapping minimal generators
	NEAT [+N]	MESS [- N]
	furniture, kitchenware	*meat, salt*

The mass/count distinction is a matter of non-overlap (Landman 2011)

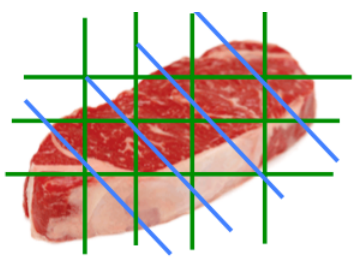
Basic intuition

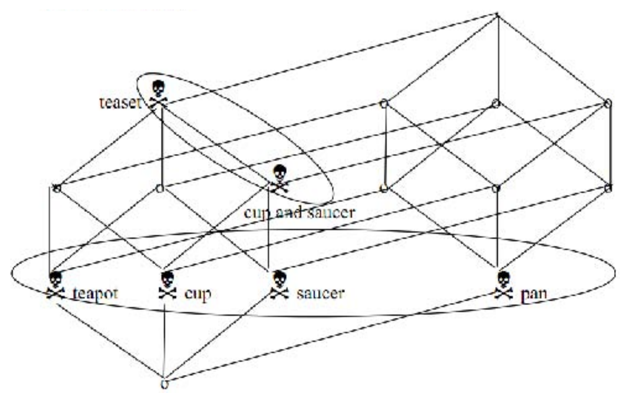
- The denotation of a **count noun** is generated from a single set of non-overlapping elements (generators) – counting succeeds!



There is **only one way ("one variant")** of partitioning the lattice structure corrresponding to CAT (a number neutral property that applies to individuals and to groups of cats) into its minimal (non-overlapping) cat-units.

- The **mass noun** denotation is a simultaneous multiplicity of sets of non-overlapping elements, each represents a different way of partitioning the *same* stuff (i.e. with the same supremum). This means that the set of generators will contain mutually overlapping elements – counting fails!





The mass/count distinction is a matter of non-overlap (Landman 2011)

Let *X* be a function from worlds to regular sets.

X is [+C], **count,** iff for every w: **gen**(*X*w) is disjoint
i.e. the generators of *Xw* do not overlap - disjoint generators

X is [-C], **mass,** iff for every w: if |Xw|>1 then **gen**(*X*w) is not disjoint,
i.e. the generators of *X*w overlap - always overlapping generators

X is [+N], **neat,** iff for every w: **min**(*X*w) is disjoint
i.e. the minimal elements of *Xw* do not overlap

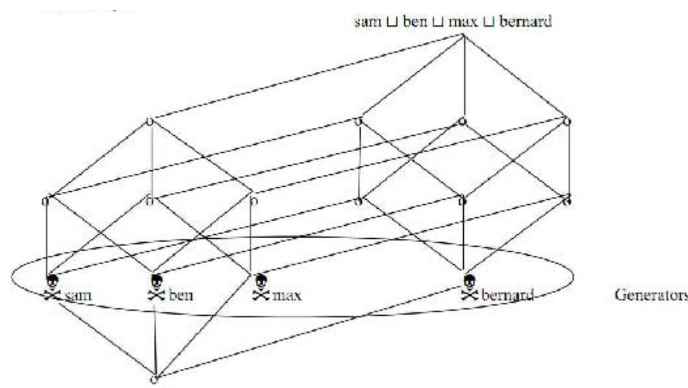
X is [-N], **mess**, iff for every w: if |Xw|>1 then **min**(*X*w) is not disjoint,
i.e. the minimal elements of *X*w overlap.

By definition, **count** entails **neat:** [+C] ⇒ [+N]
Equivalently, **mess** entails **mass**: [-N] ⇒ [-C]
neat mass: [-C, +N].

The mass/count distinction is a matter of non-overlap (Landman 2011)

Count nouns

- The denotation of a count noun is generated from/by a disjoint set of generators (or a set of non-overlapping elements), for every world *w*: **gen**(P*w*).
- Example: CATw - In a domain with four cats, ***Sam, Ben, Max, Bernard***, a disjoint set of four cats, the set of generators is: {sam, ben, max, bernard}.



