Cooking with Semantics

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ACL 2014 Semantic Parsing workshop
Overview + applications

• We want to parse how-to instructions from the open web

• Enable smart semantic search for instructions

• Improve accuracy of frame-semantic parsing with ‘common sense’ reasoning based on planning and affordances

• Aid model-based interpretation of how-to videos
What makes it hard?

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<th>Actions</th>
<th>Control</th>
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<td>• Conditionals</td>
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**Elided:**
Pour batter into prepared pans. Bake.

**Implicitly available:**
Blend confectioners’ sugar, hot water and almond extract in a small bowl.
Our approach

Action ontology

**Heat**
- Object
- Method
- Temperature

**Mix**
- Location
- Method

... 

Domain model

Heat(x::Ingredient): InOven(x) -> IsHeated(x)
Mix(x1, x2): ∃Mixture(x1,x2)
Move(x1::Ingredient, x2::Location): In(x1, x2)

Affordances

Fryable(Egg) = 8
Fryable(Milk) = -3

Learned through co-occurrence statistics across the whole web
Inference

Start with two eggs and one cup milk. Fry the eggs.

Frame parser

<table>
<thead>
<tr>
<th>Fry</th>
<th>the eggs.</th>
</tr>
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<tbody>
<tr>
<td>fry.01</td>
<td>Arg 1: ‘the food’</td>
</tr>
</tbody>
</table>

Latent state

<table>
<thead>
<tr>
<th>Kind</th>
<th>Quantity</th>
<th>Cooked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>2 whole</td>
<td>No</td>
</tr>
<tr>
<td>Milk</td>
<td>1 cup</td>
<td>No</td>
</tr>
</tbody>
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1. Propbank frame fry.01 maps to Heat(method=Fry)
2. Compatibility(Heat.Object, x)=f(
   A. Affordances(x.Kind) (how cookable is x?)
   B. State(x) (has this x already been cooked?)
   C. Recency(x) (have I recently used x?)
   D. LexicalSimilary(“the eggs”, x))
3. Heat.Object = argmax(Compatibility({egg, milk}))
Inference

Start with two eggs and one cup milk. Fry one egg.

1. Propbank frame fry.01 maps to Heat(method=Fry)
2. Compatibility(Heat.Object, x)=f(
   A. Affordances(x.Kind) (how cookable is x?)
   B. State(x) (has this x already been cooked?)
   C. Recency(x) (have I recently used x?)
   D. LexicalSimilary("the eggs", x))
3. Heat.Object <- argmax(Compatibility({egg, milk}))
4. Quantity analysis
5. Back-tracking planner
The inputs

260 delicious recipes from allrecipes.com
Courtesy of the Carnegie Mellon CURD dataset*

*D. Tasse and N. Smith, 2008
Example parse

3 cups all-purpose flour
3 eggs
2 cups white sugar
1 cup vegetable oil
2 cups applesauce
1 cup raisins (optional)
1 teaspoon ground cinnamon
1 teaspoon baking soda
1/4 teaspoon baking powder
1/2 cup sour cream

Directions

1. Preheat oven to 350 degrees F (175 degrees C). Grease and flour two 9 x 5 inch loaf pans.

2. Beat together eggs, sugar, and oil. Blend in applesauce, and then sour cream or buttermilk. Mix in flour, baking powder, soda, and cinnamon. Stir in raisins. Pour batter into prepared pans.


Source: allrecipes.com/recipe/applesauce-bread-i
Inferred cooking program:

1. **Preheat**(oven, temperature="350 degrees F")
2. **Let** bowl <- NewLocation()  ← Implicit actions
3. **Move**(\{egg, sugar, oil\}, bowl)
4. **Mix**(bowl, method=Beat)
5. **Move**(applesauce, bowl, method=Blend)
6. **Move**(sourcream, bowl, method=Blend)
7. **Move**(\{flour, soda, cinnamon\}, bowl)
8. **Move**(raisins, bowl, method=Stir)
9. **Move**(bowl, oven)
10. **Heat**(bowl, time=80 minutes, method=Bake)

Implicit argument

“Preheat oven to 350 degrees F (175 degrees C). Grease and flour two 9 x 5 inch loaf pans. Beat together eggs, sugar and oil. Blend in applesauce, and then sour cream or buttermilk. Mix in flour, baking powder, soda, and cinnamon. Stir in raisins. Pour batter into prepared pans. Bake for 80 minutes. Cool on wire racks.”
Next steps

Crowdsourced annotations

Model-based video understanding

New domains

Pragmatics understanding

Grice Maxims

- **Maxim of Quantity**: Be exactly as informative as required
  - Make your contribution as informative as required (for the current purposes of exchange)
  - Do not make your contribution more informative than is required

- **Maxim of Quality**: Try to make your contribution one that is true:
  - Do not say what you believe to be false
  - Do not say that for which you lack adequate evidence
Thanks to

- Google
- Members of Machine Intelligence
- Josh Tenenbaum and Ryan Adams
- Yoav, Tom, Jonathan for organizing