Semantic Similarity Measures for the development of Thai Dialog System

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Abstract. Semantic similarity plays an important role in a number of applications including information extraction, information retrieval, document clustering and ontology learning. Most work has concentrated on English and other European languages. However, for the Thai language, there has been no research about word semantic similarity. This paper presents an experiment and benchmark data sets investigating the application of a WordNet-based machine measure to Thai similarity. Because there is no functioning Thai WordNet we also investigate the use of English WordNet with machine translation of Thai words.

Keywords: word-to-word similarity, word-to-word comparison, semantic similarity measures, Benchmark, Thai Dialog System.

1 Introduction

Conversational Agents (CAs) are applied in a broad range of areas including business [1], education [2] and entertainment [3]. CAs may be used in unmanned call centres or as personal shopping or navigation assistants to reduced operating cost and provide 24/7 access for users. Most CAs use English, However some work has been done in Chinese [4] and Japanese [5]. Little or no work has been done in Thai.

The chief barrier to deploying CAs effectively in the real world is the labour cost of scripting and maintenance. Consequently, a new generation of Short Text Semantic Similarity-based agents is being introduced to overcome their problem.

Recently, a new generation of CAs has begun to emerge using Short Text Semantic Similarity measures to analyse user utterances [6]. The majority of these make use of word-to-word similarity measures based on WordNet [7]. Although work has begun on a Thai WordNet [8] it is not fully populated.

Therefore, this paper investigates the research question: Can a WordNet-based word similarity measure be developed for the Thai language by translating Thai words into English and using the English Language WordNet in a word similarity algorithm?

This work requires a Thai word similarity benchmark data set. The Thai language is the official language of Thailand, spoken by over 20 million people [9]. The Thai alphabet uses forty-four consonants and fifteen basic vowel characters to create a

word. These are horizontally placed, left to right, with no intervening space. Vowels are written after, before, below, or, above the consonant they modify, although the consonant always sounds first when the syllable is spoken.

Judgments of semantic similarity are a matter of human intuition and there is no objective method of obtaining ground truth ratings for experimental data. However, a 65 word pair data set in English collected by Rubenstein and Goodenough [10] using questionnaire-based has produced repeatable results [11]

The rest of this paper is organized as follows: Section 2 describes how the word semantic similarity measure works; Section 3 describes the collection of a Thai word similarity benchmark data set from participants using a method based on [10]; Section 4 discusses human and machine similarity ratings and section 5 outlines directions for future work.

2 The Semantic Similarity Method

There are numerous approaches to word semantic similarity; including thesaurus based [12, 13], dictionary based [14], and WordNet based [15, 16]. All use a lexical resource such as a directed graph or network and their semantic similarity is measured from the particular graph or network. WordNet [7] was developed by Princeton University, and is a machine-readable lexical database which is organized by word senses. Words in WordNet can be broken down into: 'nouns', 'verbs', 'adjectives' and 'adverbs' which are grouped into sets of synonyms. These synonyms are called 'synsets' and are connected by means of 'conceptual-semantic' and 'lexical' relations. Figure 2 is part of the hierarchy of WordNet.

Fig. 1. Part of WordNet

WordNet approaches can be classified as: information content methods [17, 18], edge counting methods [15, 19], feature based methods [20] and hybrid methods [21]; detailed reviews of word similarity can be found in [22], [23].

In this paper, we approximate the semantic similarity between two words by using the method shown in [22] that does the estimation by looking their subsumer of two words in WordNet. According to [24], [25] the STASIS measure performs very well when compared with other measures. Also, the STASIS measure is more effective when using it automatically as it is simple and fast to calculate. The STASIS measure calculates by the following formulas:

Given two words, $w1$ and $w2$, the semantic similarity $s(w1, w2)$ (equation 1) can be calculate from:

$$s(w1, w2) = \tanh(0.45 * h) * e^{(-0.2 * d)} \quad (1)$$

Where $d1$ and $d2$ are the depth of $w1$ and $w2$, and h is the depth of their least common subsumer in WordNet, d (equation 2) can be calculate from:

$$d = d1 + d2 - (2 * h) \quad (2)$$

For example, $w1$ is *teacher* and $w2$ is *boy* in Fig. 1, the depth of $w1$ and $w2$ are 7 and 5 respectively, the synset of *person* is called the subsumer for words of *teacher* and *boy*. Therefore, h for *teacher* and *boy* is 3, and the d of *teacher* and *boy* is 6.

To address the research question in section 1, the algorithm was adapted by using machine translation of Thai words to English before submitting them to the algorithm. This was done by choosing the first sense returned by the google translation [26] utility. The Google translation engine [27] uses the United Nations parallel corpus to train their translation engine. Apart from English to Thai, it can translate over 53 languages on which further research can be done.