For every world *w*, COUNT is a *function* on CATw:
= {COUNT_{CATw}(a): a ∈ $\textbf{gen}_{CATw}$(sam ⊔ ben ⊔ max ⊔ bernard)}
= COUNT_{CATw} (sam) + COUNT_{CATw} (ben) + COUNT_{CATw} (max) + COUNT_{CATw} (bernard)
= 1 + 1 + 1 + 1 = 4

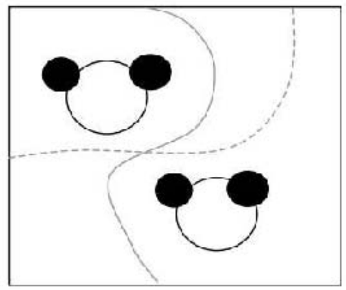
For every world w, **gen**(CAT*w*) forms a single variant for CATw.

- Let *X* be a function from worlds to regular sets. *X* is [+C], **count,** iff for every w: **gen**(*X*w) is disjoint i.e. the generators of *Xw* do not overlap - disjoint generators.

The mass/count distinction is a matter of non-overlap (Landman 2011)

MESS mass Ns (*water, meat, salt*): minimal elements always overlap

water: H_2O molecules

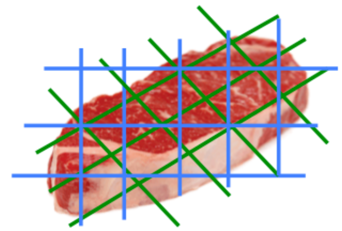


- We may partition a body of water down to water molecules, like the two "Mickey Mouse" molecules in the above picture. According to Landman, *the space between the molecules* is part of the body of water and shouldn't be ignored. That is, a minimal element in the denotation of the mass noun *water* is something that consists of some essential structure (a "Mickey Mouse" molecule H_2O) and some space. There are many ways of dividing that space, and hence, many ways of partitioning the water into minimal mass-parts.
- Mass perspective *merges* all such variants into one part-of structure, and gives *overlapping* building blocks, i.e., building blocks coming from a multiplicity of different ways of dividing the stuff into minimal parts (multiplicity of simultaneous variants).

If you try to count such overlapping building blocks, you are guaranteed to count wrong!

The mass/count distinction is a matter of non-overlap (Landman 2011)

MESS mass Ns (*water, meat, salt*): minimal elements always overlap

meat: (i)  (ii) 

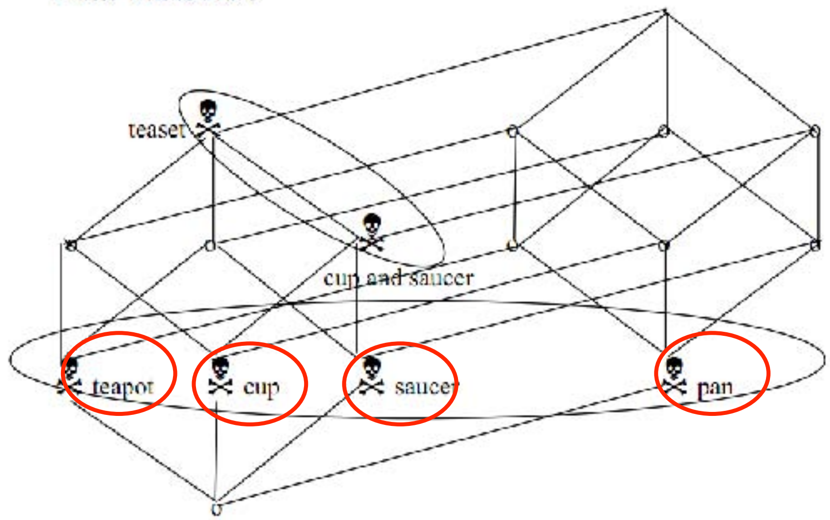
- We can think of meat as being built from minimal parts, not natural meatparts (unlike in the case of water where the natural minimal parts are H2O water molecules), but minimal parts that are appropriately minimal in a context. Suppose we have a meat cutting machine consisting of two sharp knife-lattices that cut the meat, as in (i). We may move the knife-lattices slightly, outlined in blue in (ii), and get a different partition into minimal meat pieces. There are many ways of partitioning the meat, and each partition consists of pieces which, in a given context, can count as minimal meat pieces.
- None of these partitions has a privileged status, in providing *its* minimal pieces with the privileged status of being the 'real' minimal pieces.
- The mass noun denotation is generated from a simultaneous multiplicity of such partition variants, each variant representing a different way of partitioning the *same* stuff (i.e. with the same supremum). Given that the variants represent different partitions of the same stuff, the set of generators will contain mutually overlapping elements.

