Different Kinds of Count Nouns and Plurals

Manfred Krifka
ZAS Berlin and Humboldt Universität zu Berlin
krifka@rz.hu-berlin.de

Goals:
- Discuss the types of count nouns and corresponding constructions in classifier and non-classifier languages.
- Discuss different kinds of plurals (semantically unmarked, semantically marked, and agreement plural) and their interaction with count noun constructions.
- Bring ideas developed in the formal semantics of mass nouns and plurals to bear on the analysis of typologically different types of number constructions.

1. The mass/count distinction in English

Jespersen (1924): mass words vs. countables, mass nouns vs. count nouns

<u>Main morphosyntactic criteria for the mass/count distinction in English</u>

(1) Number distinction: *bean / beans* vs. *rice / *rices*, cf. also Pluraletantum **oat / oats*

(2) Combination with numerals: *one bean, three beans* vs. **one rice / *three rice(s)*

(3) Full syntactic phrase (DP) for mass nouns: **Bean / Rice was spilled all over the floor.*
But this holds only for singular count nouns: *Beans were spilled all over the floor.*

<u>No fixed categoriziation</u>

The categorization of a noun as mass or count is not fixed (as gender in gender languages).
- Mass nouns coerced to count nouns: *three beers*
  (portions, or subkinds in the taxonomic interpretation)
- Count nouns coerced into mass nouns: *a lot of apple*
  (reference to the substance objects are made up)

Taxonomic interpretations, as well as generic interpretations, ignored here (cf. Krifka 1995).

<u>Semantic and cognitive criteria for the mass/count distinction:</u>
- Liquids and substances are mass (lack of defined boundary): *water, milk, gold*
- Small objects tend to be mass (irrelevance of defined boundary):
  rice vs. *beans*; *sand, gravel – pebbles, stones, rocks*
- Entities high on the animacy scale tend to be count (Smith-Stark 1974)

Count nouns appear to be more complex in their semantics than mass nouns. Quine (1960) remarks that to learn a count noun like *apple* it is not sufficient to learn "how much of what goes on counts as apple" – "we must learn how much counts as an apple, and how much as another. Such terms possess built-in modes (...) of dividing their reference".

<u>Cognitive and semantic criteria might diverge</u>

There are mass nouns that denote entities one would expect to be denoted by count nouns, e.g. *jewelry*, *silverware*, *furniture*, *drapery*.
Barner & Snedeker (2005) show that this plays a role in comparison constructions:

(4) Count noun — Object mass noun — Substance mass noun

|------------------- counting -------------------------------| |------- measuring -------------|

<u>Relevance of cognitive criteria beyond language:</u>

Cf. Spelke 1985 and others.
- Infants (3 months) marvel at two cars bumping into each other, resulting in a bigger car, they don't stare if two drops of water bump into each other, resulting in a bigger drop.
- Infants marvel at an object traversing a solid object, they don't stare at an object traversing a fluid substance. (Rhesus monkeys do the same, cf. Hauser 1996).

Explanation: It is advantageous to generalize the property of one instantiation of a substance to other instantiations, even if they are of different size, form, etc..

To be expected: Cognitive differentiation of substances and objects bootstrap the acquisition of the mass/count-distinction; cf. Macnamara 1982; Soja, Carey & Spelke 1991

2. The mass/count distinction in a typological perspective

The difference between mass / count is reflected in many languages – but in quite different ways (cf. Koptjevskaja-Tamm 2004, Gil 2005, Doetjes t.a.). One rough classification:

<u>Number marking languages: [+Num –Cl]</u>
- combination numeral + count noun, i.e. there are no classifiers,
- count noun appears in plural form with numerals > 1

Examples: English, see above.

<u>Classifier languages: [–Num +Cl]</u>
- combination numeral + classifier + count noun, i.e. numeral + count noun not possible
- count noun does not appear in plural form

Example: Chinese (Mandarin):

(5) *sān ge rén* (three CL person) 'three persons' — **sān rén* (three person) — **sān ge rén men* (three CL person PL)

It has been proposed that Chinese does not have any count nouns, the classifier construction being only a variant of the measure construction. But there are morphosyntactic differences (cf. Henne e.a. 1977):

- Count nouns select particular classifiers, mass nouns do not.
- With measure expressions we often find the subordinating linking particle *de*, especially with time-bound measure terms.

(6) *liǎng bàng (de) ròu* / two pound LNK meat / 'two pounds of meat'
*liǎng pī (*de) luózi* / two CL LNK mule / 'two mules'
*sān wūzi *(de) rén* / three room LNK person / 'three roomful of people'

Doetjes (t.a.) adduces more evidence for the mass/count distinction in Chinese, e.g. the possibility that measure terms, but not classifiers, are modified by adjectives.

Non-marking languages [–Num –Cl]

- combination numeral + count noun, i.e. no classifiers
- count noun does not appear in plural form

Example: Tagalog, Turkish

(7) a. *tatlong tao / *tao-tao*
five person person.PL
'five persons'

b. *dört çocuk / *çocuk-lar*
five child child-PL
'five children'

Example: Denë Sułine (Wilhelm 2006): No plural, numerals incompatible with mass nouns:

(8) *solághe ts'éré / *ˀejëretł'ue / ˀejëretł'ue tılı*
five blanket milk milk container
'five blankets / *milk / cartons of milk'

Cf. also Müller e.a. (2006) on Karitiana, which is similar to Denë Sułine.

What about [+Num +Cl]?

In this typology, the combination [+Num +Cl] is absent. It is ruled out by the generalization of Greenberg (1972) and Sanches & Slobin (1973); however, there may be counterexamples (see Aikhenvald 2000: 100-101, and below).

