LA EXTRACCIÓN ABIERTA DE INFORMACIÓN PARA EL ESPAÑOL

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OUTLINE

Introduction
  • Open Information Extraction (Open IE)
  • Applications of Open IE
  • Approaches to Open IE
  • Problem

Open IE for Spanish

Experiments & Results

Error Analysis

Conclusions and Future Work
TRADITIONAL IE

• Find all, say, acquisitions: *quien compró que*
• Target relations are predefined:
  • Relations: *acquisition(arg1, arg2, ..., argN)*
  • args: *personas, empresas, moneda...*
• Hand-labeled *lexicalized* training examples
• Lots of training data
• Tuned linguistic technologies (NER, parsing, ...)
• Extensive human involvement

*Used in:* Domain-specific information extraction from relatively small homogeneous corpora
WHAT IS OPEN IE? 1/2

Introduced by Banko et al. in 2007

**Arbitrary relations**, not predefined:

*Born in, comes from, makes a deal with, ...*

Extracted tuples are called “**assertions**”:

<Argument1, Relation, Argument2>

*McCain fought hard against Obama, but finally lost the election*

- <McCain, fought against, Obama>
- <McCain, lost, the election>
WHAT IS OPEN IE? 2/2

Unlexicalized, domain-independent:
looks only at POS/syntactic structure

No need in extensive hand-labeled training dataset:
uses heuristics or distant supervision

Fast and scalable to the Web:
appropriate for a large heterogeneous corpus

Can serve even undefined user needs:
users can interactively refine their need
APPLICATIONS OF OPEN IE

Different from traditional IE!

• Common-sense knowledge collection
• New perspectives in QA systems
• New approach to IR [Etzoni, 2011]
• Machine Reading: automatic, unsupervised understanding of text [Etzioni et al., 2006]
• Web text quality automatic assessment [Horn & Zhila et al., 2013 @ NoDaLiDa]
APPROACHES TO OPEN IE

1. ML-based
   TextRunner (Banko, 2007), $WOE^{pos}$ & $WOE^{parse}$ (Wu & Weld, 2010)
   **Shortcomings:** Extracts incoherent relations
   “The Mark 14 **was central to** the torpedo scandal of the fleet.”
   <was central torpedo>

2. Syntactic and context analysis
   OLLIE (Mausam, 2012), FES (Aguilar, 2012)
   **Shortcomings:** slow, computational resource demanding

3. POS analysis and syntactic constraints
   ReVerb (Fader et al., 2011)
   **Shortcomings:** only verb–based relations
   **Advantages:** fast, easy to implement, accurate, efficient
PROBLEM

- Requires language-specific information
  e.g. Typical POS sequence in a relation
- Was implemented for English only
  “simple canonical ways in which verbs express relationships in English” [Etzoni et al., 2011]

3. POS analysis and syntactic constraints

ReVerb (Fader et al., 2011)

What are peculiarities of application of this method to another language?
WHY IS IT IMPORTANT?

• Different morphology (different POS-tagging)
• Different grammar (i.e. word order)
• In general:
  • Languages are different
  • No work on languages other than English
  • We cannot expect the same behavior
OUTLINE

Introduction

Open IE for Spanish
  • Architecture of ExtrHech system

Experiments & Results

Error Analysis

Conclusions
ARCHITECTURE OF EXTRHECH OPEN IE SYSTEM FOR SPANISH 1/2

**Input**
POS-tagged text

**ExtrHech**
-Syntactic constraints

**Output**
List of assertions
<Arg1; Rel; Arg2>

**EAGLES** POS-tag set for Spanish from Freeling-2.2

**Syntactic constraints as regular expressions**
1. “Relation phrase”-first approach: looks for **verb phrase**
   \[ VREL \rightarrow (V W*P) \mid (V) \]
2. Looks for **noun phrases** to the left and right
   \[ NP \rightarrow N \mid (PREP N) ? \]
3. Rules for
   - Coordinating conjunctions
   - Relative clauses
   - Participles
ARCHITECTURE OF EXTRHECH OPEN IE SYSTEM FOR SPANISH 2/2: LIMITATIONS

- Does not resolve zero subject (anaphora issues)