If you try to count such overlapping building blocks, you are guaranteed to count wrong!

The mass/count distinction is a matter of non-overlap (Landman 2011)

NEAT mass Ns (*kitchenware, furniture*): minimal elements do not overlap, the overlap is not located in the minimal generators, but in their sums.

kitchenware



- Neat mass Ns like *kitchenware, shoeware, headgear* are real mass nouns (*pace* Chierchia 1998): they can involve measures in the way mess mass Ns (*meat*) can and count nouns cannot:

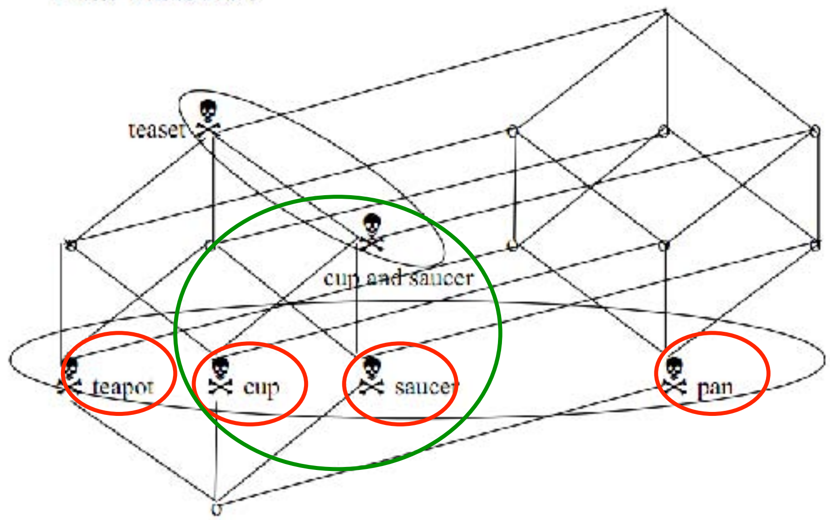
  ✓much meat ✓much kitchenware #much cat #much cats

- Neat mass are mass nouns with naturally minimal parts. *Kitchenware* is a neat mass N, because the minimal elements are neatly disjoint: the teapot, the cup, the saucer, the pan. The minimal building blocks are what we intuitively want to count as one.
- Puzzle: Although the denotation of *furniture* contains minimal elements, namely the individual pieces of furniture, we cannot count *furniture*.

The mass/count distinction is a matter of non-overlap (Landman 2011)

NEAT mass Ns (*kitchenware, furniture*): minimal elements do not overlap, the overlap is not located in the minimal generators, but in their sums.

