Lecture 13: Generalized Quantifiers

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Summary

- lfSent:: Sent -> LF *(= Formula Term)*
  - s1 = Sent(NP1 Some Boy) (VP1 Admired Goldilocks)
  - lfSent s1 = E x1 conj[boy[x1],admire[x1,Goldilocks]]
- evl:: Eq a => *Evaluates formula in a model*
  [a] -> *Domain*
  Interp a -> *interpretation of relation symbols*
  FInterp a -> *interpretation of function symbols*
  Lookup a -> *interpretation of variables*
  Formula Term -> Bool

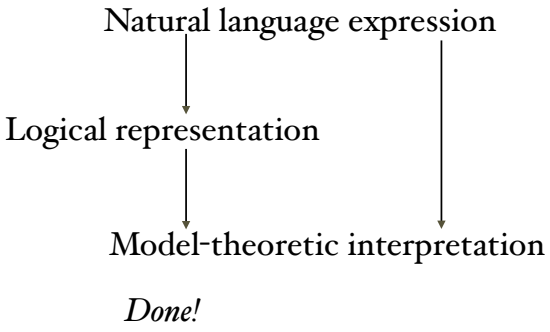
Evaluating

- where
  - domain = entities = [A..Z,UnSpec]
  - int0 in MCWPL.hs gives values for all relation symbols
  - fint3 gives values for all constants (functions)
  - ass0 gives value for variables
- evl entities int0 fint3 ass0 (lfSent s1)
  returns meaning of s1 in model
- See code!!!

Direct Interpretation

Interpreting language

- Two options: indirect & direct



Why do the second?

- Principle of compositionally:
  - Meaning of whole composed from meaning of parts
  - Want to preserve structure of sentences.
  - Every girl liked a dog
    - $\forall x\,(girl(x) \rightarrow \exists y(dog(y) \wedge liked(x,y)))$
    - *Draw parse trees!*
- Problems with general quantifiers

Generalized Quantifiers

- Approach due to Barwise & Cooper (1981)
- Quantifiers are binary relations over power set of domain of discourse.
  - Every dog barked: $\{x \mid dog(x)\} \subseteq \{x: barked(x)\}$
  - A dog barked: $\{x \mid dog(x)\} \cap \{x: barked(x)\} \neq \varnothing$
  - Most dogs barked:
    $|\{x \mid dog(x)\} \cap \{x: barked(x)\}| > 0.5*|\{x \mid dog(x)\}$

Conditions on Quantifiers

- Write $D_E AB$ to stand for determiner expression (like those on previous slide) with E the domain of discourse, A the restriction and B its body.
  - E.g., "Every dog barked" has dog(x) as restriction and barked(x) as the body.
  - Similarly for "A dog barked" or "Most dogs barked"

Conditions on Quantifiers

- Require:
  - EXT: For all A, B $\subseteq$ E $\subseteq$ E', $D_E AB \Leftrightarrow D_{E'} AB$
    - *Extension*
    - Expanding the domain makes no difference to truth if A, B fixed.
    - Really, only A $\cup$ B matters
  - CONS: For all A, B $\subseteq$ E $\subseteq$ E', $D_E AB \Leftrightarrow D_{E'} A(A \cap B)$
    - *Conservativity*
    - For the body, only the elements in the body matter
    - Not hold of "Only dogs barked"
  - EXT + CONS $\Rightarrow$ Only A-B and A$\cap$B matter in determining truth of $D_E AB$

Expressing Quantifiers

- Quantifiers can be expressed using only $|A \cap B|$ and $|A - B|$
  - All A are B $\Rightarrow |A - B| = 0$
  - Some A are B $\Rightarrow |A \cap B| > 0$
  - Most A are B $\Rightarrow |A \cap B| > |A - B|$

Further Conditions

- For quantifiers on quantity:
  - ISOM: If f is a bijection from E to E',
    then $D_E AB \Leftrightarrow D_{E'}$ f[A] f[B]

Questions?