Cognate and Misspelling Features for Natural Language Identification

Garrett Nicolai, Bradley Hauer, Mohammad Salameh, Lei Yao, Grzegorz Kondrak
Department of Computing Science, University of Alberta

Introduction

- Support Vector Machines are applied to the Native Language Identification task.
- We introduce 2 novel features: Spelling Error Alignments, and Cognate Interference Features, which improve classifier accuracy by 2 and 4%, respectively.
- Our best classifier contains our features, as well as a set of other common features.

Features

- Word Unigrams:
  - Function words:
    - A list of 295 common function words such as “for”, “the”, “I”, etc.
  - Content words:
    - We consider all word unigrams encountered in training.
- Word Bigrams
- Character Bigrams
  - Binary feature that indicates if bigram occurs in document with greater-than-average frequency
- Part-of-Speech Bigrams
- Meta-features:
  - Number of words / sentence
  - Number of characters / document
  - Number of words / document
  - Number of characters / document
  - Average Word Length
- Syntax Production Rules
  - Rules of the form A → BC
  - Rules with and without terminals
- Cognate Interference Rules
- Spelling Error Features

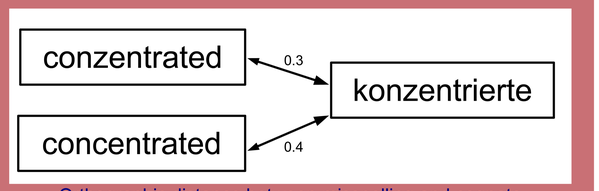
Features were used to train a multi-class Support Vector Machine with a linear kernel.

Cognate Features

- We hypothesize that spelling is affected by L1.
- If the misspelling is closer to the L1 word than the L2 word is, we activate a cognate feature.
- Cognate features were developed for French, German, Italian, and Spanish.

1. For each misspelled English word *m* found in a document, identify the most likely intended word *e* using a spell-checking program.
2. For each language L:
   (a) Look up the translation *f* of the intended word *e* in language L.
   (b) Compute the orthographic edit distance *D* between the words.
   (c) If $D(e,f) < t$ then *f* is assumed to be a cognate of *e.*
   (d) If *f* is a cognate and $D(m,f) < D(e,f)$ then we consider it as a clue that L = L1.

Algorithm for determining cognate interference



Orthographic distance between misspelling and cognate

- *conzentrated* is closer to *konzentrierte* than *concentrated* is.
- The German feature fires.

Misspelling	Intended	Cognate
developped	developed	developpé (FRE)
exemple	example	exemple (FRE)
organisation	organization	organisation (GER)
conzentrated	concentrated	konzentrierte (GER)
comercial	commercial	comercial (SPA)
sistem	system	sistema (SPA)

Examples of cognate interference

Spelling Error Features

- We hypothesize that speakers with the same L1 make similar spelling mistakes.
- Misspellings are aligned with their proposed corrections. An example alignment is shown below.
- Alignments are used as binary features in the SVM: if the error is detected, the feature is 1, otherwise, it is 0.

a	bu	s	t	ru	ct
|	|	|	|	|	|
a	b	s	t	ra	ct

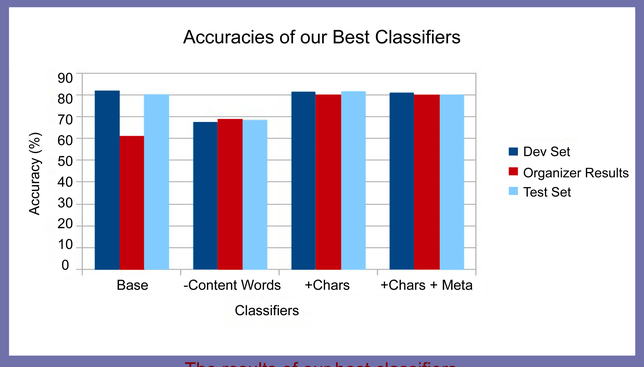
An alignment of a misspelled word and its correction

- Common spelling errors are shown below.
- These errors suggest L1 interference.
- Common across all languages:
  - Transposition
  - Doubling errors
  - Vowel representations
- Spelling errors can catch common mistakes not detected by cognates:
  - i.e, *quality* has Spanish cognate *cualidad*, but spelling mistake qu->cu extends to *cuick, cuest*, etc.

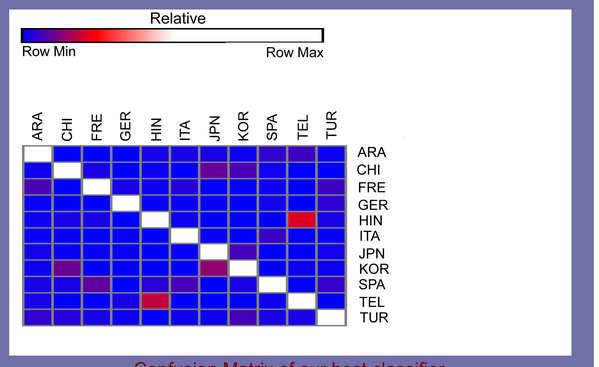
ARA	CHI	FRE	GER	HIN	ITA	JPN	KOR	SPA	TEL	TUR
me -> m	o -> e	n -> nn	ct -> kt	ze -> se	y->i	r -> l	ur -> u	ss -> s	za -> sa	ci -> si
ne -> n	i -> u	ll -> l	's -> s	e -> ea	ch -> c	l -> r	ed -> d	nm -> m	po -> pu	hy -> y
t -> te	t -> d	xa -> xe	ed -> et	es -> ce	b -> bb	n -> nn	ti -> i	qu -> cu	al -> l	ge -> g

Common misspellings for each of the languages

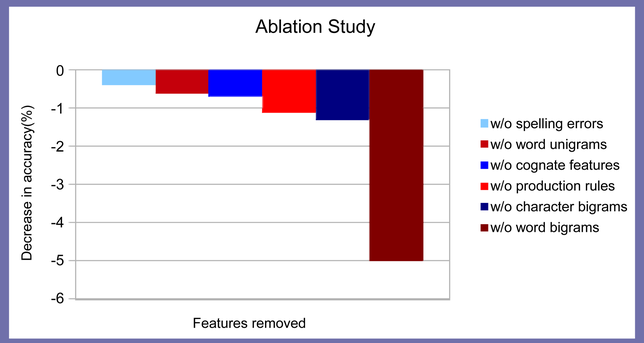
Results



The results of our best classifiers



Confusion Matrix of our best classifier



The results of an ablation study with our features

- Best accuracy of 81.7% obtained with all features except POS bigrams.
- Misclassifications often occur between languages with historical connections.
- Both cognates and spelling features improve accuracy of classifier.