kitchenware

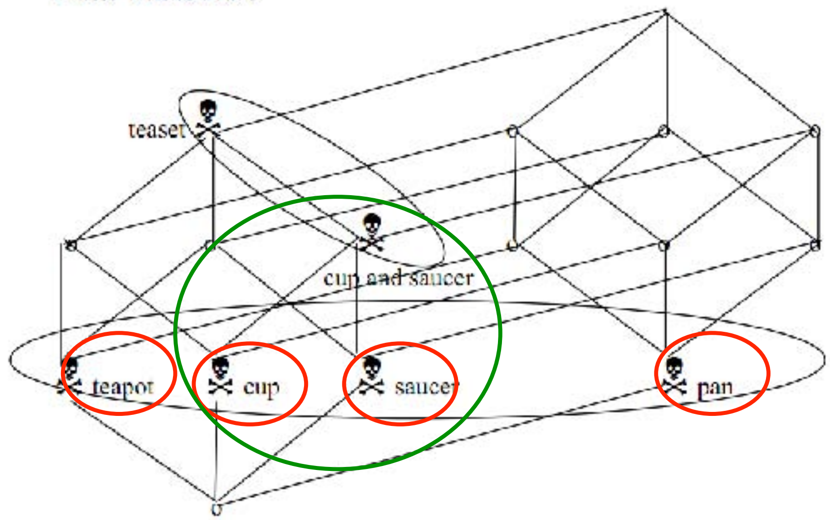


- While the minimal building blocks are what we intuitively want to count as one, at the same time, singularities and pluralities are counted as one simultaneously in the same context, without making sure that they do not overlap: the teapot, the cup, the saucer, the cup and saucer together all count as kitchenware and can all count as one simultaneously in the same context.

The mass/count distinction is a matter of non-overlap (Landman 2011)

NEAT mass Ns (*kitchenware, furniture*): minimal elements do not overlap, the overlap is not located in the minimal generators, but in their sums.

kitchenware



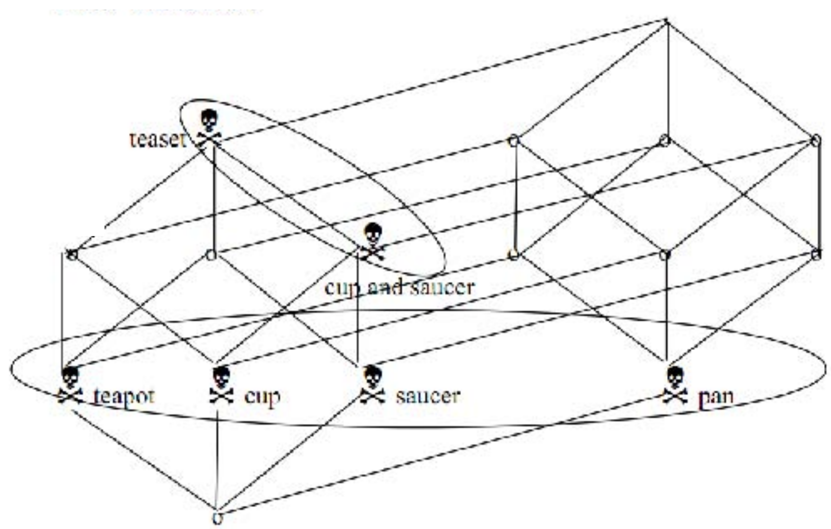
In other words:

- The generating set of *kitchenware* overlaps: a sum and its parts count as one simultaneously.
- The denotations of *neat nouns* are sets in which the distinction between *singular individuals* and *plural individuals* is not properly articulated.

Therefore, the counting goes wrong.

The mass/count distinction is a matter of non-overlap (Landman 2011)

