Universal networking language: A framework for emerging NLP applications

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Universal Networking Language:A framework for emerging NLP applications

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Abstract---**Presently there has been a surge for representing information in a common language for use cases like question-answering system, machine translation, text summarization etc. UNL has been a centre of attraction for researchers in the past two decades and many have tried to harness its power. This paper throws a glimpse into the strides made by such researchers. As UNL provides a language independent platform it eases out the decision making by accessing the valuable and meaningful information, which is otherwise a challenging errand. Thus it captures information and finds its major application in Natural Language Processing (NLP) domain. The paper is written with the intent to introduce its readers to the UNL framework and explain how it is being used to solve some real world problems.**

Keywords—UNL; NLP; information retrieval; machine translation; summarization

I. INTRODUCTION

The objective of this literature survey is to understand Universal Networking Language (UNL) and its applications in the NLP context. This paper discusses about the advancements made in this field and about the currently ongoing researches. It represents natural language extracted text data in a semantic format. It aims to solve the language barrier problem during interaction with the machine. UNL not only just makes it possible to render people with a Common Language Infrastructure (CLI) meant to distribute, receive and understand multilingual information but side by side makes a way to provide the computer systems with ample amount of knowledge which is both understandable as well as accessible. UNL makes it possible for people to describe all knowledge and information that is conveyed by natural languages to computers and also enables the computers to process this information and knowledge. UNL is used to structure the narrative information by extracting the relevant information from the narrative texts by providing data for decision making and thus cater to the NLP applications .There is a lot of buzz about UNL in the recent years and much research has been done on this field. In the next few sections some light is thrown into them.

The rest of paper is organized as follows: Section 2 discusses the UNL system following which is Section 3 for UNL components and language specifications. Section 4 tells about the Tools, Methodologies and materials for UNL related activities .Then in Section 5 advancements in the process of and UNLization and NLization are presented for different languages. Section 6 discusses the applications of UNL in various NLP contexts. Conclusion and Future Scope are given in Section 7.

II. UNL SYSTEM

UNL system consists of a mechanism which shall convert a given sentence into Universal words and vice-versa. UNL system includes language resources. This is a language bundle in any natural language. To process this resource UNL has a parser and to maintain the parser it has supporting tools.

Language resources classified as Independent and dependent consist of a database of language which the parser shall refer to. Independent language resources are common to all languages like knowledge about concepts. UNL maintains a common repository for all languages: UNL Ontology (UNLKB). Dependent parts are different for each language like word dictionary. UNL maintains a separate repository in each Language server. These are used by the parser module of the UNL which consists of the EnConversion and DeConversion currently referred to as UNLization and NLization. UNLization converts any natural language to the UNL while NLization converts UNL to corresponding natural language. Both use a set of grammar rules.

III. UNL COMPONENTS/LANGUAGE

This section shall discuss the various components that make up a UNL module. UNL broadly consists of below sub components:

A. Universal Expressions

UE can be considered to be a graph with Universal words forming the nodes. In this graph also known as semantic graph or hypergraph, UNL expresses knowledge. The edges of this graph form the relation between the concepts.

B. Universal words

Universal words are the basic units of the UNL vocabulary. They can be thought of as words in any normal language. They are the nodes of the universal expression. They, in combination with attributes and relation represent the words. A UW of UNL is defined in format given by (1).

$$<uw>=<headword>[<constraintlist>] \qquad (1)$$

The headword in the UW can be an English expression, word, phase, compound word, or it can even be a sentence in English. In case the meaning of a headword given comes out to be unique, the headword itself will become UW. If a UW consists of a headword only, it is named as the Basic UW. In the sentence given by (2) the UW will be: Dogs (icl>animal).

$$\text{Dogs are loyal.} \qquad (2)$$

C. Relations

A UW is linked with other UW by a relation to make a UNL expression. Relations can be circumstantial pertaining to time, purpose, place or can even be in the argumentative form pointing to the object, agent or the goal. They along with the UW make the semantic network in the UNL. They are the edges of the hypergraph or UNL expression. For example, in the English sentence given by (3) there are two UW's boy (icl>person)@singular) and car(icl>object) @singular) and drives is the relation which connects these two UW.

$$\text{Boy drives car.} \qquad (3)$$

D. Attributes

Attributes describe the subjectivity of sentences. Subjectivity can be with respect to parameters like time, emphasis, focus, attitude, feeling etc. They are attached with the UW. For instance in sentence "I can drive a car", reference to ability is made, so one of the attributes shall be @ability. Semantic hyper graph for an English sentence is illustrated in Fig. 1.
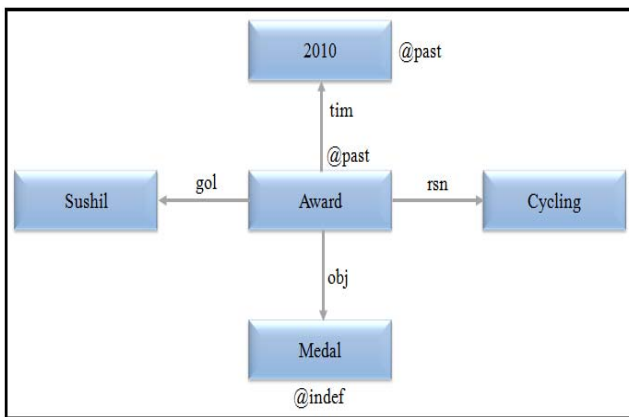

