Language Identification in Social Media is a Challenging Task

- Plenty of languages
  - Only half of them are in English

- Informal writing
  - Great -> gr8

- Code-mixing

Twitter Language Map

http://www.fastcodesign.com/1665366/infographic-of-the-day-the-many-languages-of-twitter
Code-Mixing

• Mixing multiple languages
  – Inter-sentential
  – Intra-sentential
  – Word-level

• Phonetic typing
  – Writing in Roman script instead of native language script
  – Ad-hoc Romanisation
Example: Phonetically Typed Code-Mixed Content

Achha ei prosno ta ageo keu korechhe kina jani na, tobe ei page-e Cr Arindam Sarkar er reign of terror dekhe amar akta prosno mathaye ghurchhe. Tumi ki 1st year er Class Representative howa ta beshi seriously niye felechhile naki Cr er onyo ortho achhe?

Achha ei prosno ta ageo keu korechhe kina jani na, tobe ei page-e Cr Arindam Sarkar er reign of terror dekhe amar akta prosno mathaye ghurchhe. Tumi ki 1st year er Class Representative howa ta beshi seriously niye felechhile naki Cr er onyo ortho achhe?

- Bengali
- English
Goal of our Work

Word-Level Language Identification with Phonetically Typed Code-Mixed Content
Corpus

- **English-Hindi-Bengali**
- phonetically typed code-mixed content
- Facebook post and comments
- Indian student community

Reasons:
- Code-mixing is frequent among speakers who are multilingual and younger in age.
  - India is a country with 30 spoken languages, among which 22 are official.
  - 65% of Indian population is 35 or under. **

Currently our corpus contains 2335 posts and 9813 comments.

Annotation (1)

• Annotation Type: Human Annotation

• Number of Annotators: 4
  - 3 students from Computer Science background from same university
  - 1 author of this paper

• Target:
  - Capture
    • inter-sentential code-mixing
    • intra-sentential code-mixing
    • word-level code-mixing
Annotation (2)

- **Tags**: `<T attribute = “L”> </T>`
  - **T**: Type of code-mixing
    - sentence (sent)
    - fragment (frag)
    - inclusion (incl)
    - word level code-mixing (wlcm)
  - **L**: Language(s) of code-mixing
    - English (en)
    - Hindi (hi)
    - Bengali (bn)
    - Mixed (mixd)
    - Universals (univ)
    - Undefined (undef)
Sentence

<sent lang ="language"> .... </sent>

- Identifies sentence boundary
- Identifies inter-sentential code-mixing
• **English Sentence:** what a.....6 hrs long...but really nice tennis....
  
  ```
  <sent lang="en">
  what a.....6 hrs long...but really nice tennis....
  </sent>
  ```

• **Bengali Sentence:** shubho nabo borsho.. :) 
  
  ```
  <sent lang="bn">
  shubho nabo borsho.. :) 
  </sent>
  ```

• **Hindi Sentence:** karwa sachh ..... :( 
  
  ```
  <sent lang="hi">
  karwa sachh ..... :( 
  </sent>
  ```
• **Univ-Sentence:** hahahahahahah....!!!!!!
  
  ```xml
  <sent lang="univ">
    hahahahahahah....!!!!!!
  </sent>
  ```

• **Mixed-Sentence:** oye hoye ..... angreji me kahte hai ke I love u.. !!!
  
  ```xml
  <sent lang="mixd">
    <frag lang="hi">
      oye hoye ..... angreji me kahte hai ke
    </frag>
    <frag lang="en">
      I love u.. !!!
    </frag>
  </sent>
  ```
Annotation (6)

- **Fragment**

  `<frag lang ="language"> ... </frag>`
  
  - Identifies groups of grammatically related words in a sentence
  
  - Identifies intra-sentential code-mixing
Mixed-Sentence: oye hoye ..... angreji me kahte hai ke I love u.. !!!

<sent lang="mixd">
  <frag lang="hi">
    oye hoye ..... angreji me kahte hai ke
  </frag>
  <frag lang="en">
    I love u.. !!!
  </frag>
</sent>
Inclusion

<incl lang="language"> ... </incl>

- Identifies foreign word or phrase
- Within sentence or fragment
- Assimilated in native language
- Identifies intra-sentential code-mixing
Sentence with inclusion: Na re seriously ami khub kharap achi.

