How many *most’s*?

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The Broader Issue

<table>
<thead>
<tr>
<th><strong>Majority</strong></th>
<th>• Fred has read <em>most</em> Shakespeare plays</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relative</strong></td>
<td>• Fred has read the <em>most</em> Shakespeare plays</td>
</tr>
<tr>
<td><strong>Adjectival Superlative</strong></td>
<td>• Fred bought the <em>most</em> expensive book</td>
</tr>
<tr>
<td><strong>Superlative Quantifier</strong></td>
<td>• Fred has read at <em>most</em> 15 Shakespeare plays</td>
</tr>
</tbody>
</table>

Same underlying core semantics?
Outline

- Unifying majority & relative most as many + -est (Hackl 2009)
- Degree-operator analysis of many/much
- Extension to adjectival superlative most
- Extension to superlative quantifier most
- A closer look at majority most – and a connection to analog quantity comparison
- Summary

Majority vs. Relative Most

<table>
<thead>
<tr>
<th>Out of 37 Shakespeare plays...</th>
<th>Majority</th>
<th>Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred: 28</td>
<td>True</td>
<td>False</td>
</tr>
<tr>
<td>John: 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fred: 14</td>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td>All other relevant individuals: &lt;10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hackl (2009)

**5**

- **Most** = **many** + **-est**  
  [majority & relative]
  
  - cf. German **die meisten**

- Availability of majority vs. relative reading parallels ambiguity in superlatives

<table>
<thead>
<tr>
<th>Fred climbed the highest mountain</th>
<th>Fred has read…</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Higher than any other mountain (Absolute)</td>
<td>…most Shakespeare plays (Majority)</td>
</tr>
<tr>
<td>• Higher than mountains climbed by any other relevant individual (Relative)</td>
<td>…the most Shakespeare plays (Relative)</td>
</tr>
</tbody>
</table>

- Ambiguity derives from 2 scope options for superlative morpheme, corresponding to 2 choices for comparison class (Heim 1999):

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- **Semantics:**

  \[
  [[\text{-est}]](C_{(et)})(D_{(d,et)})(x)=1 \text{ iff } \\
  \forall y \in C[y \neq x \rightarrow \max\{d:D(d)(x)\} > \max\{d:D(d)(y)\}]
  \]

  defined iff \(x \in C\) and \(C\) has multiple members

  \[
  [[\text{many}]] = \lambda P_{(et)} \lambda d \lambda x. P(x) \land |x| \geq d
  \]

- **Syntax**

  [**Majority**]

  Fred has read \([DP [NP -est1 [NP d1-many Shakespeare plays]]]]\)

  [**Relative**]

  Fred \([-est1 [has read [DP the [NP d1-many Shakespeare plays]]]]\)
Hackl (2009)

Relative

Fred has read the most Shakespeare plays

Fred [-est, [has read [DP the [NP d1-many Shakespeare plays]]]]

\[ C = \{Fred, Sue, Jane, Bob, \ldots\} \]

\[ \forall x \in C \neg(x = Fred) \rightarrow \max\{d : \exists y[S-play(y) \land \text{read } y \land |y| \geq d] \} > \max\{d : \exists y[S-play(y) \land \text{read } y \land |y| \geq d] \} \]

• True iff # of plays Fred read exceeds # read by all other members of C

Hackl (2009)

Majority

Fred has read most Shakespeare plays

Fred has read [DP [NP -est, [NP d1-many Shakespeare plays]]]

\[ C = \{Hamlet\setminus Othello\setminus Lear, Hamlet\setminus Othello, Othello\setminus Romeo\& Juliet, \ldots\} \]

\[ \exists x[S-play(x) \land \text{read } x \land \forall y[S-play(y) \Rightarrow \max\{d : |x| \geq d\} > \max\{d : |y| \geq d\}] \]

