IMPLEMENTATION OF NLIZATION FRAMEWORK FOR VERBS, PRONOUNS AND DETERMINERS WITH EUGENE

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ABSTRACT

UNL system is designed and implemented by a nonprofit organization, UNDL Foundation at Geneva in 1999. UNL applications are application softwares that allow end users to accomplish natural language tasks, such as translating, summarizing, retrieving or extracting information, etc. Two major web based application softwares are Interactive ANalyzer (IAN), which is a natural language analysis system. It represents natural language sentences as semantic networks in the UNL format. Other application software is dEep-to-sUrface GENErator (EUGENE), which is an open-source interactive NLizer. It generates natural language sentences out of semantic networks represented in the UNL format. In this paper, NLization framework with EUGENE is focused, while using UNL system for accomplishing the task of machine translation. In whole NLization process, EUGENE takes a UNL input and delivers an output in natural language without any human intervention. It is language-independent and has to be parametrized to the natural language input through a dictionary and a grammar, provided as separate interpretable files. In this paper, it is explained that how UNL input is syntactically and semantically analyzed with the UNL-NL T-Grammar for NLization of UNL sentences involving verbs, pronouns and determiners for Punjabi natural language.

KEYWORDS

Rule based Approach, Interlingua, Multilingual, NLization, UNL

1. INTRODUCTION

Today all over the world work is in progress by various government/educational organizations and some individual researchers for technological development of most widely spoken natural languages. Machine Translation is most challenging task which is to be accomplished before excelling further in other sub domains of NLP (Natural Language Processing). The process of translating a text written in some language to another language’s text is called Machine Translation.

There are many approaches used for machine translation. Interlingua based approach which is a rule based can be adopted for multilingual machine translation, as depicted in Figure 1.

In this approach, the target language is first transformed into some intermediate form, while preserving the semantic information associated with the words of source language. This intermediate form is independent of source language. From this intermediate form variety of natural languages can be generated, by a separate process using respective language word dictionaries and sets of grammar rules. If traditional statistical approach is followed then total of \( n^*(n-1) \) systems will be required for \( n \) number of languages in multilingual machine translation. But, interlingua approach for machine translation system is a novel approach, here only \( 2n \) language systems are required, \( i.e., \) two systems per language.
Universal Networking Language (i.e., UNL) system is based on interlingua approach. UNL system is designed and implemented by UNDL foundation which is a non-profit organization based in Geneva, Switzerland in 1996. UNL system comprises of two components one is UNLizer for converting the source language to UNL form (an intermediate form) and other is NLizer for generating target language from UNL form, using respective language word dictionaries and sets of grammar rules. UNLization and NLization are different for different languages, because sentence structures of different languages are different.

In this paper, NLization for Punjabi language for verb, pronouns and determiners from UNL form (an intermediate form) is discussed. EUGENE (dEep-to-sUrface Natural language GENErator), is an open-source interactive NLizer, which is a new deconverter based on a high-level linguist-driven three-layered formalism, developed by UNDL Foundation. It generates natural language sentences out of semantic networks represented in the UNL format. In its current release, it is a web application developed in Java [1].

2. RELATED WORK

Initially ‘DeCo’ was a tool for NLization, which was proposed by UNDL foundation in 2000. This DeConverter actually transforms the input, a UNL expression, into a directed graph structure with hyper-nodes. DeConversion of a UNL expression is carried out by applying DeConversion rules to these nodes. It processes the nodes from the entry node, to find an appropriate word for each node and generates a word sequence of target language. In this process, the system makes use of syntactic rules in order to produce syntactic structure of the target language and morphological rules to generate its morphemes, as depicted in Figure 2. DeConversion process ends when all words for all nodes are found and a word sequence of target sentence is completed.
Here, ‘G’ indicates generation windows and ‘C’ indicates condition windows of the DeConverter. The DeConverter operates on the node-list through generation windows. Condition windows are used to check conditions for applying a rule. In the initial stage, the entry node of a UNL expression exists in the node-list and at the end of DeConversion, the node-list is converted to list of equivalent morphemes of the target language arranged syntactically to produce target language sentence [2].

3. EUGENE SPECIFICATIONS

EUGENE is a fully automatic engine. It takes a UNL input and delivers an output in natural language without any human intervention [3]. It is language-independent and as a universal engine, EUGENE must be parameterized to the target languages with few files for UNL-NL generation. These files are processed by EUGENE, through following tabs.

