Automatic Corpus-based Thai Word Extraction with the C4.5 Learning Algorithm

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Introduction (1)

- Problems of Thai Word Identification
  - No word boundary -> Thais have difficulties in defining words.
    Example:
    …notwithstandingiampresenting...
    Notwithstanding , Not + with + standing, Not + withstanding
  - Thai processing relies on human created dictionaries which have several limitations.
    - inconsistency
    - coverage

Introduction (2)

- Words cannot be defined clearly and consistently:
  - problems in

    Machine Translation, Information Retrieval

    Speech Synthesis

    Speech Recognition

    etc.

Our Approach (1)

- Corpus-Based Word Extraction
  - Unlabelled Corpus-Based
  - Automatic
  - Clear and Computable

Our Approach(2)

- Building a suffix array of 3-to-30-character substrings from the corpus
- Word/Non-word string disambiguation
- Applying the C4.5 machine learning
- The attributes applied to the disambiguation are:

Attributes(1) : Left and Right Mutual Information

$$Lm(xyz) = \frac{p(xyz)}{p(x)\,p(yz)} \qquad Rm(xyz) = \frac{p(xyz)}{p(xy)\,p(z)}$$

where

x is the leftmost character of string *xyz*
y is the middle substring of *xyz*
z is the rightmost character of string *xyz*
p( ) is the probability function.

High mutual information implies that *xyz* co-occurs more than expected by chance. If *xyz* is a word, its *Lm* and *Rm* must be high.
…*Efunction*… and ...*Function*...

Attributes(2) : Left and Right Entropy

$$Le(y) = -\sum_{\text{all } x \in A} p(xy \mid y).log_2\, p(xy \mid y)$$

$$Re(y) = -\sum_{\text{all } z \in A} p(yz \mid y).log_2\, p(yz \mid y)$$

where

x is the leftmost character of string *xyz*
y is the middle substring of *xyz*
z is the rightmost character of string *xyz*
p( ) is the probability function.

Entropy shows the variety of characters before and after a word.
If *xyz* is a word, its left and right entropy must be high.
Example: ...?*function*..., ...*?unction*...

Attributes(3): Frequency, Length Functional Words

- Frequency

  Words tend to be used more often than non-word string sequences.

- Length

  Short strings are likely to happen by chance.
  The long and short strings should be treated differently.

- Functional Words

  Functional words are used mostly in phrases. They are useful to disambiguate words and phrases.
  Func(s) = 1 if *s* contains functional words.
  = 0 if otherwise.

Attributes(4): First Two and Last Two Characters

- Frequency of the first-two characters of the considered string which appears in the first-two characters of words in the dictionary

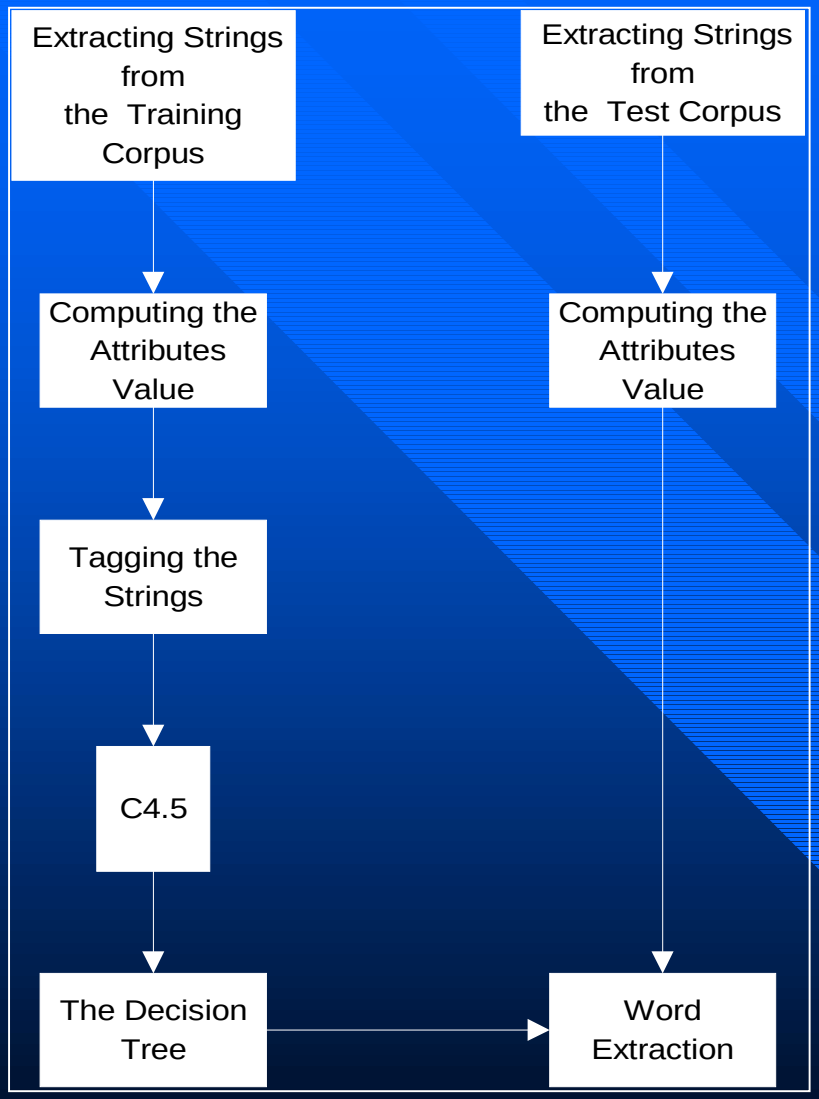
  high frequency -> the beginning of the considered string conforms to the Thai spelling system.