NEAT mass Ns: *kitchenware* – why counting goes wrong

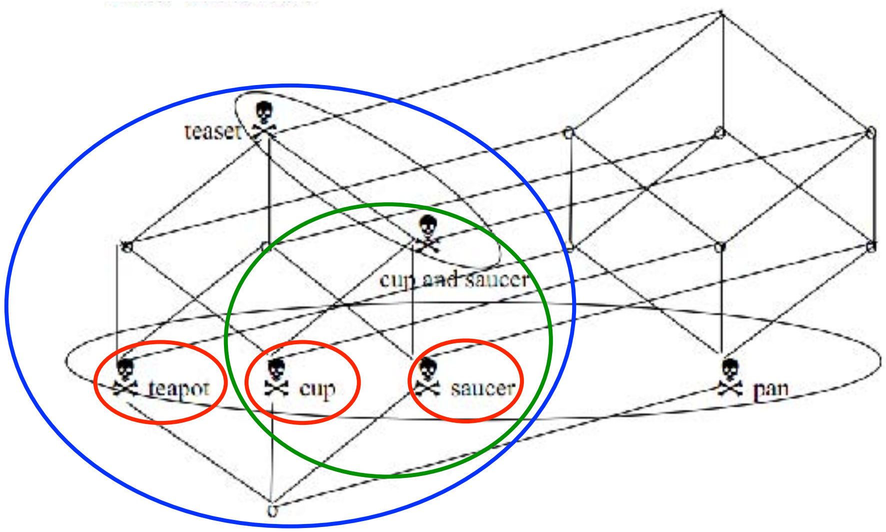


Let us have the set of generators, **gen**(X), of regular set *X* be the set of *semantic building blocks*, i.e., the things that we would want to count as *one*. Then we get:

gen(*KITCHENWAREw*) = { *the teapot, the cup, the saucer, the pan, the cup and saucer, the teaset* }

The mass/count distinction is a matter of non-overlap (Landman 2011)

NEAT mass Ns: *kitchenware* – why counting goes wrong



Let us have the set of generators, **gen**(X), of regular set *X* be the set of *semantic building blocks*, i.e., the things that we would want to count as *one*. Then we get,

- counting relative to the variant: {*the teaset*}
  $\mathbf{COUNT}_{KITCHENWAREw}$(*the teaset*) = 1, because *the teaset* ∈ **gen**(*KITCHENWAREw*)
- counting relative to the variant: {*the teapot*, *the cup_and_saucer*}
  $\mathbf{COUNT}_{KITCHENWAREw}$(*the teaset*) = 2, because *the teaset* = *the teapot* ⊔ *the cup_and_saucer* and *the teapot, the cup_and_saucer* ∈ **gen**(*KITCHENWAREw*)
- counting relative to the variant: {*the teapot, the cup, the saucer*}
  $\mathbf{COUNT}_{KITCHENWAREw}$(*the teaset*) = 3, because *the teapot* ⊔ *the cup* ⊔ *the saucer* and *the teapot, the cup, the saucer* ∈ **gen**(*KITCHENWAREw*)

The mass/count distinction is a matter of non-overlap (Landman 2011)

Problem 1: Intra- and crosslinguistic variation

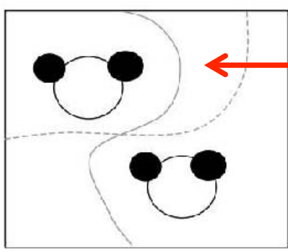
- If the denotation of the English **[+C]** ***lentils*** is built from non-overlapping generators, then it is puzzling
  - why the same should not be true of the **mass** Czech *čočka* ('lentil'),
  - why the same should not be true of the **mass** English *rice*?

The mass/count distinction is a matter of non-overlap (Landman 2011)

Problem 2: Overlap and mess mass nouns

- **MESS mass Ns (*water, salt, meat*)**:
  Claim that stretches the limits of cognitive plausibility: minimal elements always overlap in their non-essential structure, e.g., the overlap is located in the space between the hydrogen and oxygen molecules of water.
- **MESS mass nouns like *mud* – what are the minimal generators?**
  We have no (clear) idea of which mud-instances qualify as minimal building blocks, or minimal generators (a "mud chopper" analogy to the meat chopper example is rather tenuous). Therefore, the question about their OVERLAP, or DISJOINTNESS, does not arise.

water: H_2O molecules



overlap

in non-essential structure

in/of what?

Semantic atomicity

Rothstein, Susan (2010). Counting and the mass/count distinction. *Journal of Semantics*, 27(3):343–397.

- Goal: A theory of what atomicity is and how count nouns access the atoms grammatically, when used in grammatical counting (felicitous modification with numerals) or reciprocal constructions, for instance.

