Improving Punjabi Part of Speech Tagger by Using Reduced Tag Set

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Abstract- POS tagging is the fundamental task in almost all the NLP applications Like Grammar Checking, Speech processing,Machine translation etc. that assign the correct tag to the word for a number of available tags. The accuracy of a tagger is the biggest challenge today. A Lot of tagger have been proposed by different Researchers for the different languages (Punjabi, Hindi, Bengali etc.) using different techniques like HMM (Hidden Markov Model), SVM (Support Vector Machine), ME (Maximum Entropy) etc. A Punjabi POS tagger based on HMM model is one of them [1] This tagger uses Hidden Markov Model., a statistical technique to accurately tag the words in Punjabi language using 630 tags developed by Mandeep Singh and G S Lehal [2] .This large tag set (630 tags)results in data sparseness problem. To cope up with this problem, in this research paper an experiment with reduced POS tag set (36 tags) proposed by Technical Development of Indian Languages (TDIL) has been used to improve the tagging accuracy of HMM based POS tagger. Finally the result has been manually evaluated from a linguistic person.

Keywords-Parts-of-speech tagger, Punjabi, HMM technique, TDIL proposed Punjabi tag set.

INTRODUCTION

POS tagging is the process of assigning the correct tag to the word from a number of available tags. Here the tag means grammatical information of the word. It is well known that a computer will understand and process the language if the meaning of each and every word of that language is known. In most of the natural language processing applications like grammar checking, sentence identification, phrase chunking etc. the computer required only grammatical information of the input text. This grammatical information is given in the form tags called part of speech tags. Here the parts of speech are different word classes in which a word lies like noun, adjective, verb etc.A word can occur in more than one word class in different context. Same word can act as a noun in one sentence and the same can act as a verb in other sentence. e.g. consider the following sentences:

Sentence 1: ਰੱਸੀਕੱਸਕੇਬਣ

Sentence 2: ਰੱਸੀਜ਼ੋਰਨਾਲਕੱਸ

In sentence 1 the "ਕੱਸ" is a noun and in sentence 2 "ਕੱਸ" is a verb. So the same word "ਕੱਸ" occurs in two different word classes in two different situations. So in order to assign the exact grammatical information to a word one must know the context in which that word has occurred. For a computer system it is very difficult to understand the context of the sentence. Therefore different techniques are used to assign the part of speech tag to a word.

RELATED WORK

Different techniques used for POS tagging of Indian Languages:

There are basically three techniques used for part of speech tagging. 1) Rule based method 2) Statistical based method and Neural network based method. Besides these three a hybrid method is also used. This hybrid method is the combination of two or three of above mention techniques. In rule based technique different hand written rules are used for disambiguation of tags. These rules are developed manually. Therefore thorough knowledge of language is required to develop the rules. This rule based technique has been used by Sreeganesh (2006) for Telugu language; another rule based POS tagger was developed for Punjabi language by Mandeep Singh Gill, Gurpreet Singh Lehal (2008). Statistical method is another technique commonly used for part of speech tagging. Most commonly used statistical methods are support vector machine (SVM) used byEkbal and S. Bandyopadhyay(2008) for Bengali language; V.Dhanalakshmi et al. (2008)for Tamil language, M Anandkumar, Vijaya M.S, Loganathan R, Soman K.P, Rjendran S (2008) ;SindhiyaBinulal et al. for POS tagging of Telugu language. Antony P.J et al. for Malyalam language. Hidden markov model based technique used by Manish Shrivastava&Pushpak Bhattacharyya for POS tagger for Hindi language; Manju K et al. for Malayalam language;NavanathSaharia et.al for Assamese; Sanjeevkumar Sharma et al. (2011) for Punjabi Language; Ekbal, S. Mondal et al. for Bengali language. Maximum entropy based technique was used by AniketDalal et al. for Hindi language; Ekbal et al. (2008) for Bengali language. Conditional Random Field based technique has been used by Ravindran et al. and Himanshu et al. for POS tagging and chunking of Hindi language; other Indian languages on which this CRF technique has been applied are Bengali [10] and Manipuri [30]. Neural network based technique has been used

by Ankur Parikh for Hindi Language [3]. In hybrid based approach used a combination of rule based and HMM based technique has been used by Arulmozhi P et al. for development of Tamil POS tagger; Chirag Patel and KarthikGali [8] used a combination of rule based method and CRF for Gujarati Pos tagger

