

Handling Complete-Verbs of Telugu in Machine Translation

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Abstract: Verbs can be divided into two types, transitive and intransitive. A verb can be derived into many forms like complete, incomplete, reflexive, causative, interrogative, passive, negative, etc. in Telugu. Transitive verbs need an object to perform action on it, while intransitive verbs do not need. Between the complete and incomplete verbs, only complete verbs can convey fulfilled or complete meaning of the sentence, while incomplete verbs cannot. Reflexive verbs convey that the action performed is for self. Causative verbs convey that the action is made done. Interrogative verbs are used for inquiry. Passive verbs are object oriented, which emphasize action rather than actor. A verb can be derived into its negative and positive forms. Verbs can again be grouped into regular and irregular type based on the way how they form. Various types of complete-verb derivatives of regular and irregular verbs, based on tense/ mood, number, and gender are discussed in detail in this paper. Only complete verbs of Telugu were considered for handling their conjugations in Machine Translation (MT) in this paper.

Keywords: Telugu Conjugations, Conjugation Handling, Machine Translation, Morphological Analysis.

I. INTRODUCTION

Much vocabulary is adopted from Sanskrit into Telugu [5] [14]. As in Sanskrit, the vocabulary of Telugu also can be briefly classified into verbs and non-verbs [6]. Verbs describe actions. Inflections of verbs are known as conjugations [1] [11]. Verb phrases/derivatives can be formed by appending suitable appendices to the root verb based on the tense/ mood [7] [12]. Various types of information like person, number, gender and tense can be inferred from the conjugation [13]. Unless the context is preserved/ maintained, it is not possible to recognize the gender of subject if the conjugation is in plural form [2], [3]. Verbs can be classified into three in Telugu according to the way of termination of verbs as shown in Table 1 [2][4].

Table 1. Classification of verbs based on their termination

Class	Description	Example
First	root verbs do not end with 'cu' or 'yu'	tiTTu(to Scold), konu(to Buy), etc.
Second	root verbs end in 'yu'	vrAyu(to write), thrOyu(to Push), etc.
Third	root verbs end in 'cu'	kolucu(to Measure), pilucu(to Call)etc.

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Few verbs which form irregularly such as 'agu (to Become), pOvu (to Go), vaccu (to Come), iccu (to Give), caccu (to Die), teccu (to Bring)', etc. are known as irregular verbs [8][15].

Like in many other languages, verbs can be derived into their complete and incomplete forms in Telugu also. Complete verbs give complete meaning of the sentence, for instance, 'rAjubhOjanamcEsivETakuveLLenu' (literally means, king went for hunting after having eaten meals). Incomplete verbs cannot give complete meaning to the sentence, for instance, 'rAjubhOjanamcEsi' (literally means, king having eaten meals)... it is unknown what king has done after having eaten meals. The sentence is not conveying complete meaning. Based on the nature, verb can be derived into its tenses and moods as in Table 2.

Table 2. Telugu verb tenses and moods

Tense / Mood	Description	Example
<i>bhUtakAlakriya</i> (past tense)	Describe s the actions that were happened in past	<i>rAmuDuvAlinicaMpenu</i> (Ram a killedVali)
<i>vartamAnakAlakriya</i> (present tense)	Describe s the actions that are being done at present	<i>nEnupustakaMcaduvucunna</i> (I am reading book)
<i>bhavishyatAlakriya</i> (future tense)	Describes the actions that will be done in future	<i>ataDuvaccEnelalOvastADu</i> (He will come in next month)
<i>taddharmakriya</i> (facts)	Describes facts and habits	<i>pakshuluegurunu</i> (Birds fly)
<i>SAPArthaka</i> / <i>ASIrvacanakriya</i> (curse / bless)	Describes curses or blessings	<i>ninnudEvuDudIviMconugAka</i> (May god bless you)
<i>prArthanArthakakriya</i> (requesting)	Describes the requesting	<i>nAkubodhistArA</i> (Will you teach me)

All the verb conjugations can be derived into -their negative forms also as in Table 3.



Table 3. Telugu verb tenses and moods in negative forms

Negative Tense / Mood	Example for negative form
<i>bhUtakAlakriya</i> (past tense)	<i>rAmuDuvAlinicaMpalEdu</i> (Rama did not kill Vali)
<i>vartamAnakAlakriya</i> (present tense)	<i>nEnupustakaMcadavaDaMIEdu</i> (I am not reading book)
<i>bhavishyatkAlakriya</i> (future tense)	<i>ataDuvaccEnelalOrADu</i> (He will not come in next month)
<i>taddharmakriya</i> (facts)	<i>pakshuluegaravu</i> (Birds do not fly)
<i>SAPArthaka</i> / <i>ASIrvacanakriya</i> (curse / bless)	<i>ninnudEvuDudIviMcaDugAka</i> (May god not bless you)
<i>prArthanArthakakriya</i> (requesting)	<i>nAkubodhiMcarA</i> (Will you not teach me)

Proper understand and translation of complete verbs play crucial role in NLP. As precisely as possible the words needs to be split into verbs and verb forms.

