The semantics and pragmatics of directional numeral modifiers

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1 Introduction

Numeral modifiers: expressions that specify a relation between the number they modify and the element the modified numeral is applied to.

(1) a. More than three people arrived.
b. Anne can spend no more than €150 on food this week.
c. Oliver owns at least four pairs of jeans.
d. Teachers generally earn under €40.000 a year.
e. There will be between forty and fifty people at the party.
f. We accept reservations from parties from six guests.
g. James can be sentenced to up to five years in prison

Directional numeral modifiers:

(2) a. Mary walked up to the edge of the lake.
b. Mary can fit up to five suitcases in her car.

(3) Dutch
a. Marie liep tot de rand van het meer.
Mary walked TOT the edge of the lake.
'Mary walked up to the edge of the lake.'
b. Er kunnen tot vijf mensen mee.
There can TOT five people with.
'Up to five people can come.'

(4) Farsi
a. Ta labe daryache raftim.
TA edge lake went.
'We went up to the edge of the lake.'
b. Ta si nafar dar mehmani hozur dashtand.
TA thirty people at the party showed up.
'Up to thirty people showed up at the party.'

(5) Greek

a. Perpatisame mehri tin akri tis limnis.
We walked MEHRI the edge of the lake.
'We walked up to the edge of the lake.'

b. Boro na paro mehri pede meres adhia.
I can get MEHRI five days off.
'I can get up to five days off.'

Main claims:

- In any language, if an upper-bounded numeral modifier is directional, it has the following three properties:
  - It displays the bottom-of-the-scale-effect.
  - It has positive directivity.
  - Its upper bound is defeasible and reinforceable.
- The cause of these properties is in the bounds: the lower bound of directional numeral modifiers is asserted while their upper bound is implicated.
- $[\![\text{up to } n]\!] = \lambda P \forall m \in [s, ..., n] \wedge s \geq 1 : P(m)$
  Implicature: $\forall m > n : \neg P(m)$

2 Data

2.1 The bottom-of-the-scale effect

Directional numeral modifiers cannot be combined with the numeral at the bottom of the scale they quantify over (Schwarz, Buccola, & Hamilton, 2012):

(6) a. At most ten people died in the crash.
b. At most one person died in the crash.

(7) a. Up to ten people died in the crash.
b. #Up to one person died in the crash.

This property is not specific to the number one. The bottom-of-the-scale element can be higher, like 'half a dozen' in a situation in which eggs are only sold in cartons of six (example from Schwarz et al., 2012):

(8) a. He bought at most a dozen eggs.
b. He bought up to a dozen eggs.

(9) a. He bought at most half a dozen eggs.
b. #He bought up to half a dozen eggs.

It can also be lower:

(10) a. We will need at most one litre of milk.
b. We will need up to one litre of milk.

2.2 Directivity

- Positive directivity: the emphasis lies on the elements for which the sentence holds.
- Negative directivity: the emphasis lies on the elements for which the sentence does not hold. (Terminology from Nouwen, 2010b).

(11) a. In the airplane crash, a few people were killed, which is a terrible thing.
b. ?In the airplane crash, few people were killed, which is a terrible thing.

(12) a. In the airplane crash, few people were killed, which is a good thing.
b. ?In the airplane crash, a few people were killed, which is a good thing.

(Example from Sanford, Fay, Stewart, & Moxey, 2002).

Directional numeral modifiers have positive directivity:

(13) a. Fortunately, I can get up to five days off work.
b. ?Fortunately, I can get at most five days off work.

(14) a. ?Fortunately, that horrible singer will sing up to five songs.
b. Fortunately, that horrible singer will sing at most five songs.

In the context of an advertisement:

(15) a. Get a discount of up to 50%!
b. ?Get a discount of at most 50%!

2.3 Defeasible and reinforceable upper bound

The upper bound of directional numeral modifiers can be cancelled:

(16) a. Up to thirty people showed up at the party.
b. In fact, I believe there were thirty-two people there.

(17) a. At most thirty people showed up at the party.
b. ??In fact, I believe there were thirty-two people there.

(18) a. Peter is allowed to choose up to ten presents, perhaps even more.
b. #Peter is allowed to choose at most ten presents, perhaps even more.

It can also be reinforced:

(19) a. Up to ten people showed up, but there were no more than ten people there.
b. #At most ten people showed up, but there were no more than ten people there.

