Compositionality in Quantifier Phrases and Quantifier Words
Lecture 1
Three classes of quantifier phrases

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Oct. 16, 2012
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The classical view

All quantifier phrases are equal
in their internal structure and
in the way they take scope.

Montague 1974, Barwise & Cooper 1981, May 1985, Heim & Kratzer 1998, and many others

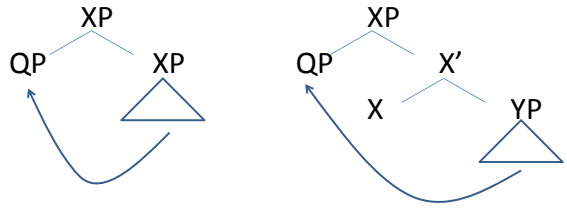
The classical view

All quantifier phrases are equal
in their internal structure and
in the way they take scope.

Quantifier	**Restriction**	**Scope**
every	dog(s)	_ barked
some		_ barked rarely
most		_ saw a cat
more than five		a cat saw _
very few		no cat saw _

Scope assignment

The Quantifier Phrase + Scope structure may be the original constituent structure, or it may be created by Quantifier Raising (QR) or by some other operation, adjunction or feature checking.



Quantifier phrases denote Generalized Quantifiers	Scopes denote properties
λP[every-dog'(P)]	λx[saw-a-cat'(x)] λx[a-cat-saw'(x)]
`the set of properties that every dog has'	`the property of seeing a cat / being seen by a cat'

Predictions of the classical view

Re: internal structure
When two quantifiers have the same denotation, differences in their internal structures do not matter.

Re: scope taking
All QPs have the same ability to scope over any other QP or operator, and over the same syntactic domains (with the possible exception where the result is incoherent gibberish)

Are these predictions correct?

Scope taking is not uniform (old observations)

I can't believe the rumor that he bribed <u>two judges</u>.

✓ `for two particular judges, I can't believe the rumor that he bribed them'

I can't believe the rumor that he bribed <u>every judge</u>.

`for every judge, I can't believe the rumor that he bribed him/her'

More than one girl saw <u>every film</u>.

✓ `for every film, more than one girl saw it'

Every girl saw <u>more than one film</u>.

`there is more than one film that every girl saw'

Are these predictions correct?

Internal structure matters (more recent observations)

At least two men left IFF *More than one man left*

✓ At least two doctors shook hands.

More than one doctor shook hands.

At most four men left IFF *Fewer than five men left*

Beryl had three sherries.

OK ⇒ Beryl had fewer than five sherries.

NO ⇒ Beryl had at most four sherries.

Most of the men left IFF *More than 50% of the men left*

The kids read most of the books each.

✓ The kids read more than 50% of the books each.

What emerges: Three classes of "quantifier phrases"

1 Bare (numeral) indefinites 2 Distributive universals	**Formal tools**
both have two kinds of scope:	**choice functions**
unbounded existential scope	**Skolemization**
clause-bounded distributive scope	**Dist, * operators**
3 Counting quantifiers (aka modified numerals)	
clause-bounded, intervention-sensitive split scope	**degree quantification**

Discussion will be based on

Indefinites and universals

Ruys 1992, Reinhart 1997, Beghelli & Stowell 1997, Szabolcsi 1997, Farkas 1997, Lin 1998, Kratzer 1998, Matthewson 1999, Stanley & Szabo 2000, Chierchia 2003, Schlenker 2006

Counting quantifiers

Sutton 1993, Cresti 1995, Beghelli & Stowell 1997, Szabolcsi 1997, Heim 2001, Hackl 2000, 2009, Szabolcsi 2006, Geurts & Nouwen 2007, Takahashi 2006

See Chapters 6 to 11 of Quantification (Szabolcsi 2010) for comprehensive discussion.

1 Bare (numeral) indefinites

Seem to have unbounded, island-free scope

I can't believe [the rumor [that he bribed <u>two judges</u>]].

✓ `for two particular judges, I can't believe the rumor that he bribed them'

Each student has to hunt down [every paper which shows [that <u>a certain claim by Chomsky</u> is wrong]].

