Multilingual Automatic Translation Based on UNL: A Case Study for the Vietnamese Language

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Abstract: In the field of natural language processing, Universal Networking Language (UNL) has been used by various researchers as an inter-lingual approach to automatic machine translation. The UNL system consists of two main components, namely, EnConverter for converting text from a source language to UNL, and DeConverter for converting from UNL to a target language. Currently, many projects are researching how to apply UNL to different languages. In this paper, we introduce the tools that are UNL’s applications and discuss how to reuse them to encode a Vietnamese sentence into UNL expressions and decode UNL expressions into a Vietnamese sentence. The testing was done with about 1,000 Vietnamese sentences (a dictionary that includes 4573 entries and 3161 rules). In addition, we compare the proportion of sentences translated based on a direct method (Google Translator) and another one based on UNL.

Keywords: Universal networking language (UNL), UNL system, IAN, EnCo, EUGENE, DeCo

1. Introduction

Universal networking language (UNL), UNL system, IAN, EnCo, EUGENE, DeCo

Fig. 1. Models of n*(n-1) or 2*n translation pairs.
UNL has been developed for about 50 different languages [3]. For example, research results for Russian and English are at www.unl.ru; UNL platform tools for 48 languages are at www.undl.org/unlpf, www.unl.ru, www.undl.org/unlexp, and www.eolss.net, etc. In addition, there are a lot of tools for supporting the encoding and decoding process of languages provided by the UNDL at www.undl.org/ and at www.unlweb.net/wiki/tools.

Although UNL has been studied and widely used in the world. In Vietnam, it has not been studied and disseminated. Our team has been carrying out research into UNL since 2005 and has achieved some results, such as studying possibilities to apply UNL to Vietnamese [6], building a UNL - Vietnamese dictionary [3, 4], and testing tools available for UNL to apply them for the Vietnamese language. In this paper, we mainly focus on testing the feasibility of applying UNL Vietnamese with these tools. First, we briefly introduce UNL and the system. Second, we introduce some tools that we have developed in research projects related to UNL. The final section presents experimental tools for the Vietnamese language. We especially want to mention translating a sentence from Vietnamese into UNL, and vice versa. From the experimental results, we show the orientation of further research that can apply UNL to developing automatic translation software for Vietnamese and ethnic minority dialects in Vietnam, such as Cham, Khmer, and Co-tu.

2. UNL Language and System

2.1. Introduction

The idea behind developing a multilingual translation system to use a pivot language that can cover the whole content of any natural language. In 1996, UNL was proposed by Dr. Hiroshi Uchida at the Senior Research Institute, United Nations University, Tokyo, Japan [1]. UNL has all the corresponding components of a natural language and includes word concept expressions called universal words (UWs), which link together to generate the UNL expression of a sentence. These links are called relations, which define the role of each word in a sentence. Showing the speaker's point of view is expressed through attributes.

- **Universal Words**: Although UWs are mainly English, UWs include some words from other languages and semantic information to define the concept in the natural language. In this way, it helps to limit the inherent ambiguity of words in natural language. For example, the English word "state" will have two different words: state (icl>country) to represent the country, and state (icl>region) to denote a region of the country.

- **Relations**: There are 56 relations in UNL, which are used to connect two UWs to build a semantic network of a UNL expression. These relations are the edges of the UNL graph or binary relations, which directly generate UNL expressions. For example, in a sentence like “The boy eats potatoes in the kitchen”, there is a verb ("eats") and three arguments; two of them are instances of argumentative relations ("boy" is the agent of the verb "eats", whereas "potatoes" is the object) and one is a circumstantial relation ("kitchen" is the place where the action described in the sentence takes place).

- **Attributes**: Attributes are used to describe the subjective information of a sentence. They clarify the speaker's point of view. The attributes include information about time or aspects of the event (number, polarity, modality, etc.). There are 87 attributes to clarify the semantics of the sentence.

In addition, the UNL system also uses a knowledge base so it can provide a semantic definition of the concept and confirm the extent of the relations to avoid definite ambiguity.