<sent lang="bn">
  Na re
  <incl lang="en">
    seriously
  </incl>
  ami khub kharap achi.
</sent>
Word-Level Code-Mixing

<wlcm type="languages"> ... </wlcm>

- Capture intra-word code-mixing
- Smallest unit of code-mixing
Word-level code mixing (EN-BN) : chapless

*where*

- **Root word:** chap (Bengali)
- **Appended Suffix:** less (English)

```xml
<wlcm type="bn-and-en">chapless</wlcm>
```
5,233 tokens are identified as NE and 715 tokens are identified as Acronym (e.g. JU).
Total: 195,570
## Tag-Level Statistics

<table>
<thead>
<tr>
<th>Tags</th>
<th>EN</th>
<th>BN</th>
<th>HI</th>
<th>Mixd</th>
<th>Univ</th>
<th>Undef</th>
</tr>
</thead>
<tbody>
<tr>
<td>sent</td>
<td>5,370</td>
<td>5,523</td>
<td>354</td>
<td>204</td>
<td>746</td>
<td>15</td>
</tr>
<tr>
<td>frag</td>
<td>288</td>
<td>213</td>
<td>40</td>
<td>-</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>incl</td>
<td>7,377</td>
<td>262</td>
<td>94</td>
<td>-</td>
<td>1,032</td>
<td>1</td>
</tr>
<tr>
<td>wlcm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>477</td>
</tr>
</tbody>
</table>
Ambiguous Words

• Some types are annotated in multiple languages, e.g 'to', 'clg', 'baba'
  • Common vocabulary between languages
  • Effect of phonetic typing

<table>
<thead>
<tr>
<th>Labels</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN</td>
<td>9,109</td>
<td>34.40</td>
</tr>
<tr>
<td>BN</td>
<td>14,345</td>
<td>54.18</td>
</tr>
<tr>
<td>HI</td>
<td>1,039</td>
<td>3.92</td>
</tr>
<tr>
<td>EN or BN</td>
<td>1,479</td>
<td>5.58</td>
</tr>
<tr>
<td>EN or HI</td>
<td>61</td>
<td>0.23</td>
</tr>
<tr>
<td>BN or HI</td>
<td>277</td>
<td>1.04</td>
</tr>
<tr>
<td>EN or BN or HI</td>
<td>165</td>
<td>0.62</td>
</tr>
</tbody>
</table>
IAA (1)

Token-Level Kappa = 0.884

[Calculated on randomly selected 100 comments between 2 annotators]
### Tag-level Kappa = 0.6683

<table>
<thead>
<tr>
<th>Tag</th>
<th>Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>sent</td>
<td>0.6825</td>
</tr>
<tr>
<td>frag</td>
<td>0.5171</td>
</tr>
<tr>
<td>incl</td>
<td>0.5507</td>
</tr>
<tr>
<td>wlcm</td>
<td>0.6223</td>
</tr>
<tr>
<td>ne</td>
<td>0.6172</td>
</tr>
<tr>
<td>acro</td>
<td>0.6144</td>
</tr>
<tr>
<td>All tags</td>
<td>0.6683</td>
</tr>
</tbody>
</table>

[Calculated on randomly selected 100 comments between 2 annotators]

**Annotation**

<sent lang="bn">ki
  <incl lang="en"> cntrl </incl>
  korte parli na
</sent>

**Word-level representation**

B-SENT-bn ki
B-INCL-en/I-SENT-bn cntrl
I-SENT-bn krte
I-SENT-bn parli
I-SENT-bn na
Experiments (1)

• Approaches
  – Dictionary-based
  – SVM without contextual information
  – SVM and CRF with contextual information

• 5-fold cross-validation

• 4-way classification (en, bn, hi and univ)
Experiments (2)

- To avoid unrealistic context,
  - NEs and WLCMs are included for context features
  - With label 'other' in training (5-way system)

- Two special cases:
  - Gold NEs and WLCMs do not count for evaluation
  - Back-off to 4-way system (en, bn, hi and univ) when 'other' is predicted
Dictionary Approach (1)

• Full-form dictionaries extracted from
  – British National Corpus
  – SEMEVAL 2013 Twitter data
  – Lexical normalisation list (Han and Baldwin, 2011)
  – Training data

• No transliterated Bengali or Hindi dictionary available
Dictionary Approach (2)

- Language prediction by presence in dictionaries
- Use normalised word frequencies
- For OOVs or ties, the majority language is predicted
- UNIV identified with hand-crafted regular expressions
## Dictionary Approach (3)

<table>
<thead>
<tr>
<th>Dictionary</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNC</td>
<td>80.09</td>
</tr>
<tr>
<td>SEMEVAL Twitter</td>
<td>77.61</td>
</tr>
<tr>
<td>LexNormList</td>
<td>79.86</td>
</tr>
<tr>
<td>Training Data</td>
<td>90.21</td>
</tr>
<tr>
<td>LexNormList+Training Data</td>
<td>93.12</td>
</tr>
</tbody>
</table>