✓ `each student > a certain claim > every paper'

✓ `a certain claim > each student > every paper'

[If <u>some lady</u> dies], Bill inherits a house.

✓ `for some lady, if she dies, Bill inherits a house'

Bare (numeral) indefinites

But do they have island-free scope?

A student has to hunt down [every paper which shows [that <u>certain claims by Chomsky</u> are wrong]].

✓ `for certain claims, a student has to hunt down...'

BUT students cannot vary with claims!

[If <u>two ladies</u> die], Bill inherits a house.

✓ `for two particular ladies, if they die...'

BUT only one house in total can be inherited!

COMPARE <u>Two ladies</u> left Bill a house.

✓ `two houses in total'

A contradiction!

The findings cannot be described using the classical scope vocabulary.

The first set of data shows that indefinites can be referentially independent of quantifiers and negation that c-command them outside islands => they have unbounded scope.

The second set shows that plural indefinites cannot induce variation in other, clause-external indefinites => they have clause-internal scope.

Solution

Distinguish two kinds of scope for indefinites.

"**Existential scope**," which pertains to referential independence. Unbounded.

Formal tool: choice function variable, existentially closed from a distance, or contextually given

"**Distributive scope**," which pertains to the ability to induce variation in others. Clause-bounded.

Formal tool: silent distributive operator on the predicate (a universal quantifier, * operator)

Choice functions cf

A choice function cf looks at every set and chooses an element of that set. **dog(cf(dog)) always true**

cf_1(dog)= Fido	cf_2(dog)=Spot	...
cf_1(cat)=Max	cf_2(cat)=Tiger	...
cf_1(city)=Paris	cf_2(city)=LA	...
cf_1(two-dogs)= {Fido, Spot}	cf_2(two-dogs)= {King, Spot}	...
...	...	...

also with sets whose elements are not individuals:

two-dogs' = { {Fido, Spot}, [King, Spot}, {Spike,King}, {Fido,King}, {Fido,Spike}, {Spike,Spot} }

Uses of choice functions

Since the value of cf(dog) is an individual dog, cf(dog) in the place of an individual expression i well-formed:

hungry'(fido') hungry'(cf(dog'))

$\exists$cf[hungry'(cf(dog'))] iff $\exists$x[dog'(x) $\wedge$ hungry'(x)]

`there is a choice function such that the individual it chooses from the set of dogs is hungry'

hungry'(cf(dog')) iff dog'(x) $\wedge$ hungry'(x)

`the individual that the contextually relevant choice function chooses from the set of dogs is hungry'

Similarly for pluralities or sets, cf(two-dogs').

Using cfs avoids the unbounded QR of indefinites. Two possible analyses of maximal scope

If two relatives of his die, Bill inherits a house.

$\exists$**cf** [**cf**(two-ladies) die $\rightarrow$ Bill inherits a house]

`there is a choice function cf such that if the pair that cf chooses from the set of pairs of ladies dies, Bill inherits a house'

(**cf**(two-ladies) die) $\rightarrow$ Bill inherits a house

`if the pair that the contextually relevant cf chooses from the set of pairs of ladies dies, Bill inherits a house'

"Distributive scope" of indefinites

Two ladies EACH left him a house.

$\exists$cf [cf(two-ladies') *left-him-a-house']

If α is a plurality and β is a property, [α *β] is true iff $\forall$x[atom(x, α) $\rightarrow$ β(x)].

The * operator (Link 1983), like adverbial *each*, is adjoined to the predicate, not to NP, and is thus unaffected by the extra-clausal existential scoping of the plural indefinite.

If two ladies EACH die, Bill inherits a house.

A new way of creating dependencies: Skolemization

Every number is smaller than its successor.

$\forall n \exists m$ [imm. succeed(m, n) $\wedge$ n < m]

$\forall n$ [n < successor(n)]

A Skolem function has zero, one, or more parameters (individual arguments) that can make it dependent on quantifiers it is in the scope of. In mathematics, Skolem functions are used to rid formulae of existential quantifiers.

A Skolem function need not also be a choice function (see above), but it can be.