3.1. UNL Input
UNL Documents containing universal semantic network to be used for the generation of natural language texts are inputted into the system using first tab of EUGENE.

3.2. Dictionary
An editor and for inputting a lexical database, where root words are mapped into natural language entries, along with the corresponding features, to be provided according to the UNL Dictionary Specifications.

3.3. T-Rules
An editor and inputting transformation grammar(s), i.e., a set of transformation rules used to convert the UNL graphs into natural language sentences, to be provided according to the UNL Grammar Specifications.

3.4. D-Rules
An editor and for inputting disambiguation grammar(s), i.e., a set of disambiguation rules used to improve the results of the tokenization and of the transformation.

3.5. EUGENE
A console, from where the output corresponding to the UNL input sentence can be generated. The output can be displayed in five different trace levels. It takes a UNL input, processes it using T-rules and Dictionary loaded, finally, delivers an output in natural language without any human intervention.

In the next subsection features of Punjabi language and positioning of different part of speech in a sentence of Punjabi language discussed in brief.

4. FUTURE OF PUNJABI LANGUAGE
Punjabi is an Indo-Aryan language and is constitutionally recognized language of India. Indo-Aryan languages form a subgroup of the Indo-Iranian group of languages, which in turn belong to Indo-European family of languages. Punjabi is widely spoken in north-west India, Pakistan, United States, Australia, United Kingdom and Canada. There are more than 91 million native speakers of Punjabi language, which makes it approximately the 12th most widely spoken language in the world [4].
Punjabi has word classes in the form of noun, pronoun, adjective, cardinal, ordinal, main verb, auxiliary verb, adverb, postposition, conjunction, interjection, and particle. Punjabi nouns change forms for number (singular or plural) and case in sentences. Punjabi nouns have assigned gender (masculine or feminine), e.g., ਕੰਧ kandh ‘fence’ is used in feminine gender and ਮੇਜ਼ mēz ‘table’ is used in masculine gender. Punjabi has six types of pronouns. These are: personal pronouns, e.g., ਮੈਂ maiṃ ‘i’; reflexive pronouns, e.g., ਅਪਾ atial ‘some what equivalent to honorific form of English second person ‘you’); demonstrative pronouns, e.g., ਅਪ ਅਤੀ uh ‘that’; indefinite pronouns, e.g., ਕੋਈ kōī etc.; relative pronouns (to join two clauses in a complex sentence), e.g., ਜੋ jō and interrogative pronouns, e.g., ਕੌਣ kauṇ ‘who’ etc. In Punjabi language, adjectives usually precede the nouns but follow the pronouns. The example of adjective preceding noun is, ਸੋਹਣਾ ਮੰਡਾ sohṇā mūndā ‘handsome boy’ and the example of adjective following pronoun is, ਮੈਂ ਸੋਹਣਾ ਹਾਂ maiṃ sohṇā hāṃ. ‘I am handsome’. In a Punjabi sentence, verbs must agree with the subject or object of the sentence in terms of gender, number, and person. Punjabi verbs change forms for gender, number, person, and tense. The verbs have assigned transitivity and causality. In Punjabi, there are two auxiliary verbs – ‘ਹੈ hai’ for present tense (e.g., ਰਾਮ ਅੰਬ ਖਾਧਾ hai rām amb khādā ‘Ram eats mango’) and ਸੀ sī for past tense (e.g., ਰਾਮ ਨੇ ਅੰਬ ਆਪਣਾ ਸੀ rām nē amb āpāṇā sī ‘Ram had eaten mango’). All the forms of these two auxiliary verbs can equally be used for both the genders [2]. For future tense in sentences, ‘EGA’ form of main verb is used and in those sentences auxiliary.

5. IMPLEMENTATION FOR NLIZATION OF PUNJABI

The proposed NLization system for Punjabi has been tested on five types of part of speech sentences, which are, Determiners, Nouns, Verbs, Pronouns, Sentence Structure and Cardinals. Here, in this paper, NLization for Determiners, Verbs and Pronouns types of parts of speech, are discussed. Table 1 depicts the number T-rules and Dictionary words written corresponding to each type of part of speech.

| Type   | No. of Sentences | Rules | Dictionary Words |
|--------|------------------|-------|------------------|
| Verbs  | 50               | 25    | 3                |
| Pronouns | 40            | 8     | 20               |
| Determiners | 60          | 50    | 15               |

Detailed description for processing of these sentences is given in next subsection.