Fig 1 .Semantic hypergraph for "Sushil was awarded a medal for cycling in 2010."

IV. Tools And Resources For Unl

A lot of manuals, books, papers, slides and examples can be accessed from the official website of UNL: http://www.undl.org. Apart from these UNL Data in chronological order can be obtained in the form of UNL Documents. These constitute various UNL converted from natural language catering to topics like Biographies, Wikipedia Articles, UNESCO Documents etc. These can be used for various research related activities. Next discussed are the tools built for the UNL system.

A. IAN

An acronym for Interactive Analyzer is basically an UNLization tool which takes natural language as input and delivers the language independent module UNL form corresponding to it. In the system provided here the syntactic processing is done automatically through the grammar provided for the specific natural language, but ambiguities related to syntax are signalled to the user, who may backtrack and choose different syntactic paths for the conversion. So here the human interaction is optional but can always be used in case improvement in the results is desired.

B. EUGENE

It's basically the tool used for natural language generation. It is a fully automatic tool that takes UNL as the input and outputs the natural language that is desired without any human intervention. Here dictionary and the grammar rules are supplied corresponding to the desired natural language in form of separate interpretable files.

C. UNL Editor

UNL Editor is an authoring tool which provides the graphical interface to allow the users to manipulate high-level graphs instead of traditional low-level UNL statements. However language specialists are required to upload the texts which are meant to be analyzed, thereby selecting the corresponding UWs (i.e., the nodes in the graph); creating semantic relations between nodes; and assigning attributes to nodes .This whole process leads to production of results which help in the decision making process.

D. UNL web

It is a web portal that is created and maintained by the UNDL foundation to facilitate the research carried in the field of UNL development and reduces the language barriers that come in the way. Being a property of United Nations it serves as an asset to mankind to bring together all developers and researchers onto one integrated platform.

It consists of five basic systems that help in this process:

- The UNL^{arium}, which provides development environment to create and edit language resources.
- The UNL^{dev} which is meant to facilitate the applications and computer programs related to UNL framework.

- The UNL^{wiki} providing the necessary documentation and instructions for carrying out UNL related activities.
- The UNL^{forum}, a social portal to discuss the issues relating to UNL framework and spread the information.
- VALERIE, a virtual learning environment for the purpose of teaching and training the UNL developers and researchers.

V. UNLIZATION AND NLIZATION

UNLization is to convert from any native language to UNL while NLization means to convert a UNL expression to a native language. Primarily researches have used three approaches to achieve UNLization and NLization.
- Creating new architecture from scratch.
- UNLization and NLization tools given by the UNL
- Integrating UNL into pre-existing Machine Translations.

Table 1 presents the development of UNLization and NLization modules for various languages.

Table 1. Development of UNLization and NLization systems

Language	System	Developers(year)
Brazilian – Portuguese	EnConverter and DeConverter	Martins *et al.* (1997)[29], Martins *et al.* (2002)[30]
French	EnConverter and DeConverter	Serasset and Boitet (2000)[31], Blanc (2005)[5]
Hindi	EnConverter and DeConverter	Bhattacharya (2001), Dave *et al.* 2001)[32,33]
Tamil	DeConverter	Dhanabalan and Geetha (2003)[34]
Chinese	DeConverter	Shi and Chen (2005)[35]
Arabic	DeConverter	Daoud (2005), Adly and Alansary (2009)[36]
Nepali	DeConverter	Keshari and Bista (2005)[37]
Bangla	EnConverter	Choudhury *et al.* (2005)[38] Mridha *et al.* (2010)[39]
English	EnConverter and DeConverter	Jain and Damani (2009)[40]
Punjabi	EnConverter and DeConverter	Kumar and Sharma(2012)[9]
Persian	DeConverter	Ariana and Rashidi(2015)[12]
Bengali	EnConverter and DeConverter	Dey and Bhattacharyya (2005)[2]
Tamil	EnConvertor	Dhanabalan *et al.* (2002)

VI. APPLICATIONS OF UNL IN NLP DOMAIN

Researchers widely exploited the applications of UNL in various contexts of Natural Language Processing (NLP) such as knowledge management, knowledge representation, language independent Universal Digital Library, multilingual search engine etc. The coming section presents the works of various researchers in this direction.

