Psycholinguistic Analysis of Code Mixing - SNLP Term Project

Avirup Saha, Soumi Das, Indrasekhar Sengupta, Ayan Chandra

Mentor: Jasabanta Patro

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Introduction

Code switching or **code mixing** is a lexical phenomenon which refers to natural switching of words or phrases between more than one language. **Code borrowing** or **lexical borrowing** refers to the situation where words from one language (say L1) become part of the vocabulary of another language (say L2) due to widespread adoption. This occurs when

- the native language L2 lacks suitable words that convey the same senses appropriately
- foreign word usage dominates its equivalent native language due to wide popularity

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- P(क्लास जाना) > P(कक्षा जाना)

Examples of code mixing

- वह एक cool dude है

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- वह एक cool dude है
- restaurant में खाना
- यह train का time change हो गया हैं क्या?

Goals

In this project we aim to **characterize code borrowing and code mixing** from the psycholinguistic point of view. In particular, we wish to:

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- Propose psycholinguistic based metrics for quantification and prediction of lexical borrowing from code mixing.
- Compare our metrics with various social media based metrics.
- Measure how efficiently our metrics improve the language tagging process as compared to baselines.

Design of Experiment

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- We record user responses as well as reaction times.

Survey Configuration

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- 1. Entire list of phrases has been broken down into three sets.
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  3. Each phrase stays for 5 seconds before timeout.
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- >60 participants took part in the survey, out of which 47 participants completed the entire three set of surveys.

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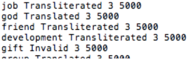
- 

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job Transliterated 3 5000
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Figure: Features of dataset

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  Figure: Features of dataset

- A reference file that holds the mapping between participant ID and the survey output files.
    ```

Defining Metrics

Table: Measures for Defining Metrics

	Transliteration	**Translation**
Valid	Valid Transliteration	Valid Translation
Invalid	Invalid Transliteration	Invalid Translation

Defining Metrics

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- $$\text{Metric-2} = \frac{\text{Valid Transliteration}}{\text{Valid Translation} + \text{Invalid Transliteration}}$$

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- $$\text{Metric-3} = \frac{\dfrac{\text{Valid Transliteration}}{\text{Average Reaction Time for Valid Transliteration}}}{\dfrac{\text{Valid Translation}}{\text{Average Reaction Time for Valid Translation}}}$$

Defining Metrics

- $$\text{Metric-4} = \frac{\frac{\text{Valid Transliteration}}{\text{Average Reaction Time for Valid Transliteration}}}{\frac{\text{Valid Translation}}{\text{Average Reaction Time for Valid Translation}} + \frac{\text{Invalid Transliteration}}{\text{Average Reaction Time for Invalid Transliteration}}}$$

Table: Words with Metric Values

Word	Metric-1	Metric-2	Metric-3	Metric-4
play	0.6190	0.4127	0.3137	1.472e-06
lyrics	0.7	0.5	0.4359	1.7699e-06
people	0.4222	0.2639	0.1334	1.2357e-06
uncle	1.3125	1.1666	1.6794	9.0603e-06
politics	0.5555	0.3906	0.3332	1.373e-06
review	0.8571	0.5882	0.7920	2.173e-06
parliament	0.7555	0.5965	0.5219	1.743e-06
house	0.5581	0.375	0.3107	1.459e-06
film	1.2286	1.1316	2.447	1.677e-06
god	0.5238	0.344	0.2265	9.757e-07