Crosslinguistic validity

- Upper-bounded directional numeral modifiers have these three properties in at least the following languages:
  - Danish
  - Dutch
  - English
  - Farsi
  - French
  - German
  - Greek
  - Hungarian
  - Italian
  - Polish
  - Romanian
  - Russian
  - Spanish
  - Turkish
- For details, see Blok (2013).

3 Analysis

3.1 Main proposal

The difference between directional numeral modifiers and other upper-bounded numeral modifiers is that directional numeral modifiers assert a lower bound and merely implicate an upper bound. This is represented in figure 1 below.

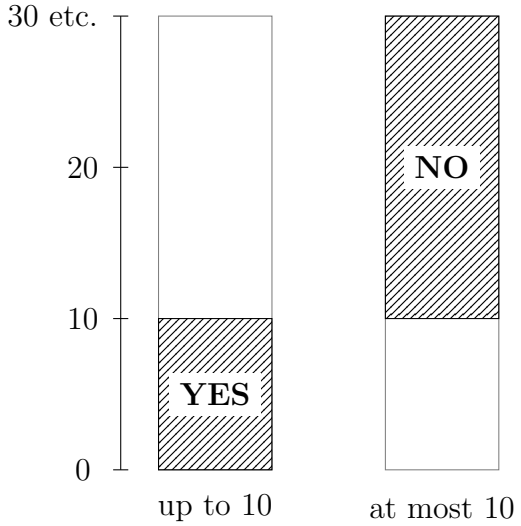

Figure 1: Visual representation of the meanings of *up to* and *at most*

The semantics is given in (20) (this is a modified version of the semantics of *up to* in Nouwen, 2008).

(20) $[\![\text{up to } n]\!] = \lambda P \forall m \in [s, ..., n] \wedge s > 0 : P(m)$
Range requirement: $s \neq n$
Implicature: $\forall m > n : \neg P(m)$

I propose that the implicature is a Gricean quantity implicature: If a speaker utters (16-a), she expresses that according to her, the range of possible numbers of guests is between one and thirty. If she in fact believes that there may have been thirty-two or forty people at the party, she should have said so.

(21) ... [up to 28] < [up to 29] < **[up to 30]** ~~< [up to 31] < [up to 32] ...~~

Unlike their upper bound ((16)-(19)), the lower bound of directional numeral modifiers is neither defeasible nor reinforceable:

(22) a. #Up to three people showed up, if any.
b. At most three people showed up, if any.

(23) a. #At least one person and up to ten people showed up.
b. At least one person and at most ten people showed up.

s is a contextually given starting point of the scale. I assume that the degree quantifier *up to* 10 takes scope over the sentence, leaving a degree trace in its argument position. I further assume the existence of a degree predicate *many* of type $\langle \delta, \langle \langle e,t \rangle, \langle \langle e,t \rangle, t \rangle \rangle \rangle$ that combines with the degree trace left by *up to* n (Hackl, 2000; Nouwen, 2010a):

(24) $[\![\text{many}]\!] = \lambda n \lambda P \lambda Q : \exists x[\#x = n \wedge P(x) \wedge Q(x)]$

The semantics of a sentence like (25-a), then, is as in (25-c).

(25) a. Emily is allowed to buy up to 10 books.
b. [Up to 10 [λn [◊ [Emily buy n-many books]]]]
c. $\forall m \in [s, ..., 10] \wedge s > 0 : \Diamond \exists x[\#x = m \wedge \text{books}(x) \wedge \text{buy}(e, x)]$
d. Emily is allowed to buy one book, Emily is allowed to buy two books, ... , Emily is allowed to buy ten books.

In the absence of a modal, a sentence with *up to* can be interpreted with respect to a silent speaker possibility operator (as in Nouwen, 2008):

(26) a. Up to thirty people showed up.
b. [Up to 30 [λn [◊ [n-many people] showed up]]]
c. $\forall m \in [s, ..., 30] \wedge s > 0 : \Diamond \exists x[\#x = m \wedge \text{people}(x) \wedge \text{showed-up}(x)]$
d. It's possible that one person showed up, it's possible that two people showed up, ... , it's possible that 30 people showed up.

3.2 The quirks of directional numeral modifiers explained

Defeasible and reinforceable upper bound

The defeasibility and reinforceability of the upper bound of directional numeral modifiers follow from the fact that it is implicated rather than asserted.