5.1. NLization of Verbs

The process of NLization of input UNL sentence containing verb to natural language sentence is illustrated with an example sentence given in (1).

Example English sentence is: He has arrived

UNL expression for this example sentence is given in (2).

{unl}

agt(arrive:0B.@present.@perfect., 00:01.@3.@male)

{/unl}

...(1)

...(2)
5.2. NLization of Pronouns

The process of NLization of input UNL sentence containing pronouns to natural language sentence is illustrated with an example sentence given in (4).

Example English sentence is: They love each other  …(4)
UNL expression for this example sentence is given in (5).
{unl}
agt(love:03.@present.@reciprocal, 00:01.@3.@pl)
{/unl}
Equivalent Punjabi sentence is:
ਉਹਨੀਆਂ ਦੀਆਂ ਖਾਸ ਗੁਣਾਂ ਵਿਰੁਧਾਂ …(6)
Transliterated Punjabi sentence is: uh na dian khati kitaban.

UNL expression in this example contains two root words, first is a verb, i.e., ‘arrive’ and second is pronoun, i.e., ‘00:01.@3’/third person pronoun. The NLization process of example sentence is described in Table 2.

5.2. NLization of Determiners

The process of NLization of input UNL sentence containing determiners to natural language sentence is illustrated with an example sentence given in (7).

Example English sentence is: A lot of their books  …(7)
UNL expression for this example sentence is given in (8).
{unl}
pos(book:05.@multal, 00:03.@3.@pl)
{/unl}
Equivalent Punjabi sentence is: 
ਉਹਨਾਂ ਦੀਆਂ ਬਹੁਤ ਕਿਤਾਬਾਂ   …(9)
Transliterated Punjabi sentence is: uhna dian bhot kitaban.

UNL expression in this example contains two root words, first is a noun, i.e., ‘book’ and second is pronoun, i.e., ‘00:01.@3’/third person pronoun. The NLization process of example sentence is described in Table 3.
`phunch`, because this root word does not have any combination of attributes as are involved in this rule.
This paradigm M2 has been defined to attach word "ਨੂਨ" nun for UNL relation 'AGT'. Here attribute 'FLX' is indicate that word has been processed for inflections.

| Expression | Description | Result |
|------------|-------------|--------|
| \(x,M2\):=(%x,-M2,+FLX(AGT:0>"ਨੂ")| This paradigm M2 has been defined to attach word "ਨੂਨ" nun for UNL relation 'AGT'. Here attribute 'FLX' is indicate that word has been processed for inflections. | To: [00:01. @3.@male] Result: ["ਉਹ":01.@3.@male] Nothing is appended to UW 'ਉਹ' uh because this root word does not have 'AGT' attribute with it. |
| \(\text{agt}(\%a,V, @\text{present}, @\text{perfect}, \text{PRS}; \%b,R):=\text{agt}(\%a, +\text{PER}, +\text{PRS}, -\text{present}; \%b)\) | It adds 'PER' and 'PRS' attributes to the verb depending upon attributes associated with the node, because 'PRS&PER' combination is necessary for appending appropriate postfix to Punjabi root word verb. | To: \text{agt}(\text{arrive}:07.@\text{not}.@\text{present}.@\text{perfect}, 00:01.@3.@male) Result: \text{agt}(\text{arrive}:07.@\text{not}.@\text{perfect}, 00:01.@3) Nothing is appended to any Punjabi root word as postfix, '@\text{present}' attribute is removed from second node '%b' and 'PRS' and 'PES' are added to first node '%a'. |
| \(\text{agt}(\%a, ^\text{MCL}; \%b,R, @\text{male}):=\text{agt}(\%a, +\text{MCL}, -\text{NUM}, +\text{NUM}=\text{SNG}; \%b, -@\text{male})\) | It adds 'MCL' and 'SNG' attributes to the verb because of '@male' attribute associated with the second node '%b', as 'PRS&PER&MCL&SNG' combination is necessary for appending appropriate postfix to Punjabi root word. | To: \text{agt}(\text{arrive}:07.@\text{not}.@\text{present}.@\text{perfect}, 00:01.@3.@male) Result: \text{agt}(\text{arrive}:07.@\text{not}.@\text{perfect}, 00:01.@3) Nothing is appended to any Punjabi root word as postfix, just '@\text{male}' attribute is removed from second node '%b' and 'MCL' and 'SNG'
### Table 3. NLization process of example (5) UNL sentence