3. The meaning of mass nouns and measure constructions

3.1 Mereological structures

To handle mass nouns and plural of count nouns, semanticists have argued for a **sum** operation for individuals $\sqcup$ that defines a **part** relation $\sqsubseteq$ and an **overlap** relation o:

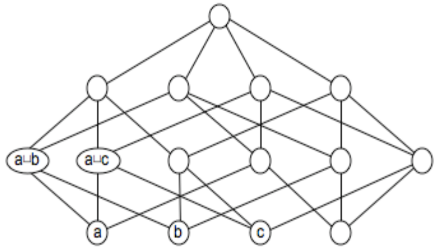
(9) a. sum operation $\sqcup$, where $x \sqcup y$ = the sum of x and y
(an idempotent, commutative, associative operation)

b. part relation $\sqsubseteq$, where $x \sqsubseteq y :\Leftrightarrow x \sqcup y = x$
(a reflexive, transitive, antisymmetric relation)

c. proper part relation $\sqsubset$, where $x \sqsubset y :\Leftrightarrow x \sqsubseteq y \wedge \neg y \sqsubseteq x$

d. overlap relation $x \circ y :\Leftrightarrow \exists z[z \sqsubseteq x \wedge z \sqsubseteq y]$

Illustration by Hasse diagram:



Examples:
$a \sqsubseteq a \sqcup b$
$a \sqsubset a \sqcup b$
$a \sqsubseteq a$
$a \sqcup b \circ a \sqcup c$

Elements that do not have proper parts (like a, b, c above) are called **atoms**. It is useful to define the notion of an **atomic part**, $\sqsubseteq_a$.

(10) a. $\text{ATOM}(x) :\Leftrightarrow \neg\exists y[y \sqsubset x]$

b. $y \sqsubseteq_a x :\Leftrightarrow y \sqsubseteq x \wedge \text{ATOM}(y)$

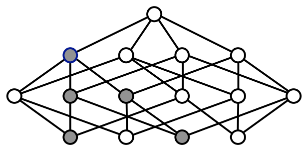
It is useful to assume a general join operation. For example, we have $\sqcup\{a, b, c\} = a \sqcup b \sqcup c$.

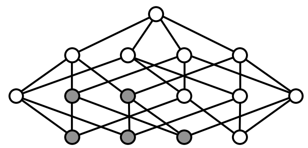
(11) $\sqcup P$ = the smallest individual x such that $\forall y[P(y) \rightarrow y \sqsubseteq x]$

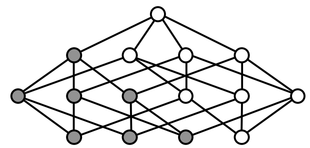
3.2 The meaning of mass nouns and measure constructions

Mass nouns are said to be **cumulative** and **homogeneous**:

(12) A predicate P is cumulative iff: $P(x) \wedge P(y) \rightarrow P(x \sqcup y)$
A predicate P is homogeneous iff: $P(x) \wedge y \sqsubseteq x \rightarrow P(y)$


cumulative


homogeneous


cumulative and homogeneous

Opinions differ whether mass nouns should be considered in general **divisive** (that is, whenever a mass noun applies to x then it also applies to a proper part of x). Divisivity might be plausible for substance mass nouns like *water*, *gold* etc. but not for object mass nouns like *furniture*, *silverware, jewelry*: Part of a spoon does not fall under *silverware*.

3.3 Meaning of measure constructions

Measure constructions like *two kilograms of rice*, *three buckets of berries* involve a measure expression (mensurative) that is interpreted by a **measure function**.

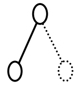
Measure functions

Measure constructions are interpreted by **additive** and **archimedian** measure functions:

(13) μ is an additive measure function with respect to $\sqcup$ iff μ maps entities to numbers such that: $\neg\, x \circ y \rightarrow [\mu(x \sqcup y) = \mu(x) + \mu(y)]$

(14) μ is an archimedian measure function iff: if $\mu(x) > 0$ and $y \sqsubseteq x$, then $\mu(y) > 0$

When we assume the following **remainder principle** –



(15) If $y \sqsubset x$, then there is a z, $\neg z \circ y$, such that $y \sqcup z = x$

then we can show that μ is **monotonic** (Schwarzschild 2002):

(16) μ is a monotonic measure function with respect to $\sqsubseteq$ iff: if $x \sqsubset y$, then $\mu(x) < \mu(y)$

Examples of monotonic measure functions: *kilograms, meters, cubic meters, calories, Euros*

Examples of non-monotonic measure functions: *degrees Celsius, carats, IQ, ...*

Observation (Krifka 1989, Schwarzschild 2002):

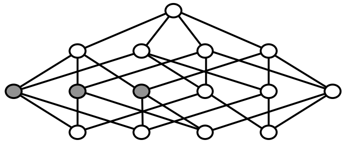
(17) *twenty liters of water / *twenty degree Celsius of water*

<u>Measure constructions</u>

(18) ⟦*two kilograms of rice*⟧ $= \lambda x[\text{RICE}(x) \wedge \text{KG}(x) = 2]$

This is a predicate that applies to all x that fall under the mass noun meaning RICE and for which the measure function KG assigns the number 2.

As KG is a monotonic measure function, the resulting predicate is not cumulative or homogenous anymore. Rather, it is **quantized**, in the sense that if it applies to an individual x, it cannot apply to any proper part of x.



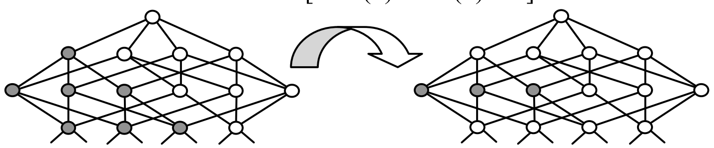
(19) A predicate P is quantized
iff $P(x) \rightarrow \neg\exists y[y \sqsubset x \wedge P(y)]$

Measure constructions like *two pounds* can be analyzed as predicates that restrict the cumulative, homogeneous meaning of a mass noun to the meaning of a quantized noun:[†]

(20) ⟦*two kilograms*⟧ $= \lambda P \lambda x[P(x) \wedge \text{KG}(x) = 2]$

⟦*rice*⟧ $= \text{RICE}$

⟦*two kilograms of rice*⟧ $= \lambda P \lambda x[P(x) \wedge \text{KG}(x) = 2](\text{RICE})$
$= \lambda x[\text{RICE}(x) \wedge \text{KG}(x) = 2]$



⟦*rice*⟧ ⟦*two kilograms of rice*⟧

4. Measure Functions for Count Nouns

4.1 A general measure function for count nouns

A plausible interpretation of the meaning of count nouns is that their meaning is based on a special measure function that counts atoms, #:

(21) # is the function with the smallest domain such that:
a. If ATOM(x), then $\#(x) = 1$ (standardization)
b. If $\neg x \circ y$, then $\#(x \sqcup y) = \#(x) + \#(y)$ (additivity)

Notice: # is a monotonic measure function if we assume the remainder principle.