  “Cerró la entrada.”
  ("[He] closed the entrance.")
OUTLINE

Introduction

Open IE for Spanish

Experiments & Results
  • For different Spanish datasets
  • For parallel English-Spanish dataset
  • Performance comparison

Error Analysis

Conclusions
EXPERIMENT OVER TWO SPANISH DATASETS 1/2

FACT-SPA-CIC

- 68 sentences in Spanish
- Manually selected from school textbooks
- Grammatically and orthographically correct

RAW WEB TEXT

- 159 sentences
- Randomly extracted from Web (with language detection filter)
- 36 sentences (22%) either grammatically incorrect or incoherent

“cronista cumple del diego video diego el 10”

(“journalist accomplishes of the [D]iego video [D]iego 10 [points]”)
PERFORMANCE FOR SPANISH DATASETS 2/2

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Precision</th>
<th>Recall</th>
</tr>
</thead>
<tbody>
<tr>
<td>FactSpaCIC (grammatically correct)</td>
<td>87%</td>
<td>70%</td>
</tr>
<tr>
<td>Raw Web text (noisy)</td>
<td>55%</td>
<td>49%</td>
</tr>
</tbody>
</table>

**Precision** = \[
\frac{\text{correct assertions}}{\text{all extracted assertions}}
\]

**Recall** = \[
\frac{\text{correct assertions}}{\text{all possible assertions}}
\]

- **correct assertions** as evaluated by two human annotators
- **all possible (correct) assertions** = all expected extractions + assertions returned by the system that both annotators considered correct
**EXPERIMENT OVER PARALLEL ENGLISH-SPANISH DATASET**

Gramatically correct dataset FactSpaCIC of 68 sentences was translated into English

<table>
<thead>
<tr>
<th>System</th>
<th>Precision</th>
<th>Recall</th>
<th>correct extractions</th>
<th>found extractions</th>
<th>expected extractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExtrHech (Spanish)</td>
<td>87%</td>
<td>70%</td>
<td>99.5</td>
<td>115</td>
<td>137</td>
</tr>
<tr>
<td>ReVerb (English)</td>
<td>76%</td>
<td>50%</td>
<td>71</td>
<td>93</td>
<td>139</td>
</tr>
</tbody>
</table>

- ReVerb turned out to be less robust: More unattempted sentences
## COMPARISON OF PERFORMANCE FOR VARIOUS OPEN IE SYSTEMS

<table>
<thead>
<tr>
<th>System</th>
<th>Approach</th>
<th>Dataset (# of sent.)</th>
<th>Precision</th>
<th>Recall</th>
<th>Running Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ExtrHech</strong> (Spanish)</td>
<td>syntactic constr. over POS-tagged text</td>
<td>FactSpaCIC (68)</td>
<td>0.87</td>
<td>0.73</td>
<td>&lt; 5 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>raw Web text (159)</td>
<td>0.55</td>
<td>0.49</td>
<td></td>
</tr>
<tr>
<td><strong>ReVerb</strong>   (English)</td>
<td>syntactic constr. over POS-tagged text</td>
<td>FactSpaCIC (68), translated</td>
<td>0.76</td>
<td>0.50</td>
<td>&lt; 5 min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yahoo (500)</td>
<td>0.87</td>
<td>at 0.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.60</td>
<td>at 0.50</td>
<td></td>
</tr>
<tr>
<td><strong>TextRunner</strong> (English)</td>
<td>self-learning on POS-tagged text</td>
<td>Yahoo (500)</td>
<td>&lt; 0.64</td>
<td>at &gt;0</td>
<td>&lt; 5 min</td>
</tr>
<tr>
<td><strong>WOE</strong> &lt;sup&gt;parse&lt;/sup&gt; (English)</td>
<td>self-learning on parsed text</td>
<td>Yahoo (500)</td>
<td>0.87</td>
<td>at 0.15</td>
<td>hours</td>
</tr>
<tr>
<td><strong>OLLIE</strong>   (English)</td>
<td>context analysis of parsed text</td>
<td>news, Wikipedia, biology textbooks (300)</td>
<td>0.66–0.85</td>
<td></td>
<td>N/A, probably hours</td>
</tr>
</tbody>
</table>
OUTLINE