  Ex.

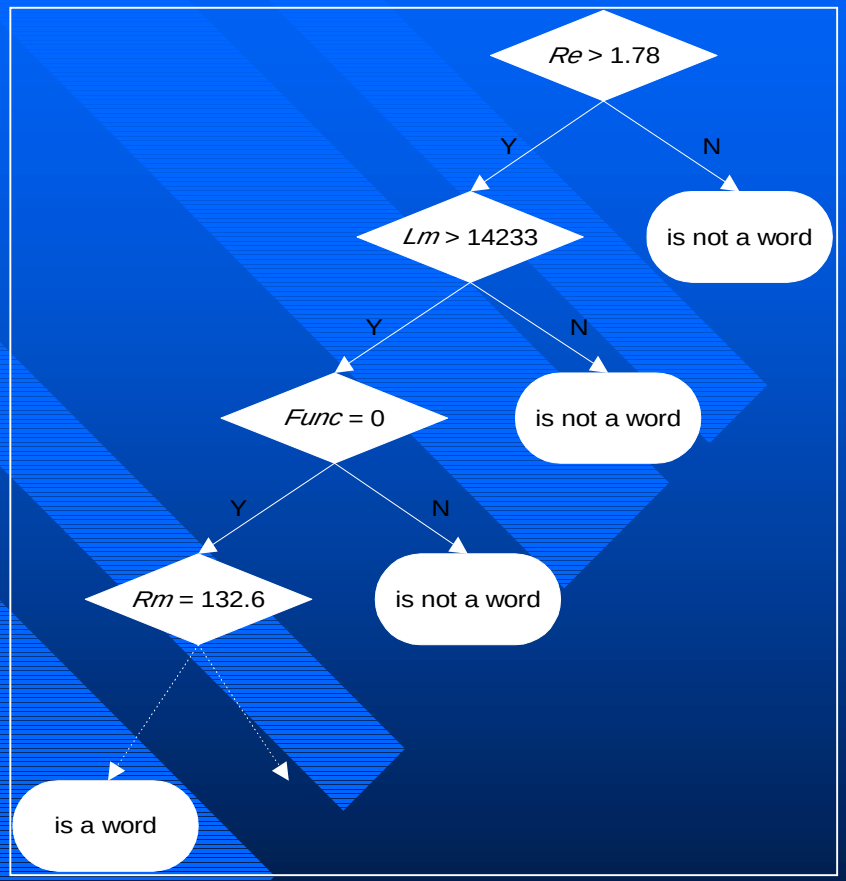
  Function: how likely *fu* can be the beginning of word.

- This idea can be also applied to the last-two characters.

Applying C4.5 to Word Extraction



The Process



The Decision Tree

Experimental Results (1)

The Precision of Word Extraction

	No. of strings extracted by the decision tree	No. of words extracted	No. of non-word strings extracted
Training Set	1882 (100%)	1643 (87.3%)	239 (12.7%)
Test Set	1815 (100%)	1526 (84.1%)	289 (15.9%)

The Recall of Word Extraction

	No. of words that has more than 2 occurrences in corpus	No. of words extracted by the decision tree	No. of words in corpus that are found RID
Training Set	2933 (100%)	1643 (56.0%)	1833 (62.5%)
Test Set	2720 (100%)	1526 (56.1%)	1580 (58.1%)

Remark: These precision and recall are measured against 30,000 strings that occur more than 2 times in the corpus and conform to some simple Thai spelling rules.

Experimental Results (2)

Word Extraction VS. a Dictionary

	No. of words extracted by the decision tree	No. of words extracted by the decision tree which is in RID	No. of words extracted by the decision tree which is not in RID
Training Set	1643 (100.0%)	1082 (65.9%)	561 (34.1%)
Test Set	1526 (100.1%)	1046 (68.5%)	480 (31.5%)

The Relationship of Accuracy, Frequency and Length

- Both precision and recall are getting higher as the length and frequency of strings increase.
- The new created words have tendency to be long. Our extraction yields a high accuracy in extracting temporal words.

Conclusion

- C4.5 has been applied to word extraction, using attributes: mutual information, entropy, frequency, length, functional words, and the first two and last two characters.
- Our approach yields 85% in precision an 56% in recall measure.
- Our approach is promising for building a corpus-based dictionary for non-word boundary languages.

Thank You for Your Attention