II. COMPLETE VERBS OF TELUGU

Conjugations of complete-verbs will be derived into various forms based on their gender, number and tense/mood as described in Table 4 [13]. There are variations in conjugations in singular forms of masculine and feminine genders but not in plural form [9] [10]. Same word is used to represent both the genders in plural form.

Table 4. Derivatives of regular verb forms for masculine and feminine genders in Telugu

Tense/ Mood	G	Singular	Plural
Past tense	M	<i>cEsinADu / cESADu, cUsinADu / cUSADu, etc.</i>	<i>cEsinAru / cESArU, cUsinAru/ cUSArU, etc.</i>
	F	<i>cEsinadi / cEsiMdi, cUsinadi / cUsiMdi, etc.</i>	
Present tense	M	<i>cEyucunnADu/ cEstunnADu, cUCucunnADu/ cUstunnADu, etc.</i>	<i>cEyucunnAru/ cEstunnAru, cUCucunnAru/ cUstunnAru, etc.</i>
	F	<i>cEyucunnadi/ cEstunnadi, cUCucunnadi/ cUstunnadi, etc.</i>	
Future tense	M	<i>cEyagalaDu/ cEstADu, cUDagalaDu, cUstADu, etc</i>	<i>cEyagalaru/ cEstAru, cUDagalaru/ cUstAru, etc.</i>
	F	<i>cEyagaladu/ cEstuMdi, cUDagaladu, cUstuMdi, etc</i>	
Facts / habits	M	<i>cEstADu, cUstADu, etc</i>	<i>cEstAru/ cEyuduru, cUstAru/ cUcedaru, etc.</i>
	F	<i>cEstuMdi, cUstuMdi, etc</i>	
Curse/ bless	M	<i>cEstADu, cEstADugAka, cUstADu, cUstADugAka, etc</i>	<i>cEstAru, cEstArugAka, cUstAru, cUstArugAka, etc.</i>
	F	<i>cEstuMdi, cEstuMdigAka, cUstuMdi, cUstuMdigAkaetc</i>	
Request	M	<i>cEyavA, cEyagalavA, cUDavA, cUDagalavA, etc.</i>	<i>cEsedarA/ cEstAra, cUedarA/ cUstAra, etc.</i>
	F	<i>cEyavA, cEyagalavA, cUDavA, cUDagalavA, etc.</i>	

Singular forms of conjugations for neuter gender are as same as the feminine gender, but plural forms are different as described in the Table 5.

Table 5. Derivatives of regular verb forms for neuter gender in Telugu

Tense / Mood	Neuter (Singular)	Neuter (Plural)
Past tense	<i>cEsinadi / cEsiMdi, cUsinadi / cUsiMdi, etc.</i>	<i>cEsinavi, cUsinavi, etc.</i>
Present tense	<i>cEyucunnadi/ cEstunnadi, cUCucunnadi/ cUstunnadi, etc.</i>	<i>cEyucunnavi/ cEstunnavi, cUCucunnavi/ cUstunnavi, etc.</i>
Future tense	<i>cEyagaladu/ cEstuMdi, cUDagaladu, cUstuMdi, etc</i>	<i>cEyagalavu, cUDagalavu, etc.</i>
Facts / habits	<i>cEstuMdi, cUstuMdi, etc</i>	<i>cEstAyi/ cEstavi, cUstAyi/ cUstavi, etc.</i>
Curse / bless	<i>cEstuMdigAka, cUstuMdigAkaetc</i>	<i>cEstAyigAka, cUstAyi/ cUstavi, cUstavigAka, etc.</i>
Request	<i>cEyavA, cEyagalavA, cUDavA, cUDagalavA, etc.</i>	<i>cEyavA, cEyagalavA, cUDavA, cUDagalavA, etc.</i>

Irregular complete-verb forms are as described in the Tables 6 and Table 7.

Table 6. Derivatives of irregular verb forms for masculine and feminine genders in Telugu