A first proposal for the meaning of count noun expressions:

(22) ⟦*three beans*⟧ $= \lambda x[\text{BEANS}(x) \wedge \#(x)=3]$

4.2 Specialized counting functions?

A general measure function # is problematic in view of the fact that the nature of the things counted play a role.

(23) a. ?*How many things are in this room?*
b. *How many chairs are in this room?*

(24) a. *How many soldiers did Caesar bring to Britain?*
b. *How many legions did Caesar bring to Britain?*

(25) a. *These are three chapters of her dissertation.*
b. *These are 120 pages of her dissertation.*

Proposal (Krifka 1989, 1995): When counting we need **natural units**:

(26) ⟦*thirteen chairs*⟧ $= \lambda x[\text{CHAIRS}(x) \wedge \text{NU}(\text{CHAIRS})(x) = 13]$

where NU maps a property to the natural unit of this property. Different properties might have the same natural units, e.g. pieces of furniture. For others, the natural unit might be context-dependent, e.g. for *thing.*

(27) a. NU(CHAIRS) = NU(FURNITURE)
b. NU(THING, c), where c: context

In the following, we will use to #, for simplicity.

5. Theories for Count Nouns

Goal: Discuss theories that have been proposed for Count Nouns in light of various phenomena, starting with familiar [+Num –Cl] languages but working to enlarge the coverage to other types.

5.1 Singulars atomic, plurals als pluralities

<u>The basic idea</u>

Versions of the following theory have been proposed by Link (1991) and Chierchia (1998):

Singular count nouns in [+Num –Cl] languages apply to atoms (or natural units):

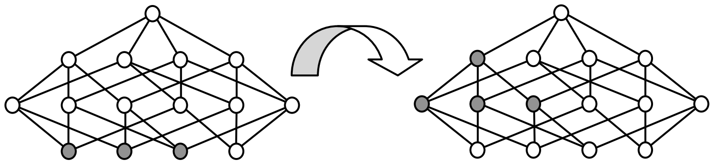
(28) ⟦*bean*⟧ $= \lambda x[\text{BEAN}(x) \wedge \text{ATOM}(x)]$

Plural count nouns in [+Num –Cl]: closure under join minus atoms (“**strong plurals**”):

(29) ⟦*beans*⟧ = the smallest set P such that
$\forall x,y \in$ ⟦*bean*⟧ $[x \neq y \rightarrow x \sqcup y \in P] \wedge \forall x,y \in P[x \sqcup y \in P]$
$=$ sP $[\forall x,y \in$ ⟦*bean*⟧ $[x \neq y \rightarrow x \sqcup y \in P] \wedge \forall x,y \in P[x \sqcup y \in P]]$[†]

[†] I write ⟦α⟧ for the interpretation of an expression α, which possibly depends on a context. SMALL CAPS are used for lexical meanings, and in general for non-logical constants. The regular λ-calculus is used, that is, λX[...X...] is a function that maps entities of the type of the variable X to the value described as [...X...].

[†] Here sP[…P…] is shorthand for $\iota P[[\ldots P\ldots] \wedge \forall P'[[\ldots P'\ldots] \rightarrow P \subseteq P']]$.



$\llbracket \textit{bean} \rrbracket$ $\llbracket \textit{beans} \rrbracket$

<u>Things explained</u>

Explanation of count noun constructions:

(30) $\llbracket \textit{two beans} \rrbracket = \lambda P\lambda x[P(x) \wedge \#(x)=2](\llbracket \textit{beans} \rrbracket) = \lambda x[\llbracket \textit{beans} \rrbracket(x) \wedge \#(x)=2]$

Explanation of **one beans*:

(31) $\llbracket \textit{one beans} \rrbracket = \lambda x[\llbracket \textit{beans} \rrbracket(x) \wedge \#(x)=2]$, necessarily empty.

Explanation of **rices* (if not coerced to count noun): No semantic effect of pluralization for cumulative and homogenous predicates.

(32) $\llbracket \textit{rices} \rrbracket = \mathrm{s}P\, [\forall x,y \in \llbracket \textit{rice} \rrbracket, x \neq y[x \sqcup y \in P] \wedge \forall x,y \in P[x \sqcup y \in P]]$
$= \llbracket \textit{rice} \rrbracket$

<u>The problem of plurals applying to atoms</u>

In languages like English, plural includes reference to single entities (cf. Krifka 1989, Sauerland, Anderson & Yatsushiro 2005):

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

(34) *In case you have children, bring them with you to the party.*
(applies also to single children).

Why don't we say ?*John has children* if it is known that he has one child? Because of pragmatic competition (scalar implicature) between *children* and the more specific *a child*.

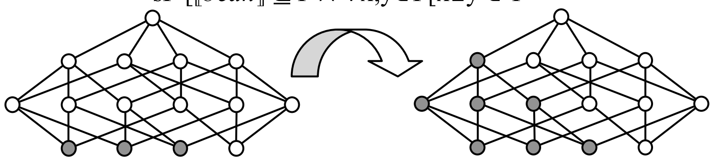
5.2 Singulars as atomic, plurals include atoms

<u>The basic idea</u>

As before, singular count nouns in [+Num –Cl] languages apply to atoms (or natural units), but plurals are simply closures under the join operation, including atoms ("**weak plurals**"):

(35) $\llbracket \textit{bean} \rrbracket$: $\lambda x[\mathrm{BEAN}(x) \wedge \mathrm{ATOM}(x)]$

(36) $\llbracket \textit{beans} \rrbracket :=$ the smallest set P such that $\llbracket \textit{bean} \rrbracket \subseteq P \wedge \forall x,y \in P[x \sqcup y \in P]$
$= \mathrm{s}P\, [\llbracket \textit{bean} \rrbracket \subseteq P \wedge \forall x,y \in P[x \sqcup y \in P$



$\llbracket \textit{bean} \rrbracket$ $\llbracket \textit{beans} \rrbracket$

<u>Things explained</u>

**rices*: as before. Rule (36) does not lead to a change of meaning.

Plurals applying to atoms: We now have $\llbracket \textit{bean} \rrbracket \subseteq \llbracket \textit{beans} \rrbracket$, i.e. the plural form is the semantically more general or "unmarked" form. This appears to be in conflict with the morphologically marked status of the singular. But notice that, at least in languages like English, *bean* is not a full NP; we have to compare *a bean* and *beans*, which arguably have the same markedness status.

