Abstract Meaning Representation of Constructions: The More We Include, the Better the Representation

Claire Bonial (Army Research Lab), Bianca Badarau (SDL), Kira Griffitt (Linguistic Data Consortium), Ulf Hermjakob, Kevin Knight (USC Information Sciences Institute) Tim O’Gorman, Martha Palmer (University of Colorado Boulder) Nathan Schneider (Georgetown University)

LREC
10 May 2018
Introduction

Where does meaning come from?

• Individual words **compose** meaning

  Lexical Predicate

  *She moved the foam off her cappuccino*

  NP. Agent  NP. Theme  PP. Path

• Flexible templates (compatible with certain words) can also carry meaning

  Construction: **Caused-Motion**

  *She moved the foam off her cappuccino*

  NP. Agent  Verb  NP. Theme  PP. Path
Introduction

Where does meaning come from?

Why does this matter?

NLP Impact:

• What do we store in a computational lexicon?

• Semantic Role Labeling / Syntactic Parsing: What do we assume are predicates and arguments of those predicates?
Introduction

What do we store in a computational lexicon?
What do I consider predicates and their args?

• Individual words

Lexical Predicate

She moved the foam off her cappuccino
NP. Agent NP. Theme PP. Path

• Constructions (pairing of form + meaning)

Construction: Caused-Motion

She moved the foam off her cappuccino
NP. Agent Verb NP. Theme PP. Path

Construction Grammar: Fillmore et al., 1988; Kay & Fillmore, 1999; Michaelis & Lambrecht, 1996
Introduction

What do we store in a computational lexicon? What do I consider predicates and their args?

• Individual words

Lexical Predicate

She moved the foam off her cappuccino
NP. Agent  NP. Theme  PP. Path

• Constructions (pairing of form + meaning)

Construction: Caused-Motion

She sneezed the foam off her cappuccino
NP. Agent Verb  NP. Theme  PP. Path

Construction Grammar: Fillmore et al., 1988; Kay & Fillmore, 1999; Michaelis & Lambrecht, 1996
Background: Constructions

She sneezed the foam off her cappuccino.

• Sneeze.01 (typically intransitive)
  – Arg0: sneezer
• Caused Motion Construction
  – Mover, moved, path

Argument Structure Constructions: productive patterns, licensing verb and arguments

Argument Structure Constructions: Goldberg, 1995
Research Problem

How can we extend the Abstract Meaning Representation (AMR) to account for meaning stemming from constructions?
Background: AMR

- Goals:
  - creating large-scale semantics bank
  - simple structures, like Penn Treebank

- Supporting research in:
  - semantic parsing
  - natural language generation
  - machine translation

- 70 plus research papers use AMR!

http://amr.isi.edu/index.html; Banarescu et al., 2013
Background: AMR

AMR assigns semantic roles of individual lexical predicates.

• Assign.01 from PropBank “Rolesets”
  – ARG0 (assigner): AMR
  – ARG1 (assigned): semantic roles
  – ARG2 (assigned-to): individual lexical predicates

PropBank: Palmer et al., 2005; http://propbank.github.io
Background: AMR

**AMR assigns semantic roles...**

AMR assigns semantic roles of individual lexical predicates...

should represent concepts and relations consistently, despite syntactic differences.

- Assignment → Assign.01
  - ARG0 (assigner): AMR
  - ARG1 (assigned): *semantic roles*
  - ARG2 (assigned-to): *individual lexical predicates*
AMR Approach to Constructions

The more we include, the better the representation.

• Include.01, representation $\rightarrow$ represent.01, better $\rightarrow$ good.02

• Gap in representation: Correlation

Annotating constructions required a novel approach...
AMR Approach to Constructions

1. Exploiting lexical predicate rolesets in combination with modifier roles (e.g., Source, Destination), addition of implicit predicates (e.g., Cause-01, Move-01)
   - Where existing AMR machinery provides adequate coverage of constructional meaning

2. Adding constructional rolesets
   - Where existing AMR machinery does not adequately capture semantics, and/or
   - We can add a single construction roleset in lieu of many individual lexical rolesets
Exploiting Lexical Rolesets

- **Intransitive Motion Construction:**

  Rumble-01
  Arg0: entity rumbling
  Arg1: sound/utterance
  Arg2: hearer

  2. The troops rumbled along the main road.
  \[(r / \text{rumble-01})
  \quad :\text{ARG0} (t / \text{troop})
  \quad :\text{path} (p / \text{along})
  \quad :\text{op1} (r2 / \text{road})
  \quad :\text{mod} (m / \text{main}))\]

- **Caused-Motion Construction:**

  Blink-01
  Arg0: blinker
  Arg1: eyes (usually unstated)

  3. He blinked the snow off his eyelashes.
  \[(b / \text{blink-01})
  \quad :\text{ARG0} (h/ \text{he})
  \quad :\text{ARG0-of} (c5 / \text{cause-01})
  \quad :\text{ARG1} (m2 / \text{move-01})
  \quad :\text{ARG1} (s / \text{snow})
  \quad :\text{source} (e / \text{eyelash})
  \quad :\text{part-of} (h)\]

  i.e. *He blinked, the blinking caused the snow to move from his eyelashes.*
Adding Constructional Rolesets

• Degree-Related Constructions – Have-Degree-91:
  – Comparison
  – Superlative
  – Degree-consequence

• Quantity-Related Constructions – Have-Quant-91:
  – Comparison
  – Superlative
  – Quantity-consequence

• The X-er, The Y-er – Correlate-91
• Comparing Resemblance – Have-Degree-of-Resemblance-91

Degree-Related Constructions

**Have-Degree-91**
Arg1: domain, entity characterized by attribute
Arg2: attribute (e.g. tall)
Arg3: degree itself (e.g. more/most, less/least, equal)
Arg4: compared-to
Arg5: superlative: reference to superset
Arg6: consequence, result of degree

**Comparative:**
4. The girl is taller than the boy.
   (h / have-degree-91
    :ARG1 (g / girl)
    :ARG2 (t / tall)
    :ARG3 (m / more)
    :ARG4 (b / boy))
i.e. The girl is more tall compared to the boy.

