Abstract

The paper reports on efforts taken to create lexical resources pertaining to Indian languages, using the collaborative model. The lexical resources being developed are: (1) transfer lexicon and grammar from English to several Indian languages, and (2) dependency tree bank of annotated corpora for several Indian languages. The dependency trees are based on the Paninian model. (3) is an attempt to build a bilingual dictionary of 'core meanings'.

1. Introduction

Non-availability of lexical resources in the electronic form is a major bottleneck for anyone working in the field of NLP in Indian languages. It was decided to take some measures which would remove this bottleneck in a quick and efficient way.

As a first step in this direction a collaborative effort was undertaken to develop a bilingual electronic dictionary in the open source model. The interesting aspect of this effort was that the work was carried out by school children, teachers and others. People in about 8 cities were involved in the exercise. The school teachers participated, to some extent, in correcting and refining the work.

The development of the dictionary resource took advantage of the bilingual ability of the contributors. The contributors provided the basic data:

a) A number of Hindi equivalents required to cover various senses of the English lexical item in various contexts.

b) An English example sentence for every Hindi equivalent.

(The developed resource is now available as an "open resource" under General Public License. (http://www.gnu.org/licenses/licenses.html)

It might appear difficult to create a major resource like a dictionary in this way, with a diverse set of people working on it. Admittedly there are variations in quality at present. But the coverage is already quite exhaustive. A number of factors made it possible:

1. The contributors were advised to consult various mono- and bi-lingual dictionaries. Many contributors including students working in a classroom setting with a local teacher, consulted monolingual advanced learner's dictionaries for English. (However, they did not copy the entries, instead they supplied Hindi equivalents for the available detailed differentiation of English senses, wherever the Hindi equivalents were different, or represented different meanings in their judgement.)
2. The initial information that was to be incorporated in the dictionary was kept to the minimum so that anyone who is sufficiently bilingual could participate in the activity. This is why even school children could contribute to the effort.

3. Some amount of editing was carried out by a small central team. (However, in future we would like this also to be carried out in a distributed way, perhaps out of a few tens or hundreds of better trained people, such as teachers. Only the final output would be corrected by the smaller centralized team.)

Modern technology permits the incremental improvement and enhancement of the basic resource over a period of time. That was a basic consideration in embarking on such an exercise. The result of this effort has led to the rapid creation of the present dictionary (Shabdaanjali: English-Hindi e-Dictionary, Ver. 0.2) which is available as an open resource. The dictionary consists of more than 25000 head words, with fairly detailed differentiation of senses.

