

IMPROVING YORÙBÁ DIACRITIC RESTORATION

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1 INTRODUCTION

Yorùbá is a tonal language spoken by more than 40 Million people in the countries of Nigeria, Benin and Togo in West Africa. The phonology is comprised of eighteen consonants, seven oral vowel and five nasal vowel phonemes with three kinds of tones realized on all vowels and syllabic nasal consonants (Akinlabi, 2004). Yorùbá orthography makes notable use of tonal diacritics, known as *amí ohùn*, to designate tonal patterns, and orthographic diacritics like underdots for various language sounds (Adegbola & Odilinye, 2012; Wells, 2000).

Diacritics provide morphological information, are crucial for lexical disambiguation, pronunciation and are vital for any computational Speech or Natural Language Processing task. To unlock the potential for a robust ecosystem of *Yorùbá-first* language technologies, Yorùbá text must be correctly represented on current and future computing environments. The ultimate objective of automatic diacritic restoration (ADR) systems is to facilitate text entry and text correction that motivates and encourages the correct orthography and promotes quotidian usage of the language in electronic media.

1.1 AMBIGUITY IN NON-DIACRITIZED TEXT

The main challenge in non-diacritized text is that it is very ambiguous (Orife, 2018; Adegbola & Odilinye, 2012; Asahiah et al., 2017; De Pauw et al., 2007). ADR attempts to decode the ambiguity present in undiacritized text. Adegbola et al. assert that for ADR the “prevailing error factor is the number of valid alternative arrangements of the diacritical marks that can be applied to the vowels and syllabic nasals within the words” (Adegbola & Odilinye, 2012).

Table 1: Diacritic characters with their non-diacritic forms

Characters	Examples
à á ǎ	a gbà (<i>spread</i>), gba (<i>accept</i>), gbá (<i>hit</i>)
è é ẹ ẹ ẹ	e èsè (<i>dye</i>), ẹsẹ (<i>foot</i>), esé (<i>cat</i>)
ì í	i ìlù (<i>drum</i>), ilu (<i>opener</i>), ilú (<i>town</i>)
ò ó ọ ọ ọ ọ	o arọ (<i>an invalid</i>), aró (<i>indigo</i>), àrò (<i>hearth</i>), àrọ (<i>funnel</i>), àrọ (<i>catfish</i>)
ù ú ǔ	u kùn (<i>to paint</i>), kun (<i>to carve</i>), kún (<i>be full</i>)
̀ ́ ̃	n ò (a negator), n (<i>I</i>), ń (continuous aspect marker)
ș	s șà (<i>to choose</i>), șá (<i>fade</i>), sà (<i>to baptise</i>), sá (<i>to run</i>)

1.2 IMPROVING GENERALIZATION PERFORMANCE

In our efforts to make the the first open-sourced ADR models available to a wider audience, we frequently tested on colloquial, conversational text. We observed that these early models suffered from domain-mismatch generalization errors and appeared particularly not-robust when presented with contractions or variants of common phrases. Because they were trained on majority Biblical text, we attributed these errors to low-diversity of sources and an insufficient number of training examples. To remedy this problem, we set about to we demonstrate that we can improve the model trained on majority Biblical text, using appreciably more text from a variety of sources.

2 METHODOLOGY

Data Collection We started by first attempting a comprehensive GitHub, literature and Google web search, assembling all the public-domain Yorùbá sources online. Those without admissible or consistent quality were put into a special queue for human supervision and corrections. This notably included Wikipedia and Twitter. TIMI OCR SENTENCE HERE. In Table 2 we summarize each of the admitted corpora to convey a sense of the subject matter and word distributions.