Tense / Mood	G	Singular	Plural
Past tense	M	<i>ayinADu / ayyADu, pOyinADu / pOyADu, etc.</i>	<i>ayinAru / ayyAru, pOinAru/ pOyAru, etc.</i>
	F	<i>ayinadi / ayiMdi, pOyinadi / pOyiMdi, etc.</i>	
Present tense	M	<i>agucunnADu/ agutunnADu, pOvucunnADu/ pOtunnADu, etc.</i>	<i>agucunnAru/ avutunnAru, pOvucunnAru/ pOtunnAru, etc.</i>
	F	<i>agucunnadi/ agutunnadi/ pOvucunnadi/ pOtunnadi, etc.</i>	
Future tense	M	<i>avagalaDu/ agutADu, pOgalaDu, pOtADu, etc</i>	<i>agagalaru/ agutAru, pOgalaru/ pOtAru, etc.</i>
	F	<i>avagaladu/ agutuMdi, pOgaladu, pOtuMdi, etc</i>	
Facts / habits	M	<i>agutADu, pOtADu, etc</i>	<i>avutAru/ aguduru, pOtAru/ pOyedaru, etc.</i>
	F	<i>avutuMdi, pOtuMdi, etc</i>	
Curse/ bless	M	<i>avutADu, avutADugAka, pOtADu, pOtADugAka, etc</i>	<i>avutAru, pOtAru/ pOtArugAka, etc.</i>
	F	<i>avutuMdi, avutuMdigAka, pOtuMdi, pOtuMdigAkaetc</i>	
Request	M	<i>avavA, avagalavA, pOvA, pOgalavA, etc.</i>	<i>ayyedarA/ avagalavA, pOyedarA/ pOtAra, etc.</i>
	F	<i>avavA, avagalavA, pOvA, pOgalavA, etc.</i>	

Table 7. Derivatives of irregular verb forms for neuter gender in Telugu

Tense/ Mood	Neuter (Singular)	Neuter (Plural)
Past tense	<i>ayinadi / ayiMdi, pOyinadi / pOyiMdi, etc.</i>	<i>ayinavi, pOyinavi, etc.</i>
Present tense	<i>agucunnadi/ agutunnadi, pOvucunnadi/ pOtunnadi, etc.</i>	<i>agucunnavi/ agutunnavi, pOvucunnavi/ pOtunnavi, etc.</i>
Future tense	<i>avagaladu/ agutuMdi, pOgaladu, pOtuMdi, etc.</i>	<i>avagalavu, pOgalavu, etc.</i>
Facts / habits	<i>avutuMdi, pOtuMdi, etc.</i>	<i>avutAyi/ avutavi, pOtAyi/ pOtavi, etc.</i>
Curse / bless	<i>avutuMdi, pOtuMdi, avutuMdigAka, pOtuMdigAka etc.</i>	<i>avutAyi/ avutavigAka, pOtAyi/ pOtavi, pOtAyigAka, etc.</i>
Request	<i>avavA, avagalavA, pOvA, pOgalavA, etc.</i>	<i>avavA, cavagalavA, pOvA, pOgalavA, etc.</i>

Verbs can be derived in to two categories considering, on which the action reflects, i.e. self or others. If the verb represents the action reflects self, then the verbs are known as reflexive verbs [16]. For instance, e.g. *vaMDukonucunnADu*(he is cooking for self). If the verb represents the action reflects others, then the verbs are known as transitive verbs, e.g. *vaMDucunnADu*(he is cooking – for others).

Appending the word ‘ukonu’ to the root verb, as well as to its tenses and moods, is a custom in formation of reflexive verbs. Examples of reflexive verbs are *caduvukonu* (to Read for self), *cUsukonu*(to Look at self), *caMpukonu* (to Kill for self), etc. Few verbs are reflexive by default even without appending the word ‘ukonu’. For example, *snAnamucEyu* (to take Bath), *munugu*(to take Dip), *tinu* (to Eat), *nidriMcu* (to Sleep), etc. In some of the cases, appending ‘ukonu’ to the root verb gives a different meaning despite of giving the reflexive meaning, e.g. *anu*(to Say) and *anukonu*(to Think – not a reflexive verb),



naDacu (to Walk – transitive verb) and *naDacukonu* (to Behave – not a reflexive verb), etc [1] [13]. Since majority of reflexive verbs contain the word ‘*ukonu*’ in their verb derivatives, the term ‘*ukonu*’ was searched for in the token to identify the reflexivity as in Table 8 and Table 9.

Table 8. Derivatives of reflexive complete-verb forms for masculine and feminine genders in Telugu

Tense / Mood	G	Singular	Plural
Past tense	M	<i>cEsukunnADu, cUsukunnADu, etc</i>	<i>cEsukunnAru, cUsukunnAru, etc.</i>
	F	<i>cEsukunnadi, cUsukunnadi, etc.</i>	
Present tense	M	<i>cEsukonucunnADu, cUcukonucunnAD, etc.</i>	<i>cEsukonucunnAru, cUcukonucunnAru, etc.</i>
	F	<i>cEsukonucunnadi, cUcukonucunnadi, etc.</i>	
Future tense	M	<i>cEsukOgalaDu, cUcukOgalaDu, etc.</i>	<i>cEsukOgalaru, cUcukOgalaru, etc.</i>
	F	<i>cEsukOgaladu, cUcukOgaladu, etc.</i>	
Facts / habits	M	<i>cEsukoMTADu, cUcukoMTADu, etc.</i>	<i>cEsukoMTAru, cUcukoMTAru, etc.</i>
	F	<i>cEsukoMTuMdi, cUcukoMTuMdi, etc.</i>	
Curse/ bless	M	<i>cEsukoMTADugAka, cUcukoMTADugAka, etc.</i>	<i>cEsukoMTArugAka, cUcukoMTArugAk, etc.</i>
	F	<i>cEsukoMTuMdigAka, cUcukoMTuMdigAka, etc.</i>	
Request	M	<i>cEsukonavA, cUcukonavA, etc.</i>	<i>cEsukonarA, cUcukonarA, etc.</i>
	F	<i>cEsukonavA, cUcukonavA, etc.</i>	