3 Experiment Procedures

3.1 Participants

Similarity ratings were collected from 40 native Thai speakers to create a benchmark data set. The participants had an equal number of Art/Humanities and Science/Engineering backgrounds. They consisted of 12 undergraduates and 28 postgraduates studying in 4 different UK universities. The average age of the participants was 25 and standard deviation was 2.8, with 23 male and 17 female. This is comparable with participant groups used for English word similarity [10, 11]

3.2 Materials

Following previous practice [6, 11] a representative subset of 30 word pairs was chosen from the Rubenstein and Goodenough data set. Those 30 word pairs were translated in to Thai by a native Thai speaker using the first meaning from an established Thai-English dictionary [28]. Each word pair was printed on a separate card using a standard Thai font. A questionnaire was produced containing instructions for recording similarity ratings and a small amount of personal data (Name, Confirmation of being a native Thai speaker, Age, Gender, and Academic background).

3.3 Procedure

The participants were asked to perform the following procedure:

1. Please sort the cards in to four groups in a rough order of the similarity of meaning of the word pair.
2. After sorting the cards into groups, order the cards in each group according to similarity of meaning. (i.e. the card that containing the lowest similarity of meaning is at the top of the group.)
3. Please recheck the cards in every group. You may change a pair of word to other groups at this stage.
4. Please rate the semantic similarity rating of each pair of words by writing a number between 0.0 (minimum similarity) and 0.9 for first group, 1.0 and 1.9 for second group, 2.0 to 2.9 for third group, 3.0 and 4.0 (maximum similarity) for fourth group on the recording sheet. You can use the first decimal place (e.g. 2.5) to show finer degrees of similarity. You also may assign the same value to more than one pair.

The cards were shuffled into a random order before being given to the participants.

3.4 The Benchmark data sets

The benchmark data set is shown in Table 1. R&G words are the original words from Rubenstein and Goodenough [10]. Translated words are the Thai words translated as described in 3.2.

Table 1. The average of similarity rating from 40 native Thai speakers.

Pair Number	Word Pair				Human Rating
	Word 1		Word 2		
	R&G Word	Translated Word	R&G Word	Translated Word	
1	Cord	สายไฟ	Smile	รอยยิ้ม	0.078
5	Autograph	ลายมือชื่อ	Shore	ชายฝั่ง	0.022
9	Asylum	ที่หลบภัย	Fruit	ผลไม้	0.068
13	Boy	เด็กผู้ชาย	Rooster	นกตัวผู้	0.682
17	Coast	ฝั่งทะเล	Forest	ป่าไม้	0.632
21	Boy	เด็กผู้ชาย	Sage	นักปราชญ์	0.598
25	Forest	ป่าไม้	Graveyard	สุสาน	0.548
29	Bird	นก	Woodland	ป่าเขา	0.595
33	Hill	เนินเขา	Woodland	ป่าเขา	2.162
37	Magician	นักมายากล	Oracle	คำทำนาย	1.260
41	Oracle	คำทำนาย	Sage	นักปราชญ์	1.298
47	Furnace	เตาหลอม	Stove	เตาไฟ	1.612
48	Magician	นักมายากล	Wizard	พ่อมด	1.570
49	Hill	เนินเขา	Mound	ภูเขา	2.420
50	Cord	สายไฟ	String	เชือก	0.882
51	Glass	แก้ว	Tumbler	ถ้วยแก้ว	3.125
52	Grin	ยิ้มกว้าง	Smile	รอยยิ้ม	2.330
53	Serf	ทาส	Slave	ข้ารับใช้	3.345
54	Journey	การเดินทาง	Voyage	การท่องเที่ยว	2.788
55	Autograph	ลายมือชื่อ	Signature	ลายเซ็น	3.223
56	Coast	ฝั่งทะเล	Shore	ชายฝั่ง	3.218
57	Forest	ป่าไม้	Woodland	ป่าเขา	2.830
58	Implement	อุปกรณ์	Tool	เครื่องมือ	3.335
59	Cock	ไก่ตัวผู้	Rooster	นกตัวผู้	1.515
60	Boy	เด็กผู้ชาย	Lad	เด็กหนุ่ม	2.425
61	Cushion	เบาะ	Pillow	หมอน	2.035
62	Cemetery	ป่าช้า	Graveyard	สุสาน	3.400
63	Automobile	รถยนต์	Car	รถเก๋ง	3.080
64	Midday	เที่ยงวัน	Noon	กลางวัน	3.008
65	Gem	อัญมณี	Jewel	เพชรพลอย	3.075

4 Experiment Results

4.1 Semantic Similarity Ratings

Table 2 shows the semantic similarity ratings for the translated word pairs. Column 1 is the number of the word pair as shown in table 1. Column 2 is the human rating for the Thai word pairs. Column 3 is the machine rating for the Thai word pairs using the algorithm described in section 2. Columns 4 and 5 are the human rating and the machine ratings obtain from Rubenstein and Goodenough [10]. Human ratings are

calculated as the mean of the ratings provided by the set of participants for each word pair. All of the measures have been scaled in the range 0 to 1 to aid comparison.

Table 2. Semantic Similarity of Human Rating and Machine Rating.