• If non-identity \((x \neq y)\) construed as non-overlap \((x \cap y = \emptyset)\),
true iff set of plays Fred read outnumbers set of plays he hasn’t read
Degree-based theory of Q-adjectives

- Most = superlative of many & much (Bresnan 1973)
- Many/much (and few/little) as degree operators (Solt 2009, 2010)
  \[
  [[\text{many}]] = [[\text{much}]] = \lambda d.\lambda x.P_{(d_t)}(d)
  \]
- Motivated by non-quantificational/non-adjectival uses
  Many fewer than 100 students attended to lecture
- Quantificational uses involve null measure function MEAS and quantification via existential closure \(\exists\)
  Fred is diligent; in fact, he is too much so

Applied to (the) Most

- Fred has read the most Shakespeare plays

\[
\begin{align*}
\text{Fred [-est}_2 [d_2\text{-many}_1 [\text{has read } & \text{DP the } \{\text{MeasP } d_1\text{-MEAS } [\text{NP } S. \text{ plays}]\}]])] = \\
&\lambda d.\lambda x.\exists y[S\text{-play}(y) \land x \text{ read } y \land |y| \geq d_1]
\end{align*}
\]

\[
\begin{align*}
\text{[[has read the } & d_1\text{-MEAS Shakespeare plays]}} = \\
&\lambda d.\lambda x.\exists y[S\text{-play}(y) \land x \text{ read } y \land |y| \geq d_1]
\end{align*}
\]

\[
\begin{align*}
\text{[[d}_2\text{-many(has read the } & d_1\text{-MEAS Shakespeare plays)]}} = \\
&\lambda x.\exists y[S\text{-play}(y) \land x \text{ read } y \land |y| \geq d_2]
\end{align*}
\]

**Application of -est produces same results as Hackl (2009)**
Adjectival Superlative Most

- Fred bought the most expensive book

- Looks like spell-out of superlative morpheme
  - the smartest
  - the most intelligent

- Allows absolute and relative readings (like synthetic superlatives)

- Captured as (null) much + -est

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Adjectival Superlative Most

- Fred bought the most expensive book

- Relative

Fred [-est₂ [d₂-much₁ [bought [DP the [NP d₁-expensive book]]]]]

[[bought the d₁-expensive book]] =

\[= \lambda d₁. \lambda x. \exists y [\text{book}(y) \land x \text{ bought } y \land \text{COST}(y) \geq d₁]\]

[[d₂-much(bought the d₁-expensive book)]] =

\[= \lambda x. \exists y [\text{book}(y) \land x \text{ bought } y \land \text{COST}(y) \geq d₂]\]

\[\rightarrow \lambda d₂. \lambda x. \exists y [\text{book}(y) \land x \text{ bought } y \land \text{COST}(y) \geq d₂]\]

- Identical set of degrees; serves as argument to -est

- Adjectival superlative most aligned to superlatives
Superlative Quantifier *Most*

- Fred has read at most 15 Shakespeare plays

- Evidence of link to superlative:
  - Paraphrasable with explicit superlative
    - The largest number of Shakespeare plays Fred could have read is 15
  - Similar use of other superlatives
    - Fred will arrive by 11 at the latest
    - Fred is 30 at the oldest
  - Cross-linguistic parallels (e.g. German):
    - Fred hat höchstens 15 Stücke von Shakespeare gelesen

- Requires a range of values (Nouwen 2010):
  - Fred invited at most 15 friends
    - Infelicitous if speaker knows precisely how many
    - Felicitous on epistemic reading
  - Fred can invite at most 15 friends
  - The students invited at most 15 friends

Parallels restriction on the superlative
- You're the best mother I have

- Existing accounts (e.g. Krifka 1999; Geurts & Nouwen 2007; Nouwen 2010) do not capture these connections
Superlative Quantifier *Most*

Fred has read...

