

Inflection rules for Marathi to English in rule based machine translation

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ABSTRACT

Machine translation is important application in natural language processing. Machine translation means translation from source language to target language to save the meaning of the sentence. A large amount of research is going on in the area of machine translation. However, research with machine translation remains highly localized to the particular source and target languages as they differ syntactically and morphologically. Appropriate inflections result correct translation. This paper elaborates the rules for inflecting the parts-of-speech and implements the inflection for Marathi to English translation. The inflection of nouns, pronouns, verbs, adjectives are carried out on the basis of semantics of the sentence. The results are discussed with examples.

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1. INTRODUCTION

Machine translation is one of the emphasis applications in natural language processing (NLP). Institutions and organizations in India have started working on machine translation systems for Indian languages and have gained satisfactory results [1], [2]. Communication plays important role in life of people. There are many languages used for communication all around the world and good literary works are available in every language. It is not possible to learn all the languages and so there is a need to develop effective machine translation means for targeting multiple languages. English is the language used by majority of the world population for official work, literary work, and all sorts of communication. Marathi is primary language and mostly used in Indian state Maharashtra. It is found that about 71 million people speak Marathi and variety of literature and novels are available in Marathi and hence there is a need for Marathi to English translation [3]. Researches have published the work mostly related to pair of languages and some standard tools are also available for translation [4]-[6]. But it is found that more contribution is needed for Marathi to English translation. As the structure and the grammar vary for the source and target languages, the restructuring and grammatical rules need to be observed correctly. This paper mainly discusses the inflectional rules related to the Marathi-English language pair. Rules are discussed with examples. Rules play important role in rule based machine translation. This paper includes the literature review related to inflections, importance of adpositions in linguistics, proposed work, inflectional rules, research method, results, and discussion.

Tidke and Sugandhi [7] presented the implementation of the inflection for English to Marathi translation for parts of speech like nouns, pronouns, verbs, and adjectives. Wren and Martin [8] written book on English grammar in which various rules are given for English word inflection. Conway [9] has discussed the problem of English plurals and claimed that even at the lexical level; it can be a complex matter to

correctly inflect the individual words of a sentence to reflect their number, person, mood, and case. As per related work there is no sufficient work is done infection on Indian languages. In this paper we are working on Marathi language. As Marathi language is very rich in morphology so it's little bit difficult to study. Adpositions are words which can occur before or after a word, phrase or clause that is necessary to complete the meaning of a given sentence. Adpositions are mainly categorized as: Prepositions, postpositions and circumpositions.

- Prepositions: Prepositions mean the words which occur before the complement [9]. A preposition occurs in English language. These prepositions are usually converted into postpositions in Marathi language.
- Example: The birds are sitting **on** the tree. Here 'on' is the preposition.
- Postpositions: Postpositions mean the words which occur after the complement [10]. Postpositions occur in Marathi language. Example: पक्षी झाडावर बसलेले आहेत. Here 'वर' is the postposition.
- Circumpositions: Circumpositions are words appear on before and after the complement. Circumpositions used in English language. Example: I will play regularly from now on. Here 'from ... on' are the circumpositions. English language has SVO structure and Marathi language has SOV structure. The languages which follow SVO structure use prepositions. Hence, during translation of a Marathi sentence to an English sentence, there is a necessary to change the postpositions of language Marathi which is the source language of the research to prepositions of language English which is the target language of the research. So, translation postpositions to prepositions are a main problem which needs to be solved by inflecting the nouns, verbs, and cases (Vibhakti). Depending upon suffix attached to Marathi word there is a change in words position of English words while translating.