The bottom-of-the-scale effect

The bottom-of-the-scale effect is illustrated in (27-a) (= (7-b)). The semantics is given in (27-b).

(27) a. #Up to one person died in the crash.
b. $\forall m \in [s, ..., 1] \wedge s > 0 : \Diamond \exists x[\#x = m \wedge \text{people}(x) \wedge \text{died-in-the-crash}(x)]$
Range requirement: $s \neq n$

The infelicitousness of (27-a) is due to the fact that *up to one* contradicts the range requirement. As it is impossible for half a person to die, s has to be 1, so $s = n$.

Even if *at most*, too, requires quantification over a range of values, its compatibiltiy with 0 means the interval quantified over by *at most 1* would be [0,1]; $s \neq n$.

Directivity

Directivity stems from the fact that (unlike other upper-bounded numeral modifiers such as *at most*), directional numeral modifiers assert the existence of at least one element for which the sentence holds (see (22-a)). This is equally true for other positively directive quantifiers:

(28) a. Few people were present, if any.
b. #A few people were present, if any.

(29) a. Not quite all people were present. In fact, I don't think anyone showed up.
b. Nearly all people were present. #In fact, I don't think anyone showed up.

The guaranteed existence of the elements for which the predicate holds highlights these predicates. If a quantifier that does not guarantee this, such as *at most*, had positive directivity, it would in some cases highlight the elements for which the sentence holds while claiming that there are no such elements.

3.3 Why an interval?

(30) $[\![\text{up to } n]\!] = \lambda P \boldsymbol{\forall m \in [s, ..., n]} \wedge s > 0 : P(m)$ where $\boldsymbol{s \neq n}$

Homogeneity

In many languages, directional numeral modifiers have not only a spatial but also a temporal meaning. The temporal and spatial counterparts of directional numeral modifiers require a homogeneous interval of moments in time and points in space respectively (all examples and definitions in this section are from Nouwen, 2008):

(31) a. #I ate an apple until 3pm.
b. I slept until 3pm.

(32) 'I slept' holds at interval I. $\rightarrow$ 'I slept' holds at each sub-interval I' of I. (see also e.g. de Swart, 1996; Condoravdi, 2008)

(33) a. #He relocated up to Amsterdam.
b. He ran up to the edge of the lake. (examples from Piñón, 1994)

(34) $[\![\text{p up to x}]\!] = \forall P' \subseteq P$: p holds at P', where P is some path ending in x (see also e.g. Zwarts, 2008, Pantcheva, 2011)

The range requirement

We see something similar in the numeral domain. Directional numeral modifiers belong in a class of numeral modifiers that require a range of possibilities to quantify over (Nouwen, 2010a):

(35) a. Sarah is allowed to spend up to 20% of the budget.
b. Jim polished up to five pairs of shoes.
c. #The total number of visitors last year was up to 1000. (Nouwen, 2008)

4 Conclusions and future work

- The thing that makes directional numeral modifiers different is that they assert a lower bound and implicate an upper bound.
- This difference explains why directional numeral modifiers display the bottom-of-the-scale effect, have positive directivity, and have an upper bound that is cancellable and reinforceable.

The account predicts that directional numeral modifiers are upward entailing. Is this the case?

Normally, upper-bounded numeral modifiers are downward entailing, while lowed-bounded numeral modifiers are upward entailing:

(36) a. {At most / fewer than} ten people are reading a novel. $\models$
b. {At most / fewer than} ten people are reading a crime novel.

(37) a. {At least / more than} ten people are reading a crime novel. $\models$
b. {At least / more than} ten people are reading a novel.

What about directional numeral modifiers?

(38) a. Up to ten people are reading a novel. ?$\models$
b. Up to ten people are reading a crime novel.
($\not\models$ according to Schwarz et al., 2012)

(39) a. Up to ten people are reading a crime novel. ?$\models$
b. Up to ten people are reading a novel.

Dutch examples:

(40) a. Maximaal 50% van de bevolking stemt links. $\models$
b. Maximaal 50% van de bevolking stemt GroenLinks.

(41) a. Tot 50% van de bevolking stemt links. ?$\models$
b. Tot 50% van de bevolking stemt GroenLinks.

(42) a. Tot 50% van de bevolking stemt GroenLinks. ?$\models$
b. Tot 50% van de bevolking stemt links.

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