**Task & Problem Definition**

**Input**
- A KB as a collection of triples \((r, e_1, e_2)\)
- A single-relation question, describing a relation and one of its entity arguments

**Output**
- An entity that has the relation with the given entity

**Convolutional Deep Semantic Similarity Model [Shen et al., 2014]**

- Input is mapped to two \(k\)-dimensional vectors
- Probability is determined by softmax of their cosine similarity

**Key Ideas & Related Work**

- Simple Context-Free Grammar
  - Separate a question into a relation pattern and an entity mention
- Paraphrase detection using convolutional neural net
  - Inspired by Paralex [Fader et al., 2013]
- 35M question paraphrase pairs from WikiAnswers
  - Learn weighted lexical matching rules

**Experiments: Data & Task**

**Knowledge base: ReVerb [Fader et al., 2011]**

<table>
<thead>
<tr>
<th>Relation</th>
<th>Entity Argument #1</th>
<th>Entity Argument #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>be-official-language</td>
<td>chinese and english, hong kong</td>
<td></td>
</tr>
<tr>
<td>be-second-largest-city-in</td>
<td>armenia, perth</td>
<td></td>
</tr>
<tr>
<td>be-tallest-mountain-in</td>
<td>ararat, armenia</td>
<td></td>
</tr>
<tr>
<td>have-population-of</td>
<td>city of vancouver, 587,891</td>
<td></td>
</tr>
</tbody>
</table>

provide | microsoft, office-software |
use-for | los angeles, los angeles |

**Paralex dataset [Fader et al., 2013]**

- 1.8M (question, single-relation queries)
  - When were DVD players invented?
    - Ax. be-invent-in (dvd-player, x)
  - 1.2M (relation pattern, relation)
  - When were X invented?
    - be-invent-in
  - 160k (mention, entity)
    - Saint Patrick day
    - st-patrick’s day

**Task: Question Answering**

- What language do people in Hong Kong use?
  - be-speak-in (english, hong-kong)
- be-predominant-language-in (cantonese, hong-kong)
  - Where do you find Mt Ararat?
    - be-highest-mountain-in (ararat, turkey)
    - be-mountain-in (ararat, armenia)

**Experiments: Results**

**Conclusions**

- A new semantic parsing framework for single-relation questions
  - Use a semantic similarity function to match patterns and relations, as well as mentions and entities
- Semantic similarity model – Convolutional neural networks with letter-trigram vector input
  - Go beyond bag-of-words and handle OOV better
  - Outperform previous work using lexical matching rules

**Future work**

- Apply this approach to more structured KB (Frebase)
- Extend this work to handle multi-relation questions