Two possible analyses of clause-external but dependent readings

Each student hunts down [every paper which shows [that a certain claim is wrong]].

✓ `each student > a certain claim > every paper'

with intermediate $\exists$-closure of cf:

$\forall x$[student'(x)$\rightarrow$ $\exists$**cf**$\forall$y[paper'(y) $\wedge$ show'(y, wrong'(**cf**(claim'))) $\rightarrow$ hunt-down'(x, y)]]

with Skolemized contextual choice function, cf(x):

$\forall x$[student'(x)$\rightarrow$ $\forall$y[paper'(y) $\wedge$ show'(y, wrong'(**cf(x)**(claim'))) $\rightarrow$ hunt-down'(x, y)]]

Two distinct dependent readings

If every student improves in a particularly difficult area, the teacher will be happy.

Maximal-scope, independent reading:

the same area for everyone (say, calculus)

Dependent reading #1:

every student must improve in some difficult area or other, no matter which area

Dependent reading #2 with strict co-variation:

every student must improve specifically in the difficult area he/she has the most problems with

Here $\exists$-closure vs. Skolemization make a truth-conditional difference

Dependent reading #1:

($\forall x \exists$cf[improve'(x, in cf(area'))]) $\rightarrow$ happy'(the-tchr')

Dependent reading #2:

($\forall x$ [improve'(x, in cf(x)(area'))]) $\rightarrow$ happy'(the-tchr')

The Skolemized choice function cf(x) selects, for any x, the area that x has the most problems with.

The same function can select different areas from the set of areas, depending on which x it is working for.

Are indefinites all alike?

Ability to take clause-external scope:

certain NP > *two NP, some NP* > *a(n) NP*

Adding a relative clause or PP often helps.

(A) certain NP is the typical item for contextually given and potentially Skolemized indefinites.

Note: Counting quantifiers or modified numerals (*at least/at most two NP, more/less than two NP, more NP1 than NP2, two or more NP*, etc.) are not considered under the rubric "indefinite".

Are universals all alike? *each* vs. *every* vs. *all the*

Some tourist or other thought that ... sight(s) was/were boring.
Can tourists vary with sights?
each: yes *every*: no *all the*: no

Some tourist or other visited ... sight(s).
Can tourists vary with sights?
each: yes *every*: yes *all the*: no

... tourist(s) lifted up the van.
Can the tourists have acted collectively?
each: no *every*: no *all the*: yes

[although: ✓ *It took every tourist to lift up the van.*]

Focus on *every NP*-type universals

E*very NP* is distributive,
easily takes clause-internal inverse scope,
but doesn't take extra-clausal scope.

Preliminary conclusion:

Every NP only has distributive scope, which is clause-internal. The distributive operator is probably part of *every NP* though, not a VP-adverb, unlike with plural indefinites.

Is this conclusion correct?

Unbounded existential scope for universals?

You cannot list every prime number.

⇒There is a set, the one containing all primes, such that you cannot list every element of it.

I don't believe that you listed every prime number.

⇒There is a set, the one containing all primes, such that I don't believe that you listed every element of it.

If every prime number is divisible by 1, then ...

⇒There is a set, the one containing all primes, such that if every element of it is divisible by 1, then ...

Domain restriction and co-variation

Context: There are 3 empty vinegar bottles and 4 full wine bottles in the cupboard. We need vinegar. I look in the cupboard and report,

Every bottle is empty.

Can this be true? Not every bottle in the world, not even every bottle in the cupboard is empty!

Context: "Syntax" is a course that every student must complete at some point. Head of department notices,

Every "Syntax" teacher failed every first-year student.

Can this be true? Did they all teach all the first-years?

Parallelism with indefinites

The prime numbers examples show that sentences with universals entail the maximal-scope existence of the (non-empty) restrictor set. (*Every NP* is a principal filter.)

The bottles example shows that the restrictor set of *every* can be further delimited by context.

The first-years example shows that the restrictor sets can co-vary with a c-commanding quantifier.