| Rule Fired | Description | Action Taken |
|------------|-------------|--------------|
| `(\%x,M2):=(\%x,- M2,+FLX(AGT:=0>"ਨ"));` | This paradigm M2 has been defined to attach word "ਨ" `nun` for UNL relation 'AGT'. Here attribute 'FLX' is indicate that word has been processed for inflections. | `To: [00:01.@3.@pl]`<br>Result:`["ਨ".01.@3]`<br>Nothing is appended to root word 'ਨ' `nun` because 'AGT' was not associated with it. |
| `agt(%a,V,@reciprocal;%b,@3, @ pl):=(%b)(" ")(%a);` | It resolves the 'agt' relationship, places pronoun before verb and introduces new node of single space (" ") between two nodes. It also adds '3PS' and 'PLR' as attributes of verb, when attribute '@reciprocal' was with first and '@3', '@pl' were associated with second node '%b' in UNL sentence. | `To: agt(love:03.@present. @reciprocal, 00:01.@3.@pl)`<br>Result:`#L(00:01.@3, -:02); #L(-:02, love:03.@present.@reciprocal )`<br>Intermediate Output:`ਨ ਪੂਰਚ`<br>`uh piyar` |
It resolves attribute ‘@reciprocal’ associated with verb and removes it from the verb after resolution. It adds “ਇਕ ਦੇ ਜੇ ਨਾਰ” ik duje nun before verb.

It appends “ਕਰਦੇ ਹਨ” karde han on right of verb by resolving its ‘@present’ attribute, only if ‘INF’ (indefinite tense) and 3PS, PLR (added manually by second fired rule) are associated with the verb.

It fires the corresponding paradigm rule to inflect the root word “ਉਹ” uh.

| Rule Fired                                                                                                      | Description                                                                                           | Action Taken                                                                                      |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| (%x,M2):=(%x,-M2,+FLX(SNG:=0>“”; PLR:=0>“ਨਾਂ”));                                                                 | This paradigm M2 has been defined to attach word “ਨਾਂ” nan when attribute ‘PLR’ is associated with root word. Here attribute ‘FLX’ is indicate that word has been processed for inflections. | To: [00:01.@3]                                                                                   |
| Result:[“ਉਹ”:01.@3]                                                                                              | Nothing is appended to root word ‘ਉਹ’ uh because ‘AGT’ was not associated with it.                    | Result:[“ਉਹ”:01.@3]                                                                               |
| (%x,M3):=(%x,M3,+FLX(SNG:=0>“”; PLR:=0>“ਗਕਤਾਬ”));                                                                | This paradigm M2 has been defined to attach word “ਗਕਤਾਬ” (to the right, for denoting multiple books in Punjabi) to the root word in Punjabi only | To: [book:05]                                                                                   |
| Result: [“ਗਕਤਾਬ”:05]                                                                                             | Nothing is added because number information of the root word is ‘SNG’ initially.                      | Result: [“ਗਕਤਾਬ”:05]                                                                           |
### Table

| Rule | Description | Example | Result |
|------|-------------|---------|--------|
| pos(%a,FEM,N,@multal;%b,@3,@pl,POD):= (%b,+PLR)("ਦੀਆਂ") (%a); | It resolves the 'pos' relationship, places pronoun before object, also introduces "ਦੀਆਂ" in b/w them because first node '%a' has attributes '@multal' (multiple) and 'FEM' (female). | To: pos(book:05.@multal, 00:03.@3.@pl) | #L(00:03.@3.@pl, ਦੀਆਂ :01); #L(ਪ੍ਰਵੇਸੀ :01, book:05.@multal) |
| (N,@multal,%a):="ਸਭਤ " (%a,-@multal,-NUM, +NUM=PLR); | It resolves '@multal' (multiple) attribute by adding "ਸਭਤ " boht before the noun and updates its number information to 'PLR', i.e., plural. | To: [book:05.@multal] | #L(ਸਭਤ :02, -:04); #L(-:04, book:05) |
| ([N][D],FLX,^inflected,%x):=(!FLX,-FLX,^inflected,%x); | It fires the corresponding paradigm rule to inflect the root word "ਗਕਤਾਬ" kitab, it attaches word "ਦੀਆਂ" (to the right, for denoting multiple books in Punjabi). | To: [book:05] | Intermediate Output: ["ਗਕਤਾਬ":05] |
| ([N][D],FLX,^inflected,%x):=(!FLX,-FLX,^inflected,%x); | It fires the corresponding paradigm rule to inflect the root word "ਉਹ" uh. It attaches word "ਨਾਂ" nan to the right, in Punjabi. | To: [:"ਨਾਂ":01.@3.@pl] | Result: [:"ਨਾਂ":05] |