<u>The problem of **one beans*</u>

Now **one beans* should have a derivation that is as well-formed as *two beans*:

(37) a. $\llbracket \textit{two beans} \rrbracket = \lambda P\lambda x[P(x) \wedge \#(x)=2](\llbracket \textit{beans} \rrbracket) = \lambda x[\llbracket \textit{beans} \rrbracket(x) \wedge \#(x)=2]$

b. $\llbracket \textit{one beans} \rrbracket = \lambda P\lambda x[P(x) \wedge \#(x)=1](\llbracket \textit{beans} \rrbracket) = \lambda x[\llbracket \textit{beans} \rrbracket(x) \wedge \#(x)=1]$

Possible explanation: This meaning can be constructed in a simpler way:

(38) $\llbracket \textit{one bean} \rrbracket = \lambda P\lambda x[P(x) \wedge \#(x)=1](\llbracket \textit{bean} \rrbracket) = \lambda x[\llbracket \textit{bean} \rrbracket(x) \wedge \#(x)=1] = \llbracket \textit{bean} \rrbracket$

But then this meaning could be most easily constructed with the bare noun *bean*, which is ungrammatical as an NP in English: **John noticed bean.* (o.k. in mass noun interpretation).

<u>The problem of **three silverware*</u>

Arguably, object mass nouns like *silverware* have the same structural meaning as *beans*: They apply to a set of atomic objects and sums of atomic objects. This predicts that expressions like **three silverware* should be fine, but they aren't.

(39) $\llbracket \textit{three silverware} \rrbracket$
$= \lambda P\lambda x[P(x) \wedge \#(x)=3](\llbracket \textit{silverware} \rrbracket) = \lambda x[\llbracket \textit{silverware} \rrbracket(x) \wedge \#(x)=2]$

5.3 Semantic plural vs agreement plural

<u>The basic idea</u>

Proposal: We assume a semantic plural operation (weak plurals) as in (36) for "bare plurals" as in *John bought beans* and measure constructions like *Beans were spilled.*

(40) $\llbracket \textit{Beans were spilled.} \rrbracket = \exists x[\llbracket \textit{beans} \rrbracket(x) \wedge \llbracket \textit{were spilled} \rrbracket(x)]$

(41) $\llbracket \textit{two kilograms of beans} \rrbracket$
$= \lambda P\lambda x[P(x) \wedge \mathrm{KG}(x)=2](\llbracket \textit{beans} \rrbracket) = \lambda x[\llbracket \textit{beans} \rrbracket(x) \wedge \mathrm{KG}(x)=2]$

But we assume that number word meanings combine with atomic count noun meanings, and that the choice of singular/plural forms is solely a manner of agreement (Krifka 1995):

(42) NPsg → NUMsg Nsg NUMsg → {*a, one*} Nsg → {*bean, ...*}
NPpl → NUMpl Npl NUMpl → {*two, three, ...*} Npl → {*beans, ...*}

For count noun constructions we have various options, for example that Nsg nouns are atomic and that NPpl include atoms (cf. (35), (36)).

(43) $\llbracket [_{\mathrm{NPpl}}\, [_{\mathrm{NUMpl}}\, \textit{two}]\, [_{\mathrm{Npl}}\, \textit{beans}]] \rrbracket = \lambda P\lambda x[P(x) \wedge \#(x)=2](\llbracket \textit{beans} \rrbracket)$

$\llbracket [_{\mathrm{NPsg}}\, [_{\mathrm{NUMsg}}\, \textit{one}]\, [_{\mathrm{Nsg}}\, \textit{bean}]] \rrbracket = \lambda P\lambda x[P(x) \wedge \#(x)=1](\llbracket \textit{bean} \rrbracket)$

For the semantic plural in *John bought beans* we assume a morphological operation that changes a count noun N to an NP:

(44) NPpl → Npl
Npl → Nsg -*s*

(45) $\llbracket [_{\mathrm{NPpl}}\, [_{\mathrm{Npl}}\, [_{\mathrm{Nsg}}\, \textit{bean}]\textit{-s}]]] \rrbracket = \llbracket \textit{-s} \rrbracket(\llbracket [_{\mathrm{Nsg}}\, \textit{bean}] \rrbracket) = \mathrm{s}P[P \subseteq \llbracket \textit{bean} \rrbracket \wedge \forall x,y \in P[x \sqcup y \in P]]$

Things explained

*one beans: wrong agreement.

*John bought bean: wrong syntactic category, *bean* is N, not NP, as required for the object position. It is fine in positions that use N, e.g. in composition: *bean soup*.[†]

Explanation of *a bean* vs. *one bean*: The indefinite article induces the category change from N to NP without any meaning change; in particular, it is not related to alterantive number words. Hence: *How many children do you have? – I have one child. / *I have a child*.

Explanation of *three silverware*: Mass nouns do not have plural forms (in mass noun use)

The problem of *one silverware*:

If *silverware* is Nsg, then rule (42) should allow for *one silverware*. No semantic objections either as *silverware*, an object count noun, is atomic.

The problem of classifier languages:

If we assume that classifier languages have count nouns (similar to English *silverware*, cf. constructions like *three pieces of silverware*), then it is unclear what necessitates the use of classifiers.

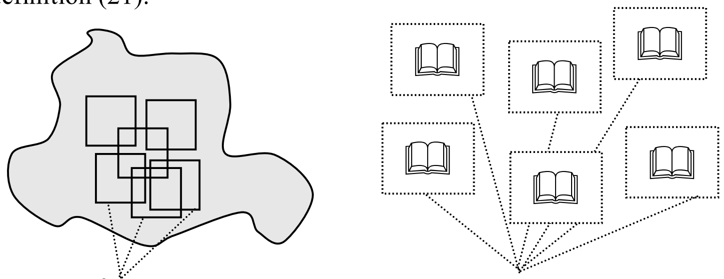
6. A new view of Count Nouns

6.1 Measuring vs. Counting

Measuring functions, e.g. KG: If $\text{KG}(x) = 1$ and $\text{KG}(y) = 1$, then x and y may overlap.