All combinations were tried.
SVM without Context (1)

- Features
  - Character n-grams (G)
  - Presence in dictionary (D)
  - Binary indicators of word Length (L)
    - Split points determined by decision tree (J48) trained only with length of a word as a single feature
  - Capitalization (C)

- SVM linear kernel with optimised 'C' parameter
• Binary indicators for length feature

**J48 Pruned Tree**

- length <= 3
  - length <= 1: en
  - length > 1: bn
- length > 3
  - length <= 6: bn
  - length > 6
    - length <= 8: bn
    - length > 8
      - length <= 13: en
      - length > 13: bn

**Extracted Length Features**

- Is greater than 3
- Is greater than 1
- Is greater than 6
- Is greater than 8
- Is greater than 13

Encoding 6 ranges: 0-1, 2-3, 4-6, 7-8, 9-13 and 14-inf
SVM without Context (3)

- GDLC: 94.75%
  - GLC: 94.64%
    - GL: 94.62%
  - GDL: 94.73%
  - GDC: 94.72%
- GC: 94.64%
- GD: 94.67%
- G: 94.62%
SVM with Context (1)

- Features
  - Character n-grams (G)
  - Presence in dictionary (D)
  - Binary indicators of word length (L)
  - Capitalization (C)
  - Previous words (Pi)
  - Next words (Ni)
## SVM with Context (2)

<table>
<thead>
<tr>
<th>Context</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDLC (no context)</td>
<td>94.75</td>
</tr>
<tr>
<td>GDLC+P2</td>
<td>94.66</td>
</tr>
<tr>
<td>GDLC+P1</td>
<td>94.55</td>
</tr>
<tr>
<td>GDLC+N1</td>
<td>94.53</td>
</tr>
<tr>
<td>GDLC+N2</td>
<td>94.37</td>
</tr>
<tr>
<td><strong>GDLC+P1N1</strong></td>
<td><strong>95.14</strong></td>
</tr>
<tr>
<td>GDLC+P2N2</td>
<td>94.55</td>
</tr>
</tbody>
</table>
CRF (1)

- Linear chain Conditional Random Field (CRF) with increasing order (0,1,2)

- Features
  - Character n-grams (G)
  - Presence in dictionary (D)
  - Word length (L)
  - Capitalisation (C)
## CRF (2)

<table>
<thead>
<tr>
<th>Features</th>
<th>Order-0</th>
<th>Order-1</th>
<th>Order-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>92.80</td>
<td>95.16</td>
<td>95.36</td>
</tr>
<tr>
<td>GD</td>
<td>93.42</td>
<td>95.59</td>
<td>95.98</td>
</tr>
<tr>
<td>GL</td>
<td>92.82</td>
<td>95.14</td>
<td>95.41</td>
</tr>
<tr>
<td>GDL</td>
<td>93.47</td>
<td>95.60</td>
<td>95.94</td>
</tr>
<tr>
<td>GC</td>
<td>92.07</td>
<td>94.60</td>
<td>95.05</td>
</tr>
<tr>
<td>GDC</td>
<td>93.47</td>
<td>95.62</td>
<td>95.98</td>
</tr>
<tr>
<td>GLC</td>
<td>92.36</td>
<td>94.53</td>
<td>95.02</td>
</tr>
<tr>
<td>GDLC</td>
<td>93.47</td>
<td>95.58</td>
<td>95.98</td>
</tr>
</tbody>
</table>
Test Set Results

- Dictionary
  - 93.64%
- SVM without context
  - 95.21%
- SVM with context
  - 95.52%
- CRF
  - 95.76%
Conclusion (1)

- Contextual clues are helpful:
  - The following example is wrongly classified by all our systems that do not use context information.
  - All context-based systems classify it correctly.


Conclusion (2)

- Character n-grams are helpful features for language identification experiments.

- Adding dictionary-based predictions as features gives a small boost to accuracy.
We re-ran our CRF experiments with Wapiti (Lavergne et al., 2010) instead of Mallet
- 96.37% accuracy (+0.39 percentage points)
THANK YOU
SVM without Context (4)

GDL: 94.75%

GLC: 94.64%
GL: 94.62%
G: 94.62%

GDL: 94.73%
GC: 94.64%
GD: 94.67%

GDC: 94.72%

+0.11  +0.02  +0.03
+0.02  +0.00  +0.11
+0.11  +0.06  +0.11
+0.00  +0.02  +0.05