- ... most Shakespeare plays
  - Comparison of plays
  - *Majority*

- ... the most Shakespeare plays
  - Comparison of readers
  - *Relative*

- ... at most 15 Shakespeare plays
  - Comparison of worlds
  - *Superlative Quantifier*

- Covert modality (Nouwen 2010) captured via set of accessible worlds as comparison class

\[
\langle \text{at most 15} \rangle = \lambda D_{(d)} \forall w [\langle \text{most} \rangle(Acc)(\lambda w' \lambda d. D(d) \text{ in } w')(w) \rightarrow \\
\max \{d : D(d) \text{ in } w\} = 15]
\]
**Superlative Quantifier Most**

\[
\forall W \forall W'_{ac} \left[ \forall w \rightarrow \max\{d: \exists y[S\text{-play}(y) \land Fred \text{ read } y \text{ in } w \land |y| \geq d]\} \rightarrow \max\{d: \exists y[S\text{-play}(y) \land Fred \text{ read } y \text{ in } w' \land |y| \geq d]\} \rightarrow \max\{d: \exists y[S\text{-play}(y) \land Fred \text{ read } y \text{ in } w \land |y| \geq d]\} = 15
\]

where two worlds are considered distinct \((w' \neq w)\) iff the maximum # of plays Fred read in them is different

‘In the worlds where Fred read the most plays, he read 15’

- To satisfy the presupposition that \(C\) has multiple distinct elements, must be distinct epistemic possibilities

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**Majority Most Revisited**

- Unified analysis of majority & relative most (Hackl 2009 and present extension)
  - \(\text{Most} = \text{many} + \text{-est}\)
  - Majority vs. relative readings reflect scope of \text{-est}
  - Majority most aligned to superlatives on absolute reading

- Facts explained
  - Cross-linguistic pattern: both readings available to superlative form of many
    
    \[
    \text{Cei mai multi oameni beau bere} \quad \text{Romanian} \quad (\text{Živanović 2008})
    
    ‘Most/the most people drink beer’
**Majority Most Revisited**

- Facts explained
  - Absence of *fewest* corresponding to majority *most* (Hackl 2009)

\[
\left[\text{NP} \quad \text{est} \quad \text{NP} \quad \text{d-many} \quad \text{NP} \quad \text{d-MEAS Shakespeare plays}]] \right] =
\{ x : x \text{ is a plurality of Shakespeare plays larger than any other non-overlapping plurality of Shakespeare plays} \}
\]

\[
\left[\text{NP} \quad \text{est} \quad \text{NP} \quad \text{d-few} \quad \text{NP} \quad \text{d-MEAS Shakespeare plays}]] \right] =
\{ x : x \text{ is a plurality of Shakespeare plays smaller than any other non-overlapping plurality of Shakespeare plays} \}
\]

- An objection diffused:
  - Absence of definite article with majority *most* (vs. absolute superlative *the longest*)

\[
\left[\text{NP} \quad \text{est} \quad \text{NP} \quad \text{d-long Shakespeare play}]] \right] =
\{ x : x \text{ is a Shakespeare play longer than any Shakespeare play} \}
\]
- Singleton set

\[
\left[\text{NP} \quad \text{est} \quad \text{NP} \quad \text{d-many} \quad \text{NP} \quad \text{d-MEAS Shakespeare plays}]] \right] =
\{ x : x \text{ is a plurality of Shakespeare plays larger than any other non-overlapping plurality of Shakespeare plays} \}
\]
- Not a singleton set
However...

Fred has read most Shakespeare plays
Plays Fred has read: 19/37   Plays Fred hasn't read: 18/37
INFELICITOUS (FALSE?)