Pair Number	Thai		English	
	Thai Human Rating	Thai Machine Rating	English Human Rating	English Machine Rating
1	0.020	0.001	0.005	0.070
5	0.006	0.038	0.015	0.050
9	0.017	0.016	0.048	0.156
13	0.170	0.241	0.110	0.107
17	0.158	0.320	0.212	0.320
21	0.150	0.366	0.240	0.366
25	0.137	0.175	0.250	0.175
29	0.149	0.200	0.310	0.200
33	0.540	0.320	0.370	0.320
37	0.315	0.016	0.455	0.245
41	0.324	0.011	0.652	0.366
47	0.403	0.448	0.778	0.548
48	0.392	0.367	0.802	0.366
49	0.605	0.655	0.822	0.817
50	0.220	0.241	0.852	0.814
51	0.781	0.817	0.862	0.817
52	0.582	0.667	0.865	0.667
53	0.836	0.670	0.865	0.818
54	0.697	1.000	0.895	0.547
55	0.806	1.000	0.898	0.818
56	0.804	1.000	0.900	0.817
57	0.708	1.000	0.912	1.000
58	0.834	0.547	0.915	0.817
59	0.379	0.448	0.920	1.000
60	0.606	0.670	0.955	0.670
61	0.509	0.547	0.960	0.817
62	0.850	1.000	0.970	1.000
63	0.770	1.000	0.980	1.000
64	0.752	1.000	0.985	1.000
65	0.769	1.000	0.985	1.000

4.2 Discussion

The experimental results in the previous section suggest that the Thai word-to-word semantic similarity measure and semantic similarity of human rating provides good results. As can be seen in Figure 2, most of the correlation points are near the linear line with a correlation of 0.889.

Fig. 2. The correlation between Thai human rating and Thai machine rating.

Table 3 illustrates the agreement of both of the machine measures with human ratings by calculating the correlation coefficients (r) between the human ratings and the machine ratings over the data set.

Table 3. Correlation coefficients.

	Correlation r
Thai human similarity rating and machine similarity measure	0.889
English human similarity rating and machine similarity measure	0.911
Thai human similarity rating and English human similarity rating	0.857
Worst Thai native speaker participant and the least of the group	0.639
Best Thai native speaker participant and the least of the group	0.946

The Thai machine measure is performing close to the English machine measure, with a different of 0.022 between the two correlation coefficients. The Thai machine measure is also performing better than the correlation between the worst performing human and the least of the group ($r = 0.639$) which supports the view that it could form the basis of an effective algorithm. Furthermore, because the best performing human achieved the correlation of 0.946 it shows this benchmark data set is capable of measuring considerable improvement over the current algorithm and should be useful to researchers on Thai semantic similarity.

Word pair 37 (Magician-Oracle) and 41 (Oracle-Sage) in Table 2 illustrate an interesting problem. Both pairs of nouns contain the word ‘oracle’. In general, ‘Oracle’ means either ‘a message given by an oracle’ or ‘someone who gave advice to people or told them what would happen’; the definition can be found in [29]. We took the first meaning from Thai-English dictionary [28] which is ‘คำทำนาย’ likely to mean ‘prediction’. After we translated the word back to English via google translate, the first meaning from google translation was chosen which is ‘prophecy’. Consequently, the machine rating that we got is low because their subsume is *entity*.

The human rating was significantly higher than the machine rating as shown in table 2. This shows that the way that the machines calculate the rating for pairs of nouns is based on only this first meaning that comes up in the dictionary. On the other hand, participants reported selecting a word sense based on all of their personal knowledge of a word. The measure cannot predict which sense a human will use. Table 4 illustrates the words found to raise problems of ambiguity during machine translation.

Table 4. The exception of translate word

R&G word	Thai word	Google word	R&G word	Thai word	Google word
Cord	สายไฟ	Wire	Voyage	การท่องเที่ยว	Travel
String	เชือก	Rope	Shore	ชายฝั่ง	Coast
Sage	นักปราชญ์	Savant	Autograph	ลายมือชื่อ	Signature
Oracle	คำทำนาย	Prophecy	Jewel	เพชรพลอย	Gem
Cushion	เบาะ	Pad	Stove	เตาไฟ	Fireplace
Rooster	นกตัวผู้	Bird	Wizard	พ่อมด	Necromancer
Woodland	ป่าเขา	Forest	Implement	อุปกรณ์	Equipment
Serf	ทาส	Thrall	Asylum	ที่หลบภัย	Shadow
Automobile	รถยนต์	Car	Mound	ภูเขา	Mountain
Journey	การเดินทาง	Travel			

However, the result of this research is encouraging, and indicates the potential of semantic similarity measurement for Thai words as we explained earlier.

5 Future Work

The long term goal of the current work is to apply a word similarity measure as a component of Short Text Semantic Similarity measurement [19, 30] that can be used in Thai CAs.

We described how the Thai word-to-word semantic similarity works, showed a Thai benchmark data set, and discussed the experimental results. We are in the early stage of a completely new design to develop the Thai CAs mentioned in section 4. Further research will involve the development of the Short Text Semantic Similarity Measure for the development of a Thai dialog system. After we implement all the measures that we need to, we will develop a novel Thai CAs by using those measures.

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