Word by Word Labelling of Romanized Sindhi Text by using Online Python Tool

Irum Naz Sodhar[1]
Post-Doctoral Fellow, Department of Computer Science, Kulliyyah (Faculty) of Information and Communication Technology, International Islamic University Malaysia

Abdul Hafeez Buller[2]
Post-Doctoral Fellow, Department of Civil Engineering, Kulliyyah (Faculty) of Engineering, International Islamic University Malaysia

Suriani Sulaiman[3]
Assistant Professor, Department of Computer Science, Kulliyyah (Faculty) of Information and Communication Technology, International Islamic University Malaysia

Anam Naz Sodhar[4]
Postgraduate Student, Quaid-e-awam University of Engineering, Science & Technology, Nawabshah, Sindh, Pakistan

***Abstract*—Sindhi is one of the most ancient languages in the world and it has its own written and spoken scripts. After the rigorous study it was found that a lot of research work has been done in different languages, but word by word labelling of Sindhi language had not been done yet. In this research study, word labelling was done on 100 sentences of Romanized Sindhi texts using Python online tool. The dataset was collected from different sources which include Sindhi newspaper, blogs and social media webpages. From this dataset, a rule-based model has been applied for the Parts-of-Speech (POS) tagging of the Romanized Sindhi sentences. A total of 624 words of Romanized Sindhi texts were tested and successfully tagged by the SindhiNLP tool in which 482 words were tagged as nouns and pronouns, 92 words tagged as verbs and 50 words tagged as determinants.**

Keywords—Romanized sindhi; word labelling; rule-based model; POS tagging; SindhiNLP tool

I. Introduction

Sindhi is one of the most ancient languages in the world which has its own script in written and spoken forms [1-3]. Communication technologies are increasing day-by-day for different purposes, while different applications and software are used for daily communications such as WhatsApp, Facebook, Twitter, Telegram and Instagram [4-5]. In the community that uses Sindhi as their main language, Romanized Sindhi texts are used in daily communication especially in writing text messages on mobile phones, WhatsApp and other social media platforms [6].

Natural Language Processing has a vital role in the field of machine learning. This field provides language processing tasks such as of Parts–of–Speech tagging, tokenization of text (i.e., words, sentences, and paragraph) to the users [7-8]. In this research study, 100 sentences of Romanized Sindhi texts were labelled. The word labelling process which consists of two natural language processing tasks which is tokenization and POS tagging was performed using an online SindhiNLP tool [9]. Before performing the two tasks, a rule-based model has been applied for the POS tagging of the sentences to improve the accuracy of the POS tags [10-12].

After the review of the literature it was observed that a lot of vacuum is still available for the Sindhi language. This research study presents the word by word labelling of Sindhi language after Romanization.

II. Methodology for Labelling of Romanized Sindhi

The procedure for labelling of the Sindhi Romanized text has been divided into various stages as shown in Fig. 1. The first phase involves the data collection process from different sources of Sindhi scripts, the second stage is the conversion of Sindhi scripts into Romanian scripts (i.e., Romanization), the third stage identifies the issues in word labelling after applying the rule-based model and the final task is to do a thorough analysis on the results produced [13].

A. Dataset of Sindhi Text

Sindhi language is one of the oldest, historical and most commonly used languages in the world. Sindhi language is more difficult than other languages due to the difficulty in reading, writing and understanding the scripts [13-14]. Sindhi language is spoken by the people in the province of Sindh which is the second largest populated province of Pakistan. Sindhi is the official language of the Sindh province in which almost 15% of the population use Sindhi as their mother tongue [14-15]. As Sindhi language is mostly used in Sindh-Pakistan, the data for this research study was collected within the province of Sindh. Data was collected from different sources (Sindhi newspaper, blogs, and social media webpages) which provided the rules and guidelines of Romanized Sindhi for text communication.

B. Sindhi Alphabet

Sindhi language has its own script and written style like other languages (Arabic, Urdu, and English) [16]. In Sindhi script there are 52 alphabetical letters for writing and speaking purposes and presented in Fig. 2. Sindhi language has one of the largest numbers of alphabetical letters as compared to other languages. Similar to Arabic and Urdu scripts, the Sindhi script is written from right to left with a total of 52 alphabets [17].