2. PROPOSED METHOD

In this paper we are designing inflection rules to POS tags (noun, pronoun, adjective and verb) of Marathi language. As shown in Figure 1, output of tokenization [11] and stemming is provided to morphology analysis. We are taking help of shallow parser to retrieve part of speech tags and its morphology analysis. Morphology analysis describes multiplicity, gender, person, and tense of verb. Before implementing inflection module, we have to define rules for inflection of each POS tag. Generating the appropriate inflection of a word is needed to keep the correct inflection of the word in English [12], [13]. Words can be classified in two types based on the inflection [14], [15]: inflectional words and non-inflectional words. The inflectional words are noun, pronoun, adjective and verb. The non-inflectional words are adverb, preposition, interjection, and conjunction. The words are inflected on the basis of changing gender (masculine, feminine, neuter), multiplicity (singular, plural), tense (present, past, future), person (first, second, third) and case (genitive/possessive case).

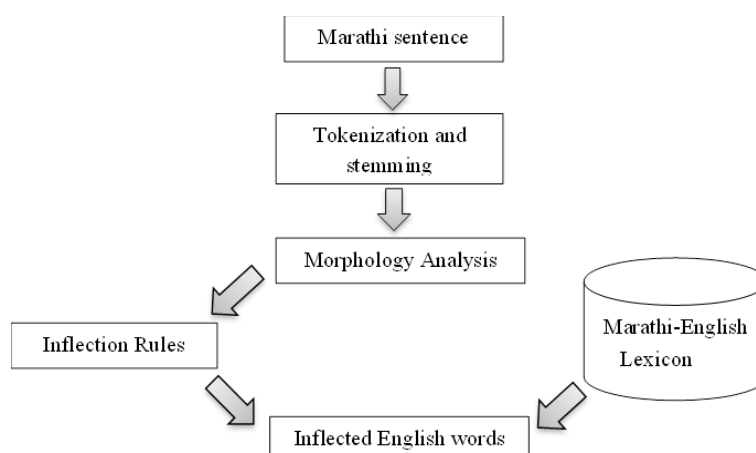


Figure 1. Proposed work system architecture

2.1. Inflection module

2.1.1. Noun inflection rules

Declension means inflection of nouns in English language. Noun paradigms inflect for number (singular or plural) but not for gender or case except genitive/possessive case. Generally, nouns are made

plural by appending -s but this approach fails miserably on many special cases such as: class → classes, story → stories and box → boxes. So, there are some pure suffix-based approaches as given in Table 1.

The suffixes which mostly added in noun plural inflections in English language are: -s, -es, -ves, -ies, -en, -ee, -e, and -ices. Conway [9] has discussed the problem of English plurals and claimed that even at the lexical level; it can be a complex matter to correctly inflect the individual words of a sentence to reflect their number, person, mood, and case. Out of the three noun cases, inflection occurs in only possessive case. Possessive case is used to denote authorship, origin, and ownership. Inflection of nouns in the possessive case is carried out by adding of -'s or -s' to the end of a noun. Table 2 includes the noun case inflection.

Table 1. Noun multiplicity inflection

Terminating Strings of the root word	Plural Inflection	Examples
Noun ending with -s/-sh/-ch/-x/-o/-us	Adding -es	Class-Classes Match-Matches Box-Boxes
Nouns ending with -y & preceded by a consonant	-y replace by -i and add -es	City-Cities Story-Stories
Nouns ending with -f/-fe	-f/-fe replace by v and add -es	Wife-Wives Leaf-Leaves
Nouns ending with -oo	Replace by -ee	Foot-Feet Tooth-Teeth
Nouns ending with -an	Replace by -en	Man-Men Woman-Women
Nouns ending with -ix General noun	Replace by -ices Adding -s	Matrix-Matrices Book-Books Desk-Desks

Table 2. Noun case inflection

Original word type	Inflection Rule	Examples
Noun-singular	Add “ ‘s “	The boy’s school
Noun-plural and ends with ‘s’	Add “ ‘ “	Boys’ school Horses’ tails.
Noun-plural but does not ends with ‘s’	Add “ ‘s “	Men’s club Children’s books
Two nouns are closely connected	Add “ ‘s “ to second noun	Karim and Salim’s Bakery
Nouns telling distance/space/ weight	Add “ ‘s “	I want a day’s leave. Shila will be back in a month’s time.