For example, the sentence "John, who is the chairman of the company, has arranged a meeting at his residence" is represented by the UNL language as follows:

```
{unl}
mod(chairman(icl>post):01.0.present.0.def,comp
  any(icl>institution):02.0.def)
  aobj(chairman(icl>post):01.0.present.0.def,
    John(icl>person):00)
agt(arrange(icl>do):03.0.entry.0.present.0.comp
  lete.0.pred,John(icl>person):00)
pos(residence(icl>shelter):04,John(icl>person):00)
obj(arrange(icl>do):03.0.entry.0.present.0.comp
  lete.0.pred,meeting(icl>conference):05.0.indef)
plc(arrange(icl>do):03.0.entry.0.present.0.comp
  lete.0.pred,residence(icl>shelter):04)
{/unl}
```

UNL expressions can also be represented in the form of UNL graphs. The UNL graph of the above-mentioned sentence is given in Fig. 2.

In Fig. 2, **agt** means the agent, **obj** is an object; **plc** is a place; **aobj** is an attributed object; and **mod** is a modifier. The detailed list of such relations can be found in the reference cited above. Also, the **icl** construct helps restrict the meaning of the word to a single meaning.

![Fig. 2. Sentence expressed in terms of a graph.](image-url)
2.2. UNL System

To integrate a language into the general UNL system, each natural language builds a language server on the Internet with the functions EnConverter and DeConverter. EnConverter and DeConverter are the core pieces of software in a UNL system. EnConverter is responsible for converting documents from the source natural language (NL) into UNL and DeConverter translates the text from UNL into the target NL. UNL servers can be connected to the Internet to carry out the conversions between natural languages and UNL expressions.

Anybody with access to the Internet can have EnConverter translate text in a source language into UNL expressions. The same UNL expressions can be translated into the target language via DeConverter. For the encoding and decoding process, we have to build a set of both encoding and decoding rules, and we need a bilingual UNL–NL dictionary.

The universal parser (UP) is a specialized version of EnConverter. It generates UNL expressions from annotated sentences by referring to the UW dictionary without using grammatical features. All UNL expressions are verified by the UNL verifier and are then stored in the format of a UNL document. DeConverter converts UNL expressions into natural language sentences. Both EnConverter and DeConverter perform their functions based on a set of grammar rules and a word dictionary of the target language. Consulting the UNL ontology and/or a co-occurrence dictionary in EnConverter or DeConverter is optional.

Fig. 4 shows the structure of the UNL system and how it is connected to supporting tools and UNL-based applications. Highlighted parts are the components of the UNL system.

2.3. Support from UNL project

The UNL project has developed some tools to support adding a new language to the system. These tools are for semi-automatic language-independent analysis, but still need the support of a language specialist to resolve ambiguity. They will divide the input sentence, link correlative lexical items in the dictionary, and apply the transformation rules of grammar.

At the same time, we use UNL resources, such as UNL–NL dictionaries and UNL transformation, to process a source natural language into UNL documents, and process UNL documents into the target natural language. To use these tools, users must comply with the specified data format and format structures of grammar transformation rules. But there are still some languages that do not follow the rules, so these tools need adjusting.

3. Proposal for Vietnamese

Fig. 5 shows the mechanism how the conversion from a source text to the target text through the UNL system. We propose a system for the Vietnamese language based on the UNL system.

In this model, there is some important work to complete, such as the development dictionaries, grammatical resources, and tools for EnConverter and DeConverter.

The Vietnamese–UNL and UNL–Vietnamese dictionaries are built for use in EnConverter and DeConverter phases. They are important resources for integrating the Vietnamese language into the UNL system, and we developed them from 2010 to 2014 [3, 4].