.**Existing POS tagger of Punjabi Language**

Punjabi (or Panjabi) language is a member of the Indo-Aryan family of languages. It is also known as Indic languages. Other members of this family are Hindi, Bengali, Gujarati, and Marathi etc. Two POS tagging system with two different techniques have been developed for Punjabi language. First by Mandeep Singh Gill et al. (2008) [18] and second was by Sanjeevkumar Sharma etal. (2011)[1]. The first system was developed as a sub part of grammar checker project. These rules were implemented by using regular expression. The main reason for using this rule based technique was that the rules can be edited i.e. new rules can be added or deleted. A tag set of more than 630 tags was also developed. Second POS tagging system has been developed by using statistical method. Hidden Markov model was used to disambiguate the tags. Viterby algorithm was used for implementation of Hidden Markov model. The tag set used in the second system was same as was proposed by Mandeepsingh et al. They also tried a hybrid approach that is combination of rule based system and statistical approach in which the output of rule based system was fed to the statistical based system. This gives further improvement on the accuracy of the POS tagger.

Tag set

A tag set is a set of all the tags used to represent the grammatical information of the language. The number of tags used for a language depends upon the length of the tag which further depends upon the amount of information that we want to represent using a tag. e.g. if just basic word class is to be represented with each word then the length of the tag will be 2, 3 or 4. One extra character will be required for extra grammatical information that is to be represented with tag. E.g. to represent only word class we can use NN tag for noun. But if we want to represent gender information also then an extra character will be added to this tag. This extra character may be M for masculine gender, F for feminine gender and B for both types. Therefore proposed tag for a masculine noun will be NNM, for feminine it will be NNF and for both categories it may be NNB. This extra information not only increases the length of the tag but also increase the no of tags. As in above case if the information of only word class is to be represented then only one tag was sufficient and as the information increases the number of tags also increase and becomes 3 in above case. From above discussion it is concluded that the information has a direct effect on the number of tags.

Punjabi tag set

Existing Punjabi POS Tagset

As discussed in above section two POS tagger has been developed for Punjabi language. In both of these POS taggers same tag set has been used. This tag set was developed by keeping in mind that this POS tagger has to be used for grammar checking software of Punjabi language. This tag set was fine grained and more than 630 tags were used.

New proposed tag set by TDIL:

Depending on some general principle of tag set design strategy, a number of POS tag sets have been developed by different organizations. For POS annotation of texts in Punjabi, we have used tag set proposed by TDIL (Technical Development of Indian Languages). There were 36 tags proposed by TDIL for Punjabi language.

INTRODUCTION TO HMM

Hidden Markov Model was proposed byL. E. Baum. It is a statistical model used to solve classification type of problems. This model is used to assigns the joint probability to paired observation and label sequence. In order to maximize the joint likelihood of training sets parameters are trained. In NLP applications this type of training is done by using accurate annotated corpus. The main advantage of this model is that it is easy to understand and implemented. The accuracy of this model is directly proportional to size of training data.

Basic Definitions and Notation

According to (Rabiner, 1989), the HMM can be defines by using the following five elements:

1. N, it is the number of distinct states in the model. For part-of-speech tagging, N is the total number of tags that can be used by the system. In existing system these are more than 360 tags and in our propose system these are 36 tags only. Each possible tag for the system corresponds to one state of the HMM.

2. M, the number of distinct output symbols in the alphabet of the HMM. For part-of-speech tagging, M is the number of words in the lexicon of the system. As the exact number of words of a language can't be counted so the distinct wordspresent in the training corpus is taken as M.

3. A = $\{a_{ij}\}$, the state transition probability distribution.Where $a_{ij}$is the probability that the system will move from state i to state j in one transition. For part-of-speechtagging, these states are represented by the tags, so $a_{ij}$is the probability that the model will move from tag t_i to t_j. Thisprobability can be estimated using training corpus.

4. B = {$b_j(k)$), the emission probability. The probability $b_j(k)$is the probability that the k-th output symbol will beemitted when the model is in state j. For part-of-speech tagging, this is the probability that the word $W_k$will beassign tag t_j(i.e.,$P(W_k|t_j)$). This probability can be again estimated from a training corpus.