Table: Top Ranked Words as per Metric-1

Rank	Words
1	film
2	interview
3	college
4	uncle
5	body

Table: Top Ranked Words as per Metric-2

Rank	Words
1	film
2	college
3	uncle
4	interview
5	body

Table: Top Ranked Words as per Metric-3

Rank	Words
1	film
2	college
3	interview
4	uncle
5	body

Table: Top Ranked Words as per Metric-4

Rank	Words
1	film
2	college
3	uncle
4	interview
5	body

Top Ranked Words

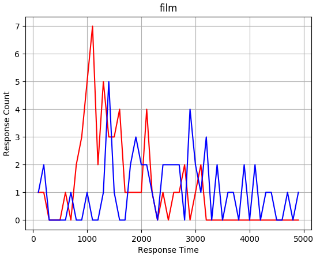

Figure: Word with rank-1 as per Metrics 1-4 (red: transliterated, blue: translated)

Top Ranked Words

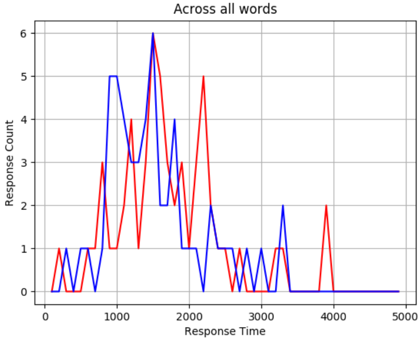

Table: Ground-Truth

Word	Survey_Rank	UUR	UTR	Log_ranking
blue	1	4	6	5
body	2	20	20	43
boy	3	2	2	8
car	4	23	23	30
class	5.5	28	29	19
college	5.5	14	14	15
cool	8	21	21	32
day	8	7	7	3
degree	8	16	16	34
development	10	15	15	41

Comparison with ground truth

Table: Spearman's Rank Correlation Coefficient of Metrics with Ground Truth (Survey Rank)

Metric	Correlation Coefficient
1	0.021173803109
2	0.0939040333899
3	0.0472114201021
4	0.0748703083899

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- We divide the range (0, 5000) into N equal sized intervals
- We count the above responses in each interval and estimate corresponding probabilities by normalization by sum of all counts to obtain two probability vectors A_w and B_w for each word w.

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- $$\text{Metric-5} = \|A_w - B_w\|_2$$

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- $$A_w(i) = P(Valid\ \ Translation \mid RT \in (t_i, t_{i+1})), i \in \{1, 2, \ldots, N\}$$

- $$B_w(i) = P(Valid\ \ Transliteration \mid RT \in (t_i, t_{i+1})), i \in \{1, 2, \ldots, N\}$$

Comparison of Metric-5 with ground truth

Table: SRCC of Metric-5 with Ground Truth (Survey_Rank) for varying interval size

interval size (ms)	SRCC (Metric-5)
50	0.0577821089436
100	0.163456571933
150	0.0621271160135
200	-0.0191634267035
250	0.00204280183134
300	0.0269455289182
350	0.0170233485945
400	0.00444228334752
450	0.0897860043013
500	0.0454604471038

Top Ranked Words as per Metric-5

Table: Top Ranked Words as per Metric-5 for interval size 100 ms

Rank	Words
1	well
2	boy
3	woman
4	question
5	friend

Word vectors for Metric-5

Table: Word vectors for top-ranked word as per Metric-5 ("well") for interval size 100 ms

A_w	B_w
0.111111111111	0.0
0.0	0.0196078431373
0.0	0.0
0.0	0.0392156862745
0.0	0.117647058824

Conclusion and Further Work

We have conducted a study on psycholinguistic behavior of code mixing and defined metrics to indicate the likelihood of code borrowing. Future work includes:

- Pruning the existing metrics from experiment.

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- Pruning the existing metrics from experiment.
- Finding more appropriate metrics to capture the degree of code borrowing.
- Continuing the survey for user base of different age group and regions so that the degree of code borrowing can be indicated differently for each category.

References

- Jasabanta Patro, Bidisha Samanta, Saurabh Singh, Abhipsa Basu, Prithwish Mukherjee, Monojit Choudhury, Animesh Mukherjee, "All that is English may be Hindi: Enhancing language identification through automatic ranking of likeliness of word borrowing in social media", EMNLP 2017
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