Administrivia

• Reminder
  – Homework 2 due next Tuesday
  – need help getting started?
Administrivia

• today
  – (3:30pm – 4:40pm)
    • lecture here in Comm 214
  – (4:45pm – 5:45pm) (EXTRA)
    • lab practice in Social Sciences Lab 224

• we’ll begin doing the homework exercises in the lab
Today’s Topics

• Grammar Rule Recursion
  – Prolog behavior

• Handout (from Tuesday)
  – Chapter 3: *More about Predicates*
    • Short Quiz #3 on Thursday
Grammar Rule Recursion

• **Recursion:**
  – A phrase may contain embedded inside another instance of the same phrase

• **Example:**
  – sentence with a relative clause
  – \([\text{Sbar} \ [\text{S} I \text{ saw} \ [\text{NP} \text{ the man} \ [\text{Sbar} \ [\text{S} \text{ attacked me}])))])
  – \([\text{Sbar} \ [\text{S} I \text{ saw} \ [\text{NP} \text{ the man} \ [\text{Sbar} \ [\text{S} \text{ attacked} \ [\text{NP} \text{ the dog} \ [\text{Sbar} \ [\text{S} \text{ attacked me } ]])])]))])]
Grammar Rule Recursion

• Example:
  – assuming NP (not DP analysis) for simplicity...
  – \([_{NP} \ [_{NP} \text{John}] \text{'s mother}]\)
  – \([_{NP} \ [_{NP} \ [_{NP} \text{John}]]\text{'s mother]}\text{'}s \text{ cat}]\)

• DCG rules:
  – \(\text{np} \rightarrow \text{np}, \ [``\text{'s}'], \ n.\)
  – \(\text{n} \rightarrow [\text{mother}].\)
  – \(\text{n} \rightarrow [\text{cat}].\)
  – \(\text{np} \rightarrow [\text{john}].\)
Grammar Rule Recursion

• Prolog Computation Rule:
  – select “first” matching grammar rule each time we call a non-terminal
  – “first” = first line that matches

• DCG rules:
  - np --> np, ['"s"], n.
  - n --> [mother].
  - n --> [cat].
  - np --> [john].
  – Leads to infinite loop here...
Grammar Rule Recursion

• General Rule for writing recursive rules:
  – put recursive case last
  – i.e. place non-recursive rules for a non-terminal ahead of the recursive ones

• DCG rules:
  - np --> [john].
  - np --> np, [``s``], n.
  - n --> [mother].
  - n --> [cat].
  – no looping here...
Grammar Rule Recursion

• You’ll need it for homework 2...

• Examples:

  – \[[S\text{bar} [NP \text{Who}] [S [VP [V is] [NP[NP [DET a][N student]]]]]]\text{CONJ and}}[NP [DET a][N baseball fan]]]

  – \[[S\text{bar} [NP \text{Who}] [S [VP [V is] [NP[NP [DET a][N student]]]]]]\text{CONJ and}}[NP [\text{NEG not}]NP [DET a][N baseball fan]]]

• Consider a possible NP rule for conjoining two NPs:

  – \text{np} \rightarrow \text{np, conj, np}.

  – \text{conj} \rightarrow \text{[and]}. 
More about Predicates

• 3.1 Other Types of Predicates: Adjectives, Predicate Nominals
  – (1) Shelby is small
  – (2) Shelby is a dog

• Semantics of *is* and *a*.
• Possibilities:
  – Meaningless
  – Non-interfering meaning - trivial meaning
More about Predicates

• 3.1 Other Types of Predicates: Adjectives, Predicate Nominals
  – (1) Shelby is small
  – (2) Shelby is a dog

• Semantics of (indefinite determiner) a.
  – (3) a dog bit me
  – (4) the/one/every dog bit me

  – quantifier?
More about Predicates

• Semantics of (indefinite determiner) $a$.
  – (3) a dog bit me
  – (4) the/one/every dog bit me
  – quantifier?
  – (3’) there exists a dog $x$ such that $\text{bit}(x, \text{me})$
  – (4’) every: for each dog $x$, $\text{bit}(x, \text{me})$
More about Predicates

• Semantics of (indefinite determiner) *a*.
  – (3) a dog bit me
  – (3’) there exists a dog $x$ such that $\text{bit}(x,\text{me})$

  – (2) Shelby is a dog
  – semantics involving “there exist a dog $x$”
More about Predicates

• Semantics of (indefinite determiner) $a$.
  – (3) a dog bit me
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  – (2) Shelby is a dog
  – semantics involving “there exist a dog $x$”
  – No...
More about Predicates

• 3.2 Transitive Verbs
  – (5) Shelby saw Hannibal

• 3.3 Relative Clauses
  – (7) Hannibal is [who Shelby saw]

  – semantics of [who Shelby saw]
More about Predicates

• 3.3 Relative Clauses
  – (7) Hannibal is [who Shelby saw]
  – semantics of [who Shelby saw]
    – Shelby saw who saw(shelby,who).
    – (with logic variable) saw(shelby,X).
More about Predicates

• 3.4 Topicalization
  – (9) Shelby, Mary saw

• Semantics?

• Paraphrase (9) as:
  – (10) Shelby is who₁ Mary saw e₁
More about Predicates

• 3.5 Sub-atomic Semantics
• Event semantics
  – (11) Sylvia petted Shelby
• introduce an event variable, call it e
• Prolog-style, we can say:
  – event(e), agent(e,sylvia), patient(e,shelby).
• Notions like:
  – agent, patient, instrument etc. are called thematic roles
More about Predicates

- **lambda calculus:**
  - easy to introduce now...

- Example:

- *barks:* \( \lambda x.x \) barks \( barks(X) \).

  - Shelby barks
  - \([\lambda x.x \text{ barks}](\text{Shelby})\)
  - barks(\(X\)), \(X = \text{shelby}\)

- **Generalization:**
  - \([\lambda x.[\lambda y.y \text{ saw } x]\] \)
Quiz 3

• (3pts)
• Give lambda calculus semantics for:
  – likes
  – likes Mary
  – John likes Mary