- **Main claim**: atomicity in the count domain is atomicity relative to a context *k*, where *k* is a set of entities that count as atoms (i.e. count as one) in a particular context.
- Count nouns are treated as expressions grammatically encoding countability: they denote sets of (semantic) atoms, which are entities indexed for the particular context in which they count as one.

- **Main data**: *fence, wall, rope, ...*
  Count nouns (exhibiting the distributional properties of count nouns) but denote sets of entities that do not have spatial properties constant across time; what counts as "one" need not be conceptually "natural units" (*pace* Krifka 1989), or inherently individuable, but rather is context-dependent, and may be conceptually arbitrary.

Semantic atomicity (Rothstein 2010)

- The basic denotation of a noun like *fence* (the root noun meaning) is a set of fence units of different sizes, possibly overlapping. Therefore, we cannot count the members of the root noun meaning of *fence*. Before we can count fences, and by the same token before we can combine a numeral with the noun *fence*, we need to access *fence*-atoms to be counted. This is done relative to a given context.

- The COUNTk operation selects atoms in a root noun meaning *Nroot*: operation COUNTk applies to the root noun meaning *Nroot* and gives the set of ordered pairs {<d,k> d ∈ N ∩ k}:

  COUNTk (Nroot)={<d,k> d ∈ Nroot ∩ k} (Rothstein 2010, p. 364)

  – Count nouns derived with COUNTk are not sets of individuals, but sets of pairs of an individual *d* and the context *k*, i.e. the context in which the first member of the pair counts as an atom. The value of *k* is chosen once and for all in a given context of utterance.
  – Given any root noun meaning *N*root and a context *k*, the intersection *Nroot ∩ k* is a set of *N*-atoms of the same kind, and for any *x,y ∈ Nroot ∩k*, if *x≠ y* then *x* and *y* do not overlap.

Semantic atomicity (Rothstein 2010)

- Count nouns differ from mass nouns in denoting different kinds of entities: count noun meanings are derived from mass noun meanings by means of a counting operation (the COUNTk operation) which assigns the value "1" (see also Krifka's (1989) "natural unit" function).

- Consequences:

  - A typal distinction between the denotations of mass and count nouns (see also Link 1983, and Krifka 1989 for different implementations of this distinction, and contra Chierchia 1998).
  - Semantic atomicity derived via the COUNTk operation replaces natural atomicity of Krifka (1989), which allows to treat count nouns like *fence, wall* and *bouquet* whose spatial properties are not constant over time, and which are not inherently individuable.

Semantic atomicity (Rothstein 2010)

- 3 different notions of atomicity assumed for the denotations of nouns:
  - formally atomic: being an atom in a Boolean structure (Chierchia 1998)
  - naturally atomic: being inherently individuable, e.g., *boy, furniture*
  - semantically atomic: contextually determined what counts as 'one', e.g., *boy, fence*
- Naturally atomic predicates denote a set of entities that are inherently individuable as 'one' and that are cognitively salient as individuals.
- Natural atomicity is not the basis of grammatical countability. Reason:
  Being inherently individuable is neither necessary nor sufficient for [+C] noun encoding.
  It is not sufficient, because there are naturally atomic nouns that are grammatically mass*: furniture*.
  It is not necessary, because there are count nouns that are not naturally atomic, because they fail to have spatial properties constant across time : *fence, rope, string, wall ...* They are individuated and made disjoint relative to a counting context.

Semantic atomicity (Rothstein 2010)

“fake” mass nouns (*furniture*) pattern with prototypical mass nouns (*mud*):

“For mass substance nouns like *mud*, we assume, like Chierchia [1998], that the atoms of the set are the minimal relevant quantities of mud. Chierchia [1998] argues that the minimal elements here are specified by context or may be left vague and unspecified, and thus, the information as to what counts as a minimal element is usually neither explicitly nor implicitly specified, nor recoverable from context nor identifiable via perceptual salience. (...) As with furniture, the set of minimal elements is not lexically accessible and is not countable” (p. 362).