The powerset of set S is the set of all subsets of S.

cf(powerset(bottle')) = a contextually relevant subset of the set of bottles

cf(x)(powerset(first-year')) = contextually relevant subsets of the set of first-years, chosen in variation with a quantifier that binds the Skolem parameter x.

Interim summary

Potentially unbounded existential scope and tensed-clause bounded distributive scope are distinguished for both indefinites and *every NP*-type universals.

two books
- ♦ cf(two-books')
  or skolemized cf(x)(two-books')
- ♦ cf is ∃-closed or contextually given
- ♦ distributivity via *predicate; * = ∀

every book
- ♦ cf(powerset(book'))
  or skolemized cf(x)(powerset(book'))
- ♦ cf unambiguously given in context
- ♦ moves to Spec,DistP; Dist = ∀

Why is dual scope news?

Traditional examples inspired by predicate logic:

Every student *read* ***a book***.

Not discovered or not investigated:

Two students *read a book.*

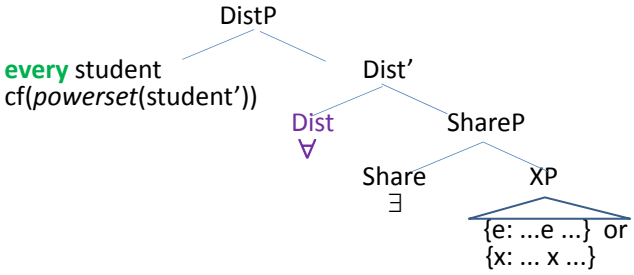
Every prof failed ***every first-year student***.

In the traditional examples, *every man* can induce variation but itself does not exhibit variation;
a book can vary but itself does not induce variation.
"What is the scope of QP?" was a different question in each case.
For *every man*, "What is its distributive scope?"
For *a book*, "What is its existential scope?"

2 *Every NP*

contributes a subset of NP, but not distributivity

compare **mei-ge xuesheng dou VP** (Lin 1996, 1998)



Every signals the association of *every student* with **Dist**, like negative concord markers do with the real negation.

How do *some students'* and *every student'* differ?

The cupboard has 3 empty vinegar bottles and 4 full wine bottles.

(i) *Every bottle is empty.*

(ii) *Some bottles are empty.*

Both can be true here.

(i) requires a cf that is unambiguous in the context: the cf variable is deictic.

(ii) asserts that there exists a contextually relevant cf: the cf variable is ∃-closed.

3 Counting quantifiers

Unlike indefinites and *every NP*-type universals, counters do not take existential scope outside their own clause.

Some tourist or other thought that more than ten sights were boring.
there are more than ten sights which ...

Counters do not take inverse scope over the subject (at most, they take inverse scope over another counter in subject).

Every girl read more than ten books.
there are more than ten books read by every girl
Some girl or other read more than ten books.
girls vary with books
At least one girl read more than ten books.
? girls vary with books

Counters consist of a numerical and an individual quantifier that can "split"

How many patients must Dr. X visit?

✓`For what number *n*, there are *n* patients whom Dr. X must visit?' (individual reading)

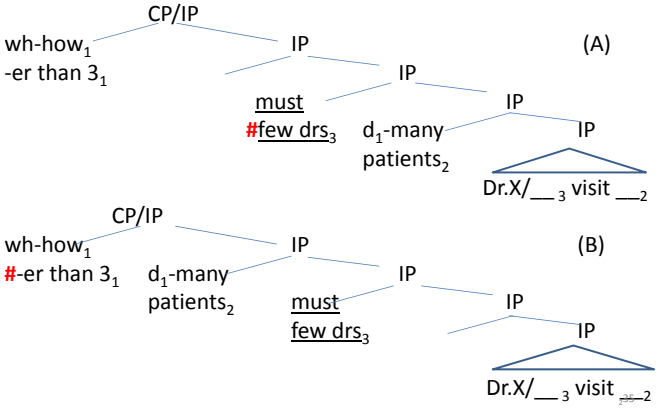
✓ `For what number *n*, it must be that there are *n* patients whom Dr. X visits?' (cardinal reading)

How many patients did few doctors visit?

