Cooking with Semantics

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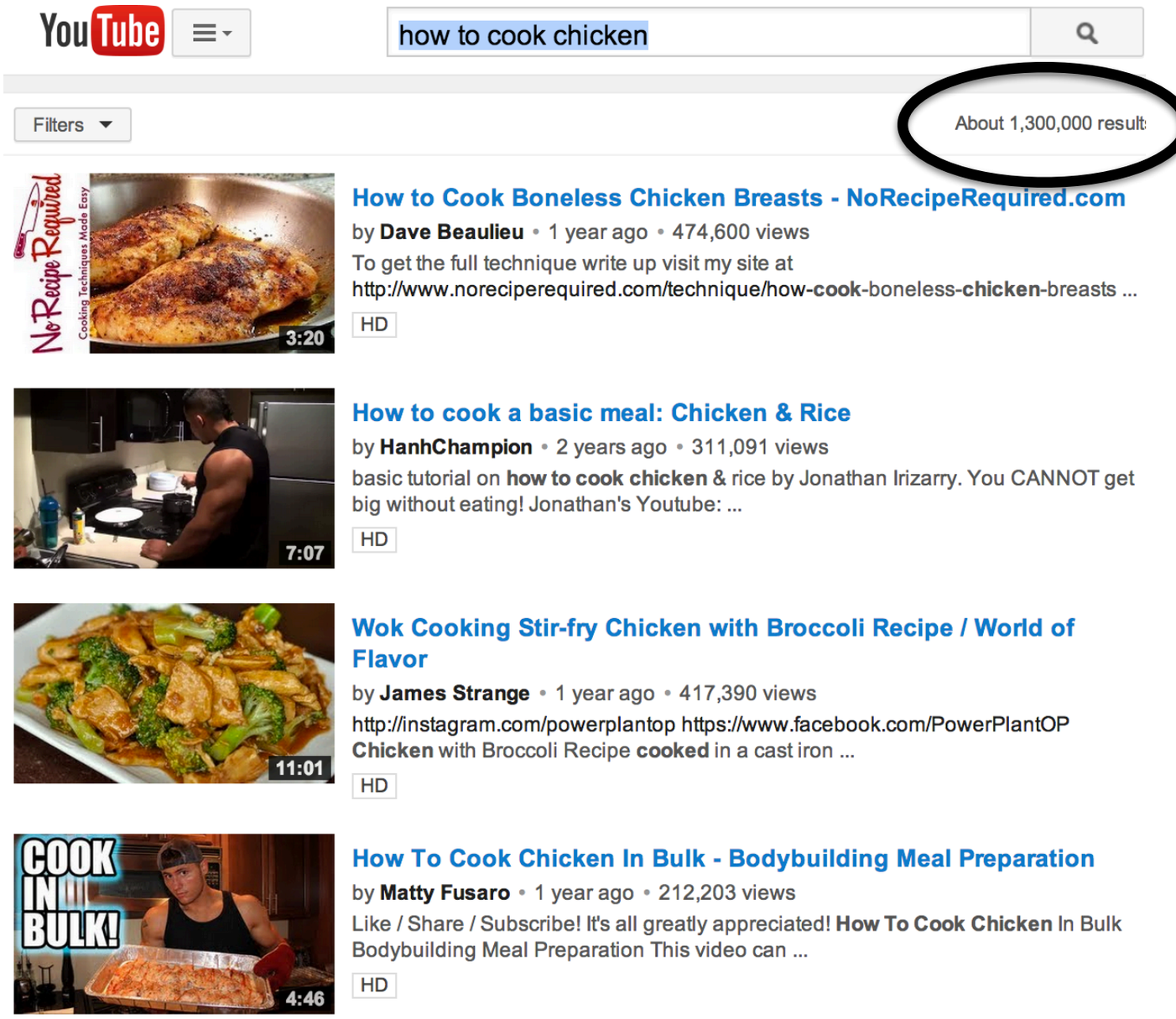
ACL 2014 Semantic Parsing workshop

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?

Arguments	Actions	Control
• Elided • Implicitly available • Incompletely specified	• Ambiguous senses • Omitted/implied	• Conditionals • Sequencing • Alternatives

What makes it hard?

Arguments	Actions	Control
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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-occurance statistics across the whole web

Inference

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

Frame parser

Fry	the eggs.
fry.01	Arg 1: ‘the food’

Latent state

Kind	Quantity	Cooked
Egg	2 whole	No
Milk	1 cup	No

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.

