The Semantics of Plurals

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An observation

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  (1) The boys surrounded the building.

  (2) The boys are tall.

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Observation 1

Choice of predicate affects availability of distributive readings.

Another observation

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- But not in every context:

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Observation 2

Quantifiers and other operators may induce a distributive reading.

A third observation

- Here is another ambiguous example:

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Observation 3

Distributivity creates numerical dependencies between quantifiers.

The source of distributivity

- Take a sentence like (7):

  (7) Two students danced.

- We know this sentence is ambiguous between a distributive reading and a collective reading:

  (8) a. $\textsc{dance}(a \oplus b)$
  b. $\textsc{dance}(a) \wedge \textsc{dance}(b)$

- What is the source of the distributivity?

  1. The DP **two students**
  2. The VP **danced**

Both DPs and VPs are ambiguous

- Two early approaches indicate that the ambiguity lies in both DPs and VPs.
- Bennett (1974), who extends Montague grammar to deal with plurals, argues that distributive and collective DPs are of different types, the former denoting sets (type $\langle e, t \rangle$) and the latter denoting sets of sets (type $\langle \langle e, t \rangle, t \rangle$).
- Predicates have to be specified as being of type $\langle \langle e, t \rangle, t \rangle$ (select for distributive) or $\langle \langle \langle e, t \rangle, t \rangle, t \rangle$ (select for collective) or ambiguous between both.

Both DPs and VPs are ambiguous

- Scha (1981), building on Bartsch (1973), treats all predication as inherently collective.
- Distributive predication (and cumulative predication, more on that later) is derived from collective predication via meaning postulates.
- Both determiners, and verbs, have to be lexically marked as to whether they allow this to happen.
- Neither approach is particularly attractive from a compositional semantics perspective, and they quickly gave way to views that attribute the ambiguity to either the DP or the VP but not both.

DP ambiguity

- One such view was offered by Lakoff (1970).
- Re-formulating his approach in more modern terms, it states that noun phrases are ambiguous between two readings:
  1. A quantifier reading
  2. An argument reading

DP ambiguity

- Quantifiers undergo obligatory raising, while arguments do not.
- So, for example:

(9) $[\![\text{John and Bill}]\!]_C = j \oplus b$

(10) $[\![\text{John and Bill}]\!]_D = \lambda P[P(j) \wedge P(b)]$

DP ambiguity

- Predicates, however, are unambiguous:

(11) $[\![\text{tall}]\!] = \{j, b\}$

(12) $[\![\text{met}]\!] = \{j \oplus b\}$

(13) $[\![\text{dance}]\!] = \{j, b, j \oplus b\}$

DP ambiguity

- Predicates, however, are unambiguous:

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(15) $[\![\text{met}]\!] = \{j \oplus b\}$

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- **tall** can thus only combine with the quantifier reading of the DP.
- **met** can only combine with the argument reading.
- And **dance** can combine with both.

DP ambiguity

- This view is attractive in that it draws a simple view of distributivity, and the division of work between quantification and predicates.
- Predicate distributivity amounts to a lexical fact about their denotations. If they contain atoms in their denotation, they have distributive readings. If they contain sums, they have collective readings. The two are not mutually exclusive.
- The actual work of distributivity is done by quantifiers.
- No need to distinguish type 1 and type 2 distributivity.

DP ambiguity

- DP ambiguity views were popular in the 70s and 80s and persisted until the early 90s (Gillon 1990, 1992).
- However, a convincing argument against them was offered by (Lasersohn 1995):

  (17) The students closed their notebooks, left the room, and gathered in the hall after class.

- The same DP can have both collective a distributive readings in the same sentence.

V ambiguity

- Lasersohn's argument leads towards an alternate view, that it is the VP that is ambiguous.
- This was first proposed by Hoeksema (1983).
- In Hoeksema's view, plural NPs always denote sets of sets; below I will rewrite this as sums.

(18) $[\![\text{two men}]\!] = \{j \oplus b, b \oplus c, c \oplus j ...\}$

(19) $[\![\text{John and Bill}]\!] = \{j \oplus b\}$

V ambiguity

- Distributive/collective only predicates are unambiguous:

(20) $[\![\text{tall}]\!] = \{j \oplus b, j, b\}$

(21) $[\![\text{are a good team}]\!] = \{j \oplus b\}$

- Ambiguous sentences arise because the predicate is ambiguous:

(22) $[\![\text{dance}]\!]_C = \{j \oplus b\}$

(23) $[\![\text{dance}]\!]_C = \{j \oplus b, j, b\}$

V ambiguity

- Note that in Hoeksema's system, distributivity is an inference.