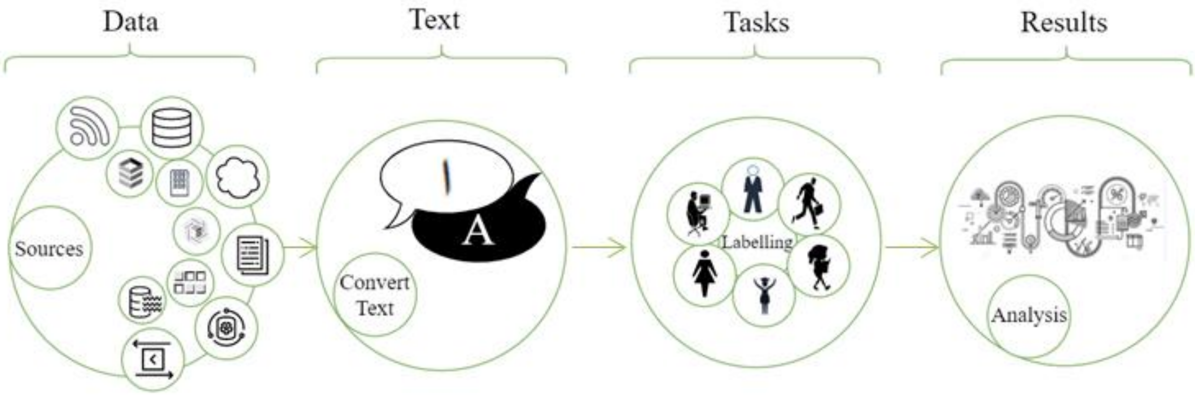
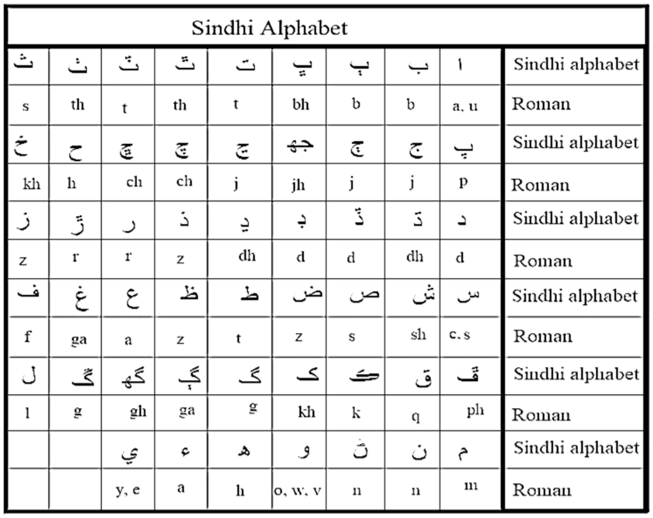


Fig. 1. Methodology of Labelling of Sindhi Text.



Sindhi Alphabet									
ث	ٺ	ٽ	ٿ	ت	ڀ	ٻ	ب	ا	Sindhi alphabet
s	th	t	th	t	bh	b	b	a, u	Roman
خ	ح	ڇ	چ	ڃ	جھ	ڄ	ج	پ	Sindhi alphabet
kh	h	ch	ch	j	jh	j	j	p	Roman
ز	ڙ	ر	ذ	ڍ	ڊ	ڏ	ڌ	د	Sindhi alphabet
z	r	r	z	dh	d	d	dh	d	Roman
ف	غ	ع	ظ	ط	ض	ص	ش	س	Sindhi alphabet
f	ga	a	z	t	z	s	sh	c, s	Roman
ل	ڳ	گھ	ڱ	گ	ک	ڪ	ق	ڦ	Sindhi alphabet
l	g	gh	ga	g	kh	k	q	ph	Roman
		ي	ء	ه	و	ڻ	ن	م	Sindhi alphabet
		y, e	a	h	o, w, v	n	n	m	Roman

Fig. 2. Sindhi-Roman Alphabet [17].

C. Romanization of Sindhi Text

In this research study, 100 sentences were used for the word labelling of Sindhi texts. After the collection of Sindhi sentences for the data set for this research study, the collected dataset was converted from Sindhi scripts into Romanized Sindhi text by using rules for Romanization of Sindhi text. Romanization of Sindhi text was successfully done following the rules for Romanized Sindhi text.

III. PRE-PROCESSING OF ROMANIZED SINDHI

Pre-processing is the basic components of NLP to filter the raw the data to useful and remove unnecessary data from the text. The pre-processing step consists two steps first is performing tokenization and second one assigning tag on each token [10].