5. $\prod = \{\prod_i\}$, the initial state distribution. It is the probabilitythat the model will start in state i. For part-of-speechtagging, this is the probability that the sentence will begin with tag ti. When using an HMM to perform part-of speech tagging, the

goal is to determine the most likely sequence of tags (states) that generates the words in the sentence (sequence of output symbols). In other words, given a sentence V, calculate the sequence U of tags that maximizes *P (V/U).* The Viterbi algorithm is a common method for calculating the most likely tag sequence when using an HMM.The proposed model is a type of first order HMM, also referred to as bigram POS tagging. For POS-tagging problem presented Hidden Markov Model is composed of two probabilities: lexical (emission) probability and contextual (transition) probability (Samuelsson, 1996).

$$(t_1,\ldots,t_n)^* = \underset{t_1\ldots t_n}{\operatorname{argmax}}\ P(t_1,\ldots,t_n)|(w_0,\ldots,w_n)$$

Using Baye's law above equation can be rewritten as:

$P(t_1,\ldots\ldots t_n|W_1,\ldots\ldots,W_n)=P(t_1,\ldots\ldots\ldots\ldots t_n)$ X

$$\frac{P(W_1,\ldots\ldots,W_n|t_1,\ldots\ldots,t_n)}{P(W_1,\ldots\ldots,W_n)}$$

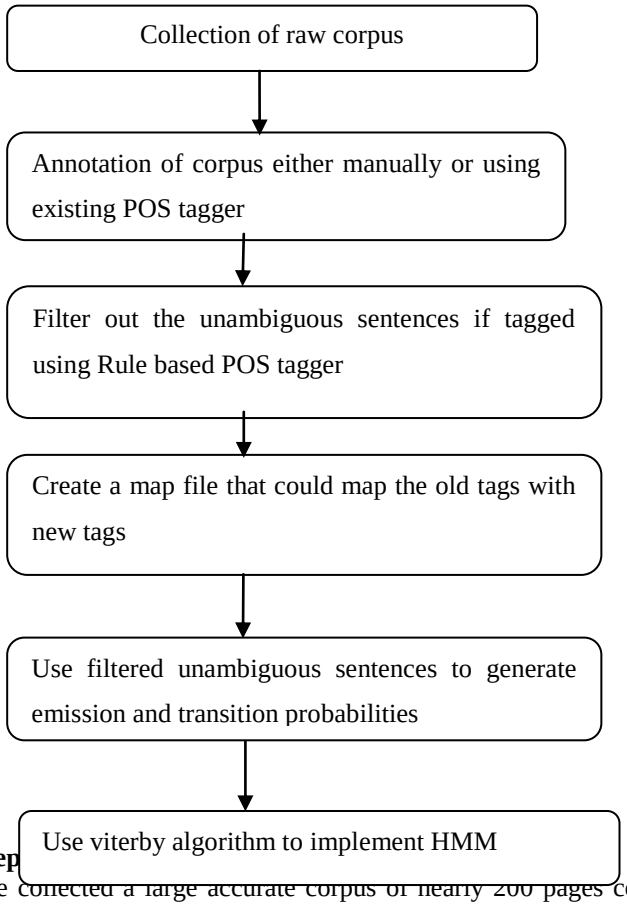
$(t_1,\ldots\ldots\ldots,t_n)=\text{argmax}P(t_1,\ldots,t_m)$ X P ($W_1,\ldots\ldots\ldots W_n|t_1,\ldots\ldots\ldots t_n$)

$(t_1,\ldots\ldots\ldots,t_n)=\text{argmax}P(t_1,\ldots\ldots\ldots,t_m)|$ ($W_0,\ldots\ldots\ldots,W_n$)

$$= argmax\Pi(P(ti|ti-1)(TRANSITION\ PROBABILITY) * P(Wi|Ti)(EMMISION\ PROBABLITY))$$

METHODOLOGY

Following flow diagram shows the steps used to implement new tag set in HMM.



Step 1:- Collection of raw corpus.

We collected a large accurate corpus of nearly 200 pages containing nearly 8000 sentences and approximately 42,000 words. This corpus was collected from internet. Following web sites were used for the collection of corpus:

- http://www.likhari.com
- http://www.charhdikala.com
- http://punjabitribuneonline.com
- www.punjabinfoline.com

Step 2:- Annotation of corpus.

For the annotation we used an existing lexicon based morphological analyzer. This morphological analyzer contains more than one million Punjabi words with their part of speech tag.

Step 3:- Mapping with new tags.

Since the existing morph used in step 2 contains tags that have been developed using a tagset of 630 tags and in new system we have to use the tags proposed by TDIL, so mapping of tags was done to reduce the 630 tags to 36 tags. The tags of annotated corpus developed in above step were converted in to standard common tags set for Indian Languages and as per IIIT tagset guidelines. This mapping was partially done manually and partially by computer by using a map file. The map file was manually developed with the help of linguistic.