Semantic atomicity (Rothstein 2010)

Problem 1: No (clear) line drawn between ***furniture*** ("fake" mass Ns) and ***water*** (prototypical mass Ns) (similarly as in Chierchia 1998, 2010, and unlike in Landman 2011)

- Rothstein (2010, p.362): "As with *furniture*, [with *mud*] the set of minimal elements is not lexically accessible and is not countable."
- Chierchia (1998): both have atoms that are not lexically accessible (only only count Ns encode lexical access to the set of atoms)
- Chierchia (2010): both have vague unstable minimal individuals that are "not accessible to our perception (p.123).

Rothstein's (2010) and Chierchia's (1998) analyses are vulnerable to Landman's (2011) objection against Chierchia (1998):

> "A set of atoms is sitting at the bottom of the mass noun denotation and at the bottom of the count noun denotation. The theory postulates that it can be pulled out in the second case, but not in the first case, and this is why you can't count. The problem is that it is not particularly difficult to semantically or contextually pull a set of atoms out of an atomic structure. . . . a child can do it. And there, of course, is the problem: the child doesn't do it" (p.15).

Semantic atomicity (Rothstein 2010)

Problem 2: It is unclear how a line is to be drawn betwen count Ns like ***cat*** and and granular mass nouns like ***rice*** (and also fibrous mass Ns like *hair*).

We reject the claim of Rothstein 2010 (and Chierchia 2010) that it has to do with lexical access to atoms. If we reject with Landman (2011) that it is not particularly difficult to semantically or contextually pull a set of atoms out of an atomic structure of *furniture*, then the same argument could be made for *rice*.

Why cannot we directly count *rice* (despite the perceptual salience of grains of rice) but we can cats?

Summary of main problems

- ***furniture* (NEAT)** versus ***water/mud* (*MESS*)**
  Chierchia (1998, 2010), Rothstein (2010) and Landman (2011) cannot draw a line between NEAT mass nouns like *furniture* and MESS mass nouns like *water, mud*.
  - Chierchia (1998, 2010), Rothstein (2010): see Landman's objection against Chierchia (1998).
  - Landman (2011) is problematic, because of the key overlap relation as it is applied to the minimal generators of mess mass Ns with natural minimal elements like *water*, where is located in their non-essential structures surrounding the essential structures. Second, Landman is forced to claim that there are minimal elements of *mud* just like there are minimal elements of water, which are natural molecules of water. Minimal mud-units, which are not natural mud-parts, but minimal parts that are appropriately minimal in a context, whatever they are relative to a context, then they will overlap. (The intensions of mess mass nouns like *mud* do not determine what counts as one as they do in neat mass nouns.) However, we do not have a clear idea how to cognitively recognize such minimal mud-units, so we are uncertain about their properties having the potential of overlapping. But what is the essential and non-essential structure of minimal mud-units in the denotation of *mud*? Given that we cannot coherently answer this question, the question of overlap does not arise.

Summary of main problems

- ***furniture* (NEAT)** versus ***water/mud (MESS)***
  - Landman (2011) (cont.) The main point of Landman's account seems to be that one must either establish non-overlap or ignore overlap in order to count.
    We cannot ignore overlap in the case of mud, because the question of (non)-overlap does not arise.
    We cannot establish non-overlap for the generators/entities of type mud. No amount of mud-stuff is sufficiently certain to be a single mud individual. Therefore, we cannot judge mud-generators as disjoint.

Summary of main problems

- ***A division among MESS Ns: mud/ water*** *versus* ***rice/hair***

Chierchia (1998, 2010), Rothstein (2010) and Landman (2011) do not separate mess mass Ns like *mud, water* from mess mass Ns denoting granular substances (like *rice, lentils*) and fibrous substances (like *hair*).

This distinction is important, given that in most (if not all) languages nouns for mess mass Ns like *mud, water* have mass syntax, but nouns for granular and fibrous substances exhibit intra- and cross-linguistic variation in their mass/count encoding.

Landman is also forced to state that rice-atoms overlap, which we also reject.

