Abstract

Cross lingual information access (CLIA) systems are required to access the large amounts of multilingual content generated on the world wide web in the form of blogs, news articles and documents. In this paper, we discuss our approach to query formation for CLIA systems where language resources are replaced by Wikipedia. We claim that Wikipedia, with its rich multilingual content and structure, forms an ideal platform to build a CLIA system. Our approach is particularly useful for under-resourced languages, as all the languages don't have the resources(tools) with sufficient accuracies. We propose a context aware language-independent query formation method which, with the help of bilingual dictionaries, forms queries in the target language. Results are encouraging with a precision of 69.75% and thus endorse our claim on using Wikipedia for building CLIA systems.

1 INTRODUCTION

Cross lingual information access (CLIA) systems enable users to access the rich multilingual content that is created on the web daily. Such systems are vital to bridge the gap between information available and languages known to the user. Considerable amount of research has been done on building such systems but most of them rely heavily on the language resources and tools developed. With a constant increase in the number of languages around the world with their content on the web, CLIA systems are in need. Language independent approach is particularly useful for languages that fall into the category of under-resourced (African, few Asian languages), that doesn’t have sufficient resources. In our approach towards language-independent CLIA system, we have developed context aware query translation using Wikipedia. Due to voluntary contribution of millions of users, Wikipedia gathers very significant amount of updated knowledge and provides a structured way to access it.

Figure 1: Number of Wikipedia pages (Y-axis) with and without Inter language link (ILL) to English in each language (X-axis)

The statistics in the Figure 1 show that it has rich multilingual content and is growing independent of the presence of English counter part. With its structurally rich content, it provides an ideal platform to perform cross lingual research. We harness Wikipedia and its structure to replace the language specific resources required for CLIA.

Our work is different from existing approaches in
terms of

• No language resource has been used at any
  stage of query translation.

• Wikipedia structure has been fully utilized for
  achieving CLIA between English and Hindi,
  unlike the existing approaches, especially for
  query formation.

We have constructed a bilingual dictionary using
  cross lingual links present across the articles of
  same topic in different languages. As each word in
  the dictionary can have several translations based on
  various attributes like context, sense etc, we need
  a mechanism to identify the target word accurately
  based on the context of the query. To identify
  the context of a query, “Content Words”, that are
  built for each Wikipedia article, are used. “Content
  Words” of the article are similar to the tags of the
  article, that reflects the context of the article in a more
detailed way.

In this paper, we detail our approach in forming
  this “Content Words” and using them to form the
query. Since our approach is language-independent
  and context-aware, we used a metric proposed
  by (Bharadwaj and Varma, 2011) to evaluate along
  with a dictionary-based metric. The system is built
  between languages English and Hindi. Hindi is se-
lected as target language because of the availabil-
ity of resources for evaluation. As our approach
is language-independent, it can be used to trans-
late queries between any pair of languages present
in Wikipedia. The remainder of paper is organized
as follows. Section 2 shows the related work. Pro-
posed method is discussed in Section 3. Results and
Discussion are in Section 4. We finally conclude in
Section 5.

2 RELATED WORK

We discuss the related work of the two stages are in-
volved in our system of language-independent con-
text aware query translation,

• Resource building/ collection (Dictionaries in
  our case)

• Query formation

Dictionary building can be broadly classified into
two approaches, manual and automatic. At initial
stages, various projects like (Breen, 2004) try to
build dictionaries manually, taking lot of time and
effort. Though manual approaches perform well,
they lag behind when recent vocabulary is consid-
ered. To reduce the effort involved, automatic ex-
traction of dictionaries has been envisioned. The
approach followed by (Kay and Roscheisen, 1999)
and (Brown et al., 1990) were towards statistical ma-
chine translation, that can also be applied to dic-
tionary building. The major requirement for us-
ing statistical methods is the availability of bilin-
gual parallel corpora, that again is limited for under-
resourced languages. Factors like sentence struc-
ture, grammatical differences, availability of lan-
guage resources and the amount of parallel corpus
available further hamper the recall and coverage of
the dictionaries extracted.

After parallel corpora, attempts have been made
to construct bilingual dictionaries using various
types of corpora like comparable corpus (Sadat
et al., 2003) and noisy parallel corpus (Fung and
McKown, 1997). Though there exist various ap-
proaches, most of them make use of the language
resources. Wikipedia has also been used to mine
dictionaries. (Tyers and Pienaar, 2008), (Erdmann
et al., 2008), (Erdmann et al., 2009) have built bilin-
gual dictionaries using Wikipedia and language re-
sources. We have mined our dictionaries similarly
considering the cross lingual links present. Our ap-
proach to dictionary building is detailed in section 3.