Counting functions, e.g. #: If $\#(x) = 1$ and $\#(y) = 1$, then x, y are disjoint – they do not overlap, and generally are "separated" (a topological notion not investigated further here, see Krifka 1998).

This is a special property of the value 1, which is the smallest value for counting functions, cf. definition (21).



$\text{CM}^2(x) = 1$ $\#(x) = 1$ / $\text{NU}(\text{BOOK}) = 1$

Landman (2006): With count nouns, there are distinct atoms that we can count. With mass nouns, there are "too many" elements that we could count. This can be captured by a difference between how we measure the elements of a set, and how we count them:

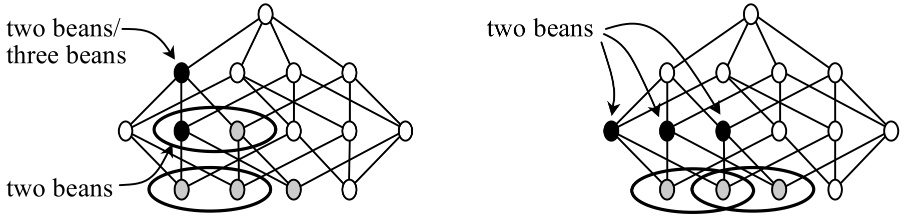
- Measuring: As before, we restrict a cumulative set to entities of a given size.

(46) $[\![\textit{two kilograms of rice}]\!] = \lambda P\lambda x[P(x) \wedge \text{KG}(x)=2]([\![\textit{rice}]\!]) = \lambda x[[\![\textit{rice}]\!](x) \wedge \text{KG}(x)=2]$

- Counting: This involves counting elements in a set, using the cardinality function card defined for sets:

(47) $[\![\textit{two beans}]\!] = \lambda P\lambda x\exists P'[P'\subseteq P \wedge \text{card}(P') = 2 \wedge x = \sqcup P'](\text{BEAN})$
$= \lambda x\exists P'[P'\subseteq \text{BEAN} \wedge \text{card}(P') = 2 \wedge x = \sqcup P']$

Under this representation, *two* acts like monotonic measure function only if P is restricted to a set of discreet, non-overlapping entities. That is, *two* **presupposes** discreetness. Otherwise, it might be that one individual and a proper part of this individual both fall under *two beans*, and that one individual falls both under *two beans* and under *three beans*.



problematic case: cumulative base set unproblematic case: atomic, discreet base set

Number words with presupposition of discreetness to the base set:[†]

(48) $[\![\textit{two}]\!] = \lambda P.\ \text{DISC}(P)\ \lambda x\exists P'[P'\subseteq P \wedge \text{card}(P') = 2 \wedge x = \sqcup P']$

where discreetness of a set is defined as:

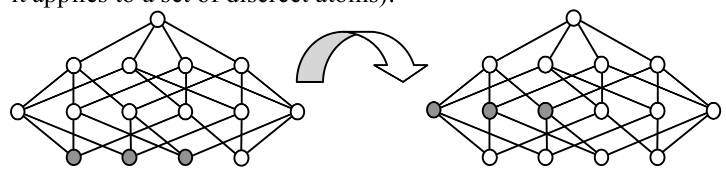
(49) $\text{DISC}(P)$ iff $\neg\exists x,y[P(x) \wedge P(y) \wedge x \circ y]$

6.2 □Count nouns apply to discreet sets

The basic idea (cf. also Rothstein 2007):

Number words in count noun constructions apply to discreet sets:

(50) $[\![[_{\text{NPpl}}\ [_{\text{NUMpl}}\ \textit{two}]\ [_{\text{Npl}}\ \textit{beans}]]]\!] = [\![\textit{two}]\!]([\![[_{\text{Npl}}\ \textit{beans}]]\!]) =$
$= \lambda P.\ \text{DISC}(P)\ \lambda x\exists P'[P'\subseteq P \wedge \text{card}(P') = 2 \wedge x = \sqcup P']([\![[_{\text{Npl}}\ \textit{beans}]]\!])$
$= \lambda x\exists P'[P'\subseteq[\![\textit{bean}]\!] \wedge \text{card}(P') = 2 \wedge x = \sqcup P']$
(recall that $[_{\text{Npl}}\ \textit{beans}]$ is an agreement plural, hence $[\![[_{\text{Npl}}\ \textit{beans}]]\!] = [\![\textit{bean}]\!]$; it applies to a set of discreet atoms).



$[\![[_{\text{Nsg}}\ \textit{bean}]]\!]$, $[\![[_{\text{Npl}}\ \textit{beans}]]\!]$ $[\![\textit{two beans}]\!]$

We assume here that singular and plural nouns (Ns) mean the same, namely sets of atoms.

[†] In Krifka (2004) I assumed that count nouns are functions from numbers to predicates, e.g. $[\![[_{\text{N}}\ \textit{bean(s)}]]\!] = \lambda n\lambda x[\text{BEANS}(x) \wedge \#(x)=n]$. This creates a semantic necessity to bind the number argument, either by a number word or by the indefinite article.

[†] I write λX.[---X---].[…X…] for a function from entities of the type of the variable X whose domain is restricted by the condition [---X---].

Bare plural NPs (i.e., NPpl) are formed via the rule (36).

Things explained

**one silverware*, **three silverware*: Mass nouns like *silverware* are cumulative, not discreet; number words cannot apply to them.

6.3 Count nouns in [–Num +Cl] languages

The basic idea

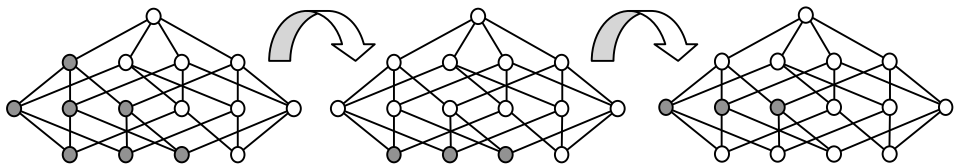
In classifier languages (and generally in classifier constructions), the function of classifiers is to provide the proper base set for numerals: They create a discreet set (cf. Rothstein 2007):

(51) $[\![\textit{rén}]\!] = \lambda x \forall y [y \sqsubseteq_a x \rightarrow \text{PERSON}(x)]$

$[\![\textit{ge}]\!] = \lambda P\, \lambda x\, [P(x) \wedge \text{ATOM}(x)]$,
(or $\lambda P\, \lambda x\, [P(x) \wedge \text{NU}(P)]$, where NU(P): natural unit of P)

$[\![\textit{ge rén}]\!] = \lambda x\, [[\![\textit{rén}]\!](x) \wedge \text{ATOM}(x)]$, a discreet set.