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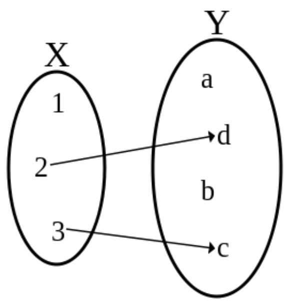
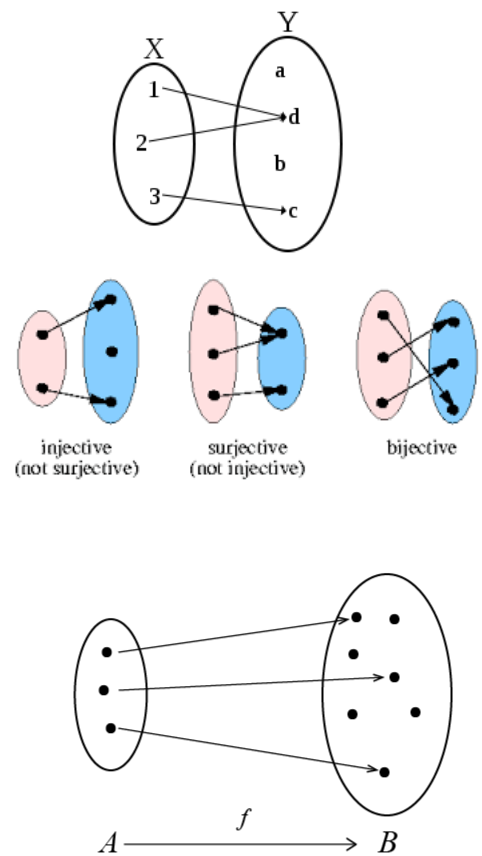
Appendix

A **partial function** from X to Y (written as $f\colon X \nrightarrow Y$) is a function $f\colon X' \to Y$, for some subset X' of X.

An example of partial function that is injective.



An example of partial function that is injective.



The mass/count distinction is a matter of non-overlap (Landman 2011)

NEAT mass Ns (*kitchenware, furniture*): minimal elements do not overlap, the **overlap is** not located in the minimal generators, but **in their sums**.

furniture

kitchenware

The mass/count distinction is a matter of vagueness (Chierchia 2010)

- Any **count N** has stable atoms in its denotation, a noun is count if there are at least some things it applies to that are clearly atomic, "stable atoms", across all admissible precisifications (ways of making things more precise).
- A count noun like CAT: When we use CAT (the number neutral property 'cat/s' that applies to individuals and to groups of cats) to count as in *four cats*, we count individuals, i.e. the cat-atoms (which constitute the smallest things to which CAT applies). **The minimal entities in the denotation of *cat*, the smallest cat parts (in the relevant sense, i.e. under '≤'), are individual cats, i.e. stable atoms.**

"There are plenty of cat-atoms that are *not* vaguely specified. There are plenty of things that we (or the relevant experts) are sure fall under the cat concept, have the cat-property or however you want to put it. In other terms, the boundary of the property 'cat/s' is such that that there definitely are *x*'s that fall under it, such that no proper part of *x* does. **We have a reasonably clear idea of what qualifies as a (more or less 'whole') cat atom**" (p. 117).

The mass/count distinction is a matter of vagueness (Chierchia 2010)

We don't have any rice.

FALSE

TRUE

Cooking a paella dish:
A: "Do we have any rice?"
B: "We don't have any rice."
is felicitous if one grain of rice is left, or a few grains.

FALSE

For some purposes, like rice allergy testing, cereal cultivation, a grain of rice qualifies as *rice*.

In this cooking context, a single grain of rice or a few grains is/are not enough to reach the threshold of significance to qualify as *rice*.

The mass/count distinction is a matter of vagueness (Chierchia 2010)

We don’t have any cats. / There is no cat in the room.

FALSE

FALSE

A single cat is enough to reach the threshold of significance to qualify as *CAT* (the number neutral property).