Relation extraction for commonsense causal reasoning

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CSE 573
Goal: commonsense cause-and-effect reasoning

• We want to answer questions like

Premise: The man lost his balance on the ladder.
What happened as a result?
Alternative 1: He fell off the ladder.
Alternative 2: He climbed up the ladder.

• Choice of Plausible Alternatives (COPA) Task: 1000 cause and effect questions in this format
  – Humans: 99% accuracy
  – Best performing algorithm: ~65% accuracy
  – Random choice: 50% accuracy
  – *There’s room for improvement*
<table>
<thead>
<tr>
<th>The farmland needed irrigation.</th>
<th>The man hated his new haircut.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A canal was constructed.</strong>&lt;br&gt;A flood occurred.</td>
<td><strong>He wore a hat.</strong>&lt;br&gt;<strong>He grew a beard.</strong></td>
</tr>
</tbody>
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<tr>
<th>My favorite song came on the radio.</th>
<th>The woman won the lottery.</th>
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<tr>
<td><strong>I covered my ears.</strong>&lt;br&gt;<strong>I sang along to it.</strong></td>
<td><strong>She bought a yacht.</strong>&lt;br&gt;<strong>She joined a church.</strong></td>
</tr>
</tbody>
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Proposed method: use relation extraction

- **Relation extraction** finds the semantic relations in text
- **Open IE** finds semantic relations in open-domain free text

**Input** = “The homeowners disliked their nosy neighbors.”

**Output** = “0.76: (The homeowners; disliked; their nosy neighbors)”

**Hypothesis**: relation pairs that more frequently co-occur in a large text corpus will be more causally connected

- If (I; poured; coffee), (I; added; milk) co-occurs more often than (I; poured; coffee), (I; voted for; Obama), then first pair more causally connected
Solve low recall with relation pair similarity score

- Open IE has high precision but low recall:
  - The relations it extracts are usually correct
  - But it misses out on a lot of true relations
- Probably won’t find relations identical to the COPA relations

Hypothesis: a relation pair is also causally connected if similar relation pairs frequently co-occur in a large corpus

Example:
If
(Princess Di; was; famous) & (The press; chased her) frequently co-occur, then
(the woman; became; famous) & (photographers; followed; her) should also be causally connected
Methodology

1. I ran a relation extractor, OLLIE, on all the COPA questions

2. I obtained results for OLLIE run on a subset of the Gigaword corpus (for time constraints I used only 2500 of the 1.2 million articles)

3. I preprocessed each relation by lower-casing and removing stop-words so
   (The homeowners; disliked; their nosy neighbors) ->
   (homeowners; disliked; nosy neighbors)

4. I found all co-occurring giga relation pairs for which one relation was similar to a copa premise and the other relation in the pair was similar to one of the copa alternatives. Co-occur defined as occurring within +-2 sentences.

5. For each COPA question, I chose the alternative for which more similar relations co-occured with the premise
2 simple similarity scores (for now)

- **Relation Similarity Score #1:**
  
  \[
  \text{[arg}_1, \text{pred}, \text{arg}_2]_1 \sim \text{[arg}_1, \text{pred}, \text{arg}_2]_2 \text{ if each corresponding element pair has a single word in common}
  \]

- **Relation Similarity Score #2: (Slow!)**
  
  \[
  \text{[arg}_1, \text{pred}, \text{arg}_2]_1 \sim \text{[arg}_1, \text{pred}, \text{arg}_2]_2 \text{ if in each corresponding element pair there exists words with a high enough wordnet similarity score}
  \]
Results

1000 articles gave 55,748 distinct relations
• SS #1: 17 questions answerable, 53 % accuracy

2500 articles gave me 142,374 distinct relations
• SS #1: 22 questions answerable, 59% accuracy

Restricted to the first 5000 relations:
• SS #3: 10 questions answerable, 6/10 correct
  (and it still had to run overnight)
In the coming week

- More data: Increase number of relations

- Better pre-processing of relations: *stemming* (drinking -> drink), replace named entities with their class, e.g.
  - ‘Princess Di’ -> ‘female’,
  - ‘John’-> ‘male’,
  - ‘Boeing’ -> ‘business’ or ‘company’.
  *(Does there exist available software to do this?)*

- More relation similarity score functions.

- Improve speed? (Python not the fastest language; Profile code)

- Can I cluster the relations using unsupervised learning?
Wordnet similarity score

- Wordnet: words arranged in synsets, groups of synonyms, hypernyms (of a), and hyponyms (has a)

- Wu-Palmer Similarity: Return a score denoting how similar two word senses are, based on the depth of the two senses in the taxonomy and that of their Least Common Subsumer (most specific ancestor node).