Table 9. Derivatives of reflexive complete-verb forms for neuter gender in Telugu

Tense / Mood	Neuter (Singular)	Neuter (Plural)
Past tense	<i>cEsukunnadi, cUsukunnadi, etc.</i>	<i>cEsukunnavi, cUsukunnavi, etc.</i>
Present tense	<i>cEsukonucunnadi, cUcukonucunnadi, etc.</i>	<i>cEsukonucunnavi, cUcukonucunnavi, etc.</i>
Future tense	<i>cEsukOgaladu, cUcukOgaladu, etc.</i>	<i>cEsukOgalavu, cUcukOgalavu, etc.</i>
Facts / habits	<i>cEsukoMTuMdi, cUcukoMTuMdi, etc.</i>	<i>cEsukoMTavi, cUcukoMTavi, etc.</i>
Curse / bless	<i>cEsukoMTuMdigAka, cUcukoMTuMdigAka, etc.</i>	<i>cEsukoMTavigAka, cUcukoMTavigAka, etc.</i>
Request	<i>cEsukonavA, cUcukonavA, etc.</i>	<i>cEsukonarA, cUcukonarA, etc.</i>

Verbs can be derived to their causative forms using the word ‘*imcu*’, e.g. *caMpu*(to kill) – *caMpiMcu* (causing to kill), *caduvu* (to read) – *cadiviMcu* (causing to read), etc. as in Table 10 and Table 11. Though few verbs seemed causative, they are not, e.g. *rakshiMcu* (to protect), *dlviMcu* (to bless), *parlkshiMcu* (to examine), *paMpiMcu* (to send), etc.

Table 10. Derivatives of regular causative verb forms for masculine and feminine genders in Telugu

Tense / Mood	G	Singular	Plural
Past tense	M	<i>cEyiMcinADu / cEyiMcADu, cUpiMcinADu / cUpiMcADu, etc.</i>	<i>cEyiMcinAru / cEyiMcAru, cUpiMcinAru/ cUpiMcAru, etc.</i>
	F	<i>cEyiMcinadi / cEyiMciMdi, cUpiMcinadi / cUpiMciMdi, etc.</i>	
Present tense	M	<i>cEyiMccunnADu/ cUpiMccunnADu/ etc.</i>	<i>cEyiMccunnAru, cUpiMccunnAru, etc.</i>
	F	<i>cEyucunnadi/ cEstunnadi, cUcunnadi/ cUstunnadi, etc.</i>	
Future tense	M	<i>cEyiMcagalaDu, cUpiMcagalaDu, etc.</i>	<i>cEyiMcagalaru, cUpiMcagalaru, etc.</i>
	F	<i>cEyiMcagaladu/ cEyiMcutuMdi, cUpiMcagaladu, etc.</i>	

Tense / Mood	G	Singular	Plural
Facts / habits	M	<i>cEyiMcutADu, cUpiMcutADu, etc</i>	<i>cEyiMcutAru/ cEyiMcuturu, cUpiMcutAru/ cUpiMcedaru, etc.</i>
	F	<i>cEyiMcutuMdi, cUpiMcutuMdi, etc</i>	
Curse/ bless	M	<i>cEyiMcutADu, cEyiMcutADugAka, cUpiMcutADugAka, etc</i>	<i>cEyiMcutAru, cEyiMcutArugAka, cUpiMcutAru, cUpiMcutArugAka, etc.</i>
	F	<i>cEyiMcutuMdi, cEyiMcutuMdigAka, cUpiMcutuMdigAkaetc</i>	
Request	M	<i>cEyiMcava, cUpiMcava, cEyiMcagalava, cUpiMcagalava, etc.</i>	<i>cEyiMcedarA/ cEyiMcutAru, cUpiMcedarA/ cUpiMcutAru, etc.</i>
	F	<i>cEyiMcava, cUpiMcava, cEyiMcagalava, cUpiMcagalava, etc.</i>	