Here is an example entry from Shabdaanjali which gives the senses as well as example sentences illustrating the senses:

```
"go","V",
--"1.jAnA"
I go to school.
--"2.rakhA~jAnA"
These clothes go into that suitcase.
--"3.samAnA[jAnA]"
This key will not go in that lock.
--"4.calanA"
How did the meeting go?
--"5.ho~jAnA[sthiti]"
Have you gone mad?
--"6.aAvAjZa~honA/karanA"
The bell has gone for this period.
--"7.nikala~jAnA"
The P.M. has already gone.
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Notice the level of details in sense differentiation. Once the task (Task 0) of building a basic dictionary was over, it was decided to go ahead and build some more specific resources based on LRNLP 2001.

2. Tasks on hand

The next level of work, based on the above resource is being carried out by several sites. Some of the work is voluntary, and some are using locally available financial resources to pay for the work. There are three tasks being carried out.

2.1. Task 1: TransLexGram (Transfer Lexicon and Grammar)

The first task being attempted, based on the Shabdaanjali is to produce transfer lexicon and grammar from English to Hindi.

The task at this level has two components:
- Providing translation of the English sentences into Hindi.
- Creating a parallel grammar from English to Hindi.

For example, the developer is provided with the entry for word 'go' from Shabdanjali in a machine readable format (only part of the entry is given below for illustration). He then fills in the above two components of information. At the end the entry has the following additional information -

HEADWORD::"go","V"
The contributors were requested to follow the following scheme while translating –

a) To give natural translations in their respective language. This was to be entered in the field TR_NAT.

b) In case an alternative translation having English influence was possible, it was also to be entered in the field TR_ENG_INFLNCE.

b) The option of giving more than one translation of the same sentence was also given. These can be entered by repeating TR_NAT field.

d) Contributors for languages other than Hindi were asked to also give the equivalent expression in their language against field MEANING_OTH. (If the language is Hindi, then do not need to do this step because it has already been done and shown against MEANING_H.

The second component called for the verb frames to be in a standard format for all verbs, so that these can be semi-automatically processed. The contributors were, therefore, provided with a guideline which clearly stated that irrespective of the mood and tense of the example sentence, the frames should be in simple present tense (habitual present tense) only.

(An expansion of the field names is attached as Appendix-1)

The development of Transfer Lexicon and Grammar is being done from English to several Indian languages. All of them are using the dictionary Shabdaanjali as a starting point.

There are six languages for which this work is being carried out. The languages are, apart from Hindi, Tamil and Telugu from southern India, Marathi and Gujarati from the western region and Oriya from the east.

As indicated above, we try to define verb frames for English and the corresponding post-position for each Indian language. Linguists are the preferred people for doing this task, but the transfer grammar is kept so natural that a person without linguistic training but with language sensitivity can also contribute to it. A short period of training or self-learning is needed. Though this grammar is expected to be used by the machine directly the framework has been kept rather simple.

The effort for Transfer Lexicon and Grammar will serve several purposes;

(a) It will generate bilingual dictionaries with detailed differentiation of senses, one for each of the Indian Languages above. Such online bilingual dictionaries are usable by human beings, as well as can be the stepping
stones for a machine translation dictionaries. (In fact, Shabdaanjali: English-Hindi dictionary in its present form without any change is being used by the experimental anusaaraka machine translation system.)

(b) The example sentences are an important aid in future development and refinement of the dictionary. Our experience shows that without the example sentences, lexicographers find it very hard to understand and refine senses in a given dictionary.

(c) It will generate corpora of parallel sentences in English and several Indian languages. Each parallel corpus will consist of sentences that are examples which differentiate among the various senses of a word. In this sense, it is a special contrastive set, which will be of special value and might also be used for developing systems across Indian languages. Such a parallel corpus along with machine learning techniques can be used to produce an example based machine translation system.

(d) The transfer patterns given in Frame-E and Frame-I have been kept simple so that even ordinary bilingual speakers can provide the information. However, these can be directly used by a machine translation system. (In fact, a member of experiments have already started using the above.)

The interesting part is that the work is being done by a loosely knit set of sites, institutes, and individuals. Technical coordination is done by a set of senior researchers.

2.2. Task 2: AnnCorra: Annotated corpus for each Indian language

The second task pertains to building a “tree-bank” or tagged corpus, in which the tags indicate the sentential analysis. The purpose behind this effort is to fill the lacuna in such resources for Indian languages. It will be an important resource for the development of Indian language parsers, machine learning of grammars, lakshans charts (discrimination nets for sense disambiguation) and a host of other tools.

Dependency analysis using the Paninian theory, is being used to mark the sentential analysis for sentences in each language (Bharati et al, 1995). The Paninian grammatical model has been chosen here for sentence analysis, and hence for the tags as well. Preference for this model is based on the following factors -

1) Being based on analysis of an Indian language it can deal better with the type of constructions Indian languages have. It is therefore more appropriate for Indian language analysis.

2) The model not only offers a mechanism for SYNTACTIC analysis but also incorporates SEMANTIC information (nowadays called dependency analysis). This makes the relationships more transparent.

For example -
- rAma ne phala kATakara pAnI piyA.
- Ram -ne fruit having-cut water drank
- (Having cut fruit, Ram drank water.)

The Analysis tree for the above sentence is:

```
pI[yA] (drink[past])
 /           |
| k1          | k2                | kr
|               |                     |
rAma[ne]      pAnI[0]     kATa[kara] (cut[having])
(Ram)         (water)       |
                 | k1               | k2
                 | rAma     phala (fruit)
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Where k1 is karta karaka, k2 is karma karaka from the Paninian theory (Bharati et. al, 1995, chap 5).