(24) a. John and Bill are a good team.
b. GOOD-TEAM($j \oplus b$)

(25) a. John and Bill are tall.
b. TALL($j \oplus b$)

- There is no difference in the logical form of a distributive or a collective sentence.
- Rather, we are able to make the lexical inference that if (25b) is true, then it must also be true that TALL(j) and TALL(b).

V ambiguity

- One problem with Hoeksema's system is that it predicts massive (and systematic) lexical ambiguity.

  (26) Two students danced.

- While it is well known that sentences like (26) are ambiguous, is it really true that there are two lexical entries for **dance**?
- Link (1983) proposes a semantics of distributivity and collectivity that avoids this problem, by introducing distributivity operators.

Distributivity operators

- Link's semantics for inherently collective and distributive predicates is the same as Hoeksema's:

  (27) $[\![\text{tall}]\!] = \{j \oplus b, j, b\}$

  (28) $[\![\text{are a good team}]\!] = \{j \oplus b\}$

- However, ambiguous predicates get only one denotation; this may be distributive, or not, depending on the current state of the world.

VP ambiguity

- Under the collective reading, arguments combine directly with the ambiguous predicate:

(29) a. John and Bill danced.
b. $\textsc{dance}(j \oplus b)$

- In the distributive reading, however, an operator ^{DIST} applies to the predicate before composition. This operator is defined as follows:

(30) $^{DIST}P = \lambda X[\forall x[x \in X \wedge \textsc{atom}(x) \rightarrow P(x)]]$

- In essence, the distributive operator takes the implication of distributivity and places it in the truth conditions.

VP ambiguity

- For example:

(31) a. John and Bill danced.
b. $\textsc{dance}(j \oplus b)$
c. $^{DIST}\textsc{dance}(j \oplus b)$

- (31b) will be true if $j \oplus b$ is in the denotation of **dance**.
- (31c) will be true if $j \oplus b$ is in the denotation of **dance**, AND j is in the denotation of **dance**, AND b is in the denotation of **dance**.

VP ambiguity

- What happens when ^{DIST} combines with lexically collective or distributive predicates?

(32) a. John and Bill are a good team.
b. GOOD-TEAM($j \oplus b$)
c. ^{DIST}GOOD-TEAM($j \oplus b$)

- Since j and b can never be in the denotation of **be a good team**, (32c) is a contradiction.

(33) a. John and Bill are tall.
b. TALL($j \oplus b$)
c. ^{DIST}TALL($j \oplus b$)

- Since it is lexically specified that if $j \oplus b$ is in the denotation of **tall**, j and b must be there too, (33b) and (33c) are equivalent.

Distributivity and plurality

- We have seen how a system such as Link's works for conjoined subjects. What of plural subjects?
- In Link's system, the denotation for plural noun phrases is achieved by the the use of a pluralizing operator *:

(34) $^*P$ is the closure of P under the sum operation.

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

(36) $[\![^*boy]\!] = \{a, b, c, a \oplus b, a \oplus c, b \oplus c, a \oplus b \oplus c\}$

- Thus:

(37) a. Some boys danced.
b. $\exists X[^*\textsc{boy}(X) \wedge^{DIST} \textsc{dance}(X)]$

Distributivity and plurality

- Landman (1989, 2000) points out that the ^{DIST} operator can be redefined in terms of the * operator:

(38) $^{DIST}P =^* ATOM(P)$, where $ATOM(P)$ is the subset of P that includes only atoms.

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- This leads to Landman's overall statement:

Definition

Distributivity is predicate plurality.

Groups

- Take the following sentence:

  (39) The cards below 7 and the cards from 7 up were separated.

- **separated** is a collective predicate; we cannot paraphrase (39) as (40):

  (40) The cards below 7 were separated and the cards from 7 up were separated.

- Thus, according to our discussion so far, (39) translates as:

  (41) $\textsc{separate}([\oplus 2 \oplus 3 \oplus 4 \oplus 5 \oplus 6] \oplus [7 \oplus 8 \oplus 9 \oplus 10 \oplus J \oplus Q \oplus K \oplus A])$

Groups

- But what of:

  (42) The cards below 9 and the cards from 9 up were separated.

  (43) $\textsc{separate}([2 \oplus 3 \oplus 4 \oplus 5 \oplus 6 \oplus 7 \oplus 8 \oplus 9] \oplus [10 \oplus J \oplus Q \oplus K \oplus A])$

- $[2 \oplus 3 \oplus 4 \oplus 5 \oplus 6 \oplus 7 \oplus 8 \oplus 9] \oplus [10 \oplus J \oplus Q \oplus K \oplus A]$ is identical to $[2 \oplus 3 \oplus 4 \oplus 5 \oplus 6] \oplus [7 \oplus 8 \oplus 9 \oplus 10 \oplus J \oplus Q \oplus K \oplus A]$.
- Thus, the two sentences appear to be synonymous.

