Targeted Paraphrasing on Deep Syntactic Layer for MT Evaluation

Petra Barančíková, Rudolf Rosa

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Introduction

Goal: Increase quality of machine translation evaluation

Human evaluation
- direct and most reliable
- slow, expensive, subjective and irreproducible

Automatic evaluation (BLEU, Meteor...)
- compare MT output to pre-existing reference translation
- fast and cheap
- only approximates human judgment, not considering synonymous expressions, incorrect alignments...

Approach: Improve automatic evaluation by providing a better reference
### Example (WMT2012)

<table>
<thead>
<tr>
<th>Source</th>
<th>Banks are testing payment by mobile telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis</td>
<td>Banks zkoušejí platbu pomocí mobilního telefonu</td>
</tr>
<tr>
<td></td>
<td>Banks are testing payment with help mobile phone</td>
</tr>
<tr>
<td></td>
<td>Banks are testing payment by mobile phone</td>
</tr>
<tr>
<td>Reference</td>
<td>Banky testují placení mobilem</td>
</tr>
<tr>
<td></td>
<td>Banks are testing paying by mobile phone</td>
</tr>
<tr>
<td></td>
<td>Banks are testing paying by mobile phone</td>
</tr>
</tbody>
</table>
Related work

- automated metrics with paraphrase support (Meteor)
- paraphrasing reference sentences for MT evaluation
Our approach

- paraphrasing and the translation itself are very similar tasks
- there are many great tools for machine translation
- let’s treat paraphrasing as monolingual machine translation
  - “translate” the reference sentence into its paraphrase so that it is more similar to the hypothesis
Data

Czech paraphrasing tables

- **WordNet PDT 1.9.**
  - high quality lemmatized paraphrases
  - insufficient amount

- **Meteor**
  - large amount of paraphrases
  - lot of noise, especially among multiword paraphrases – e.g. *jeho názoru* (of his opinion) ~ *šermoval rukama a mlátil neviditelného* (waved his arms and beat the invisible one)
  - lemmatization and filtration of one-word paraphrases
1 Introduction

2 Paraphrasing as machine translation

3 Treex paraphrasing

4 Results

5 Future work
Layers

- Interlingua
  - Transfer at a semantic layer
  - Transfer at a syntactic layer
    - Transfer at a morphological layer
      - Direct translation

Source language → Interlingua → Target language

Analysis → Transfer at a syntactic layer → Synthesis
Rule-based systems

- inconclusive results of paraphrasing using direct phrase-based translation by Moses (Barančíková and Tamchyna, 2014)
- advantages of rule-based paraphrasing at deep syntactic level
  - better preservation of meaning and grammaticality
  - more conservative paraphrases
  - no need to create large translation tables
  - adjusting the word order
1 Introduction

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Treex

- highly modular NLP software system
- developed for machine translation system TectoMT that translates on a deep syntactic layer
- open-source and available on GitHub (https://github.com/ufal/treex)
- stratificational approach to language, adopted from the Functional Generative Description theory and its later extension by the Prague Dependency Treebank
- analysis and synthesis pipeline for Czech and English
  - some support for several other languages
Layers

- **w-layer**: word layer
- **m-layer**: morphological layer
- **a-layer**: shallow-syntax/analytical layer
  - dependency tree over tokens
- **t-layer**: deep-syntax/tectogrammatical layer
  - dependency tree over content words (lemma)
  - attributes capture information from function words and inflection
    - part-of-speech, case, tense, number, gender...
Paraphrasing on t-layer

- paraphrase the lemma where appropriate
  - if a lemma in the MT hypothesis can be correct (based on paraphrase tables and the reference), then assume it is correct
- keep the other attributes unchanged
### Example (WMT2012)

<table>
<thead>
<tr>
<th>Source</th>
<th><em>The Internet has caused a boom in these speculations.</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis</td>
<td>Internet vyvolal boom v těchto spekulacích . &lt;br&gt;Internet caused boom in these speculations . &lt;br&gt;<em>The Internet has caused a boom in these speculations.</em></td>
</tr>
<tr>
<td>Reference</td>
<td>Rozkvět těchto spekulací způsobil internet . &lt;br&gt;<em>Boom these speculations caused internet.</em> &lt;br&gt;<em>A boom of these speculations was caused by the Internet.</em></td>
</tr>
</tbody>
</table>
Paraphrasing module

Hypothesis

Reference sentence

Paraphrased reference

Paraphrasing

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Reordering module

Hypothesis

<table>
<thead>
<tr>
<th>Lemmas:</th>
<th>Internet vývolal boom v těchto spekulacích.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT order:</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

Paraphrased reference

Recursive reordering

1) spekulaci
   sort order 6.003

   těchto
   sort order: 5.002

   Already sorted, we keep it as it is.

2) Boom
   sort order 3.001

   (těchto spekulaci)
   sort order 5.502

   Already sorted, we keep it as it is.

3) vyvolal
   sort order 2.004

   (Boom těchto spekulaci)
   sort order 4.668
   sort order 1.005

   Gets reordered, switching the children nodes.
Introduction

Paraphrasing as machine translation

Treex paraphrasing

Results

Future work
Results

- **2x12 English-to-Czech machine translation systems**
  - manual evaluation $\rightarrow$ human score
  - automatic evaluation $\rightarrow$ BLEU, Meteor, Exact Meteor
    - original reference
    - paraphrased reference
    - paraphrased & reordered reference

- Pearson correlation of human score and automatic score

<table>
<thead>
<tr>
<th></th>
<th>WMT12</th>
<th>WMT13</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>original</td>
<td>para</td>
</tr>
<tr>
<td>BLEU</td>
<td>0.751</td>
<td>0.783</td>
</tr>
<tr>
<td>Meteor</td>
<td>0.833</td>
<td>0.864</td>
</tr>
<tr>
<td>Ex.Meteor</td>
<td>0.861</td>
<td>0.900</td>
</tr>
</tbody>
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Future work

- more complex paraphrases (now only single-word)
- syntactic paraphrases (now only lexical)
- more sophisticated reordering (more constraints?)
- more languages (Treex-supported)