The Linear notation for the above tree is:
This linear notation is powerful enough to represent arbitrary dependency trees. Several defaults are used to reduce typing. The word group (e.g., 'rAma_ne') marked by the kArakas (e.g., k1, karta karaka) attaches or is dependent on the rightmost verb (e.g., pI). Maintaining the defaults the above sentence would thus be marked as:

- rAma_ne/k1->i phala/k2->j kATakara/kr:j->i
- Ram_erg. fruit having-cut
- pAnI/k2->i piyA::v:i
- water drank

This work is of a higher level and is planned to be done in a collaborative model by Sanskritists and other linguists trained in Paninian analysis. It is expected to draw people trained in the traditional Sanskrit shastras, particularly vyakarana shastra.

For maintaining the consistency, the same TAGSETS are provided to all the contributors. Also, most of the annotators come from a strong tradition of grammar, namely Sanskrit vyakarana.

### 2.3. Task 3: Shabda-Sutra - Bilingual dictionary of core meaning

The third task involves semantic analysis of words across languages. Polysemy is a major problem that one has to deal with while building bilingual lexical resources for the machine use. The concept of 'Sabdasutra' is an attempt to capture the underlying thread which relates various meanings in a polysymous word.

The term 'sutra' in 'Sabdasutra' is used at two levels.

**A.** One sense of the term 'Sabdasutra' is 'a formula' which encodes the basic semantic concept of a word and how it gets extended to varying usages. For example the 'Sabdasutra' for the English word 'issue' is 'viSaya[~~<niSpAdana] 'topic[~~<to come into existence]''.

(The gloss here is a rough approximation)

The notational symbol '<' implies 'is derived from' and the symbol '~' means that the sense has taken several turns in its evolution. Thus the above notation says that the meaning of 'issue' is 'topic' which has arisen from 'to-come-into-existence'after taking many turns in its evolution.

This 'sutra' is a formula which expresses that 'niSpAdana' appears to be the basic sense or the 'core' meaning of the english word 'issue'. From this 'core sense' various other meanings have evolved.

**B.** The second sense in which the term is used is that of an 'underlying thread' which connects all the meanings to which a particular word gets extended. To continue the example of 'issue' above, The formula given above has the following underlying thread :

niSpAdana(astiwa meM lAnA/AnA) --> niSpatti kA srota --> niSpatti (santAna, sansakaraNa etc)

'bring into existence --> point of origin --> the thing that comes into existence (child, edition etc).

The relation between various senses of the word 'issue' can be seen through this 'sutra' with the help of following examples from english

niSpAdana ................niSpatti kA srota
issue orders............. point of issue of a river .. niSpatti
has no issue after marriage, latest issue is out,
The way the 'underlying thread' is compressed into a 'sutra(formula)' notationally can vary depending on the complexity of the sense it is encoding.

Following are the steps in this task:

- Begin with a bilingual dictionary of English to Indian Languages  
  * Containing different senses, and  
  * Example sentences for each sense
- Identify commonality of meanings for a word
- Come up with core meaning or word-thread or sabda-sutra

This is an intricate task, and has been completed by a group of dedicated researchers for 5000 words.

For all the above tasks, a basic list of 5000 words based on high frequency is being used. The initial target is to complete 5000 high frequency words for all the Indian languages. In case some group wants to go further and work for a larger dictionary they can cover the whole dictionary (with about 25000 headwords) (http://www.gnu.org/licences/licences.html)

The target is to complete the first phase work (5000 words) in several Indian languages by the end of November, 2001.