Postpositions in Marathi occur as prepositions in English [16]. Translating Marathi sentence to English sentence requires conversion of postposition to preposition [17]. For example:

एक मार्ग पुण्यावरून गोव्याला जातो → One road goes from Pune to Goa.

In above example the suffix ला comes as a postposition in Marathi whereas the word to come as a preposition in English. Thus, postposition processing involves attachment of preposition before prepositional object. Preposition also undergoes inflections according to the suffix attached to postpositional object. In Marathi there are seven cases, each having its own functional meaning and suffixes. There are different prepositions are used according to suffix attached [18] as given in Table 3.

Table 3. Noun case inflection from Marathi to English

Case (Vibhakti)	Marathi suffix		English Suffix
	Singular	Plural	
Nominative	-	-	-
Accusative	ला,स	ना,स	to/for
Instrumental/Agent	ने	नी	By/with
Dative	ला	ना	for/to
Ablative	उन/ हून	उन/हून	from
Genitive/Possessive	चा/ ची/ चे	चा/ ची/ चे	of/s
Locative	त	त	in

2.2. Verb inflection

Inflection of verbs in English is called conjugation. The conjugation of a verb gives the different verb forms either by inflection or by combination with parts of other verbs (auxiliary verb) which shows mood, tense, number, and person. English verbs are inflected for tense. A verb lexeme has at most five forms i.e., third person singular form, past tense, progressive participle, perfect or passive participle form. In fact, most verbs have only four forms, because the past tense and the perfect (or passive) participle forms are the same. This is true for all regular verbs. In third person singular there are few variations. In present third person singular, suffix -s is added to both regular and irregular verb. If verbs end with a sibilant consonant, then suffix -es is added and if verbs end with -y preceded by a consonant have then -y changed to -i- and then the suffix -es is added. Table 4 includes verb-third person singular form inflection.

There are some variations for the progressive participle. The suffix -ing is added to all verbs to get progressive participle form. Most of the verbs add “ing” to the end without changing the spelling, but for some verb’s spelling in present participle form little bit different according to the specific environment. There are different rules according to verbs ends with as indicated in Table 5.

Table 4. Verb- third person singular form inflection

Original Word Type	Inflection Rule	Examples
Verbs ending in -ch/-s/-sh/-x/-z	Add -es	Watch → Watches Miss → Misses
Verbs ending in a consonant y	Changing the y to i and add -es	Try → Tries

Table 5. Verb-progressive participle form inflection

Original Word Type	Inflection Rule	Examples
verbs ending in silent “e”	Delete -e & add -ing	Bake → Baking Bite → Biting
verbs with a short, stressed vowel sound	double the final consonant and add -ing	Swim → Swimming Plan → Planning
verbs ending in -ie	change -ie to -y and add -ing	Lie → Lying Die → Dying
verbs ending in -c	Add -k and -ing	Frolic → Frolicking Mimic → Mimicking

Past tense and past participle form are generated by adding -ed to regular verbs, for example walk-walked-walked. Past tense and past participle form are generated by adding -ed to irregular verbs. There are mainly three types of irregular verbs. First type of Verbs in which all the three forms i.e., base form, past tense and past participle form are the same e.g., put – put – put. Next type of verbs in which second and third forms are the same e.g., sit – sat – sat and third type of verbs in which all three forms are different e.g., drink – drank – drunk. All this indicates that inflection for verbs in English requires more consideration than simply adding the affixes -s, -ing, and -ed. Conjugation of verb by combination with parts of other verbs e.g., auxiliary verb, plays vital role in translation of Marathi to English sentence [17]. Verb tense is decided according to action in a sentence is happening e.g., in the present, future, or past. There are four forms in each tense type. Regular verbs follow a standard rule when conjugated according to tense. Conjugation of the regular verb is indicated in Table 6. V_1 stands for base form of verb, V_2 for past tense of verb, V_3 for progressive participle form of verb and V_{ing} for perfect or passive participle form of verb. For Marathi language type of tense is identified from suffix attached to verb and auxiliary verb used as indicated in Table 7. Table 6 shows rules for verb conjugation in tenses according to suffix attached to Marathi verb.

