The Abu-MaTran project: tools for teaching machine translation

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Outline

1) The Abu-MaTran project in a nutshell

2) Acquisition of parallel data from the web
   - How a web crawler works
   - Web crawling in the Abu-MaTran project
   - Hands-on session: Bicrawler

3) Building statistical machine translation (SMT) systems
   - Introduction to SMT
   - SMT systems released in the Abu-MaTran project
   - Hands-on session: MTradumàtica
The Abu-MaTran project in a nutshell
Abu-MaTran in a nutshell

- Project type: Marie Curie IAPP (Industry-Academia Partnerships and Pathways)
  - core activity: transfer of knowledge
  - by means of secondments: put in contact academic and industrial partners
- Duration: 48 months (from January 2013): it is about to end
Partners

- Dublin City University (Ireland)
- Prompsit Language Engineering (Spain)
- University of Alicante (Spain)
- University of Zagreb (Croatia)
- Institute for Language and Speech Processing (Greece)
Abu-MaTran in a nutshell

- Enhance industry-academia cooperation to tackle multilinguality
- Increase low industrial adoption of machine translation
- Transfer back to academia the know-how of industry to make research products more robust
- Resources produced to be released as free/open-source software
- Focus on Croatian: language of new EU member state
- Emphasis on dissemination
Some results (I)

- Open-source software released:
  - 2 web crawlers
  - Tool for getting corpora from Twitter
  - Tool for inferring shallow-transfer rules from small parallel corpora
  - Tool for adding entries to RBMT monolingual dictionaries

- Corpora released:
  - General-domain monolingual corpora for Croatian, Serbian, Bosnian, Catalan and Finnish
  - Tweets monolingual corpora for Croatian, Serbian and Slovene
  - General-domain parallel corpora for English-to Croatian, Serbian, Bosnian and Finnish
  - Tourism parallel corpora for English-Croatian
  - ...
Some results (II)

- MT systems created:
  - RBMT: Serbian-Croatian
  - SMT: domain adaptation and linguistic resources:
    - Tourism domain English-Croatian
    - General domain English-Croatian
    - Tourism domain English-Greek

- Participation in shared tasks
  - Winning systems TweetMT 2015
Some results (III)

- Workshop organization:
  - 2014, DCU: Software management for researchers
  - 2014-2015, Zagreb: data creation for Croatian RBMT
  - 2014, Reykjavik: free/open-source RBMT linguistic resources
  - 2016, DCU: Hybrid machine translation
  - 2016, DCU: Tools for linguists
Acquisition of parallel data from the web

1) How a web crawler works
2) Web crawling in the Abu-MaTran project
3) Hands-on session: Bicrawler
How a web crawler works

- How can we turn a multilingual website ...

- ... into a parallel corpus ready for SMT?

<table>
<thead>
<tr>
<th>Our University Campus is regarded as one of the best in Europe</th>
<th>La Universidad puede presumir de tener uno de los mejores campus europeos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study with us</td>
<td>¿Vienes?</td>
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How a web crawler works

1) Download web pages
2) Extract text and remove HTML tags
3) Detect language of documents
4) Identify documents that are mutual translation **(most difficult part)**
5) Extract parallel sentences from each document pair

The Abu-MaTran project
How a web crawler works

1) Download web pages
   - The most time-consuming part: downloading a big website can take days!
   - From the main page (e.g. www.ua.es), hyperlinks are followed in order to get new documents
   - From new documents, hyperlinks are followed in order to get more documents, and so on…
   - It is very important to follow the rules in robots.txt
How a web crawler works

2) Extract text and remove HTML tags

- HTML tags need to be stored: they are needed in subsequent steps

- Text is split into **paragraphs**

```html
<div class="row">
  <div class="col-md-12">
    <h2 class="subSeccionIcono" id="vienes"><img src="https://web.ua.es/secciones-ua/images/acceso/estudia/vida-universitaria/icono1.jpg" /> Study with us</h2>
    <h3 class="subtituloIcono">The University of Alicante gives you a warm welcome and offers its services for accommodation and transport. Find out more here.</h3>
  </div>
</div>
```

Study with us

The University of Alicante gives you a warm welcome and offers its services for accommodation and transport. Find out more here.
How a web crawler works

3) Detect language of documents

Study with us

The University of Alicante gives you a warm welcome and offers its services for accommodation and transport. Find out more here.

¿Vienes?