**Superlative:**
5. She is the tallest girl on the team.
   (h / have-degree-91
    :ARG1 (s / she)
    :ARG2 (t / tall)
    :ARG3 (m / most)
    :ARG5 (g / girl
       :ARG0-of (h2 / have-org-role-91
        :ARG1 (t2 / team))))
i.e. She is the most tall of the girls on the team.
Degree-Related Constructions

**Have-Degree-91**
- Arg1: domain, entity characterized by attribute
- Arg2: attribute (e.g. tall)
- Arg3: degree itself (e.g. more/most, less/least, equal)
- Arg4: compared-to
- Arg5: superlative: reference to superset
- Arg6: consequence, result of degree

**Degree-Consequence:**

*The watch is too wide; therefore, it does not fit my wrist.*

*I was too tired to drive.*

6. The watch is too wide for my wrist.
   (h / have-degree-91
   :ARG1 (w / watch)
   :ARG2 (w2 / wide-02
       :ARG1 w)
   :ARG3 (t / too)
   :ARG6 (f / fit-06
       :ARG1 w
       :ARG2 (w3 / wrist
           :part-of (i / i))))
The X-er, The Y-er

Correlate-91
Arg1: X, degree/quant word modifying first item changing in relation to Arg2
Arg2: Y, degree/quant word modifying second item changing in relation to Arg1

10. The longer he is around, the more miserable I will be.
   ((c / correlate-91)
   :ARG1 (m2 / more)
   :ARG3-of (h2 / have-degree-91
   :ARG1 (b / be-located-at-91
   :ARG1 (h / he)
   :ARG2 (a / around))
   :ARG2 (l2 / long-03
   :ARG1 b))
   :ARG2 (m3 / more)
   :ARG3-of (h3 / have-degree-91
   :ARG1 (i / i)
   :ARG2 (m / miserable))

i.e. An increase in how long he is around correlates with an increase in how miserable I am.
Evaluation, Implementation

• New guidelines, rolesets piloted on ‘Challenge Set’
  – 50 sentences from AMR 2.0
  – Selected using keyword searches, manual analysis
  – Represents variety of degree/quantity related constructions
  – Includes tricky cases with clear inconsistencies in past annotation
• Double annotated: 1 CU annotator, 1 SDL annotator
• Agreement: 88.6% (‘smatch’ score (Cai and Knight, 2013))
• Manual retrofitting of approximately 4700 annotations
Conclusions, Future Work

- AMR 3.0 release 2018
  - 59783 total AMRs
  - 6112 instances of degree/quantity-based constructions

- Coverage of constructional semantics: a layer of meaning critical for translation, natural language understanding
  - 4 construction entries added to the AMR lexicon
  - 5 distinct constructions

- Deepening AMR...
  - More constructions?
  - Aspect, Modality
  - Multi-sentence

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Roleset/Relation</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downtoners, intensifiers</td>
<td>Degree</td>
<td>4547</td>
</tr>
<tr>
<td>Comparison, superlative, degree-consequence</td>
<td>Have-Degree-91</td>
<td>4943</td>
</tr>
<tr>
<td>Comparison, superlative, quantity-consequence, quantity reification</td>
<td>Have-Quant-91</td>
<td>1122</td>
</tr>
<tr>
<td>Comparing resemblances</td>
<td>Have-Degree-of-Resemblance-91</td>
<td>9</td>
</tr>
<tr>
<td>The X-er, The Y-er</td>
<td>Correlate-91</td>
<td>38</td>
</tr>
</tbody>
</table>
thank you
Background: Constructions

Alternative: Additional senses of lexical predicates (e.g., caused-motion sense of sneeze)

The child ???? her foot out of the boot.
Gary talked me into a corner.
They booed the clown off the stage.
She blinked the snow off her eyelashes.

Caused Motion: She sneezed the foam off her cappuccino

Syntax: NP V NP PP
Semantics: Agent V Theme Initial Location
Research Problem
Where does meaning come from?

Lexical Semantics
- pull
- motion
- boo
- tall, modifier
- adverbial, sell

Constructional Semantics
- Caused-Motion

Example sentences:
- They pulled the clown off the stage.
- They booed the clown off the stage.
- He blinked the snow off his eyelashes.
- She is as tall as her brother.
- The lower the price, the more you’ll sell.

To be comprehensive, Abstract Meaning Representation must include both lexical, constructional semantics.
Background: Constructions

Constructions: prefabricated parts, templates; pairing of form and meaning arising out of individual discourse experience.

Composition:
- WH-Question

Constructional:
- Surprise, Disapproval