Wikipedia has been used for CLIA at various
stages including query formation. Most recently,
Wikipedia structure has been exploited in (Gaillard
et al., 2010) for query translation and disambigua-
tion. In (Schönhofen et al., 2008), Wikipedia has
been exploited at all the stages of building a CLIA
system. We tread the same path of (Schönhofen
et al., 2008) in harnessing Wikipedia for dictionary
building and query formation. Similar to them we
extract concept words for each Wikipedia article and
use them to disambiguate and form the query.

For evaluation purposes, we adapted evaluation
measures based on Wikipedia and existing dictio-
naries (Bharadwaj and Varma, 2011). The authors
have proposed a classification based technique, us-
ing Wikipedia article and the inter-language links
present between them to classify the sentences as parallel or non-parallel based on the context of the sentences rather than at the syntactic level. We adopt a similar classification based technique and build feature vectors for classification using Support Vector Machines (SVM\(^1\)) for evaluation.

## 3 PROPOSED METHOD

The architecture of the system is given in the Figure 2.

![Figure 2: Architecture of the system](image)

The following subsections describe each module in detail.

### 3.1 Dictionary Building

Bilingual dictionaries (English-Hindi) are built from Wikipedia by mining parallel/near-parallel text from each structural information like title, infobox, category and abstract (initial paragraph) of the English(En) and Hindi(Hi) articles that are connected with Inter language link (ILL, arrows between En Wikipedia articles and Hi Wikipedia articles in Figure 2). The motivation for considering the other structural information of the Wikipedia article is to increase vocabulary of the dictionary both in terms of the number of words and categories of words. Titles, Infobox and Categories of the article consider only named entities that are used in the language.

To increase the coverage of the dictionary and also to include other categories of words (like negations, quantifiers etc), abstract of the article is considered. Also the Inter language links between the articles are assumed to be bi-directional even if they are unidirectional. An approach similar to (Tyers and Pienaar, 2008) is followed to construct dictionaries. The dictionary is constructed iteratively by using the previously constructed dictionaries from each structure. The structural aspects of the article used are

- Title: Titles of the articles linked.
- Infobox: Infobox of the articles that are linked.
- Category: Categories of the articles linked.
- Abstract: The initial paragraph of the articles linked are considered as the article abstracts and are used for dictionary building.

A dictionary consists of word and its several possible translations, scored according to their alignment scores. Each structural information is used to enhance the dictionary built previously. Dictionary built from titles are used as starting point. As each English word is mapped to several Hindi words, filtering of words or re-ranking of the words at query formation is vital. The scoring function used for the words while building the dictionary is

\[
score(w^i_E, w^j_H) = \frac{W^i_E \cap W^j_H}{W^i_E}
\]

Where \(w^i_E\) is the \(i^{th}\) word in English word list; \(w^j_H\) is the \(j^{th}\) word in Hindi word list; \(W^i_E \cap W^j_H\) is the count of co-occurrence of \(w^i_E\) and \(w^j_H\) in the parallel corpus and; \(W^i_E\) is the count of occurrences of the word \(w^i_E\) in the corpus.

### 3.2 Building Content words

The context of each English Wikipedia article \(A_i\) is extracted from the following structural information of the article.

- Title: Title of the article
- Redirect title: Redirect title of the article, if present.

\(^1\text{http://www.cs.cornell.edu/People/tj/svm_light/}\)
• Category: Categories of the article that are pre-defined.

• Subsections: Titles of the different subsections of the article.

• In-links: Meta data present in the links to this article from other articles in same language.

• Out-links: Meta data of the links that link the current article to other articles in same language.

As these structural attributes are spread across the article, they help to identify the context (orientation) of the article in depth when compared with the Categories of the article. Each structural aspect described above have unique content that will help to identify the context of the article. “Content Words” are formed from each of these structural aspects. Word count of the words present in each of the above mentioned attributes are calculated and are filtered by a threshold to form the context words of the article. The threshold for filtering has been calculated by manual tagging with the help of language annotators. “Content Words” for the Hindi articles are also formed similarly. The formation of “Content Words” is similar to tagging but is not a strictly tagging mechanism as we have no constraint on the number of tags. Category alone can help to get the context but considering in-links, out-links, subsections will increase the depth of context words and will reduce the information lost by tagging the words.

3.3 Query formation

Query formation of our system depends on the context words built. For an English query \( q_E \) that contains the words \( w_{E}^{i} \) (\( i: 0 \) to \( n \)),

- Build \( W_H \) of size \( m \), that contains the words returned by the dictionary for each of the words.

- For all words in \( (q_E) \), extract all the articles \( a^{k}_{i} \) (\( k: 0 \) to \( n \)) with \( w_{E}^{i} \) as one of its context word.