La Universidad de Alicante te acoge con toda clase de facilidades para el alojamiento o el transporte. Conócelas aquí.
How a web crawler works

4) Identify documents that are mutual translation
   • The most difficult part
   • There is a shared task at WMT conference
   • Clues that help us to identify pairs of documents:
     - Images
     - Numbers
     - Named entities
     - HTML structure/layout
     - Links
     - Similarity after being translated with some bilingual resource: finding parallel resources is difficult for some language pairs!
How a web crawler works

5) Extract parallel sentences from each document pair

- Don’t join sentences from different paragraphs

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Crawling tools developed

  - Developed by Prompsit Language Engineering and University of Alicante
  - Produces a parallel corpus from a multilingual web site
  - Needs bilingual lexicon
  - Document alignment by means of automatic classifier

  - Developed by ILSP (Greece)
  - Can be used to produce monolingual or parallel corpora, from multiple websites and even a list of terms
  - Does not need any bilingual resource
  - Document alignment by means of heuristics
Monolingual corpora

• Important resource for SMT: building language models
• From Internet top-level domains:
  – .hr (Croatian; 1340M toks.), .bs (Bosnian; 288M toks.), .sr (Serbian; 557M toks.) → English-Croatian tourism SMT
  – .fi (Finnish; 1700M toks.) → WMT 2015 good results
  – .cat (Catalan; 779M toks.)
• From Twitter:
  – With our tool TweetCaT: 236M toks. for Serbian/Croatian, 38M toks. for Slovene
Parallel corpora

- Even more important resource for SMT: more difficult to find
- From Internet top-level domains, with Bitextor+Spiderling:
  - .sl (Slovene-English; 37M toks.)
  - .sr (Serbian-English; 27M toks.)
  - .hr (Croatian-English; 71M toks.) → English-Croatian SMT
  - .fi (Finnish-English; 100M toks.) → WMT 2015 good results
- From lists of websites, with ILSP-FC:
  - Croatian tourism websites (Croatian-English; 146k segments) → English-Croatian tourism SMT
  - Greek tourism/culture websites (Greek-English; 4M toks.) → English-Greek tourism SMT
Bicrawler

- Web-based service for extracting parallel corpora from multilingual websites
- Makes acquisition of parallel data available to everyone
- Developed by Prompsit Language Engineering
- Built upon the two open-source web crawlers released during the project: Bitextor and ILSP-FC
- Added an additional cleaning layer to remove possible errors introduced by the crawling tools
- Free use, but limited in terms of crawling time
- Unlimited (premium) version will be available soon
Hands-on session

Building SMT systems

1) Introduction to SMT
2) SMT systems deployed in the Abu-MaTran project
3) Hands-on session: MTradumàtica
Statistical machine translation

- **Translation**: TL sentence with highest probability according to a combination of statistical models
- Translation hypotheses are built by splitting the SL sentence in segments and concatenating (not necessarily in the same order) their translations according to a phrase translation model
- Example: *the small houses*

<table>
<thead>
<tr>
<th>the</th>
<th>el</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>the</td>
<td>las</td>
<td>0.2</td>
</tr>
<tr>
<td>the small</td>
<td>el</td>
<td>0.05</td>
</tr>
<tr>
<td>small houses</td>
<td>casas pequeñas</td>
<td>0.7</td>
</tr>
<tr>
<td>small houses</td>
<td>medianas</td>
<td>0.1</td>
</tr>
<tr>
<td>el</td>
<td>hogar</td>
<td>0.3</td>
</tr>
<tr>
<td>el casas pequeñas</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>el hogar</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td>las casas pequeñas</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>el medianas hogares</td>
<td>0.015</td>
<td></td>
</tr>
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Different models

- **Phrase translation model** in both directions
- Language model of the target language (TL)
- Word penalty
- Phrase penalty
- Reordering model
- ...

The Abu-MaTran project
Phrase translation model

- Phrase table
  - Multi-word probabilistic bilingual dictionary (in both directions) with variable-length segments

| Source (s)          | Target (t)           | $p(s|t)$ | $p(t|s)$ |
|---------------------|----------------------|----------|----------|
| …                   | …                    | …        | …        |
| here are the dates  | voilà les dates de  | 1.00     | 1.00     |
| here are the dates  | voilà les dates     | 1.00     | 1.00     |
| here are the        | voici donc les      | 0.33     | 0.50     |
| here are the        | voilà les           | 0.04     | 0.50     |
| …                   | …                    | …        | …        |
Phrase translation model

Obtained from a parallel corpus

1) Compute word alignments
2) Extract bilingual phrases from the word alignments

3) Compute translation probabilities

\[
p(s|t) = \frac{\text{count}(s \leftrightarrow t)}{\text{count}(t)}; \quad p(t|s) = \frac{\text{count}(s \leftrightarrow t)}{\text{count}(s)}
\]
Target language model

- It allows us to measure how likely (fluent) a TL sentence is, how “good” it is that sentence in the TL

- Usually: statistical model based on n-grams (segments of n words)

\[
p(\text{The potential of machine translation is clear}) = \\
p(\text{The}) \times p(\text{potential}|\text{The}) \times p(\text{of}|\text{The potential}) \times \\
p(\text{machine}|\text{potential of}) \times p(\text{translation}|\text{of machine}) \times \\
p(\text{is}|\text{machine translation}) \times p(\text{clear}|\text{translation is})
\]