✓`For what number *n*, there are *n* patients whom few doctors visited?' (individual reading)

For what number *n*, for few doctors are there *n* patients whom they visited?' (cardinal reading)

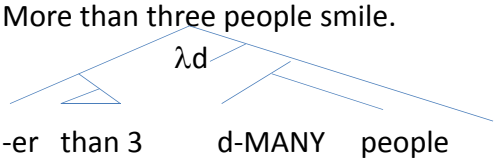
wh-how/-er than 3 ... d-many NP intervention (A) and inverse scope (B)



Degree comparison

d is a variable over degrees, D over degree intervals

More than three people smile.



d-MANY people	λP. ∃x[people'(x) ∧ |x|≥d ∧ P(x)]
-er	λD.λD'[max(D') > max(D)]
[than] 3	λd.d=3

max(λd.∃x[people'(x) ∧ smile'(x) ∧ |x|≥d]) > max(λd.d=3)

iff ∃x[people'(x) ∧ smile'(x) ∧ |x|>3]

Degree operator ... intervener ... restriction

✓ Modal or intensional operator scopally intervenes between the degree operator and its restriction *d-many/much NP* (but see Lassiter, SALT 22).

✓ Name or non-distributively interpreted plural (in)definite intervenes.

\# *Every NP, few NP, only XP,* or *negation* scopally intervenes (Honcoop 1998, Kennedy 1999, Pesetsky 2000, Heim 2001, Hackl 2000, Beck 2006).

Caveat: Sometimes a quantifier linearly intervenes, but does not scope, between the degree operator and its restriction, e.g. ✓ pair-list reading. (Szabolcsi & Zwarts 1993).

Inverse scope: over subject vs. over another VP-internal quantifier

Every student read more than one paper.
\# more than one NP > every NP

John submitted more than one paper to every journal.
✓more than one NP > every NP

John submitted every paper to more than one journal.
✓ more than one NP > every NP

Account in terms of split and intervention (Takahashi 2006)

a. The decomposition of *more than n NP* into *-er than n* and *d-many NP*.

b. QR forced by type mismatches, subject to Shortest Move.

c. Optional Quantifier Lowering, subject to Shortest Move.

d. Shortest: QR/QL targets the closest node of type t.

e. VP-internal XPs are equidistant from vP of type t.

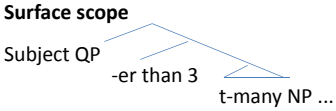
f. Intervention constraint: A quantificational DP cannot intervene between DegP and its trace in *d-many NP*.

g. Scope Economy: Covert QR/QL cannot be semantically vacuous.

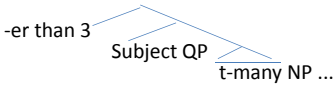
h. Scope commutativity facts of comparative quantifiers.

Subject QP and splitting counter

Surface scope

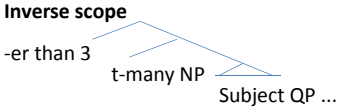


Intervention



violates Intervention (f)

Inverse scope



violates Shortest (d)

Further properties of counters

Counters host adnominal *each*.

✓ *The girls read more than ten books each.*

compare *#The girls read most of the books each.*
#The girls read some books each.
 # The girls read books each.

Their internal composition matters for acceptability, interpretation, and processing:

more than 50% of the NP vs. *most of the NP*,
more than six books vs. *at least seven books*,
fewer than seven books vs. *at most six books*

Interface Transparency

"Extending other work, our conclusion is that competent speakers associate sentences with canonical specifications of truth conditions, and that these specifications provide default verification procedures. From this perspective, examining how a sentence constrains its verification can provide clues about how speakers specify the truth condition in question. More generally, our data support an Interface Transparency Thesis (ITT), according to which speakers exhibit a bias towards the verification procedures provided by canonical specifications of truth conditions. In conjunction with specific hypotheses about canonical specifications, the ITT leads to substantive predictions, because given available information, the canonical procedure may have to rely on (noisy) input representations that lead to less accuracy in judgment, compared with an alternative strategy that is cognitively available to speakers."
(Lidz et al. 2011)