Introduction
Open IE for Spanish
Experiments & Results
Error Analysis
Conclusions
ERROR ANALYSIS

Performed:

• **For Spanish language system ExtrHech:**
  over FactSpaCIC (68 sent., grammatically correct) and Raw Web (159 sent.) datasets

• **For English language system ReVerb:**
  over the English translation of FactSpaCIC (68 sent., gram. correct)
CAUSES OF ERRORS FOR BOTH SYSTEMS 1/3

- Incorrect coord. conj.
- N-ary relation
- Incorrect relative clause
- Underspec. NP
- Incorrect POS-tagging

ExtrHech (Spanish) vs. ReVerb (English)
## CAUSES OF ERRORS FOR BOTH SYSTEMS 2/3

<table>
<thead>
<tr>
<th>Cause</th>
<th>ExtrHech</th>
<th>ReVerb</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorrect coordinative resulution</td>
<td>43%</td>
<td>14%</td>
<td>The hypothalamus is responsible for certain body functions such as temperature control and receives the signal of sleep, hunger and thirst</td>
</tr>
<tr>
<td>N-ary relation</td>
<td>24%</td>
<td>41%</td>
<td>...crevices and folds that give it the appearance of a peeled walnut</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;certain body functions; receives the signal of; sleep, hunger and thirst&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;crevices and folds; give; it&gt;</td>
</tr>
</tbody>
</table>
### CAUSES OF ERRORS FOR BOTH SYSTEMS 3/3

<table>
<thead>
<tr>
<th>Cause</th>
<th>ExtrHech</th>
<th>ReVerb</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incorrect relative clause resolution</strong></td>
<td>19%</td>
<td>9%</td>
<td>El lugar en el que florecieron las culturas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;El lugar; florecieron; las culturas&gt;</td>
</tr>
<tr>
<td><strong>Under-specified noun phrase</strong></td>
<td>10%</td>
<td>9%</td>
<td>The data from the consulted sources must be registered in index cards.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;Arg1=the consulted sources&gt;</td>
</tr>
<tr>
<td><strong>Incorrect POS tagging</strong></td>
<td>10%</td>
<td>5%</td>
<td>Archaeology uses new techniques to … study the material remains and tracks and signs that man made in the past</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;the material; signs^V; that^PN man&gt;</td>
</tr>
</tbody>
</table>
CAUSES OF ERRORS FOR SPANISH SYSTEM
1/2

Free word order: 30%
Non-contiguous relation: 5%
Over-specified relation phrase: 5%
<table>
<thead>
<tr>
<th>Cause</th>
<th>Extr Hech</th>
<th>ReVerb</th>
<th>Example</th>
<th>Intuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free word order</td>
<td>14%</td>
<td>–</td>
<td>De la médula espinal nacen los nervios periféricos.</td>
<td>Sp</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;la médula espinal; nacen; los nervios periféricos&gt;</td>
<td></td>
</tr>
<tr>
<td>Non-contiguous relation</td>
<td>5%</td>
<td>–</td>
<td>bajo cuyo nombre pueden entrar los sextantes</td>
<td>Sp</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;nombre; pueden entrar; los sextantes&gt;</td>
<td></td>
</tr>
<tr>
<td>Over-specified relation phrase</td>
<td>5%</td>
<td>–</td>
<td>La Botánica ha logrado analizar las características de la vegetación</td>
<td>sys</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;Rel = ha logrado analizar las características de&gt;</td>
<td></td>
</tr>
</tbody>
</table>
CAUSES OF ERRORS FOR ENGLISH SYSTEM