2.3. Adjective inflection

There are three forms of adjective in English grammar. They are called the degrees of comparisons i.e., positive degree, comparative degree, and superlative degree. Positive degree of an adjective is the adjective in its simple form. Adjectives are inflected to get comparative and superlative forms.

Generally, for superlative and comparative forms, adjectives are generated by adding the suffixes -er and -est to the positive form, respectively. There are some exceptional rules as shown in Table 8. Few adjectives in which comparative and superlative are not formed from positive, for example: Good–Better–Best. It can be concluded that adjective inflection in English is also more complicated than following simple rules of grammar.

Table 6. Rules for verb conjugation in tenses

Person	Tense	Masculine/Feminine/Neutral					
		Singular			Plural		
		Present	Past	Future	Present	Past	Future
First	Simple	V ₁	V ₂	shall + V ₁	V ₁	V ₂	shall + V ₁
	Continuous	am +Ving	was+Ving	shall be+Ving	are +Ving	Were+Ving	shall be+Ving
	Perfect	Have+V3	Had+V3	shall have + V3	Have+V3	Had+V3	shall have + V3
	Perfect	Have been+	Had been+	shall have been	Have been+	Had been+	shall have been
Second	Continuous	Ving	Ving	+ Ving	Ving	Ving	+ Ving
	Simple	V ₁	V ₂	will + V ₁	V ₁	V ₂	will +V1
	Continuous	are +Ving	Were+Ving	will be+Ving	are +Ving	Were+Ving	will be+Ving
	Perfect	Have+V3	Had+V3	will have + V3	Have+V3	Had+V3	will have + V3
Third	Perfect	Have been+	Had been+	will have been	Have been+	Had been+	will have been
	Continuous	Ving	Ving	+ Ving	Ving	Ving	+ Ving
	Simple	V ₁ +s/es	V ₂	will +V1	V ₁ +s/es	V ₂	will +V1
	Continuous	is +Ving	was +Ving	will be+Ving	Are+Ving	were +Ving	will be+Ving
	Perfect	has+V3	had+V3	will have + V3	has+V3	had+V3	will have + V3
	Perfect	Has been+	Had been+	will have been	Has been+	Had been+	will have been
	Continuous	Ving	Ving	+ Ving	Ving	Ving	+ Ving
	Prospective	am going to + V ₁	was going to + V1	will going to + V1	are going to + V1	were going to + V1	will going to + V1

Table 7. Suffix attached to Marathi verb in tenses

Person	Tense	Masculine/Feminine/Neutral					
		Singular			Plural		
		Present	Past	Future	Present	Past	Future
First	Simple	तो/ते	ले/लो/ल्ले	ईल	तो	ले/लो/ल्ले	ऊ
	Continuous	त + आहे	त + होतो/होती	त + असेल	त + आहे	त + होतो	त + असेल
	Perfect	ले/लो/ल्ले + आहे	ले/लो/ल्ले + होते/होती	ले/लो/ल्ले + असेल	ले/लो/ल्ले + आहे	ले/लो/ल्ले + होते/होती	ले/लो/ल्ले + असेल
	Perfect Continuous	त+ आलेला/आलेली + आहे	त + आलेला/आलेली + होतो/होती	त+ आलेला/आलेली+ असेल	त+ आलेलो + आहे	त+ आलेलो + होतो/होती	त + आलेलो + असेल
Second	Simple	तो/ते	ली/ला	शील	तो	ले/लो/ल्ले	आल
	Continuous	त + आहे	त+ होता/होती	त + असेल	त + आहे	त+ होते	त+ असाल
	Perfect	ला/ले/ल्ले + आहे	ले/ला/ल्ले + होता/होती	ले/ला/ल्ले + असेल	ले/ल्ले + आहे	ले/ल्ले + होते	ले/ल्ले + असेल
	Perfect Continuous	त+ आलेला/आलेली + आहे	त + आलेला/आलेली+ होता/होती	त+ आलेला/आलेली+ असेल	त+ आलेला/आलेली + आहे	त + आलेला/आलेली + होतो/होती	त+ आलेला/आलेले+असाल
Third	Simple	तो/ते/तात	ल्ले/ली/ला	ईल	तात	ले/ल्ले	ईल
	Continuous	त/तो/ते+आहे	त + होतो/होती/होते	त + असेल/असतील	त + आहे	त+ होते	त+ असतील
	Perfect	ले/ल्ले/ली/ला + आहे	ले/ल्ले/ली/ला + होते	ले/ल्ले/ली/ला + असेल	ले/ल्ले + आहे	ले/ल्ले + होते	ले/ल्ले + असतील
	Perfect Continuous	त+ आलेला/आलेली + आहे	त+ आलेला/आलेली + होतो/होती	त+ आलेला/आलेली+ असेल	त+ आलेले + आहे	त + आलेले + होते	त + आलेले + असतील
	Prospective	णारआहे	णारहोतो	णारअसेल	णारआहे	णारहोतो	णारअसेल