Table 11. Derivatives of causative verb forms for neuter gender in Telugu

Tense / Mood	Neuter (Singular)	Neuter (Plural)
Past tense	<i>cEyiMcinadi / cEyiMciMdi, cUpiMcinadi / cUpiMciMdi, etc.</i>	<i>cEyiMcinavi, cUpiMcinavi, etc.</i>
Present tense	<i>cEyucunnadi/ cEstunnadi, cUcunnadi/ cUstunnadi, etc.</i>	<i>cEyiMccunnavi, cUpiMccunnavi, etc.</i>
Future tense	<i>cEyiMcagaladu/ cEyiMcutuMdi, cUpiMcagaladu, etc</i>	<i>cEyiMcagalavu, cUpiMcagalavu, etc.</i>
Facts / habits	<i>cEyiMcutuMdi, cUpiMcutuMdi, etc</i>	<i>cEyiMcutuMTavi, cUpiMcutuMTavi, etc.</i>
Curse / bless	<i>cEyiMcutuMdi, cEyiMcutuMdigAka, cUpiMcutuMdigAkaetc</i>	<i>cEyiMcutuMTavigAka, cUpiMcutuMTavigAka, etc.</i>
Request	<i>cEyiMcava, cUpiMcava, cEyiMcagalava, cUpiMcagalava, etc.</i>	<i>cEyiMcava, cUpiMcava, etc.</i>

Verbs can be derived into various types of verb forms with various combinations like causative-reflexive as per need as described in Table 12 and Table 13.

Table 12. Derivatives of causative-reflexive complete-verb forms for masculine and feminine genders in Telugu

Tense / Mood	G	Singular	Plural
Past tense	M	<i>cEyiMccunnADu, cUpiMccunnADu, etc</i>	<i>cEyiMccunnAru, cUpiMccunnAru, etc.</i>
	F	<i>cEyiMccunnadi, cUpiMccunnadi, etc.</i>	
Present tense	M	<i>cEyiMccunucunnADu, cUpiMccunucunnAD, etc.</i>	<i>cEyiMccunucunnAru, cUpiMccunucunnAru, etc.</i>
	F	<i>cEyiMccunucunnadi, cUpiMccunucunnadi, etc.</i>	
Future tense	M	<i>cEyiMccukOgalaDu, cUpiMccukOgalaDu, etc.</i>	<i>cEyiMccukOgalaru, cUpiMccukOgalaru, etc.</i>
	F	<i>cEyiMccukOgaladu, cUpiMccukOgaladu, etc.</i>	
Facts / habits	M	<i>cEyiMccukoMTADu, cUpiMccukoMTADu, etc.</i>	<i>cEyiMccukoMTAru, cUpiMccukoMTAru, etc.</i>
	F	<i>cEyiMccukoMTuMdi, cUpiMccukoMTuMdi, etc.</i>	
Curse/ bless	M	<i>cEyiMccukoMTADugAka, cUpiMccukoMTADugAka, etc.</i>	<i>cEyiMccukoMTArugAka, cUpiMccukoMTArugAk, etc.</i>
	F	<i>cEyiMccukoMTuMdigAka, cUpiMccukoMTuMdigAkaetc.</i>	
Request	M	<i>cEyiMccukonavA, cUpiMccukonavA, etc.</i>	<i>cEyiMccukonarA, cUpiMccukonarA, etc.</i>
	F	<i>cEyiMccukonavA, cUpiMccukonavA, etc.</i>	



Table 13. Derivatives of causative-reflexive complete-verb forms for neuter gender in Telugu

Tense / Mood	Neuter (Singular)	Neuter (Plural)
Past tense	<i>cEyiMcukunnadi, cUpiMcukunnadi, etc.</i>	<i>cEyiMcukunnavi, cUpiMukunnavi, etc.</i>
Present tense	<i>cEyiMcukonucunnadi, cUpiMcukonucunnadi, etc.</i>	<i>cEyiMcukonucunnavi, cUpiMcukonucunnavi, etc.</i>
Future tense	<i>cEyiMcukOgaladu, cUpiMcukOgaladu, etc.</i>	<i>cEyiMcukOgalavu, cUpiMcukOgalavu, etc.</i>
Facts / habits	<i>cEyiMcukoMTuMdi, cUpiMcukoMTuMdi, etc.</i>	<i>cEyiMcukuMTavi, cUpiMcukuMTavi, etc.</i>
Curse / bless	<i>cEyiMcukuMTuMdigAka, cUpiMcukuMTuMdigAka, etc.</i>	<i>cEyiMcukuMTavigAka, cUpiMcukuMTavigAka, etc.</i>
Request	<i>cEyiMcukonava, cUpiMcukonava, etc.</i>	<i>cEyiMcukonarA, cUpiMcukonarA, etc.</i>

Verbs can be derived to their passive forms using the word ‘*abaDu*’, e.g. *caMpu*(to kill) – *caMpabaDu* (killed by), *caduvu* (to read) – *cadivabaDu* (read by), *tinu* (to eat) – *tinabaDu*(eaten by), etc. Passive verb derivatives are described in the Tables 14 and Table

Table 14. Derivatives of passive complete-verb forms for masculine and feminine genders in Telugu

