**Virtual Campus Tour System**

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**Abstract**

The ubiquity of metaphor in our daily life makes the computational realization of metaphor identification and interpretation become a crucial segment in the NLP translation field. This literature review provides the basic theory of metaphor computation, discusses the related work of the state-of-the-art models for metaphor detection and interpretation, introduces three widely used datasets and states our project outline for future work.

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# Dedications

Dedications refer to the inscription of books or other artifacts when these are specifically addressed or presented to a particular person. This practice, which once was used to gain the patronage and support of the person so addressed, is now only a mark of affection or regard.

*Chapter 1* **Introduction**

## 1.1 Background

Metaphor expressions appear pervasively in daily life as well as in many literary works. According to relevant statistics research, metaphorical usage occurs on average once in every three sentences in typical corpora. People use metaphor frequently since metaphor expression furnish vivid explanations for abstract experience and perception. Meantime, our cognitive system and ways of thinking are based on metaphors aiming to understand our world better. The cognitive and rhetorical phenomena make metaphors active in all kinds of natural language communication scenarios, while a large number of implicit metaphorical expressions have become a problematic task in natural language processing. The computational realization of metaphor identification and interpretation therefore plays a crucial role in the NLP translation field.

## 1.2 Basic linguistic theory in metaphor

Traditional metaphor theory asserts that metaphor is merely a rhetorical method, and only provides an ordinary describing function for expression. In terms of Aristotle's poetics, metaphor is the similarity between objects. This theory emphasizes the feature differences between literal and metaphorical words.

As the development of cognitive science, in light of modern linguistic theories, Lakoff and Johnson [1] assert the conceptual metaphor theory, arguing that metaphor is systematic reasoning from a concrete conceptual source domain to an abstract target domain. Normally, we use a concrete expression to describe the abstract theory. For instance (Figure 1), the metaphorical sentence "She devoured his novels" utilizes the verb "devour" to describe a sense of greedy reading rather than literally swallowing a novel.

Figure 1 "devoured" in the first sentence is literal usage, and in the second sentence is metaphorical usage, the "devoured" is the source word in the second sentence.

There is another modern linguistic theory in metaphor derives from Steen et al. [2], namely Metaphor Identification Procedure (MIP): a metaphor is identified if the literal meaning of a word contrasts with the meaning that word takes in this context. Like the previous example, the word "devour" is unusual in the context of 'novel'. A novel cannot be devoured. The contextual meaning contrasts with the literal meaning of the word. Additionally, another similar metaphor theory is SPV. The intuition of the theory is that metaphoricity is identified by detecting the incongruity between a target word and its context.

Moreover, Gentner [3] 's structural mapping theory proposed that the process of structural mapping is the analogous transfer, which seeks for structural similarity by matching different objects, and then extracts the relationship in the source problem through schema induction to solve the problem of the target domain. It is concluded that the process of metaphor mapping is essentially the matching process of the relationship structure between the source domain and the target domain.

In the 1990s, Fauconnier and Turner extended the conceptual metaphor theory and proposed a conceptual integration model [4]. Besides, other theories like basic metaphor theory and characteristic significance imbalance theory have laid a solid theoretical foundation for the metaphorical computing task.

**1.3 Research Subject of Metaphor Computing**

The metaphor computation task mainly focuses on two aspects. One is how to use a computational method to detect and classify metaphorical expressions in a typical corpus. The other task is to let the computer understand and metaphorical meaning and then interpret it into the most suitable demotic word through word context.

Metaphor detection can be seen as a classification task, which is to identify a target work if it is a metaphor expression. Various approaches have been implemented by word embedding level to sentence level. When a sentence contains words such as "as" and "like", it is readily to be detected. Whereas without such words, the difficulty of detection highly rises. In word level, machine learning methods, including SVM and random forest or word embedding methods like GloVe are developed based on the concreteness difference of the target word and source word. By measuring the cosine similarity of the components in the phrase, metaphor can be effectively detected. Metaphor detection can also be seen as a sequence labeling task, which is labelling the target word in a sentence. In sentence level, the neural network method has been widely applied for the NLP field for semantic modelling and context modelling. Beginning with the pretraining work embedding vectors, to multi-level processing algorithms, also along with neural network method in deep learning and large-scale corpus language models, novel methods are continually lifting the performance of metaphor detection result.

The task for metaphor interpretation aims to let the model understand the implicit literal meaning of metaphorical expression. How to precisely replaced metaphorical expression has been a problematic issue for long. For instance, we need to interpret the sentence “Time is money”, the computer will replace the metaphorical word “money” as its literal meaning “previous”. Human beings generally understand metaphor through association with knowledge, providing ideas for the construction of a metaphor interpretation model. However, many difficulties and problems are waiting to overcome, such as considering culture and including novel knowledge base.

*Chapter 2* **Research Background**

This section explains the technical and/or commercial background that related to the research and study.

It includes:

1. Statement of the study problems – a short statement explains the key point and focus of the research;
2. Research method – explains the potential method(s) being used and explored in the research and study;
3. Research limitation(s) – describes the technical and logical limitation(s) of the research and study;
4. Research process – describes the key process and stages of research and study.