Frame parser

Fry	the eggs.
fry.01	Arg 1: ‘the food’

Latent state

Kind	Quantity	Cooked
Egg	1 whole	No
Egg	1	Yes
Milk	1 cup	No

1. Propbank frame *fry.01* maps to *Heat(method=Fry)*
2. Compatibility(Heat.Object, x)=f(
   A.Affordances(x.Kind) *(how cookable is x?)*
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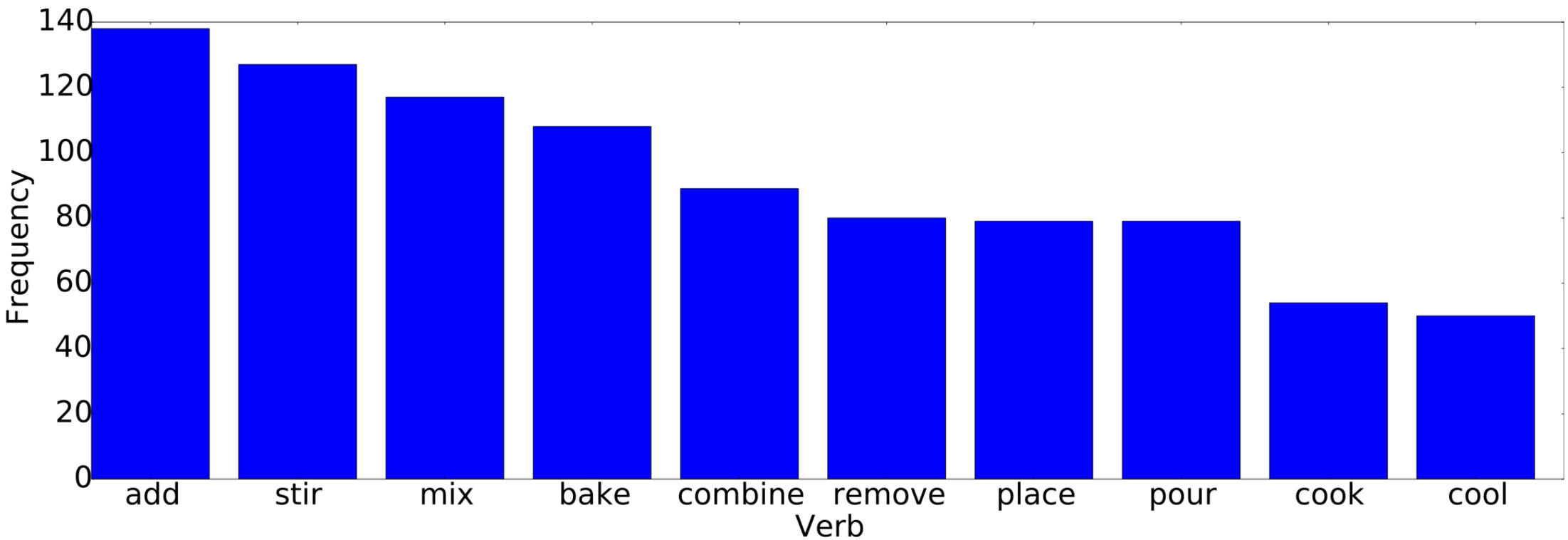
   D.LexicalSimilary(“the eggs”, x))
3. Heat.Object <- argmax(Compatibility({egg, milk}))
4. Quantity analysis
5. Back-tracking planner