Tense / Mood	G	Singular	Plural
Past tense	M	<i>cEyabaDinADu, cUpabaDinADu, etc</i>	<i>cEyabaDDAru, cUpabaDDAru, etc.</i>
	F	<i>cEyabaDinadi, cUpabaDinadi, etc.</i>	
Present tense	M	<i>cEyabaDucunnADu, cUpabaDucunnADu, etc.</i>	<i>cEyabaDucunAru, cUpabaDucunAru, etc.</i>
	F	<i>cEyabaDucunnadi, cUpabaDucunnadi, etc.</i>	
Future tense	M	<i>cEyabaDagalaDu, cUpabaDagalaDu, etc.</i>	<i>cEyabaDagalaru, cUpabaDagalaru, etc.</i>
	F	<i>cEyabaDagaladu, cUpabaDagaladu, etc.</i>	
Facts / habits	M	<i>cEyabaDatADu, cUpabaDatADu, etc.</i>	<i>cEyabaDutAru, cUpabaDutAru, etc.</i>
	F	<i>cEyabaDutuMdi, cUpabaDutuMdi, etc.</i>	
Curse/ bless	M	<i>cEyabaDatADugAka, cUpabaDatADugAka, etc.</i>	<i>cEyabaDutArugAka, cUpabaDutArugAk, etc.</i>
	F	<i>cEyabaDutuMdigAka, cUpabaDutuMdigAkaetc.</i>	
Request	M	<i>cEyabaDavA, cUpabaDavA, etc.</i>	<i>cEyabaDarA, cUpabaDarA, etc.</i>
	F	<i>cEyabaDavA, cUpabaDavA, etc.</i>	

Table 15. Derivatives of passive complete-verb forms for neuter gender in Telugu

Tense / Mood	Neuter (Singular)	Neuter (Plural)
Past tense	<i>cEyabaDinadi, cUpabaDinadi, etc.</i>	<i>cEyabaDinavi, cUpabaDinavi, etc.</i>
Present tense	<i>cEyabaDucunnadi, cUpabaDucunnadi, etc.</i>	<i>cEyabaDucunnavi, cUpabaDucunnavi, etc.</i>
Future tense	<i>cEyabaDagaladu, cUpabaDagaladu, etc.</i>	<i>cEyabaDagalavu, cUpabaDagalavu, etc.</i>
Facts / habits	<i>cEyabaDutuMdi, cUpabaDutuMdi, etc.</i>	<i>cEyabaDutavi, cUpabaDutavi, etc.</i>
Curse / bless	<i>cEyabaDutuMdigAka, cUpabaDutuMdigAkaetc.</i>	<i>cEyabaDuavigAka, cUpabaDutavigAkaetc.</i>
Request	<i>cEyabaDavA, cUpabaDavA, etc.</i>	<i>cEyabaDavA, cUpabaDavA, etc.</i>

Passive verb forms can also be derived into causative passive verb forms by employing the word ‘*iMcu*’ as described in the Tables 16 and Table 17.

Table 16. Derivatives of passive-causative complete-verb forms for masculine and feminine genders in Telugu

Tense / Mood	G	Singular	Plural
Past tense	M	<i>cEyiMcabaDinADu, cUpiMcabaDinADu, etc</i>	<i>cEyiMcabaDDAru, cUpiMcabaDDAru, etc.</i>
	F	<i>cEyiMcabaDinadi, cUpiMcabaDinadi, etc.</i>	
Present tense	M	<i>cEyiMcabaDucunnADu, cUpiMcabaDucunnADu, etc.</i>	<i>cEyiMcabaDucunAru, cUpiMcabaDucunAru, etc.</i>
	F	<i>cEyiMcabaDucunnadi, cUpiMcabaDucunnadi, etc.</i>	
Future tense	M	<i>cEyiMcabaDagalaDu, cUpiMcabaDagalaDu, etc.</i>	<i>cEyiMcabaDagalaru, cUpiMcabaDagalaru, etc.</i>
	F	<i>cEyiMcabaDagaladu, cUpiMcabaDagaladu, etc.</i>	
Facts / habits	M	<i>cEyiMcabaDatADu, cUpiMcabaDatADu, etc.</i>	<i>cEyiMcabaDutAru, cUpiMcabaDutAru, etc.</i>
	F	<i>cEyiMcabaDutuMdi, cUpiMcabaDutuMdi, etc.</i>	
Curse/ bless	M	<i>cEyiMcabaDatADugAka, cUpiMcabaDatADugAka, etc.</i>	<i>cEyiMcabaDutArugAka, cUpiMcabaDutArugAka, etc.</i>
	F	<i>cEyiMcabaDutuMdigAka, cUpiMcabaDutuMdigAkaetc.</i>	
Request	M	<i>cEyiMcabaDavA, cUpiMcabaDavA, etc.</i>	<i>cEyiMcabaDarA, cUpiMcabaDarA, etc.</i>
	F	<i>cEyiMcabaDavA, cUpiMcabaDavA, etc.</i>	

Table 15. Derivatives of passive-causative complete-verb forms for neuter gender in Telugu