$[\![\textit{liǎng ge rén}]\!] = [\![\textit{liǎng}]\!]([\![\textit{ge rén}]\!])$
$= \lambda P.\, \text{DISC}(P)\, \lambda x \exists P'[P' \subseteq P \wedge \text{card}(P') = 2 \wedge x = \sqcup P'](\lambda x\, [[\![\textit{rén}]\!](x) \wedge \text{ATOM}(x)])$
$= \lambda x \exists P'[P' \subseteq \lambda x[[\![\textit{rén}]\!](x) \wedge \text{ATOM}(x)] \wedge \text{card}(P') = 2 \wedge x = \sqcup P']$
equivalent to: $\lambda x[[\![\textit{rén}]\!](x) \wedge \#(x)=2]$



⟦*rén*⟧ ⟦*ge rén*⟧ ⟦*liǎng ge rén*⟧

The function of a classifier is to create, when applied to a bare noun, a count-noun meaning. Count nouns in [+Num –Cl] languages have meanings with "built-in" classifiers.

Notice that mensuratives like *bàng* 'pound' could not serve the same function as the classifier *ge*, as they would not create a discreet set, as required by number words.

Objection: NUM+CL form a constituent

According to Greenberg (1972), NUM+CL always occur adjacent, hence they should form a constituent. This can be captured by composing the meaning of the number word and the meaning of the classifier:

(52) $[\![\textit{liǎng ge}]\!] = \lambda P\, \lambda x \exists P'[P' \subseteq \lambda x[P(x) \wedge \text{ATOM}(x)] \wedge \text{card}(P')=2 \wedge x=\sqcup P']$

Why should NUM+CL form a constituent? Notice that whenever NUM occurs, CL has to occur as well, which might lead to this kind of reanalysis (cf. also preposition + article in French *aux* = *à les*, German *beim* = *bei dem*, etc.).

Lexical contribution of classifiers

Classifiers refer to certain spatial features of the atoms, e.g 'head' or 'tail' for animals, 'small round object', 'flat extended object', 'opening' etc. This betrays the origin of the grammaticalization process that lead to classifiers: In order to identify discreet countable entities, reference to such features of form are best.

Explained: Incompatibility with pluralization

Classifier constructions are not compatible with plural nouns. This can be captured if we assume that pluralization in classifier languages restricts the meaning of a bare noun to non-atomic entities (cf. (29):

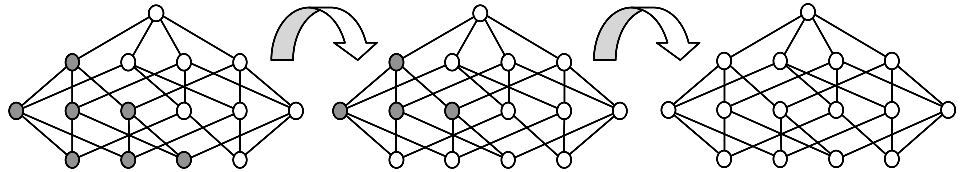
(53) $[\![\textit{men}]\!] = \lambda P'.\text{HUMAN}(P).\ \text{SP}\ [[\forall x,y \in P'[x \neq y \rightarrow P(x \sqcup y)] \wedge \forall x,y \in P[x \sqcup y \in P]]$

$[\![\textit{rén men}]\!] = \text{SP}\ [\forall x,y \in [\![\textit{rén}]\!][x \neq y \rightarrow P(x \sqcup y)] \wedge \forall x,y \in P[x \sqcup y \in P]]$
$= \lambda x[[\![\textit{rén}]\!](x) \wedge \neg\text{ATOM}(x)]$

$[\![\textit{ge}]\!] = \lambda P\, \lambda x\, [P(x) \wedge \text{ATOM}(x)]$

$[\![\textit{ge rén men}]\!] = \lambda P\, \lambda x\, [P(x) \wedge \text{ATOM}(x)](\lambda x[[\![\textit{rén}]\!](x) \wedge \neg\text{ATOM}(x)])$
$= \lambda x[[\![\textit{rén}]\!](x) \wedge \neg\text{ATOM}(x) \wedge \text{ATOM}(x)]$

This set is necessarily empty, which explains why classifiers are incompatible with plurals.



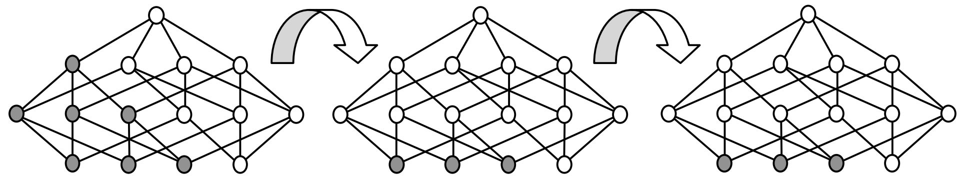
⟦*rén*⟧ ⟦*rén men*⟧ ⟦*ge rén men*⟧

Things explained: Intepretation of lacking number word

At least in some classifier languages, classifier constructions do not need a number word. Example: Mandarin, Cantonese (cf. Cheng & Sybesma 1999):

(54) *wǒ xiǎng mǎi běn shū*
I want buy CL book
'I want to buy a book.'

The current analysis predicts this interpretive possiblity, as the Cl-N construciton *ben shū* has the same meaning as *yī ben shū* 'one Cl book'.



⟦*shū*⟧ ⟦*běn shū*⟧ ⟦*yī běn shū*⟧

This does not explain yet the non-specificity reading of *ben shū*.

6.4 Count nouns in [–Num –Cl] languages

In languages that do not have classifiers but also lack plural with number constructions, at least two options are possible:

- They work like [+Num –Cl] languages but do not show agreement with the number word: NP → Num Nsg

- They work like [–Num +Cl] languages but do not have overt classifiers, i.e. the classifier function is part of the interpretation of the number word.