A. Tokenization of Romanized Sindhi Text

The tokenization of Romanized Sindhi text has been done using the online SindhiNLP Python tool [9]. The Romanized texts were prepared following the rules of Sindhi on 100 sentences. The statistical information after the tokenization process of the Sindhi text is shown in Table I. This table consists of five different columns which are: total number of sentences, total number of words, total number of characters (with space), total number of character (without space) and total number of word tokens. In this table, two types of sentences were used: sentences from Sindhi text and sentences from Romanized Sindhi text. A total of 652 words, 2,816 characters with space and 2,262 characters without space were extracted as shown in below Table I.

TABLE I. STATISTICAL STUDY DATA OF TOKEN

Description	***Total number of sentences***	***Total number of words***	***Total number of characters (with space)***	***Total number of characters (without space)***	***Total number of word tokens***
Sentences in Sindhi scripts	100	652	2816	2262	---
Sentences in Romanized Sindhi	100	624	3275	2740	624

B. Parts-of-Speech Tagging

The POS tagging task for Sindhi was designed such that the whole process was divided into a few steps. The first step involved the pre-processing of the Romanized Sindhi sentences. Subsequently, the ruled-based model of Sindhi was applied for the Romanization process as described in Table II. This Romanized Sindhi text was then used as input to the SindhiNLP tool, after the input Romanized Sindhi text, the text was pre-processed using the online SindhiNLP Python tool [9] in which the sentences were split into words (i.e, tokenization). Next, the Match step was performed which was also sub-divided into two categories: Assigned Tag and Incorrect Tag. If the tag was incorrectly assigned, we apply the rule-based model and repeat the process again.

C. Algorithm for POS Tagging of Romanized Sindhi Text

The algorithm for the Parts of speech tagging of Romanized Sindhi text was designed before the start of the research work. The algorithm used was based on the ten steps described below. The same step applies following the algorithm for every new input data of Romanized Sindhi text.

```
Step 0    Start
Step 1    Take input sentence
```

Step 2 Split text → words

Step 3 Repeat steps 2→7 when ⩾ get appropriate output

Step 4 If word is matched, continue to assign tag separately, word by word

Step 5 If same tag is assigned to multiple words, apply rules for words and assign one tag for each word

Step 6 If one tag is assigned to one word, display the word with tag

Step 7 Else, select one or more morphological rules and apply to words to extract word with appropriate tag.

Step 8 Display as output the tagged words

Step 9 Apply rules for new words when entered

Step 10 End

D. *Rule-Based Model for Labelling of Romanized Sindhi Text*

The rule-based model used in the word labelling of Sindhi text is a supervised machine learning model or hybrid model. This model combines the use of online and manual approach. This type of model is commonly used to create rules for language analysis and is a popular NLP technique to perform different tasks on different languages as it is easier to understand while the results are based on ground truth values [19-20]. Fig. 3 illustrates that the S1, S2, S3 until Sn are input sentences while R1, R2, R3 until R10 are the rules. These rules are applied on the Sindhi sentences to get the appropriate output, Y. The rules for Romanized Sindhi texts are described in Table II.