The general syntax for the UNL–NL dictionaries is as follows:

```
{NLW}{ID} "UW" {ATTR, ... } < FIG, FRE, PRI >;
```

COMMENTS
with the following definitions.
- NLW: The lexical item of the natural language. Its format is decided by the dictionary builder. It can include:
  - ID: The unique identifier (primary-key) of the entry.
  - UW: A universal word in UNL, either simple (“book”), modified (“book.@pl”) or complex (“aoj(new,book)”). This field can be empty if a word does not need a UW.
  - ATTR: The list of features of the NLW.
  - FLG: three-character language code according to ISO 639-3.
  - FRE: The frequency of the NLW in natural texts. Used for natural language analysis. It can range from 0 (infrequent) to 255 (most frequent).
  - PRI: The priority of the NLW. Used for natural language generation. It can range from 0 to 255.
  - COMMENT: Any comment necessary to clarify the mapping between NL and UNL entries. It must end with the return code.

3.1. EnConverter

To perform the encoding process, we propose reusing an available tool called Interactive Analyzer (IAN).

IAN is software developed in the Web environment to perform encoding. Each natural language can be integrated and stored on the server. Therefore, data sources can be exploited anytime, anywhere, without being dependent on geographic distance. IAN analyzes the input with the help of T-Rules and dictionaries. IAN has eight tags: Welcome, NL Input, Dictionaries, N-Rules, T-Rules, D-Rules, IAN and Compare.

The tag “NL Input” allows users to provide documentation on the natural language. The tag “Dictionaries” allows users to provide NL–UNL dictionaries according to UNL specifications [9]. The tag “T-Rules” allows users to provide grammar conversion rules from the natural language into UNL. The tag “D-Rules” provides grammar orientation from the natural language into UNL. This tag is used as a control token and improve the results of grammar transformation. The tag “IAN” shows the encoding result prescribed by UNL. The tag “Compare” is the tag to compare the results with other results.

Besides IAN, we can use EnCo for the encoding phase. EnCo is a tool used on a single machine [10]. DeCo can deconvert UNL expressions into a native language, using Word Dictionary and Grammatical Rules. The DeCo tool works as follows. First, it transforms a UNL expression input into a directed graph with hyper-nodes called a node-net. The root node of a node-net is called the entry node and it represents the main predicate of the sentence. Second, it applies the decoding rules to nodes of the node-net and creates a word string in grammatical order of the target natural language. The decoding process ends when all the words to all the nodes are found, and a word string for the target language is completed.

4. Experiment for Vietnamese

With the help of tools like IAN and EUGENE from www.unlweb.net/wiki/Tools or www.undl.org/, along with the EnCo and DeCo tools, we can perform translation between any natural language and UNL. These include DeConverter, EnConverter, the word dictionary builder, the rules builder, and specifications or manuals of the tools.

Vietnamese is the isolating language; words in Vietnamese do not ingrain. The arrangement of words in a fixed order is the primary way to denote syntactic relationships in Vietnamese. For example, when we write: "Anh ta lái đến" it is a meaning different from "Lái đến anh ta"; or a combined word order such as "củ cải" is different from "cải củ", and "tình cảm" is different from "câm tình".

To test for Vietnamese, we are going to build UNL–Vietnamese dictionaries and a rules set to provide to the tools. We encoded Vietnamese sentences into UNL and decoded UNL expressions into Vietnamese. Output was evaluated by language specialists for two criteria: to demonstrate the semantic meaning and the grammatical structure of the sentences. Next, we directly compared the quality of translations against the Google Translate tool based on the example sentences.

4.1 EnConverter with IAN

To provide the Vietnamese–UNL transformation
grammar, we may either create a new file or upload an existing file. The transformation rules adhere to the following general formalism:

$$A := B;$$

where the left side $A$ is a condition statement, and the right side $B$ is an action to be performed over $A$.