6.5 Two kinds of count nouns

Emerging picture:

- A count noun in classifier languages (and an object mass noun in non-classifier languages) has a cumulative extension, but it has non-overlapping atoms (the natural units). Classifiers restrict these cumulative extensions to the atoms.
- A count noun in [+Num –Cl] languages applies only to the non-overlapping atoms (the natural units) themselves.

In contrast, for mass nouns natural units are not defined, i.e. atomicity (or atomicity with non-overlapping atoms) is not guaranteed.

Comparison with Borer (2005): Borer assumes that all count nouns are the same (cumulative, with discreet atoms). Classifiers and number agreement have similar functions of making the atoms (natural units) accessible.

7. The Nature of Pluralization

7.1 Different kinds of plurals

We have seen that there are different kinds of plurals:

Agreement plural

This type of plural is semantically inert, and it is triggered by the specific forms of the number word. That this type of plural is not related to the semantic notion of plurality is clear with examples like (b) and (c):

(55) a. *three apples* b. *zero apples* c. *one point zero apples*

Strong Plural: Semantic plural excluding atoms (natural units)

For the explanation that classifiers are incompatible with plural nouns, we have used one definition of pluralization that excludes atoms when applied to a set of atoms, as in (29):

(56) $[\![\text{PL}]\!] = \lambda P'\ \text{s}P[\forall x,y \in P'[x \neq y \rightarrow P(x \sqcup y)] \wedge \forall x,y \in P[P(x \sqcup y)]]$

Weak Plural: Semantic plural including atom

For English we have worked with another meaning of plurals that includes atoms, as in (36):

(57) $[\![\text{PL*}]\!] = \lambda P'\ \text{s}P[\forall x,y \in P'[P(x \sqcup y)] \wedge \forall x,y \in P[P(x \sqcup y)]]$

There are even more kinds of plurals, e.g. **abundance plural** that are compatible with mass nouns, e.g. *the waters of the Nile*; see Tsoulos (2007) for the productive formation of such plurals in Modern Greek.

7.2 Classifiers and pluralization

In typical classifier languages, classifier constructions exclude plurals; this is explained if we assume that they have a plural that exclude atoms.

However, languages with plurals that do not exclude atoms, classifier constructions with plural nouns should be acceptable. This is borne out, e.g. for German:

(58) *zwanzig Stück Semmel-n* *fünf Mann Mensch-en*
twenty CL breadroll-PL five CL person-PL
'twenty breadrolls' 'five people' (title of play by Jandl and Mayröcker)

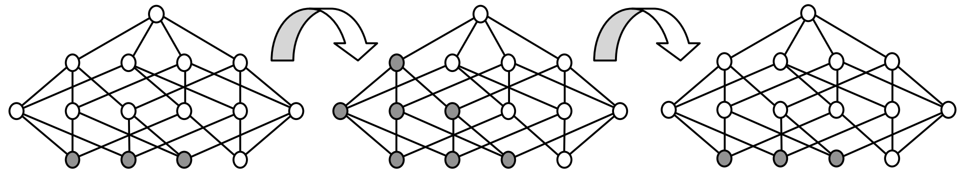
(Google has >150 occurrences of *Stück Semmeln* in this use, >4000 of *Stück Eier*)

(59) $[\![\textit{Semmel}]\!] = \lambda x[\text{BREADROLL[S]}(x) \wedge \text{ATOM}(x)]$

$[\![\textit{Semmel-n}]\!] = \text{s}P[\forall x,y \in [\![\textit{Semmel}]\!][P(x \sqcup y)] \wedge \forall x,y \in P[P(x \sqcup y)]]$
$= \lambda x \forall y[y \sqsubseteq x \wedge \text{ATOM}(x) \rightarrow [\![\textit{Semmel}]\!](x)]$

$[\![\textit{Stück}]\!] = \lambda P\ \lambda x\ [P(x) \wedge \text{ATOM}(x)]$

$[\![\textit{Stück Semmeln}]\!] = \lambda P\ \lambda x\ [P(x) \wedge \text{ATOM}(x)](\lambda x \forall y[y \sqsubseteq x \wedge \text{ATOM}(x)] \rightarrow [\![\textit{Semmel}]\!](x)])$
$= \lambda x[\forall y[y \sqsubseteq x \wedge \text{ATOM}(x) \rightarrow [\![\textit{Semmel}]\!](x)] \wedge \text{ATOM}(x)]]$
$= [\![\textit{Semmel}]\!]$



⟦*Semmel*⟧ ⟦*Semmeln*⟧ ⟦*Stück Semmeln*⟧

Notice that the diminutive *Stückchen* has a mensurative reading, and that the classifier is also compatible with the singular form:

(60) *zehn Stück Wurst* *zehn Stück Würst-e* *zehn Stück-chen Wurst /*Würste*
ten CL sausage ten CL sausag-PL ten piece-DIM sausage sausage-PL
'ten sausages' 'ten sausages' 'ten sausage pieces'

7.3 Unmarked vs. marked use of plural

One piece of evidence for the weak plural came from the use of plural in questions like *Do you have children?* and conditionals like *If you have children, bring them with you.*

If plural in Chinese is not applicable to atomic entities, we predict that the singular form is used in such cases:

(61) *Nǐ yǒu háize / #háize-men ma?*
you have child child-PL QU
'Do you have children?'

(62) *ruguo nǐ yǒu xiaohǎi / #xiahǎi-men jiù qǐng dài tā lai party*
if you have little.child little.child-PL then please bring 3SG to party
'If you have children, then please bring them to the party.'

In [-Num –Cl] languages, plural also appears to be strong (cf. Bale & Khanjian, Armenian):

(63)	*yergu*	*bezdig*	*vaze-ts*	*bezdig*	*vaze-ts*	
	two	child	run-PAST.3SG	child	run-PAST.3SG	
	'Two children ran'			'One or more children ran.'		

(64)	*Bezdig*	*uni-s?*	*Bezdig-ner*	*uni-s?*
	child	have-2SG	child-PL	
	'Do you have children?'		'Do you have two or more children?'	

8. Some Desiderata

Non-integer values of numerals with count nouns

(65) *one and a half apples, two point three apples, one point zero apples*

Such expressions cannot be captured with the card function, which only allows for integer value. Suggestion: Generalize a regular measure function that counts, for example, the stuff that makes up half of an apple as *half an apple*, of *zero point five apples*.

Notice the tendency to plural agreement in English.