Mapped File

Sr No	Old tag starts with	New tag
1	NN	N_NN/N_NST/N_NNP
2	PNP	PR_PRP
3	PNR	PR_PRF
4	PND	PR_PRC
5	PNI	PR_PRI
6	PNE	PR_PRL
7	PNN	PR_PRQ
8	AJI	JJ
9	CD	QT_C
10	OD	QT_O
11	PPU	PSP
12	AVI	RB
13	PPI	PSP
14	AVU	RB
15	VBP	V
16	CJ	CC
17	PTU	RP
18	PTV	RP
19	AJU	JJ
20	VBO	V
21	VBMA	V_VM
22	BVAX	V_VAUX
23	Unknown	RD_UNK
24	Comma , Dot, QuestionSentence, Sentence, ,Exclamation Colon, Semicolon, OpeningSingleQuote, ClosingSingle Quote, OpeningDoubleQuote, ClosingDoubleQuote	RD_PUNC
25	OpeningBracketOpeningBrace , ClosingBracket, ClosingBrace, OpeningParenthesis, ClosingParenthesis, LessThan, GreaterThan	RD_SYM
26	VBMAXPSXXTNE	V_VM_VNG
27	AJU	RP__INTF
28	PTUN	RP__NEG

29	AJIMSD	QT__QTF
30.	No specific match but generally unknown words	RD_RDF
31	No specific tag but words with hyphen in between them	RD_ECH
32	VBMAXXXXXINIAN	V__VM__VINF
33	VBMAXXXXXINDIAN	V__VM__VNF

Step 4:-Development of emission and transition probability file.Now in order to find out transition and emission probabilities we developed an application in visual studio (c#.net). The probability files were kept in txt format. These file were used for implementing HMM using viterby algorithm.

Sample transition file

Tag1/Tag2 pair	Probability
N_NN/V	0.190476
V/V_VM	0.005376
V_VM/RP	0.040698
RP/PR_PRP	0.016484
PR_PRP/N_NN	0.01066
N_NN/PSP	0.470769
PSP/N_NN	0.028161
N_NN/V_VM	0.135289

Step 5:- Viterby algorithm was used to implement HMM.

Experimental Evaluation

The accuracy of Natural Language product is generally measured in terms precision and recall. Precision is the percentage of correctly disambiguate tags. And recall is If A is the number of correctly disambiguate tags and B is the number of tags that were not disambiguate by our system then

Recall = A / (A+B)

Similarly if A is the no of correctly disambiguated tags and C is the number of incorrectly disambiguated tags then

Precision= A / (C+A)

For evaluation of the proposed POS tagger, a corpus having texts from different online resources i.e. Punjabi websites were used. The outcome was manually evaluated through a linguistic expert to mark the correct and incorrect disambiguate tags. The result obtained has been given in Table 1. The precision and recall values are given in table 2.

Table 1
Experimental Result

corpus	Total number of words	No of unknown words (not tagged by the system)	No of known words	Existing HMM based system	Proposed system
				No of correctly disambiguated tags	No of correctly disambiguated tags
Essay	5995	325	5670	5233	5610
News	4007	344	3663	3369	3595
Short stories	8047	69	9333	8602	9297
Novel	2508	211	2297	2188	2267
Book Chapter	2134	23	2111	2013	2089

Table 2
Precision and Recall of HMM based and Proposed system

Corpus type	Existing HMM based system					Proposed System				
	A	**B**	**C**	**Precision**	**Recall**	**A**	**B**	**C**	**Precision**	**Recall**
Essay	5233	775	**0**	**100%**	85.2%	5610	0	60	98.9%	**100%**
News	3369	472	**0**	**100%**	86%	3595	0	68	98.1%	**100%**
Short stories	8602	1162	**0**	**100%**	86.5%	9297	0	36	99.6%	**100%**
Novel	2188	285	**0**	**100%**	87%	2267	0	30	98.6%	**100%**
Book Chapter	2013	292	**0**	**100%**	85.5%	2089	0	22	98.9%	**100%**

Conclusion:

Efforts to improve the accuracy of HMM based Punjabi POS tagger has been done by reducing the tagset. The tagset has been reduced from more than 630 tags to 36 tags. We observed a significant improvement in the accuracy of tagging. Our proposed tagger shows an accuracy of 92-95% whereas the existing HMM based POS tagger was reported to give an accuracy of 85-87% [1]. This significant improvement is due to reduction in the tagset from more than 630 tags to 36 tags.The main problem with large tag set results in data sparseness.The reduction in the tags results in reduction in data sparseness and hence improves the accuracy.

Future scope:

This work can be further extended by using a hybrid model i.e. combination of more than one statistical model. The same approach can also be implemented for different Indian languages like Hindi, Bengali, and Telugu etc. further improvement can be done by applying different approached to find the POS tag of unknown words.

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