Goal

- A cognitively realistic parser that builds semantic representations (DRSs)
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  - it builds DRSs incrementally, in real time
  - it does semantic (truth-value) evaluation
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- A cognitively realistic parser that builds semantic representations (DRSs)
  - it builds DRSs incrementally, in real time
  - it does semantic (truth-value) evaluation
- The parser can model reaction times
Participants studied 26 facts about person-location pairs:

(1)  
   a. A hippie is in a park.  
   b. A captain is in a park.  
   c. A hippie is in a town.

- Each person concept – used 1, 2 or 3 times  
  - e.g., hippie is used 2 times in (1)  
- Each location concept – used 1, 2 or 3 times  
  - e.g., town is used once in (1)  

In the test phase, participants had to accept targets (learned facts) and reject foils (novel facts)  
- Their reaction times measured
Generalizations

(i.) fastest recall for facts whose concepts were used only once

(ii.) reaction time increases when concepts used more often

(iii.) reaction time approximately equal for targets (true sentences) and foils (false sentences)
Incremental construction of DRSs modeled in the ACT-R cognitive architecture.

- the result is one DRS with three sub-DRSs, e.g.:

A hippie is in a town.

\[
\begin{array}{c}
\text{DREF : } 1 \\
\text{PRED : } \text{hippie} \\
\text{ARG1 : } 1 \\
\end{array}
\]

\[
\begin{array}{c}
\text{DREF : } 2 \\
\text{PRED : } \text{town} \\
\text{ARG1 : } 2 \\
\end{array}
\]

\[
\begin{array}{c}
\text{PRED : } \text{in} \\
\text{ARG1 : } 1 \\
\text{ARG2 : } 2 \\
\end{array}
\]
Accounting for the generalizations

\[
\begin{align*}
\text{DREF} & : 1 \\
\text{PRED} & : \text{hippie} \\
\text{ARG1} & : 1 \\
\text{DREF} & : 2 \\
\text{PRED} & : \text{town} \\
\text{ARG1} & : 2 \\
\text{PRED} & : \text{in} \\
\text{ARG1} & : 1 \\
\text{ARG2} & : 2
\end{align*}
\]

- Semantic (truth) evaluation: fact/DRS retrieval from memory
Accounting for the generalizations

<table>
<thead>
<tr>
<th>DREF</th>
<th>PRED</th>
<th>ARG1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>hippie</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>town</td>
<td>2</td>
</tr>
</tbody>
</table>

- Semantic (truth) evaluation: fact/DRS retrieval from memory
- Spreading activation captures context effects on memory
  - if I need to slice some bread, the knife location comes to mind
Accounting for the generalizations

<table>
<thead>
<tr>
<th>DREF</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRED</td>
<td>hippie</td>
</tr>
<tr>
<td>ARG1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DREF</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRED</td>
<td>town</td>
</tr>
<tr>
<td>ARG1</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PRED</th>
<th>in</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARG1</td>
<td>1</td>
</tr>
<tr>
<td>ARG2</td>
<td>2</td>
</tr>
</tbody>
</table>

- Semantic (truth) evaluation: fact/DRS retrieval from memory
- Spreading activation captures context effects on memory
  - if I need to slice some bread, the knife location comes to mind
- Spreading activation from sub-DRSs to learned facts in memory models reaction times in Anderson (1974)
- Poster and paper provide details
Results

Demos:

- https://people.ucsc.edu/~abrsvn/demo_hippie_in_town_1.mp4
- https://people.ucsc.edu/~abrsvn/demo_hippie_in_town_2.mp4
1. INTRODUCTION

1. We outline the structure of a cognitively realistic semantic parser that incrementally constructs semantic representations (DRSs).
2. The parser composes and integrates semantic interpretations online.
3. The parser evaluates new semantic representations relative to a model (database of known facts) stored in memory.
4. The parser can model RT data and can predict the "fan effect".

- https://people.ucsc.edu/~abrsvn/demo_hippie_in_town_1.mp4
- https://people.ucsc.edu/~abrsvn/demo_hippie_in_town_2.mp4

2. FAN EFFECT (ANDERSON, 1975)

Participants studied facts about person-location pairs. 10 examples:

- A lawyer is in a cave.
- A hippie is in a town.
- A fireman is in a park.
- A doctor is in a shop.

In the test phase, participants had to accept targets (learned facts) and reject foils (novel facts).

- Each person concept – used 1, 2 or 3 times (=fan of 1, 2 or 3)
- Each location concept – used 1, 2 or 3 times (=fan of 1, 2 or 3)

In the test phase, participants had to accept targets (learned facts) and reject foils (novel facts).

<table>
<thead>
<tr>
<th>Target</th>
<th>Foil</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

3. BASIC ACCOUNT

DRS consists of three sub-DRSs:

- DREF: 1
- DREF: hippie
- DREF: arg

After constructing the DRS, the parser checks whether a matching fact is present in the model (learned facts in declarative memory).

Recall of fact i from declarative memory: parallel search driven by activation A_i, modulated by spreading activation from sub-DRS j. (Free params are in red below.)

3. INCREMENTAL DRS CONSTRUCTION AND SEMANTIC EVALUATION

Evaluation as a recall from declarative memory. Fan effect due to sub-DRSs built during incremental interpretation.

Parameter estimates obtained by embedding the parser in a Bayesian model.

Thank you!