Example:

$$\%x := (\%x)(\%y);$$

the node $\%y$ is added to the right of the node $\%x$

To encode a Vietnamese sentence “Tuấn đô” using this tool, we need to provide:

- Input: “Tuấn đô”
- After analyzing the above sentence, we have the following result from the IAN tool: [Tuấn][][đôc]
- The Vietnamese–UNL dictionary for the above sentence will be:

$$[\text{tuân}](\text{name, iof pesso}\text{r, com> male}) (\text{LEX=N, POS=PPN, SNCT}) <\text{Vie},0,0>;$$

$$[\text{đôc}](\text{read icl>see do, agt person, obj>infor}\text{mation}) (\text{LEX=V, POS=VER, att=>present}) <\text{Vie},0,0>;$$

- Use rules to encode the above sentence:

**Rule 1:** $(\%a, \text{BLK}) :=$

**Rule 2:** $(N, NT, \%a) (V, VT, att=>present, \%b) := (\text{agt}(\%a, \text{BLK}) \rightarrow \text{agt}(\%b, \text{att=>entry}; \%a));$

- Output: a UNL expression as created correspondence:

### IAN Console ###

1. Pattern: [Tuân] [] [đôc]

[S:1]

{org}

Tuân đôc

{/org}

{unl}

agt(read(icol>see do, agt person, obj>informati)n): %a.

@present.@entry, tuan(icol>name, iof person, com> male): %a1

{/unl}

[/S]

4.2. EnConverter with EnCo

With the EnCo tool, syntactic and semantic analyses are carried out by applying the enconversion rules, and the relevant operations are conducted according the rule type. Syntactic analysis is carried out by applying rules of types that are either “+”, “-”, “<” or “>”; semantic analysis is triggered by the indication of relations in the “relation.”

The enconversion rule has the following syntax:

```
<TYPE>"\%x \%y" [ACTION1] [REL2] [PRIORITY]
```

in which

- $\%x$ and $\%y$ show condition 1 and 2, which contain the lexical attributes and semantic left and right analysis windows.
- $\text{ACTION 1}$ and $\text{ACTION 2}$ show actions that are only performed if the corresponding conditions are true.
- $\text{REL1}$ and $\text{REL2}$ show possible relations between the two analysis windows.
- $\text{PRIORITY}$ describes the interpreted order of the rules.

For example:

```
{(N: null: aobj)|ADJ:+R:null};
```

This is a right modification rule. The results removed the left button of the node-list and by adding the attribute $R$ to the attributes of the right analysis window for further processing. The action field of the left analysis window contains $\text{null}$. It is not necessary to do anything in the left analysis window. The relation field of the left analysis window contains $\text{aobj}$, and the relation field of the right analysis window contains $\text{null}$. As a result, it solves the relation of $\text{aobj}$ between the left analysis window and the right analysis window.

To encode a Vietnamese sentence “Tuấn đô” using this tool, we need to provide:

- Input: “Tuấn đô”
- The Vietnamese–UNL dictionary for above sentence:

$$[\text{tuân}](\text{name, iof pesso}\text{r, com> male}) (\text{LEX=N, POS=PPN, SNCT}) <\text{Vie},0,0>;$$

$$[\text{đôc}](\text{read icl>see do, agt person, obj>infor}\text{mation}) (\text{LEX=V, POS=VER, att=>present}) <\text{Vie},0,0>;$$

- Use rules to encode the above sentence:

**Rule 1:** $(\text{mor}, \text{STAIL:mor})$

**Rule 2:** $(\text{mor}, \text{STAIL:mor})$

**Rule 3:** $(\text{mor})$

**Rule 4:** $(\text{blk:blk})$

**Rule 5:** $(\text{mor}, N, SUBJ, \text{EONP:EONP, hnp})$

**Rule 6:** $(N, PN) \rightarrow \text{BLK}$

**Rule 7:** $(\text{mor}, V, \text{EN}, \%a@present.@entry, \%a@present.@entry);$
4.3 DeConverter with EUGENE

The rules are built in the same way as for IAN. For example:

(\%x,N,\@def) := (NS(\%x,\@def,\%y,\[chiếc\],+LEX=D,+POS = ART));

Remove the attribute \@def, create new relations "NS" with two UWs "\%x" và "chiếc" where the attribute is (LEX = D, POS = ART).