- Form the corresponding Hindi set of articles \( A_{h} \) using the cross lingual link, if present in the English article set constructed in the above step.

- For each Hindi word \( w_{H}^{j} \) (\( j: 0 \) to \( m \)), add it to Hindi query \( q_{H} \) if at least one of the articles \( a_{i} \) (with \( w_{H}^{j} \) as its context word) is present in \( A_{h} \).

This approach helps to identify the context of the query as each query is represented by a set of articles instead of query words, that forms the concepts that the query can be interpreted to limited to Wikipedia domain. Queries are translated based on the architecture described in Figure 2.

4 Results and Discussion

4.1 Evaluation, Dataset and Results

A classification based approach and a dictionary based approach are employed to calculate the accuracy of the queries translated. 400 sentences with their corresponding translations (English-Hindi) have been used as test set to evaluate the performance of the query formation. The sentence pairs are provided by FIRE\(^2\). These sentences contain all types of words (Named entities, Verbs etc) and will be referred to as samples. The English language sentences are used as queries and are translated to Hindi using the approach described. Before forming the query, stop words are removed from the English sentence. The query lengths after removing stop words vary from 2 words to 8 words. The dictionary used for evaluation is an existing one, Shabdanjali\(^3\). In the following sections, we describe our two evaluation strategies and the performance of our system using them.

4.1.1 Dictionary based evaluation

Shabdanjali dictionary has been used to evaluate the translated queries. The evaluation metric is word overlap, though it is relaxed further. The formula

\(^2\)http://www.isical.ac.in/~clia/

\(^3\)Shabdanjali is an open source bilingual dictionary that is most used between English and Hindi. It is available at http://ltrc.iit.ac.in/onlineServices/Dictionaries/Dict_Frame.html
used for calculating the precision is
\[
\text{precision} = \frac{\text{No.ofCorrectSamples}}{\text{TotalNumberofSamples}} \tag{2}
\]

A sample is said to be correct if its overlap score is greater than threshold instead of complete overlap. The overlap score of each sample is measured using Formula 3. Threshold is the average overlap score of the positive training set used for training the classifier (Training dataset is discussed in Section 4.1.2).

\[
\text{overlap score} = \frac{\text{No.ofWordOverlap}}{\text{TotalNumberofWords}} \tag{3}
\]

The number of word overlaps are measured both manually and automatically to avoid inconsistent results due to various syntactic representation of the same word in Wikipedia.

The precision for the test dataset using this approach is 42.8%.

### 4.1.2 Classification based evaluation

As described in Section 2, we have used a classification based technique for identifying whether the translated queries contain the same information or not. We have collected 1600 pairs of sentences where 800 sentences are parallel to each other (positive samples, exact translations) while the other half have word overlaps, but not parallel, (not exact translations but have similar content) form the negative samples. Various statistics are extracted from Wikipedia for each sentence pair to construct feature vector as described in (Bharadwaj and Varma, 2011). Each English and Hindi sentences are queried as bag-of-words query to corresponding Wikipedia articles and statistics are extracted based on the articles retrieved. The classifier used is SVM and is trained on the feature vectors generated for 1600 samples. The precision in this approach is the accuracy of the classifier. The formula used for calculating the accuracy is

\[
\text{accuracy} = \frac{\text{No.ofSamplesCorrectlyClassified}}{\text{TotalNumberofSamples}} \tag{4}
\]

The correctness of the sample is the prediction of the classifier. The precision for the test set is 69.75%.

### 4.2 Discussion

The precision achieved by classification based evaluation is higher than that of existing dictionary (Shabdanjali) primarily due to

- Dictionary (Shabdanjali) doesn’t contain words of the query. (Coverage is less).
- Word forms present in the dictionary are different to that of words present in translated query. (Ex: spelling, tense etc).

To negate the effect of above factors, classification based evaluation (4.1.2) has been considered. Classification based evaluation shows that the results are better when the entire sentence and its context is considered. As there are no existing systems that translate queries based on the context and language independent, our results are encouraging to work in this direction. Since no language resources were used, our approach is scalable and can be applied to any pair of languages present in Wikipedia. The relatively low coverage of the dictionaries built using Wikipedia structure also affects the process of query translation. In future, the coverage of dictionaries can also be increased by considering other structural properties of Wikipedia.

### 5 Conclusion

In this paper, we have described our approach towards building a language-independent context aware query translation, replacing the language resources with the rich multilingual content provider, Wikipedia. Its structural aspects have been exploited to build the dictionary and its articles are used to form queries and also to evaluate them. Further exploitation of Wikipedia and its structure to increase the coverage of the dictionaries built will increase the overall precision. Though queries are translated in a language-independent way, using language resources of English, as it is a richly resourced language, for query formation is also envisioned.

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