A. Machine Translation

Mohanty *et al.* (2005) used the concept of semantically relatable sequence (SRS) to develop a MT system based on UNL. After analysing the the source language using semantic graphs, they used this format in generation of the target language text [1]. Dey and Bhattacharyya (2005) depicted the computational based analysis of the various complex case structures of Bengali for the Machine translation system that is based on UNL .It gave the details on the rule theory platform for the *'EnCo'* meaning enconversion and the *'DeCo'* meaning deconversion tools , driven by the generation rules and analysis rules based on the case structure of '*kaaraks'* respectively for Bengali language respectively for Bengali language[2]. Alansary and Nagi developed a Language-to-Interlanguage-to-Language System called LILY. Focusing on the Arabic linguistic resources they have evaluated a manually semantically annotated corpus and achieved an accuracy of 98 % [3]. Mohanty *et al.* (2005) have analysed the problem based upon the prepositional attachment of phrases in respect to the context of Machine translation systems for the specific English language. Performing the linguistic analysis for the six common prepositions in the English language mainly the *'on', 'in', 'to'* *'for', 'from',* and *'with'*, they used these insights for enriching the lexicon and the rule base fundamentals, for the *'EnCo'*(enconversion) tool [4].

Besides the previous works Blanc (2005) have also performed integration of the *'Ariane-G5'* ,alongside proposing the French based EnConversion and DeConversion modules. The *'Ariane-G5'* is basically used for the generation of the Machine Translation systems in the NLP context. Here in their given system, they proposed that the EnConversion will take place in primarily two steps where the first step will be to analyze the given input French text and produce corresponding depiction of its meaning which is in the form of a specific dependency tree and the second step will be to transfer lexical and structural format to the UNL graph. The process of DeConversion will similarly take place in the following two basic steps. The very first step being the transferring of the structural and the lexical form from the respective UNL graph to an accurately equivalent tree that depicts dependency and second step will be generating the French output sentence [5]. Next prominent work is the Arabic MT System that was UNL central and after developing and successfully testing it grammar was generated .This grammar has been made specifically for the tools for Machine Translation systems by Adly and Alansary (2009) [6]. Tomokiyo and Chollet (2003) have side by side proposed a new voice based UNL framework meant to represent speech control mechanisms. Their proposed system while development supported the speech to speech based machine translation. Thus the given UNL format has been designed to support texts that are written while the exploring the possible ranges to extend the attributes of UNL tags for suiting the SSMT

based processing [7]. Ali *et al* (2010) presented an annotated editor for Bangla texts which will be used for the enconversion process from Bangla sentence to UNL expression [8]. They extended their work in 2011 to develop the Bangla word dictionary and set of morphological and semantic rules.

Kumar and Sharma (2012) proposed a seven step approach to convert the source sentences in Punjabi to the UNL alongside generating attributes and universal relations as well. They designed a system for Punjabi deconvertor describing the five processes namely UNL parser, next is the lexeme selection, followed by morphology generation, function word insertion, and finally the syntactic linearization. Testing the proposed system on nearly 1000 UNL expressions they were able to achieve a bilingual evaluation understudy (BLEU) score of nearly 0.72[9]. Agarwal and Kumar (2013) proposed a system to UNL-ize the numbers till fourteen digits and ordinals written in words in Punjabi language using enconvertor called IAN and tested on sample of nearly 150 random Ordinals and Numbers achieving F-Measure of 1 on a scale of 0 to 1 [10]. Verma and Kumar (2013) presented their work to Nlize various parts of speech as Nouns, Prepostions and Pronouns in Punjabi with the help of deconvertor called EUGENE [11].

Ariana and Rashidi(2015) designed a system to convert UNL to Persian language. They have also created a special type of Persian-UNL dictionary of words that provides grammatical rules and finally suggests a routine for converting UNL sentences into their Persian equivalent form of the language independent Universal Digital Library and the multilingual based search engine [12].

B. Language Independent question answering system & Search Engine

Question answering system forms the basics of virtual assistant like SIRI. UNL opens a new door of opportunity where we do not need to maintain a corpus of every locale.