Default interpretation 'one' when number word is lacking with measure constructions

(66)	*wǒ*	*xiáng*	*mǎi*	*bàng*	*ròu*
	I	want	buy	pound	meat
	'I want to buy a pound of meat.'				

Perhaps measure expressions create a discreet partition on the extension of a mass noun, which then can be counted. Plausible e.g. for container measures.

Differences between classifier expressions and count expressions

Many languages have occasional classifiers that compete with count interpretations (examples: German, see above, and Armenian)

(67) *zwanzig Würste / zwanzig Stück Würste / zwanzig Stück Wurst*

In Armenian (cf. Borer 2005, Bale & Khanjian t.a.) we find the following constructions:

(68)	*yergu*	*hovanoc*	*yergu*	*had*	*hovanoc/*-ner*	*yergu*	*hovanoc-ner*
	two	umbrella	two	CL	umbrella /-PL	two	umbrella-PL
	''						

It is unclear how to capture the difference between such constructions.

Collective, Singulatives, and Plurals

A number of languages (Celtic, Semitic, Cushitic) have a Collective/Singulative/Plural distinction. Examples: Breton (Doetjes t.a.) In the following, *gwez* is the collective form, *gwezeenn* the singulative form, and *gwezzenon* the plural form derived from the singulative.

(69)	*ugent*	*gwez-enn*	**ugent*	*gwez*	**ugent*	*gwezz-en-on*
	twenty	tree-SNG	twenty	tree	twenty	tree-SNG-PL
	'tweny trees'					

It appears that the singulative form has a similar function as classifiers.

9. References

Aikhenvald, Alexandra Y. (2000), *Classifiers: A typology of noun classification devices*, Oxford University Press, Oxford.

Bale, Alan & Hrayr Khanjian (2008), "Classifiers and number markings", *Ms., Cambridge, MIT*

Barner, David & Jesse Snedeker (2005), "Quantity judgements and individuation: evidence that mass nouns count", *Cognition* 97.

Borer, Hagit (2005), *Structuring sense. Part I: In name only*, Oxford University Press_, Oxford.

Cheng, Lisa Lai-Shen & Rint Sybesma (1999), "Bare and not-so-bare nouns and the structure of NP", *Linguistic Inquiry* 30, 509-542.

Chierchia, Gennaro (1998), "Reference to kinds across languages", *Natural Language Semantics* 6, 339-405.

Doetjes, Jenny (to appear) "Count/mass distinctions across languages.", in Klaus von Heusinger, Claudia Maienborn & Paul Portner, *International Handbook of natural language meaning*, de Gruyter.

Gil, David (2005), "Classifiers", in Martin e.al. Haspelmath, *World Atlas of Language Structure*, Oxford, Oxford University Press, chapter 55.

Greenberg, Joseph H. (1972), "Numeral Classifiers and Substantival Number: Problems in the Genesis of a Linguistic Type.", in J. Heilmann, *Proceedings of the 11th International Congress of Linguistics, Bologna-Florence*, Bologna, Il Mulino, 17-37.

Henne, Henry, Ole Bjorn Rongen & Lars Jul Hansen (1977), *A handbook on Chinese language structure*, Universitetsforlaget, Oslo.

Jespersen, Otto (1924), *The philosophy of grammar*, Allen and Unwin, London.

Koptjevskaja-Tamm, Maria (2004), "Mass and collection", in G. Booij, Ch. Lehmann, J. Mugdan, *Morphology. A Handbook on Inflection and Word Formation*, Berlin, Mouton de Gruyter, 1016-1031.

Krifka, Manfred (1989), *Nominalreferenz und Zeitkonstitution. Zur Semantik von Massentermen, Pluraltermen und Aspektklassen*, Wilhelm Fink, München.

Krifka, Manfred (1995), "Common nouns: a contrastive analysis of Chinese and English", in Greg N. Carlson & F. J. Pelletier, *The generic book*, Chicago, London, The University of Chicago Press, 398-411.

Krifka, Manfred (1998), "The origins of telicity", in Susan Rothstein, *Events and grammar*, Dordrecht, Kluwer, 197-235.

Krifka, Manfred (2004), "Bare NPs: Kind-referring, indefinites, both, or neither?", *SALT XIII,*

Landman, Fred (2006), *On the Mass-Count Distinction*, Tel Aviv.

Link, Godehard (1991), "Plurals", in Arnim von Stechow & Dieter Wunderlich, *Handbuch Semantik*, Berlin, Mouton de Gruyter,

Macnamara, J. (1982), *Names for things: A study of human learning*, MIT Press, Cambridge, Mass.

Müller, Ana; Luciana Storto & Thiago Coutinho-Silva (2006), "Number and the count-mass distinction in Karitiana.", *UBWCWPL 19: Proceedings of the 11th workshop on structure and constituency in languages of the Americas,* 122-135.

Quine, Willard V.O. (1960), *Word and object*, MIT Press, Cambridge, Mass.

Rothstein, Susan (2007), "Counting and the mass-count distinction", Ms., Bar Ihlan University.

Sanchez, M. & L. Slobein (1972), "Numeral classifiers and number marking: An implicational universal", *Working Papers in Language Univerals* 11, 1-22.

Sauerland, Uli, Bruce Anderson & Kazuko Yatrsushiro (2005), "The plural is semantically unmarked", in Stefan Kepser & Marga Reis, *Linguistic Evidence*, Berlin, Mouton de Gruyter,

Schwarzschild, Roger (2002), "The grammar of measurement",

Smith-Stark, Cedric (1974), "The Plurality Split", *Chicago Linguistic Society Papers*, 657-671.

Soja, N., Susan Carey & Elizabeth S. Spelke (1991), "Ontological categories guide young children's inductions of word meaning: Object terms and substance terms.", *Cognition* 38, 179-211.

Spelke, E. S. (1985), "Perception of unity, persistence and identity: Thoughts on infants' conception of objects"", in J. Mehler & R. Fox, *Neonate cognition: Beyond the blooming and buzzing confusion*, Hilldale, N.J, Lawrence Earlbaum Associates.

Tsoulas, George (2007), "On the grammar of number and mass terms in Greek", *Workshop on Greek syntax and semantics, MIT.*

Wilhelm, Andrea (2006), "Count and mass nouns in Dëne Suhné.", *25th West Coast Conference on Formal Linguistics.*