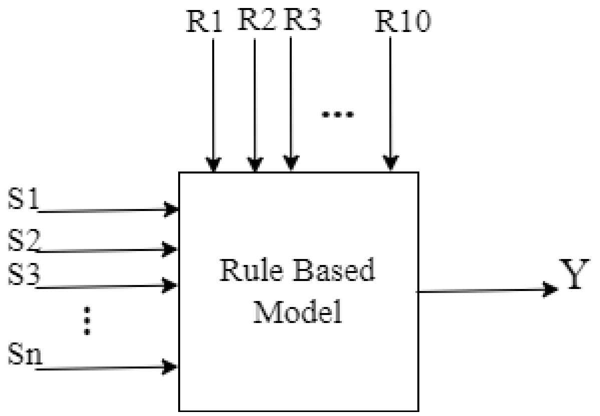


Fig. 3. Rule-Based Inputs and Output for Sindhi POS Tagging

There are ten rules that have been created for the word labelling of Romanized Sindhi texts [21-22]. Rule 1 describes the structure of a sentence and the restructuring of an input sentence by applying the SVO structure (Subject + Verb + Object) [18]. Rule 2 is used to define the prefixes of Sindhi sentences (i.e., ma, mounkhe, huwa, manhon, na, wanu sijh, cha, eho, kethe, Ali, Sara) as starting words and refers to nouns. Rule 3 describes the prefix that appears in sentences (i.e., he) as an initial word which is considered as pronouns. Rule 4 is used for the words that appear at the beginning of input sentences (i.e., Ma, Mounkhe, Huwa, Manhon, Na, Wanu sijh, cha, eho, kethe, Ali, Sara, he, etc.), considered as nouns as well as pronouns. Rule 5 describes the words that appear in the middle of an input sentence (i.e., Sadyo, Parhyo, maryo, likhyo, budho, khedan) known as the verb class. Rule 6 is used when the infix letters (i.e., a, d, e and o) appear in between words in a sentence which refers to a verb class. Rule 7 is used for postfix letters (i.e., e, o, n, i, u), if they appear in the middle of a word in a sentence which refers to a verb class. Rule 8 is used for the postfix letters (i.e., d, e, h, o, and y) if they appear at the end of the final word in a sentence, which belongs to a noun class. Rule 9 applies when the part-of-speech tagger fails to identify when the input sentences are interrogative. Rule 10 is used when the parts-of-speech tagging is performed on sentences with negation (without subject in the sentence), otherwise it was not identified. The rules used for Romanized Sindhi Text help in performing POS tagging on the SindhiNLP tool [9] to produce a more accurate part-of-speech.

TABLE II. RULES FOR ROMANIZED SINDHI TEXT FOR POS USING THE TEMPLATE

R #	Rule Description	Related Examples
1	Sentence structure should be built by applying the SVO (Subject +Verb +Object) structure.	You are teacher ↓ ↓ ↓ Subject Verb Object ↓ ↓ ↓ Tou ahen teacher
2	Prefixes (Ma, Mounkhe, Huwa, Manhon, Na, Wanu sijh, cha, eho, kethe, Ali, Sara etc.) in sentences as starting words, refers to noun class.	I am a Student → Ma/NNP ahyan/VBD shagrid/JJ → مان آهيان شاگرد →
3	Prefix (he) in sentences as starting words, refers to pronoun class.	He is intelligent He/PRP ahy/VBD hoshar/NN → هي آهي هوشيار
4	Prefixes (Ma, Mounkhe, Huwa, Manhon, Na, Wanu sijh, cha, eho, kethe, Ali, Sara, he etc.) in sentences as starting words, refers to noun as well as pronoun class.	I play game → Ma/NNP khedan/VBD rand/NN → مان کيڏان راند
5	Infixes (Sadyo, Parhyo, maryo, likhyo, budho, khedan etc.)	I wrote article → Ma/ NNP likhyo/VBD article/NN → مان لکيو آرٽيڪل

	that appear in the middle of sentences, known as verb class.	
6	Infixes (a, d, e, o) that appear in the middle of the words in sentences refers to verb class.	I am happy → Ma/NNP ahyan/VBDkush/JJ → مان آهيان خوش
7	Postfixes (e, o, n, i, u) that appear in the middle of the words in a sentence refers to verb class.	I learn Sindhi → Ma/NNP sikhan/VBD thi/NN Sindhi/NNP → مان سکان ٿي سنڌي
8	Postfixes (d, e, h, o, and y) that appears at the end of the last words in a sentence refers to noun class.	You are teacher → Tou/NNP ahen/VBD ustad/NN → تون آهين استاد
9	Parts of speech not identified when sentence is interrogative.	Do I like banana? Kayan/NN thi/NN ma/NN pasand kela/NN? → کيان ٿي مان پسند کيلا
10	Parts of speech perform on sentences with negation (without the subject in the sentence), otherwise not identified.	Do not forget → Na/NNPwesaryo/VBD → نه وساريو Negative Verb

IV. Word by Word Labelling of Romanized Sindhi

Word labelling of Romanized Sindhi Text was performed using the free online SindhiNLP Python tool [9]. Word Labelling of Romanized Sindhi text has been performed after completing the two pre-processing tasks for Sindhi Romanized text: the tokenization and part-of-speech tagging tasks as shown in Table III.

TABLE III. Word by Word Labelling of Romanized Sindhi Text (Examples)