Table 8. Adjective inflection

Original word type	Inflection Rule	Examples
Adjective ending in silent “e”	Only add -r/-st	Brave-Braver-Bravest
Adjective ending in “y”	Delete y and add i and then add -er/-est	Happy-Happier-Happiest
One syllable adjective and ends in single consonant, preceded by a short vowel	Double consonant and add -er/-est	Red-redder-reddest
Two or more syllables adjective	Add more /most before	Difficult-more difficult-most difficult

2.4. Pronoun inflection

A pronoun is a word that can be substituted for a noun or a noun phrase. Pronoun inflection is similar to noun inflection. The words are inflected on the basis of changing gender i.e., masculine, feminine and neuter; multiplicity i.e., singular, plural; and case i.e., nominative, accusative, and possessive. Pronoun inflection rules are given in Table 9.

Table 9. Pronoun inflection

Person	Gender	Nominative		Possessive		Accusative	
		Singular	Plural	Singular	Plural	Singular	Plural
First Person	M/F	I	We	My, mine, me	Our, ours, us	-	
Second Person	M/F	You		Your, yours		You	
Third Person	M	He	They	His	Their, theirs	Him	Them
	F	She		Her, hers		Her	
	N	It		its		it	

3. RESEARCH METHOD

While implementation of the inflection, there is a necessity of the information of each word i.e., POS tags, gender tags, tense, multiplicity, and degree, which are identified from Shallow parser developed by IIIT, Hyderabad, India. It provides the system with the morphological analysis of a Marathi sentence. The parser provides output in Shakti standard format [19], [20]. It provides the root word, POS tag, tense, gender, multiplicity, direct or oblique case, suffix, Vibhakti and other details important to identify the role of the word in the sentence. The output is represented as a sequence of abbreviated features, with each attribute is having a fixed position and meaning in sequence. Following eight cases are occurs in morph output: <fsaf = 'root, lcat, gend, num, pers, case, vibh, suff'>.

- Root indicates the root word of the word morphed.
- Lcat gives the lexical category of the word. The values it can take are: Noun (n), pronoun (pn), verb (v), adjective (adj), adverb (adv), and number (num).
- Gend gives the gender of the word in context. The values it can take are male (m), female (f), neutral (n).
- Num gives the impression of the word being singular(sg) or plural(pl) in nature.
- Pers gives whether the speech of the word is in the first person (1), second (2) or the third person (3).
- Case gives whether the noun has a direct or an oblique case depending on the sentence and usage.
- Vibh is the Vibhakti of the word.
- Suff identifies the suffix of the word if it contains any.