Karande (2007) has suggested a multilingual feature supporting search engine that is developed using UNL. The Proposed system required the EnConverter scheme for the conversion of the contents of one source language text to the corresponding UNL [13]. Surve *et al.* (2004) later proposed a meaning based search engine that supports interlinguism named *'Agro-Explorer'* that was specifically designed to serve the agricultural domain. It would primarily cover three basic languages Hindi, Marathi and English. It would involve the use of enconversion for converting the input english query to the UNL[14]. Ramamritham *et al.* (2006) have then further given an improvised version of *'Agro-Explorer'* to develop a new tool called *'aAQUA'* that is available online and supports multilinguism. It is a multimedia based agricultural portal meant to disseminate the information from and to the rural sections. The *'aAQUA'* has made use of information retrieval based techniques like offline access, Intelligent caching, with the provison novel database systems [15]. Cardeñosa, Gallardo and Villa (2009) deviated from the traditional Cross-lingual Information Retrieval and used cross-lingual information extraction. They proposed an UNL system backed by a language-independent UNL coded document set achieving an accuracy of nearly 82.6 % [16]. Mukerjee, Raina, Kumar, Goyal and Shukla(2005) harnessed UNL for the similar application by

using a content-level HPSG lexicon tagged with the appropriate UNL relations. They used a structure matching approach to search for the answer to a question [17]. Shukla *et al.* (2004) have proposed the two big tasks in context of implementing the proposed system on Question Answering. First being the processing of document that involves the conversion of the source data document into equivalent UNL expression followed by the crucial task of query processing and finally leading to extracting the answer from the UNL coded document [18].

C. Text Summarization

Martins and Rino (2001) gave a heuristic based method for pruning of sentences for text summarization giving special emphasis on the UNL binary relations. By identifying the non-essential segments and finding the relations in the given UNL texts they extracted the most useful sentences from it. The corpora used were composed of bureaucratic texts encoded by diverse UNL teams, and the THESES Corpus, achieving compression rates of 44.58% and 40. On similar lines 9% respectively [19]. Mangairkarasi and Gunasundari (2012) proposed a graph based approach using the Multi-List to compress a source document by extracting the important information from it leaving out the irrelevant information. The algorithm calculates the weight age of links connected to the Universal Word and then according to the highest weight age the document is summarized [20]. Lakshmana and Kalpana (2013) performed UNL based summarization for tourism domain by executing a level wise word count summarization where levels were designed based upon the IQ score [21]. Sherry and Bhatia (2015) also proposed a system that took the source document in English thereby converting it to summarized form of Punjabi document using IAN and EUGENE as conversion tools [22].

D. Semantic Textual Similarity

Iyer and Bhattacharyya (2005) have stated the application of semantic based information for improving the case retrieval in the scenarios where case based reasoning is involved It is done by giving UNL system for improving the retrieval precision after taking into consideration the available semantic information in words that are present in the problem sentence. By making use of the concept of WordNet in finding the semantic similarity between two concepts they have built this system [23] . Singh *et al.* (2012) have given a graph matching strategy using UNL for finding the Semantic Textual Similarity(STS) between the given sentences . After representing the sentences in the graphical notation their semantic content is compared .Then they calculate the recall and precision of total relations that have already matched. They concluded that the matching of the semantic based relations has greater weight than involved in the attribute matching [24].

E. Text Clustering using Semantics

Performing the text based clustering Choudhary and Bhattacharyya (2002) used the UNL representation to generate the feature vectors. Thereafter the clustering method was made into use while proposing the system that is Self-Organizing Maps (SOMs) based. They have thus concluded that UNL method in context of feature vector based generation has outperformed the methods that used the frequency as deciding parameter [25].

F. Semantic Textual Entailment Recognition

Pakray *et al.*(2011) have developed a system for textual entailment that is UNL based to compare the UNL relations in two categories namely the hypothesis and the text that has used the RTE-3 test annotated set for the purpose of developing the set that included 800 hypothesis-text paired matches. Next after implementing the matching module on the UNL relations that were identified in each of the text and hypothesis alongside, they assigned score for each of the successful match .Finally achieved an accuracy of roughly 60.3% in their system [26].

G. Relation Extraction

Nguyen and Ishizuka (2006) presented a way that focussed in solving the problem of extracting the semantic relation from UNL coded version of sentences in the desired English sentences. They have developed UNL relation classifier after using the statistical method based techniques .These were applied on the syntactic features and the several lexical cross path features reflecting the independency on the words where actual semantic relation of two phrases was involved. This approach later shown to be far better than the existing dependency path features and the normal path. Finally they evaluated the UNL supplied dataset obtaining an accuracy of nearly 79%[27].

H. Sentiment Analysis of Natural Text

Rani and Kumar (2014) proposed a method to perform sentiment analysis using UNL. Suggesting that entity identification can be an easy task using UNL UW's and relations it can be further used to extract sentiment using the attribute information[28].

VII. CONCLUSION AND FUTURE SCOPE

UNL has opened a new world of possibilities in information processing. A redundancy always existed in NLP applications like MT where there was a need to handle different languages separately, but clearly UNL eliminates this redundancy. Through the paper readers are aware of the multitudes of NLP applications that UNL handles, its amazing power and also the way that it has been harnessed till now to retrieve valuable and meaningful information. Lots of tools which have been developed can be further explored by researchers to integrate UNL with Artificial intelligence systems to build real world market applications like virtual assistant, SIRI, Cortana, Google Now etc.

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