Tense / Mood	Neuter (Singular)	Neuter (Plural)
Past tense	<i>cEyiMcabaDinadi, cUpiMcabaDinadi, etc.</i>	<i>cEyiMcabaDinavi, cUpiMcabaDinavi, etc.</i>
Present tense	<i>cEyiMcabaDucunnadi, cUpiMcabaDucunnadi, etc.</i>	<i>cEyiMcabaDucunnavi, cUpiMcabaDucunnavi, etc.</i>
Future tense	<i>cEyiMcabaDagaladu, cUpiMcabaDagaladu, etc.</i>	<i>cEyiMcabaDagalavu, cUpiMcabaDagalavu, etc.</i>
Facts / habits	<i>cEyiMcabaDutuMdi, cUpiMcabaDutuMdi, etc.</i>	<i>cEyiMcabaDutavi, cUpiMcabaDutavi, etc.</i>
Curse / bless	<i>cEyiMcabaDutuMdigAka, cUpiMcabaDutuMdigAkaetc.</i>	<i>cEyiMcabaDuavigAka, cUpiMcabaDutavigAkaetc.</i>
Request	<i>cEyiMcabaDavA, cUpiMcabaDavA, etc.</i>	<i>cEyiMcabaDavA, cUpiMcabaDavA, etc.</i>

Verb forms can be derived into its interrogative and negative forms also using ‘*A*’ and ‘*IEdu/aDu/ adu*’ respectively suitably. Examples of interrogative verbs: ‘*cadivinADA*’ (did he read), ‘*cEyucunnADA*’ (is he doing), ‘*tinagalaDA*’ (can he eat), ‘*cUstuMda*’ (will she see), examples of negative verbs: ‘*caduvaIEdu*’ (did not study), ‘*cUDaDaMIEdu*’(not seeing), ‘*tinaIEdu*’ (cannot eat), ‘*udayiMcaDu*’ (will not rise), etc. Interrogative and negative verbs can be derived into causative, reflexive, passive, etc. forms. Various combinations can generate numerous of verb forms in usage [17].

Algorithm 2.1 describes handling the complete verb forms of Telugu. Before identifying tense of verb in given verb form, the rear part of verb which is used to fetch its tense or mood, gender, person and number should be separated and then morphed for identifying verb in it, e.g. ‘*cEyucunnADu*’ (He is doing). The word ‘*cunnADu*’ describes, the verb is in continuous tense, singular, male, and third person. Remaining part of verb form ‘*cEyu*’ is examined whether it is reflexive, causative, passive, and availability in dictionary.



Algorithm 2.1 VERB_FORMS(Token)

//N-number, T-tense, G-gender, P-person, V-verb,
//CS-causative, PS-passive, IN-interrogative RF-//reflexive,
F-False, T-True

1. Start
2. CS←F, PS←F, NG←F, IN←F, RF←F,
3. Select (Last7CharsOfToken)

Case	Initialize variables
<i>tunnAnu, cunnAnu, tunnAnA, cunnAnA</i>	N ← S, T← PRE, G ← A, P← 1
<i>tunnAvu, cunnAvu, tunnAvA, cunnAvA</i>	N ← S, T← PRE, G← A, P← 2
<i>tunnADu, cunnADu, tunnADA, cunnADA</i>	N← S, T← PRE, G← M, P← 3
<i>tunnadi, cunnadi, tunnada, cunnada</i>	N← S, T← PRE, G ← F, P ← 3
<i>tunnAmu, cunnAmu, tunnAmA, cunnAmA</i>	N ← P, T← PRE, G ← A, P ← 1
<i>tunnAru, cunnAru, tunnArA, cunnArA</i>	N ← P, T← PRE, G ← A, P← 3
<i>tunnavi, cunnavi, tunnava, cunnava</i>	N ← P, T← PRE, G← N, P← 3

End select

Select (Last6CharsOfToken)

T← Last7CharsOfToken
If T =*utuMdiorutuMda*

N ← S, T← FUT, G← F, P← 3

4. Select (Last_5_Chars_of_Token)
T← Last 5 Chars of Token

Case	Initialize variables
<i>utAnu, utAnA</i>	N ← S, T← FUT, G← A, P← 1
<i>utAvu, utAvA</i>	N ← S, T← FUT, G← A, P← 2
<i>utADu, utADA</i>	N ← S, T← FUT, G← M, P← 3
<i>utAmu, utAmA</i>	N ← P, T← FUT, G← A, P← 1
<i>utAru, utArA</i>	N ← P, T← FUT, G← A, P← 3
<i>utavi, utava</i>	N ← P, T← FAC, G← N, P← 3
<i>itini, inAnu, itinA, inAnA</i>	N ← S, T← PAST, G← A, P← 1
<i>itivi, itivA</i>	N ← S, T← PAST, G← A, P← 2
<i>inADu, inADA</i>	N ← S, T← PAST, G← M, P← 3
<i>inadi, inada</i>	N ← S, T← PAST, G← F, P← 3
<i>inAmu, inAmA</i>	N ← P, T← PAST, G← A, P← 1
<i>inAru, inArA</i>	N ← P, T← PAST, G← A, P← 3
<i>inavi, inava</i>	N ← P, T← PAST, G← N, P← 3
<i>udunu, udunA</i>	N ← S, T← FAC, G← A, P← 1
<i>uduvu, uduvA</i>	N ← S, T← FAC, G← A, P← 2
<i>udumu, udumA</i>	N ← P, T ← FAC, G← A, P← 1
<i>uduru, udurA</i>	N ← P, T ← FAC, G← A, P← 1

