Arabic Language Challenges

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This lecture is not
- About Arabic language technologies
- Description of the state-of-the-art
- Highly technical
- Duplicate to other presentations (I hope)
- Boring (promise)

This lecture is about
- Why Arabic Language is Important
- Arabic orthographic nature
- Arabic morphological nature
- Arabic phonetic nature
- Challenges stem from this nature

This sentence is written in Arabic language

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Language Technology

Technology Related to the Language People Speak
- Information retrieval (Google)
- Translation (Google-translate)
- Question Answering
- Sentiment Analysis
- Automatic Speech Recognition (ASR, e.g. Siri)
- Optical Character Recognition (OCR)

Arabic Language

- Arabic is the largest living member of the Semitic language family
- It is classified as a macro-language with 27 sub-languages
- It is spoken by over 280 million people in 28 countries (middle-east)
- The language of Quran (over 1.6 billion Muslims)

Arabic Language (Internet)

- Internet users by language (2010)
- Growth in Internet (2000-2010)

Arabic Language (Types)

- Current written Arabic is the *modern standard Arabic*
  - Unified across all Arabic countries (news, political speeches)
  - Easy to understand by all Arabs
  - Not spoken by people!

- Spoken Arabic (dialectic Arabic)
  - Different across Arabic countries (regions)
  - Semi-understandable by different Arabic dialectic
  - For informal use (on social media)

- Classic Arabic (Language of Quran)
  - Contains ancient Arabic words
  - Mostly understandable by Arabic people
  - Previously used different version of Arabic scripts
Arabic Language Nature

- Orthographical nature:
  The way to write Arabic letters
  OCR

- Morphological nature:
  The way to construct Arabic sentences
  NLP, IR, MT, QA

- Phonetic nature:
  The way to pronounce Arabic letters and words
  ASR, T2S, S2S

Orthographical Nature

- Written from right to left (letters only)
- 15 of the 28 letters contain dots
- Characters are connected or semi-connected
- Character shape depends on position
- Printed text may include ligatures and kashida
- Optional diacritics may be present

15 of the 28 letters contain dots

- د ذ b\th d
- ت ث th
- ز ر z\r
- ح خ sh\s
- طظ g

Character shape depends on position

- ن ن ن
- ب ب ب
- ح ح ح
- ي ي ي
- ه ه ه
- ع ع ع
- ر ر ر
Presence of *kashida* and *ligatures*

<table>
<thead>
<tr>
<th>محمد</th>
<th>محمد</th>
</tr>
</thead>
<tbody>
<tr>
<td>للابه</td>
<td>لا</td>
</tr>
<tr>
<td>لا</td>
<td>لا</td>
</tr>
</tbody>
</table>

Optional *diacritics* may be present

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It was very ambiguous

ان الله نام بالعدل والإحسان وإيتاء ذي القربى ونبي
عن الفحشاء والمنكر واللغي يعطمكم لعلكم تذكرون

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What about Arabic OCR?

- Word Error Rates (WER) are considerably high
- Good Arabic OCR: 30-40% WER on average
- Trained on similar font: <10% WER
- Old fonts: >70% WER
- Average WER for English: <5%
Morphological Nature

- Language is built of 10k roots
- Short vowels are not written (diacritics)
- Words contain prefix, infix, and suffix (prouns, others)
  
  (the, and, his, her, their, it, him, them, will ...) are attached to the main word
- Word spelling can change according to grammatical position
- No rule for plural words
- 60 billion possible surface forms

Short vowels are not written

- In the Arabic text we do not write its short vowels and the pronouns are attached to the words
- In th Arbc txt w do nt writ its short vwls and th pronounced ar attachd to th words

Words contain prefix, infix, and suffix

They are Peter’s children
The children behaved well
Her children are cute
My children are funny
We have to save our children
Patents and children are happy
He loves his children
His children loves him

وسیکتونها
wasaya+ktub+unahaa
and will + write + they it
= and they will write it

(kataba) write
(kotub) books
(kattaba) let someone write
(kuttiba) forced to write

No rule for plural

<table>
<thead>
<tr>
<th>Singular</th>
<th>Plural</th>
</tr>
</thead>
<tbody>
<tr>
<td>رجل</td>
<td>رجلان</td>
</tr>
<tr>
<td>كاتب</td>
<td>كتاب</td>
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<tr>
<td>مكتب</td>
<td>مكتبات</td>
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<td>مكتبة</td>
<td>مكتبات</td>
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<tr>
<td>هاتف</td>
<td>هواتف</td>
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<tr>
<td>مصلي</td>
<td>مصلين</td>
</tr>
<tr>
<td>إمام</td>
<td>أئمة</td>
</tr>
</tbody>
</table>
What about Arabic IR?

- Some characters are normalized
- Diacritics (short vowels) are removed (if existed)
- Later approaches for search
  - Search with words
  - Apply light stemming for words
  - Apply morphological stemming for words
  - Simple character n-grams representation
- New Methods are being developed for Social Arabic

What about Arabic ASR?

- Needs special training and decoding
- Requires huge amount of training
- Requires diacritisation as a pre-processing step
- State-of-the-art is not bad (for MSA)
- Again for dialect, it is too bad

Phonetic Nature

Some phonemes are in Arabic doesn’t exist in other language (‘ein, ghain, ha, kha, Dad, Sad, Ta, Hamza)

Examples:
Mohamed (ha)
Attia (‘ein, Ta)
Khalid (kha)
Ghada (ghain)
Baraa (Hamza)
Diaa (Dad, Hamza)

State-of-the-art / Areas of research

<table>
<thead>
<tr>
<th>Language Technology</th>
<th>MSA</th>
<th>Dialect Arabic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stemming (Segmentation)</td>
<td>Good</td>
<td>Needs work</td>
</tr>
<tr>
<td>POS</td>
<td>Good</td>
<td>Good for some</td>
</tr>
<tr>
<td>NER</td>
<td>Good</td>
<td>Can be improved</td>
</tr>
<tr>
<td>Search (IR)</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>ASR</td>
<td>Good</td>
<td>Needs work</td>
</tr>
<tr>
<td>Sentiment analysis</td>
<td>Needs work</td>
<td>Not working!</td>
</tr>
<tr>
<td>Sarcasm detection</td>
<td>NA</td>
<td>HELP!!</td>
</tr>
<tr>
<td>Syntactic tree parsing</td>
<td>kind of</td>
<td>What is it?</td>
</tr>
</tbody>
</table>
Conclusion

- Language technology requires deep algorithms to overcome language challenges
- Arabic language is full of challenges
- Huge amount of work already done
- Huge amount of work is still needed
- Some languages are just harder to deal with in NLP than others!

Thank you
شكرا (shokran)