3. Principle for Selection of Tasks

The principle used in selecting the above tasks is that: LRs must be directly useful for at least one target application.

- The application provides focus and prioritizes tasks.
- Restricts scope of difficult problems. Instead of general solution, special solutions or walk-arounds are alright.
- Allows common decisions among teams. Acts as a yardstick to decide among alternatives.

3.1 Target Applications

The target applications which were selected were:

- Machine translation or language access  
  - Among Indian languages  
  - From English to Indian languages
- Multilingual information retrieval

The tasks described earlier have been chosen, clearly with the above applications in mind.

4. Policy for Distribution

The resources so developed would be available to people at no cost or low cost. These are like infrastructure, which everyone uses, but finds it difficult to pay for.

Most importantly, the above resources would be “open source” under GNU GPL (General Public License). This is to allow others to work on the resource, modify or refine it, and then redistribute it.
5. Conclusions

This paper reports some efforts which have created and are creating lexical resources pertaining to Indian languages, using the voluntary collaborative model. One of the novel efforts utilized work by several hundred school children spread over several cities, to yield a detailed bilingual dictionary, which is now not only available for consultation by the general public, but is also being used as a stepping stone for building several other kinds of lexical resources namely, Transfer lexicon and Grammar and Annotation of Corpora. These resources are being developed with machine translation and information retrieval in mind. The lexical resources so produced will be distributed as "open" or "free" resources under GPL.

6. Acknowledgement

The frameworks for TransLexGram and AnnCorra in the result of discussions with several people such as: Prof. Aravind K Joshi, Dr. B.Srinivas, Dr.K.V.Rama Krishnamacharyulu, Dr. Thakur Dass, Dr. V.P. Jain, among others.

Note:
A slightly modified version of this report has been submitted to the Workshop on Language Resources in Asia at the 6th Natural Language Processing Pacific Rim Symposium (NLPRS 2001), Tokyo.

References


6. LRNLNP-2001: Recommendation of Workshop on Lexical Resources for Natural Language Processing for Indian Languages, Hyderabad, Jan 2001. (lr_egroup@iiit.net)

Appendices

1. 'FIELD NAMES' Provided in Task 1 (TransLexGram):

HEADWORD - The lexical item for which the entry is being made
MEANING - Indian language equivalent for the Headword.
ENG_EXP - Example sentence in English
TR_NAT - Natural translation
TR_ENG-INFLNC - Translation having english influence
FRAME_E - Frame for the English sentence
FRAME_I - Frame for the Indian language translation
ERR - Error (this column is for human use)
COMNT - Comment (this column is for human use)
2. TAGSETS

The tagsets used here have been divided into two categories –

1) TAGSET-1 - Tags which express relationships are marked by a preceding '/' .
   For example kArakas are grammatical relationships, thus they are marked '/k1', '/k2', '/k3' etc.

2) TAGSET-2 - Tags expressing type of node are marked by a preceding '::' Verbs etc. are nodes, so they will be marked '::v'.

Some example tags -

TAGSET-1 (Expressing relationship labels) Marked '/'

s       : Sentence
  Example - [rAma ne khIra khAyI]<s>
            [rAma postp milk-rice ate_fem]
k1    : kartA u
  Example - [rAma_ne/k1 khIra khAyI]<s>
k2    : karma
  Example - [rAma_ne khIra/k2 khAyI]<s>
k3    : karaNa
  Example - [rAma_ne cammaca_se/k3
            [rAma_postp spoon_with/k3
              khIra khAyI]<s>
            milk-rice ate_f]

TAGSET-2 (for nodes) Marked '::'

v       : Verb
Kr      : Gerund
vH      : Ver-BE
  Example - rAma adhyApaka HE
yo     : Conjunct

The total number of tags is around 35. Since the task is going on, this may be revised, in case it is needed.