End select

5. If Last Char of Token = 'A' then IN←T
//checking whether the verb is interrogative
6. VERB ← (Token – TENSE)
//VERB may be in corrupted form of verb

//*cEstunnADu* => T =*tunnADu*, V=*cEs* //(corrupted form of *cEyu*)

7. If (LastXCharsOfToken) = *iMcabaD* then //check for Causal-passive, e.g. //*cEyiMcabaDu (cunnadi)* => T=*cunnadi*, //CS = *iMc*, PS = *abaD*, V=*cEy*(corrupted //form of *cEyu*)

V←MORPH(LastXCharsOfToken), CS←T, PS ← T

ElseIf(LastXCharsOfToken)=*abaD* then //check for passivity, e.g. *cEyabaDucunnadi* //=> T =*cunnadi*, PS = *abaDu* V = *cEy* //(corrupted form of *cEyu*)

V← MORPH(Token – last X characters), PS ← T
ElseIf (LastXCharsOfToken) = *incu, iMpajEyu, iMpacEy* then

//check for causality e.g. *cEyiMcucunnADu* //=> T =*cunnADu*, CS = *imcu/iMpajEyu* //iMpacEyu, V=*cEy*(corrupted form of //*cEyu*)

V← MORPH(Token – last X characters), CS ← T
ElseIf (LastXCharsOfToken) = *iMcukon* then // check for Causal reflexive, e.g.

//*vaMDiMcukonu(cunnadi)* => T =//*cunnadi*, CS = *iMc* RF = *ukonu*, V = //*vaMD*(corrupted form of *vaMDu*)

V←MORPH(Token–LastXchars), CS←T, RF←T

ElseIf (LastXCharsOfToken) = *ukon* then

//check for reflexivity, e.g. *vaMDukonu* //(cunnadi) => T =*cunnadi*, RF=*ukonu*, V = //*vaMD*(corrupted form of *vaMDu*)

V←(Token– LastXchars), RF← T

End If

9. If VERB is not a root verb then
Morph VERB suitably to identify its root form
10. Return VERB, TENSE, NUM, GEN, PER, CS, PS, RF, INT
11. End

Input	<i>caduvagalavu</i> (you can read)
Internal process	<i>caduv + agalavu</i>
Morphology	<i>caduv => caduvu</i> (study)
Outcome	<i>caduvu, FAC, S, A, 2, F, F, F, F</i>

Similarly, other types of verb forms and combinations thereof can be handled by searching for other words for negativity, etc.

III. RESULTS AND DISCUSSIONS

Morphological analysis of Telugu verb phrases helped discover the root verbs of textually disturbed conjugations with a high success and accuracy rates. Though few wrong and inaccurate interpretations were identified, the level of accuracy rates of morphological analysis and overall confidence were considerably high.

One of the reasons behind wrong and inaccurate interpretations was the presence of ambiguity in the structure of phrase itself. Few of the irregular verbs and their conjugations also deteriorated the accuracy. Overall accuracy of the system was calculated using the F-measure, (a harmonic mean of Precision and Recall) using the formulas:



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$F\text{-measure } (F) = 2 * ((Precision * Recall) / (Precision + Recall))$

$Precision = tp / (tp + fp)$

$Recall = tp / (tp + fn)$

Here tp – True positive, fp – False positive, fn – False negative

- tp is the percentage of accurately traced verbs.
- fp is the percentage of extracted conjugations which are not supposed to be.
- fn value is the percentage of wrong conjugations interpreted wrongly.

$tp = 2099, fp = 342, fn = 59$ (from the results of testing, with test data set)

$Precision = (2099 / 2441) = 0.85, Recall = (2099 / 2158) = 0.97$

$F\text{-measure} = 2 * ((0.85 * 0.97) / (0.85 + 0.97)) = 2 * (0.83 / 1.82) = 91.2\%$

IV. CONCLUSION

Verbs can be derived into countless formal conjugations in Telugu. The powerful Morphological Analysis System (MAS) could succeed in interpretation and extraction of the root verb from conjugations efficiently. Accuracy in interpreting ambiguous conjugations can be improved with more efficient MAS that preserve the context. Accuracy in handling conjugations of irregular verbs can also be improved if the research is taken up in that line.

The research can also be extended to handle informal, irregular and corrupted verb phrases since they are in much usage. There is much scope for research in handling corrupted conjugations. The research can also be extended to handle corrupted conjugations of various dialects.

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