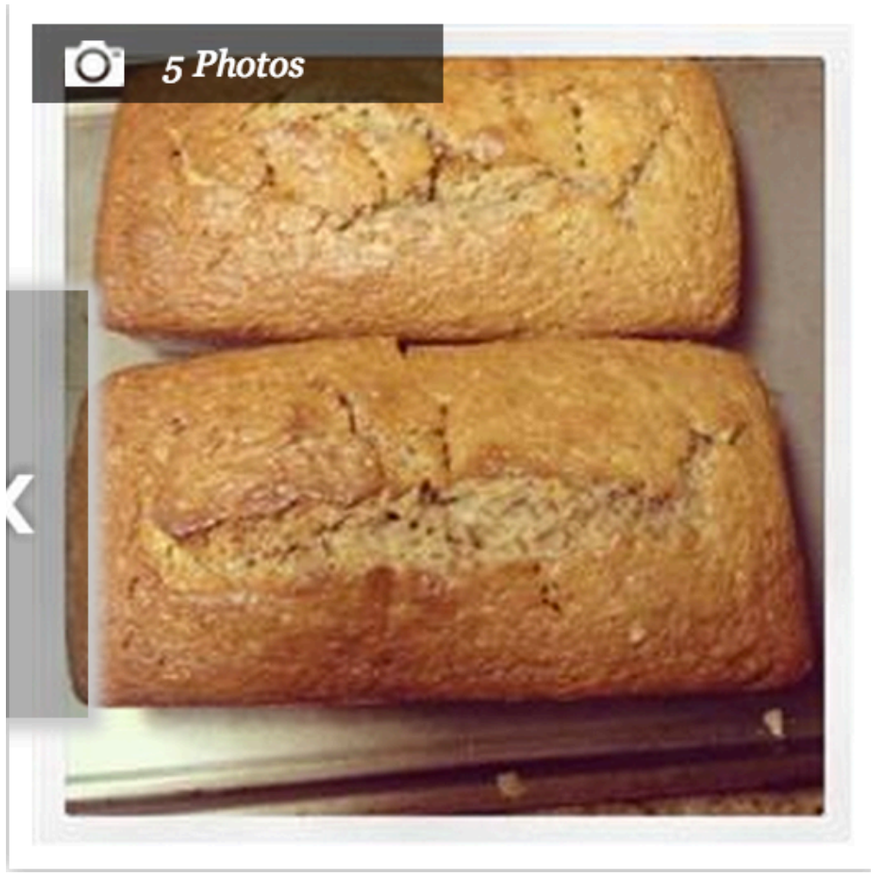
The inputs

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

Check All | Add to Shopping List

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.
3. Bake for 80 minutes. Cool on wire racks.

Source: allrecipes.com/recipe/applesauce-bread-i

“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.”

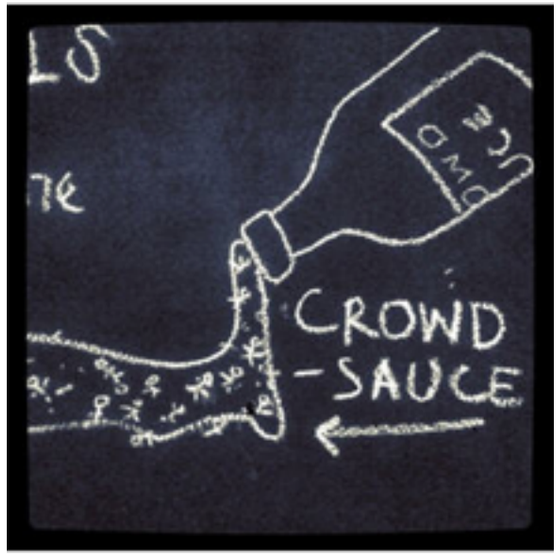
Inferred cooking program:

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

Next steps

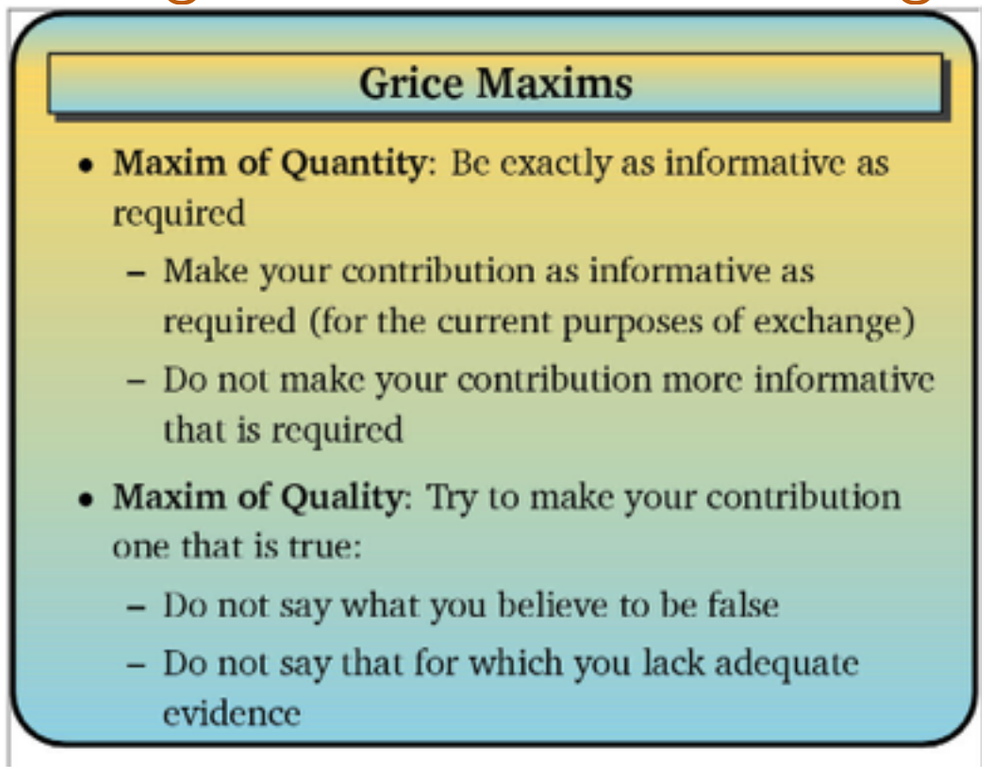
Crowdsourced annotations



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 that 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