### 6. RESULT AND DISCUSSION

In this paper, it is described in detail that, how UNL input sentence can be converted into Punjabi natural language, for Determiners, Verbs and Pronouns phrases using dictionary words and T-rules in the EUGENE console [5]. As a whole near about 140 sentences are processed successfully with exact desired output. All other sentences which fall in these three categories can also be processed easily by same set of written rules and by appending new dictionary words to the respective dictionaries.

There is a feature available on the UNDL foundation’s website, which is F-measure [6], which rates the output of NLization (output generated using EUGENE tool) with the actual expected Punjabi natural language sentences on the scale of (0-1). We can upload both the files saved in
UTF-8 .txt format and this gives us F-measure for it. F-measure for all the processed sentences is come out to be more than 90% as depicted in Figure 3.

![F-Measure](image)

Figure 3. Combined F-measure for determiners, pronouns and verbs [7]

7. CONCLUSIONS

Many issues come while processing these UNL sentences, some changes made in the rules for the later sentences may cause the earlier sentences to get effected. Every time care should be taken while making changes to the rules for creating generalized rule sets. So writing the rules and editing them according to the grammar and sentence structure in Punjabi natural language is bit tedious task, but once the rules and dictionary gets written, we can process all other sentences which fall in these categories. EUGENE tool is very effective tool for accomplishing this task. It has very high quality because of its quality features like high availability, usability, high performance, due to these features, changes and crosschecking of sentences can be made readily.

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REFERENCES

[1] R. Martins ‘Universal Networking Language (UNL): Tools’ [online] http://www.unlweb.net/wiki/Tools. (Accessed 27 October 2012).

[2] Kumar P, Sharma R K (2012) UNL Based Machine Translation System for Punjabi Language PhD Dissertation, Thapar University, Patiala, India.

[3] R. Martins ‘Universal Networking Language (UNL): EUGENE Specifications’ [online] http://www.unlweb.net/wiki/EUGENE. (Accessed 24 November 2012).

[4] Lewis, Paul M (Eds.) (2009) Ethnologue: Languages of the World. 6th edn. SIL International, Dallas.
[5] ‘Universal Networking Language (UNL): EUGENE Tool version 1.0.1’ [Online] http://dev.undlfoundation.org/generation/index.jsp. (Accessed 24 November 2012).

[6] R. Martins ‘Universal Networking Language (UNL): F-measure’ [Online]: http://www.unlweb.net/wiki/F-measure. (Accessed 30 November 2012).

[7] ‘F-measure for Punjabi Grammar by UNDL foundation’ [Online] http://www.unlweb.net/unlarium/index.php?grammar=fmeasure. (Accessed 30 November 2012).

[8] R. Martins ‘Universal Networking Language (UNL): X-bar Theory’ [Online] http://www.unlweb.net/wiki/X-bar_theory. (Accessed 30 October 2012).

[9] R. Martins ‘Universal Networking Language (UNL): Syntactic structure’ [Online] http://www.unlweb.net/wiki/Syntactic_structures, (Accessed 30 October 2012).

[10] ‘Corpus UC-A1’ [Online] http://www.unlweb.net/wiki/UC-A1, (Accessed 29 December 2013).

[11] ‘Corpus UC-A2’ [Online] http://www.unlweb.net/wiki/UC-A2, (Accessed 10 February 2003).

[12] ‘Corpus UC-B1’ [Online] http://www.unlweb.net/wiki/UC-B1, (Accessed 10 February 2013).

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