Infinite

Underspecified relation phrase

Over-specified noun phrase

No extraction

ReVerb
## CAUSES OF ERRORS FOR ENGLISH SYSTEM

### 2/2

<table>
<thead>
<tr>
<th>Cause</th>
<th>Extr Hech</th>
<th>ReVerb</th>
<th>Example</th>
<th>Intuition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infinitive</td>
<td>–</td>
<td>9%</td>
<td>such as to interpret what the eyes see, think, and control many of the body's movements</td>
<td>Eng</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;the eyes; control many of; the body's movements&gt;</td>
<td>Eng</td>
</tr>
<tr>
<td>Under-specified relation phrase</td>
<td>–</td>
<td>5%</td>
<td>a peaceful nation of navigators who was in contact with Egypt</td>
<td>sys</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;a peaceful nation of navigators; was in; contact&gt;</td>
<td></td>
</tr>
<tr>
<td>Over-specified noun phrase</td>
<td>–</td>
<td>5%</td>
<td>The mammoths migrated from Africa 3.5 million years ago</td>
<td>sys/Eng</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;Arg2 = Africa 3.5 million years&gt;</td>
<td></td>
</tr>
<tr>
<td>No extraction</td>
<td>–</td>
<td>23%</td>
<td>—</td>
<td>sys</td>
</tr>
</tbody>
</table>
OUTLINE

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CONCLUSIONS

• Open IE based on POS-tagged input & syntactic constraints adapted to Spanish

• First cross-lingual comparative study of Open IE

• Performance for Spanish is comparable to English
  • for system based on the same approach

• Detailed analysis of errors:
  • POS-tagging accuracy of 95+% is sufficient for this task
  • Inverse word order is not the biggest problem
FUTURE WORK

• Run the system over a large corpus
• Most frequent assertions will be considered “facts”
• Cluster relation phrases and arguments
• Map relations to some ontology

THANK YOU! QUESTIONS?
APPENDIX
DIFFERENCES IN IMPLEMENTATION

• Different POS-tag set:
  EAGLES vs Penn Tree

• Different verb phrase treatment:
  • Reflexive verbs in Spanish: *Juan se lava la cara.*

• Based on regular expressions

• Differences in implementation of coordinative conjunction resolution,

  *Purely engineering details*
REGEX EXAMPLES

Verb phrase:

\[ VREL \rightarrow (V\ W^*P)\lav V \]

\( W \) can be a noun, an adjective, an adverb, a pronoun, or an article

\[ W = r'(?:(?:\s+\w+\^\w+\^N......)|(?:\s+\w+\^\w+\^A.....)|(?:\s+\w+\^\w+\^R.)|(?:\s+\w+\^\w+\^P.......)|(?:\s+\w+\^\w+\^D.....)|(?:\s+\w+\^\w+\^VMN....(?:\s+\w+\^\w+\^PP...000)?))' \]
PROBLEM

3. POS analysis and syntactic constraints

ReVerb (Fader et al., 2011)

• Requires language-specific information
e.g. Typical POS sequence in a relation
• Was implemented for English only
  “simple canonical ways in which verbs express relationships in English” [Etzioni et al., 2011]

What are peculiarities of application of this method to another language?
APPROACHES TO OPEN IE 1/3

Learning based systems:
*TextRunner (Banko, 2007), WOE$^{pos}$ & WOE$^{parse}$ (Wu & Weld, 2010)*
  - Automatically labeled sentences (using heuristics or distant-supervision)
  - Learn relation phrase extractor
  - Argument-first:
    - Detect arguments (Arg1, Arg2) and then identifies a relation

Shortcomings:
  - Noisy training corpus
  - Doesn’t work well for long sentences
  - Detects incoherent relations:
    (Faust; made; a deal) instead of (Fausts; made a deal with; the devil)
APPROACHES TO OPEN IE 2/3

**Syntactic-analysis based systems:**

*OLLIE*(Mausam, 2012), *FES*(Aguilar, 2012)

- Deeper syntactic and context analysis
- Detects relations that are not expressed via a verb

**Shortcomings:**

- High computational capacity
- Slow
APPROACHES TO OPEN IE 3/3

POS analysis and syntactic constraints based systems:

*ReVerb (Fader et al., 2011)*

- Does not need labeled corpus
- POS-tagging and rules
- “Relation phrase”- first
- Fast in implementation and execution

**Shortcomings:**

- Detects only verb-based relations
- Works on a sentence-level
Does not resolve inverse word order

Object/Indirect Object - Verb – Subject

“De la médula espinal nacen los nervios periféricos”
(“Out of the spinal cord come peripheral nerves”)

76 utilizando conexión es de definición estándar.