CS182

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with slides inspired by Eva Mok and Joe Makin

April 25, 2008
Announcements

• a9 out, due Thursday
• BBS articles are assigned for the final paper!
Schedule

• Last Week
  – Metaphor understanding using KARMA
  – Grammars and parsing

• This Week
  – Construction Grammar, ECG
  – Grammar Learning

• Next Week
  – ECG Learning
Questions

• What are constructions?
• How does ECG use constructions?
• Why is learning language hard?
• What is the poverty of the stimulus?
• What is Gold's Theorem?
Constructions have **form** and **meaning** poles that are subject to type constraints.
Questions

• What are constructions?
• How does ECG use constructions?
• Why is learning language hard?
• What is the poverty of the stimulus?
• What is Gold's Theorem?
# A schema hierarchy of objects (Nomi)

<table>
<thead>
<tr>
<th>Schema</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>schema Entity</strong></td>
<td></td>
</tr>
<tr>
<td><strong>schema Place</strong></td>
<td></td>
</tr>
<tr>
<td><strong>schema Object</strong></td>
<td>subcase of Entity</td>
</tr>
<tr>
<td><strong>schema Referent</strong></td>
<td>subcase of Entity</td>
</tr>
<tr>
<td></td>
<td><strong>roles</strong></td>
</tr>
<tr>
<td></td>
<td><strong>category</strong></td>
</tr>
<tr>
<td></td>
<td><strong>distribution</strong></td>
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<tr>
<td></td>
<td><strong>boundedness</strong></td>
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<tr>
<td></td>
<td><strong>number</strong></td>
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<tr>
<td></td>
<td><strong>gender</strong></td>
</tr>
<tr>
<td></td>
<td><strong>accessibility</strong></td>
</tr>
<tr>
<td></td>
<td><strong>resolved-ref</strong></td>
</tr>
<tr>
<td><strong>schema Physical-Object</strong></td>
<td>subcase of Object, Place</td>
</tr>
<tr>
<td><strong>schema Animate</strong></td>
<td>subcase of Physical-Object</td>
</tr>
<tr>
<td></td>
<td><strong>roles</strong></td>
</tr>
<tr>
<td></td>
<td><strong>animacy</strong></td>
</tr>
<tr>
<td></td>
<td><strong>constraints</strong></td>
</tr>
<tr>
<td></td>
<td><strong>animacy</strong>→true</td>
</tr>
<tr>
<td><strong>schema Manipulable-Object</strong></td>
<td>subcase of Physical-Object</td>
</tr>
<tr>
<td><strong>schema Cup</strong></td>
<td>subcase of Manipulable-Object</td>
</tr>
<tr>
<td><strong>schema Ball</strong></td>
<td>subcase of Toy</td>
</tr>
</tbody>
</table>

| **schema Human**              | subcase of Animate                               |
|                               | **roles**                                        |
|                               | **sex**                                          |
| **schema Nomi**               | subcase of Human                                 |
|                               | **sex**→female                                   |
| **schema Toy**                | subcase of Manipulable-Object                    |
| **schema Ball**               | subcase of Toy                                   |
The schemas we just defined

- **Entity**
  - **Referent**
  - **Object**
  - **Physical-Object**
    - **Food**
      - Cake
      - Juice
    - **Manipulable-Object**
      - Cup
      - Toy
        - Ball
        - Book
        - Block
        - Doll
        - Bed
    - **Animate**
      - Human
        - Nomi
        - Mother
        - Father
# A schema hierarchy of actions (Nomi)

<table>
<thead>
<tr>
<th>Schema</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action</td>
<td>Agent: Entity</td>
</tr>
<tr>
<td>DirectedAction</td>
<td>Subcase of Action, Patient: Entity</td>
</tr>
<tr>
<td>Move</td>
<td>Subcase of Action, Mover: Entity, Direction: Place</td>
</tr>
<tr>
<td>CauseMove</td>
<td>Subcase of DirectedAction, Move, Causer: Human, Mover: Physical-Object, Motion: Move</td>
</tr>
</tbody>
</table>

**Type constraint:**
- motion.mover $\leftrightarrow$ mover
- motion.agent $\leftrightarrow$ causer
- motion.direction $\leftrightarrow$ direction
- agent $\leftrightarrow$ causer
- patient $\leftrightarrow$ mover

**Identification constraint:**
- motion.mover $\leftrightarrow$ mover
- motion.agent $\leftrightarrow$ causer
- motion.direction $\leftrightarrow$ direction
- agent $\leftrightarrow$ causer
- patient $\leftrightarrow$ mover
The schemas we just defined

Action

Directed Action  Move

Cause-Move

Transfer  JointMove
Constructions, finally (Nomi)

**Construction Ref-Expr**
- **form**: Schematic-Form
- **meaning**: Referent

**Construction Nomi-Cn**
- **level 0**
- **subcase of Ref-Expr**
- **form**: Word
  - `self.f.orth` ← "Nomi"
- **meaning**
  - evokes Nomi as n
  - `self.m.category` ↔ n
  - `self.mresolved-ref` ↔ n

**Construction Cup-Cn**
- **level 0**
- **subcase of Ref-Expr**
- **form**: Word
  - `self.f.orth` ← "cup"
- **meaning**
  - evokes Cup as n
  - `self.m.category` ↔ n
  - `self.mresolved-ref` ↔ n

Fancy way of saying that the category of the referent is Nomi.
Constructions, finally (Nomi)

- construction Motion-Verb
  - meaning : Move

- construction Cause-Motion-Verb
  - subcase of Motion-Verb
  - meaning : CauseMove

- construction Get-Cn
  - level 0
  - subcase of Cause-Motion-Verb
  - form : Word
    - self.f.orth ← "get"
Constructions, finally (Nomi)

construction Transitive-Cn
level 2
constructional constituents
agt : Ref-Expr
v : Cause-Motion-Verb
obj : Ref-Expr
form
agt.f before v.f
v.f before obj.f
meaning
v.m.agent ↔ agt.m.resolved-ref
v.m.patient ↔ obj.m.resolved-ref
Questions

- What are constructions?
- How does ECG use constructions?
- Why is learning language hard?
- What is the poverty of the stimulus?
- What is Gold's Theorem?
Difficulty of learning language

- What makes learning language difficult?
  - How many sentences do children hear?
  - How often are those sentences even correct?
  - Even when they're correct, how often are they complete?
  - How often are children corrected when saying something wrong?
  - How many possible languages are there?
Larger context

• War!
  – Is language innate?
  – Covered in book
Questions

- What are constructions?
- How does ECG use constructions?
- Why is learning language hard?
- What is the poverty of the stimulus?
- What is Gold's Theorem?
Poverty and Opulence

• Poverty of the stimulus
  – Coined to suggest how little information children have to learn from

• Opulence of the substrate
  – Opulence = “richness”
  – Coined in response to suggest how much background information children have
Questions

• What are constructions?
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• What is Gold's Theorem?
Gold's Theorem

- Suppose that you have an infinite number of languages
  - language = “set of legal sentences”
- Suppose that for every language $L_n$, there is a bigger language $L_{n+1}$
  - makes every sentence, and then some
- There's some language $L_{\infty}$
  - contains all the sentences in all other languages
- You can arrange data so that no one ever learns $L_{\infty}$