Table 2: Data sources

# words	Source or URL	Description
24,868	rma.nwu.ac.za	Lagos-NWU corpus
50,202	theyorubablog.com	language blog
910,401	bible.com/versions/911	Biblica
11,488,825	opus.nlpl.eu	JW300
831,820	bible.com/versions/207	Bible Society Nigeria
177,675	GitHub	YorùbáTwi embeddings dataset
142,991	GitHub	Language ID corpus
47,195		Yorùbá Lexicon
29,338	yoruba.unl.edu	Proverbs
2,887	unicode.org/udhr	Human rights edict
150,360	Private sources	Interview text
15,281	Private sources	Short Stories
20,038	OCR	Hàà Ènìyàn
28,308	yo.globalvoices.org	Global Voices news

Experimental setup Data preprocessing and parallel text preparation followed the same procedures used in (Orife, 2018). Experiments included evaluations of the effect of the various texts on the test accuracy, notably for JW300, which is a disproportionately large contributor to the dataset. We also evaluated models trained with pre-trained FastText embeddings to understand the boost in performance possible with word embeddings.

A new, modern multi-purpose evaluation dataset To succeed at the ADR task for users, our research experiments needed to be guided by a test set based around modern, non-archaic text in popular usage. After much review, there was a consensus that the journalistic news text best represented the modern, colloquial usage of the language. So we selected Global Voices, a multilingual community of journalists, translators, bloggers, academics and human rights activists. Their news-room articles are translated into dozens of languages. We used a web-scrape of their Yorùbá articles comprising some twenty-eight thousand tokens.

3 RESULTS

Discussion of results. Discussion of results. Discussion of results. Discussion of results. Discussion of results. Discussion of results. Discussion of results. Discussion of results.

4 CONCLUSIONS AND FUTURE WORK

Additional data and more diverse data definitely improves performance. Modern Text embeddings provide an additional boost in accuracy (TBD).

All public-domain datasets referenced in this work are available on GitHub.^{1 2}

¹<https://github.com/Niger-Volta-LTI/yoruba-text>

²<https://github.com/Niger-Volta-LTI/yoruba-adr>

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A APPENDIX

Table 3: BLEU, predicted perplexity & WER scores on the Global Voices testset

Model	BLEU	Perplexity	WER
Soft-attention model from (Orife, 2018)	26.53	1.34	-
+ Language ID corpus	42.52	1.69	-
++ Interview text	42.23	1.59	-
+ All new text <i>minus JW300</i>	43.39	1.60	-
+ All new text	59.55	1.44	-
+ All new text with FastText embedding	58.87	1.39	-
Transformer model			
+ All new text <i>minus JW300</i>	45.68	1.95	-
+ All new text	59.05	1.40	-
+ All new text + FastText embedding	59.80	1.43	-

Table 4: Example Yorùbá ADR Sentences

Source:	iriri akobuloogu zone9 ilu ethiopia je apeere .
Reference:	irírí akóbúlògù zone9 ìlú ethiopia jé àpẹẹrẹ .
Prediction:	irírí akobuloogu orílẹ ìlú ethiopia jé àpẹẹrẹ .
Source:	mo awon ondiye si ipo aare naijiria odun 2019
Reference:	mọ àwọn òndíjẹ sí ipò ààrẹ nàìjíríà ọdún 2019
Prediction:	mọ àwọn ondije sí ipò ààrẹ nàìjíríà ọdún 2019
Source:	mo ro o wipe awon obirin ti o ronu lati se ise ti okunrin maa n se gbodo gberaga .
Reference:	mo rò ó wípé àwọn obìrín tí ó ronú látí ẹ́ ẹ́ ẹ́ tí ọ̀kúnrin máa n ẹ́ ẹ́ ẹ́ gbòdò gbéraga .
Prediction:	mo rò ó wípé àwọn obìrín tí ó ronú látí ẹ́ ẹ́ ẹ́ tí ọ̀kúnrin máa n ẹ́ ẹ́ ẹ́ gbòdò gbéraga .
Source:	alaga akoko ilu-ti-ko-fi-oba-je ti china mao zedong ti yo awon eniyan ninu isoro .
Reference:	alága àkókó ìlú-tí-kò-fi-òba-jẹ ti china mao zedong ti yọ àwọn ènìyàn nínú ìṣòro .
Prediction:	alága àk òkò ilu-ti-ko-fi-oba-je ti china mao tse ti yọ àwọn ènìyàn nínú ìṣòro .