Groups

- Partially in order to solve this problem, Landman (1989), following Link (1984), introduces the notion of a group.
- A group is a noun phrase that denotes a singular entity, that corresponds to multiple entities.
- We have lexical nouns that denote groups: e.g. **The committee**:

(44) The committee is made up of John, Mary, Bill and Susan.

Or contexts?

- Imagine that in our farm we have four animals: one young pig, one old pig, one young cow, and one old cow.

  (45) The cows and the pigs were separated.

  (46) The young animals and the old animals were separated.

  (47) The animals were separated.

- We don't necessarily have pre-conceived notions of groups, but perhaps they are given by the context (Schwarzschild 1996)

Intermediate distributivity

- Some sentences cannot be simply viewed as distributive or collective (Gillon 1987, 1990):

  (48) Gilbert, Sullivan and Mozart wrote operas.

- Mozart wrote operas, and Gilbert and Sullivan wrote operas.
- The sentence is not true on the collective reading, as the three men did not write anything together.
- The sentence is not true on the distributive reading, as neither Gilbert nor Sullivan wrote operas alone.

Intermediate distributivity

- It gets even more complicated:

  (49) Rodgers, Hammerstein and Hart wrote musicals.

- Rodgers and Hammerstein wrote musicals together, and Hammerstein and Hart wrote musicals together, but they did not write musicals as a trio, nor individually.

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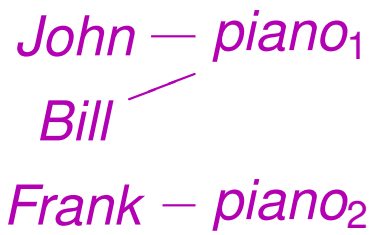
- Rodgers and Hammerstein wrote musicals together, and Hammerstein and Hart wrote musicals together, but they did not write musicals as a trio, nor individually.
- We need a theory for “intermediate” readings.

Cumulative readings

- So far, we have talked about the distinction between distributive and collective readings.
- But as far back as Scha (1981) that in sentences with more than one argument, there is another type of reading: the cumulative reading.

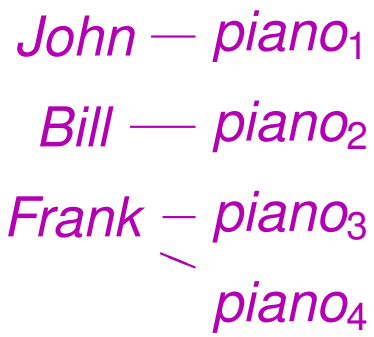
(50) Three boys carried two pianos.



Cumulative readings

- Also:

(51) Three boys carried four pianos.



Cumulative readings

- Cumulative readings have the following two properties:
  1. Each boy must participate in the carrying, and each piano must be carried.
  2. There is no number dependency between the two arguments. (No type 3 distributivity)
- Are they distributive readings? Or collective? Or neither?

The collective/collective view

- One view argues that cumulative readings are a sub-type of collective readings (Roberts 1987).
- Specifically, they argue that in the cumulative readings, both arguments are interpreted collectively.

(52) Three boys carried four pianos.

(53) A group of three boys carried a group of four pianos.

The collective/collective view

- Landman (2000), however, points out one critical flaw to this view:

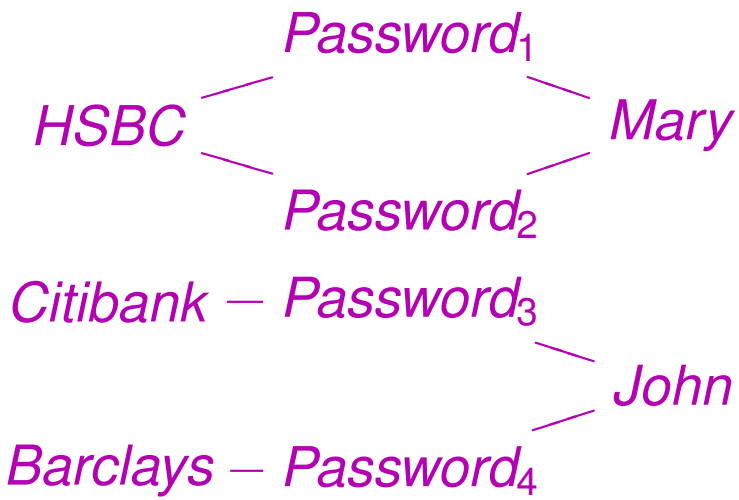
  (54) Ten hens laid fifteen eggs.

- **lay an egg** is an inherently distributive notion. It is impossible to jointly lay eggs.

Mixed distributivity

- Consider:

(55) Three banks gave two new members each exactly two passwords.



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