For example: पर्यटकांना NN <fsaf='पर्यटक, n, m, pl, o, ना,ना' name="पर्यटकांना">

Cases and tenses are identified from word endings as per defined in database, for example as shown in Table 3. Using the above retrieved information, we can apply various inflection rules as discussed in inflection module to get the correct inflection. The inflected words then mapped to the SVO structure of English to generate the correct translation [21]. We have 25,000 Marathi-English sentences from tourism domain from TDIL.

4. RESULTS AND DISCUSSION

In testing we considered 7000 sentences of tourism domain and we tested for it. Output of our system i.e., inflected words compared with our reference sentences from data set and it is observed that we got 88-90% of accuracy. While testing word sense disambiguation is also considered [5], [6], [22]-[25]. Four test cases are discussed.

- Example 1

Marathi sentence: शहराचे वातावरण पर्यटकांना आनंद देते. The result is in Table 10.

Table 10. Result for case 1

Marathi Word	Marathi Word After Suffix Separation	English Lemma	Inflected Word	Rules to Get Inflected
शहराचे	शहर	city	City's	Noun table, case inflection table
चे				
वातावरण	वातावरण	atmosphere	atmosphere	-
पर्यटकांना	पर्यटक	tourist	to tourists	Case table, Accusative Plural
	ना			Noun table, multiplicity inflection
आनंद	आनंद	pleasure	pleasure	-
देते	दे	give	gives	Verb table ,3 rd Person singular
	ते			

– Example 2

Marathi sentence: अमृतसर सुवर्ण मंदिराचे शहर आहे. The result is in Table 11.

Table 11. Result for case 2

Marathi Word	Marathi Word After Suffix Separation	English Lemma	Inflected Word	Rules to Get Inflected
अमृतसर	अमृतसर	Amritsar	Amritsar	-
सुवर्ण	सुवर्ण	Golden	of Golden	Noun case inflection table
मंदिराचे	मंदिर चे	Temple	Temple	-
शहर	शहर	city	city	-
आहे	आहे	is	is	Verb table, simple present third person

– Example 3

Marathi sentence: जल महालाची रचना इ.स 1534 बहादुरशाह गुजरातीने केली होती. The result is in Table 12.

Table 12. Result for case 3

Marathi Word	Marathi Word After Suffix Separation	English Lemma	Inflected Word	Rules to Get Inflected
जल	जल	Jal	Jal	Noun case inflection table
महालाची	महाल ची	Mahal	of Jal Mahal	
रचना	रचना	Construction	Construction	
इ.स	इ.स	AD	AD	
1534	1534	1534	1534	
बहादुरशाह	बहादुरशाह	Bahadurshah	by Bahadurshah	Noun case inflection table
गुजरातीने	गुजरात ने	Guajarati	Guajarati	
केली	कर ली	done	done	Verb table, 3 rd person past perfect tense.
होती	होती	had	had	

– Example 4

Marathi sentence: केंद्रपाडा जिल्हा लोहमार्गाला जोडलेला नाही. The result is in Table 13. In the above all cases, all example gives the inflection of pronouns, nouns, verbs according to the inflection rules discussed and defined in tables from inflection module.

Table 13. Result for case 4

Marathi Word	Marathi Word After Suffix Separation	English Lemma	Inflected Word	Rules to Get Inflected
केंद्रपाडा	केंद्रपाडा	Kendrapara	Kendrapara	
जिल्हा	जिल्हा	district	district	
लोहमार्गाला	लोहमार्ग ला	Rail route	to Rail route	Noun case inflection table, Dative case
जोडलेला	जोड	join	joined	Verb inflection, past tense form
नाही	नाही + आहे	is not	is not	

5. CONCLUSION

In the field of machine translation for Indian languages, a great amount of work has been done but for Marathi the research is limited. There is no work done on rule based Marathi to English machine

translation. This paper focuses on the issue of Marathi to English translation with proper inflection with 88-90% accuracy. This paper attempts to provide the detailed description of the rules required for inflecting the words for machine translation from Marathi to English. Ultimately it helps in appropriate translation which was confirmed by the results.

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