Fred has read the most Shakespeare plays
Fred: 19   Sue: 18   Other members of C: <18
TRUE

Fred read the longest book
Book Fred read: 300pp   Next-longest book: 299pp
TRUE

- Majority most (unlike both relative most and absolute superlatives) is insensitive to small differences in measure

Distribution of Most

The survey showed that most students (81.5%) do not use websites for math-related assignments

Source: COCA
Davies (2008-)

![Frequency distribution of percentages]
Majority vs. Relative Most

Fred has read most Shakespeare plays

\[\lambda x. \forall y: \text{S-play}(y)[x \neq y \rightarrow \max\{|d; x| \geq d\} > \max\{|d; y| \geq d\}]\]

- Comparison of (pluralities of) plays - direct

Fred has read the most Shakespeare plays

\[\lambda x. \forall y \in C[x \neq y \rightarrow \max\{|d; \exists z: \text{S-play}(z) \land x \text{ read } z \land |z| \geq d\} > \max\{|d; \exists z: \text{S-play}(z) \land y \text{ read } z \land |z| \geq d\}]}\]

- Comparison of readers - indirect

Set comparison is different

- Separate cognitive systems for precise and approximate quantity (Dehaene 1997 *inter alia*)
  - Digital vs. analog

- Approximate number system (ANS):
  - Involved in approx. arithmetic and set size comparison
  - Present in pre-verbal children, aphasia patients, cultures w/out complex number systems – and animals (lack representation of precise number)
  - ...but also active in verbal adults
  - Exhibits size & distance effects subject to Weber’s law
    - i.e., requires sufficient ratio between set sizes
**Most and Analog Quantity**

- **Use with non-enumerable sets (Solt ms.)**
  
  But like *most things*, obesity is not spread equally across social classes *(Mens Health, 23(7), p. 164, 2008)*

  cf. *But like more than half of things….*

  *Most beliefs, worries, and memories* also operate outside awareness *(Science News, 142(16), 1992)*

  cf. *More than half of beliefs, worries and memories…*

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**Most and Analog Quantity**

- **Processing**
  
  *Most of the dots are blue*

  □ In timed task, verification exhibits size & distance effects *(Pietrowski et al. 2009)*

- **Acquisition**
  
  *Most of the crayons are yellow*

  □ Young children’s acquisition of *most* independent of mastery of large exact number *(Halberda et al. 2008)*

  □ But requires sufficient difference between set sizes
Analog Quantity Formally

- Approximate (analog) quantity comparison may be modeled via a semi-order on sets (van Rooij 2009)
- Transitive with respect to > but not ~, i.e. the following may obtain: x ~ y and y ~ z but x > z
- Ordering based on a ‘significantly greater than’ relationship

A structure S, > where S is a set and > is a binary relation on S, is a semi-order iff

∀x, y, z, v, w ∈ S:

a. ¬(x > x)

b. ((x > y) ∧ (v > w)) → ((x > w) ∨ (v > y))

c. ((x > y) ∧ (y > z)) → ((x > v) ∨ (v > z))

Most and Analog Comparison

- Logical form for majority most allows default interpretation relative to (semi-)order on sets
- Necessarily for non-enumerable domains
- By strengthening to stereotypical interpretation otherwise (Horn 1984)

\[ \lambda x. \forall y : S \text{-play}(y)[x \neq y \rightarrow \max\{d : |x| \geq d\} > \max\{d : |y| \geq d\}] \]

\[ \lambda x. \forall y : S \text{-play}(y)[x \neq y \rightarrow x > y] \]

- That for relative the most does not

\[ \lambda x. \forall y \in C[x \neq y \rightarrow \max\{d : \exists z[S \text{-play}(z) \land x \text{ read } z \land |z| \geq d]\} > \max\{d : \exists z[S \text{-play}(z) \land y \text{ read } z \land |z| \geq d]\}] \]

- Not a comparison of sets
Summary

Various uses of most may be unified via:
- Degree operator analysis of superlative, with multiple scope options for superlative morpheme
- Degree operator analysis of many/much
- Extension of comparison classes to include sets of worlds
- Majority most exhibits properties that distinguish it from other most's
  - Argued to be related to potential for evaluation via analog quantity comparison

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