#	Sindhi Sentence	English Sentence	Romanized Sindhi	Word Tokens	Word Labelling
01	اهي پلي هاڻي کم کن	They better work now	Ehe kamu kan bhale hanne	Ehe kamu kan bhale hanne	Tagged Text Ehe/NNP kamu/VBD kan/NN bhale/NN hanne/NN
02	اسين هاڻي پلي آرام کريون	We should rest now	Aseen kryon bhale hanne aram	Aseen kryon bhale hanne aram	Tagged Text Aseen/NNP kryon/VBD bhale/NN hanne/NN aram/NN
03	هوءَ هک ڊاڪٽر هئي	She was a doctor	Huoa hue hek doctor	Huoa hue hek doctor	Tagged Text Huoa/NNP hue/VBP hek/NN doctor/NN
04	مان ڪراچيءَ ۾ هيس	I was in karachi	Maa'n huoas Karachi maen	Maa'n huoas Karachi maen	Tagged Text Maan/NNP huoas/VBD Karachi/NNP maen/NN
05	توهان هک خوبصورت چوکرا هئو	You are a handsome boy	Tawhan Huoao hek khubhsorat chokra	Tawhan Huoao hek khubhsorat chokra	Tagged Text Tawhan/NNP Huoao/NNP hek/NN khubhsorat/NN chokra/NN
06	هوءَ هک موهيندڙ چوکري هئي	She was an attractive girl	Huoa hui hek mohendar chokri	Huoa hui hek mohendar chokri	Tagged Text Huoa/NNP hui/NN hek/NN mohendar/NN chokri/NN
07	اهو ڏکوئيندڙ هو	It was painful	Eho dukhoindar ho	Eho dukhoindar ho	Tagged Text Eho/NNP dukhoindar/NN ho/WP
08	اسين هتي آفيس ۾ هئاسين	We were here in the office	Aseen huoaseen hite office maen	Aseen huoaseen hite office maen	Tagged Text Aseen/NNP huoaseen/VBD hite/JJ office/NN maen/NN
09	هي پهرين سال واري کلاس ۾ هو	He was in the first year class	He ho pehreyen saal ware class maen	He ho pehreyen saal ware class maen	Tagged Text He/PRP ho/VBD pehreyen/VBN saal/JJ ware/NN class/NN maen/NN
10	اهي کله راند جي ميدان ۾ هئا	They were in the playground yesterday	Uhe huoa rand maidan mean kalh	Uhe huoa rand maidan mean kalh	Tagged Text Uhe/NNP huoa/NN rand/NN maidan/NN mean/NN kalh/NN

A. Analysis of the Parts-of-Speech Tagging

The output from the word labelling task of Romanized Sindhi text performed using the online SindhiNLP Python tool [9] and Sindhi rule-based model was analyzed in which 13 different POS categories were identified. The detailed statistics of the word labelling task are shown in Table IV.

TABLE IV. DETAIL STATISTICS FOR WORD LABELLING OF ROMANIZED SINDHI TEXT

Description	***Total Number of Words***	***Total number of POS Tagged Words***	***Word Labelling of Romanized Sindhi Text***	
Romanized Sindhi Text (100 sentences were used)	624	624	POS	No. of Words
			NNP	110
			NN	372
			PRP	11
			JJ	13
			RB	11
			WP	4
			VBD	54
			VBZ	0
			VBN	4
			VBP	30
			VB	4
			WDT	0
			DT	11
			Total	624

From the results produced by the SindhiNLP POS tagger, 624 Sindhi words was successfully tagged in which 482 are noun and pronouns, 92 verbs and 50 determinants were found as illustrated in Fig. 4.

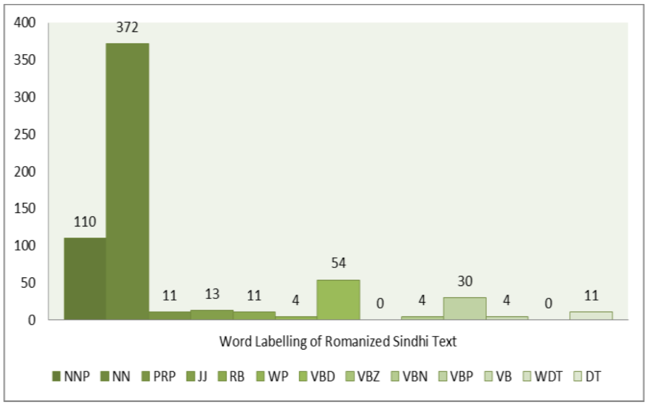


Fig. 4. Word Labelling of Romanized Sindhi Text.

V. CONCLUSION

In research study of Word by Word Labelling of Romanized Sindhi Text the conclusion is based on the following outcomes.

- A hybrid approach was used that combines online and manual approaches and a rule-based algorithm was designed and applied to the word labelling tasks.
- From the results 13 different POS categories were identified and 654 words of Romanized Sindhi Text were tested by using the SindhiNLP Python tool and all words were tagged successfully.
- From the results 482 noun/pronouns were found while the remaining 172 words were found to be adjectives, adverbs, verbs and determiners.
- For future work, Romanized Sindhi text from different domains will be used in the word labelling tasks and results will be compared using different machine learning techniques and tools.

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