To decode a UNL expression using this tool, we need to provide:
- Input:

- Output: UNL expression as created correspondence:

```plaintext
[S:1]
{org}
tuần đọc
{/org}
{unl}
[W]
:00
[/W]
{/unl}
agt(read(icl)>see>do,agt>person,obj>information):=9A.
@present.@entry,tuan(icl)>name,iof>person,com>male):03.@topic)
{/unl}
[/S]
;Time 0.0 Sec
;Done!
```

4.4. DeConverter with DeCo

The rules are built in the same way as for EnCo. For example:

"HPRON,SUBJ:subj:agt"{V,^IRG,^pred:pred}; insert object of relations "AGT" into the node list.

To decode a UNL expression using this tool, we need to provide:
- Input:

- Use rules to encode the above sentence:

```plaintext
[S:1]
{org}
I wrote
{/org}
{unl}
agt(write(icl)>communicate>do,agt>person,obj>information,ins>thing,rec>person).@entry.@past,tuan(icl)>name,iof>person,com>male)
{/unl}
[/S]
```
5. Performance Evaluation

EnCo and Deco have interfaces as well as the encoding results, which are unfriendly to users and software used on a single computer; it is difficult to share data with other users. IAN and EUGENE are built on web platforms and with a friendly interface. Special resources like dictionaries and rules can be shared with other users in the online community. However, with IAN and EUGENE, we need semantic disambiguation, and then, the system filters the candidates using the optional rules set for grammar, called D-rules.

We tested the tools with some Vietnamese sentences (for example, encoding a Vietnamese sentence into UNL, and UNL into Vietnamese) with satisfactory output for translation quality. We will continue to expand the UNL–Vietnamese dictionary and share it with the online community.

Moreover, to evaluate the translation results, we translated 1000 sentences from Vietnamese in two ways. The first was translation by Google Translate from Vietnamese to English and then from English to Vietnamese. This means that we used English as the pivot language with statistical machine translation systems.

The second was translation by a UNL system from Vietnamese to UNL through the IAN tool, and then from UNL to Vietnamese via the EUGENE tool. The rate of sentence change when comparing source and target sentences is as follows:

With the support of language experts, we will compare the results of the two systems based on two characteristics: semantics and syntax.

To support the experts in assessing the quality of the translated sentences, we developed software that displays the original sentence and its translation from the automation software, and language experts then comment on the translation quality of each sentence.

The software interface is in Fig. 6.

Table 1 shows that the rate of Vietnamese sentences changed when using UNL is lower than when using Google Translate and English as an intermediate language. This is better than natural language (for example, English).

The reason for this difference is that the use of natural
language as an intermediary language is an unbreakable barrier in the knowledge representation of a language; UNL performs with all the knowledge of the natural language without encountering problems, such as multi- semantics of a word, semantic ambiguity, grammar, and context dependence.

6. Conclusion

Through experiments, we find that conversion tools from natural language to UNL and vice versa are effective. The quality is acceptable. However, to use these tools, users must comply with the specified data format. But there still are some languages that do not follow the rules, so these tools need adjusting.

In this paper, we introduced UNL application tools for automatic Vietnamese translation. We also demonstrated how a sentence can be converted into a UNL expression, and vice versa, by taking a sentence as an example. Although we have already worked with examples, our implementation must cover all dialects of Vietnamese, but that is the start of a long journey, and we hope that we can reach that destination.

We see that the UNL system is a promising way to develop a multilingual translation system for natural language. It allows for the precise expression of any specific concept of a particular language, without ambiguities, which is understandable for computers and humans using other languages. This system allows any natural language to participate, and we only developed two encode and decode modules. We have built a large enough Vietnamese–UNL dictionary. In the future, we will install an automatic translation Vietnamese server with two functions: EnConverter and DeConverter. In the subsequent stages, we will continue to install the new server for the dialects of ethnic minorities in Vietnam, such as Chăm, Khmer, and Co-tu, in order to have a complete multilingual automatic translation system for the languages used in Vietnam.

References


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