- Easily obtained from large TL (monolingual) texts:

\[
p(\text{house}|\text{the red}) = \frac{\text{count(\text{the red house})}}{\text{count(\text{the red } *)}}
\]
Other models

- **Word penalty**: number of words in the target translation
  - The language model likes short sentences (less n-grams to score)
  - Used to avoid producing very short translations
- **Phrase penalty**: number of bilingual phrases used to produce the target
  - Used to promote the use of long phrases (fewer phrases)
- **Reordering model**: how likely is to change the order of a phrase when assembling the translation hypothesis.
Parameter tuning

- Not all models are equally important
- Probability of a translation hypothesis:
  \[
p(target|source) \propto \lambda_1 h_1(\cdot) + \lambda_2 h_2(\cdot) + \cdots + \lambda_{14} h_{14}(\cdot)
\]
- \(h_i(\cdot):\) prob of hypothesis according to model; \(\lambda_i: \) weight of model \(h_i\)
- Tuning: starting with random values for the weights \(\lambda_i,\) find the set of values that maximises translation quality
  - From a (small) development parallel corpus
  - Its SL side is translated, compared to the TL side and weights are updated to obtain a more accurate translation
  - The process is repeated iteratively
Abu-MaTran SMT systems

- English-Croatian: generic and tourism domain
- WMT 2014: English-French
- WMT 2015: English-Finnish
- WMT 2016*: English-Finnish (NMT)
- English-Greek: tourism/culture domain
English-Croatian SMT systems (I)

- Objective: build a generic (news) and a tourism-oriented SMT system

- Challenges:
  - Available parallel data is generally noisy or out-of-domain:
    - DGT and JCR (law)
    - OpenSubtitles (movie subtitles, noisy)
    - TED Talks (spoken language)
    - SETimes (news)
  - Croatian is a highly inflected language: data sparseness
English-Croatian SMT systems (II)

- Obtain additional parallel data:
  - Crawl .hr TLD and tourism web sites
  - Translate Serbian side of English-Serbian parallel data
- Select most appropriate sentences from out-of-domain data using LM perplexity difference (*data selection*)
- Use factored translation models for English→Croatian:

  Predsjednik Karzai ne želi nikakvu stranoj kontrolu
  \[
  \begin{array}{llllll}
  \text{N-M-SG-NOM} & \text{PN} & \text{ADV} & \text{VB} & \text{DT} & \text{ADJ-F-SG-LOC} \text{ N-F-SG-ACC} \\
  \end{array}
  \]

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  \[
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  \end{array}
  \]

- Results:
  - General-domain: outperforms Google Translate
  - Tourism system: outperforms general-domain system when translating tourism websites
WMT participation (I)

- Workshop on Statistical Machine Translation
  - Annual competition: build the best MT system for the news domain
  - Constrained: from the resources provided
  - Unconstrained: from any resource you can find

- WMT 2014: English → French
  - Data selection: use subset of training data likely to belong to news domain according to LM perplexity
  - Ranked 1\textsuperscript{st} constrained
WMT participation (II)

- WMT 2015: English-Finnish
  - Morphological segmentation on Finnish with Omorfi lexicon-based tool in order to deal with data sparseness:
    - Splits compound words
    - Splits simple words in lemma + morphological affixes
  - Ranked 1st constrained, 2nd unconstrained (+ crawled data)

<table>
<thead>
<tr>
<th>Finnish text</th>
<th>haluaisimme , että oppisimme tästä yhden perusasian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segmented</td>
<td>halua → ← isi → ← mme , että opp → ← isi → ← mme tästä yhde → ← n</td>
</tr>
<tr>
<td></td>
<td>perus → (basic) ← asia → (issue) ← n (case marker)</td>
</tr>
</tbody>
</table>

- WMT 2016: English → Finnish
  - Neural MT + morphological segmentation
  - Ranked 1st constrained
English-Greek tourism SMT systems

- Previously built SMT systems followed data selection as the main *domain adaptation* method.
- Domain adaptation: method to combine in-domain and out-of-domain data so as to maximize translation quality.
- We experimented with different domain adaptation methods in the literature and picked the best ones for our domain:
  - English → Greek: one LM for each domain
  - Greek → English: data selection + different LMs
- Our SMT systems are available at [http://translator.abumatran.eu](http://translator.abumatran.eu)
Our translator is working pretty well.

Naš prevoditelj radi prilično dobro.
Mtradumàtica (I)

- Web interface for Moses
- Developed by Prompsit Language Engineering for Universitat Autònoma de Barcelona
- Released as open-source software
- Allows you to easily experiment with SMT:
  - Manage files and corpora
  - Train LMs and SMT systems
  - Tune systems
  - Translate text
  - Inspect phrase table and language model
Mtradumàtica (II)

• Currently you cannot:
  – Apply data selection
  – Merge systems with domain adaptation methods
  – Evaluate systems with automatic metrics

• Useful tool for making students understand how SMT works
Hands-on session

Thank you for your attention

The Abu-MaTran project