*Chapter 3* **Literature Review**

## 3.1 Metaphor detection

### 3.1.1 Word level based metaphor detection

#### 3.1.1.1 Abstractness for metaphor detection

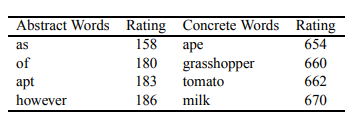
In light of the conceptual metaphor theory, Turney et al. [5] first implemented a method for identifying metaphors. Their approach to the problem of distinguishing literal and metaphorical senses is based on an algorithm for calculating the degree of abstractness of words by MRC Psycholinguistic Database (Figure 2). For instance, time is a word with a high relative abstract attribute. It therefore has a high value in using in metaphor.

Figure 2 examples for abstract words and concrete words in MRC database

Turney constructs the set of abstract words and concrete words. Then calculate the abstractness in terms of the semantic distance between the target words and the pre-designed word set. Finally, the model produces the possibility of if a word is used in metaphor or literal hinge on the word abstractness.

This model provides a new way of thinking for metaphor detection. However, the consideration of just abstractness is not a complete solution to the problem.

#### 2.1.1.2 Metaphor Detection with broader consideration on word

In 2014, Tsvetkov et al. [6] provide a broader view of metaphor detection on different languages besides English. They design three main feature categories:

(1) Abstractness and imageability: Abstractness is always concerned as the critical feature for metaphor. Imageability is not a redundant property. The majority of abstract words are hard to visualize.

(2) Supersenses: Supersenses are coarse semantic categories from WordNet. It classifies nouns and verbs into 45 classes. For instance, noun.animal, noun.body. This model also uses 13 classes adjective supersenses for addition.

(3) Vector space word representation: The model employ a 64-dimensional vector-space word representation where synonyms have similar vectors.

To make classification, the model uses a random forest classifier to consider the three features simultaneously. The classifier learns from independent subsamples of the training data. For input, each tree classifier gives the probability of each label, and those probabilities are averaged to the ensemble. Additionally, it usually performs logistic regression rather than linear results. If this probability is above a threshold, the relation will be viewed as metaphoric; otherwise, it is literal.

This model considers the word level on a higher aspect and combines them with a random tree method. However, the restriction on the input form of the phrase (Subject-Verb-Object or Adjective-Noun) limits the view for further progress.

#### 2.1.1.2 Word Embedding and WordNet for metaphor detection

In 2018, Mao et al. [7] propose an unsupervised learning method that can directly identify and interprets metaphors at word-level without any preprocessing. Their model is based on the Continuous Bag of Words (CBOW) and Skip-gram.

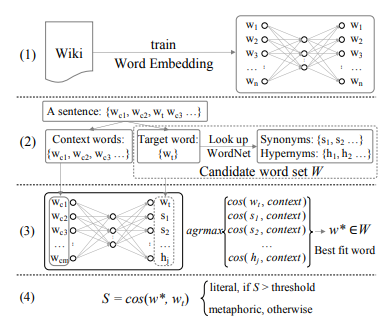
CBOW means given the context of a word, predict its center word, which has the highest probability. Skip-gram is the reverse of CBOW aiming to maximize the probability of predicting each context word given a center word.

Figure 3: word embedding based model structure

In Figure 3, it shows the structure of the entire model. First, input training word embeddings based on Wikipedia dumps for obtaining input and output word vectors. Afterwards, for a sentence, separate its target word and its context word. Furthermore, set Target words set for all the possible senses. Also, eliminate auxiliary verbs since these words contain less contextual meaning. Look up to the WordNet to get the Synonyms and Hypernyms of the Target words set and augment to Candidate word set W. In the next step, identify the best-fit word for the replacement of the target words given its context. Eventually, compute the cosine similarity between the target words the best-fit word. For S, if S is over a threshold, it will be considered as literal; otherwise, it is metaphoric.

This model makes use of the word vectors and its spatial relationship to provide a new way of thinking and directly contribute to the integration of metaphor recognition and metaphor understanding.

### 2.1.2 Neural network based metaphor detection

In sentence level, researchers find that metaphorical usage appears in a specific context. Without context, it is difficult to find the differences between metaphorical and literal expression. Therefore, constructing the interaction relation between target word and context, then discovering the connection between the two becomes a new field of thinking. The neural network method has been widely applied for the NLP field for semantic modelling and context modelling.

The main idea of the current neural network based method is to construct a semantic model for the target words and to the context of the target words. If the target word has a big difference with the context of semantics, the target word then can be considered as a metaphor; otherwise, it is not a metaphor. Many neural network models rely on the use of various semantic coding method to achieve different performance.

#### 2.1.2.1 Word Embedding and WordNet for metaphor detection

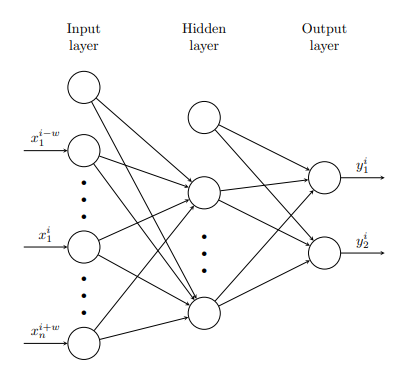
In 2016, Do Dinh and Gurevych [8] first implemented a neural network method on the metaphor detection task. The metaphor detection is treated as a tagging problem without any manual labelling. They experiment with the multilayer perceptrons with connected feedforward neural network.

Figure 4: multilayer perceptron with one hidden layer

As in Figure 4, this neural network incorporates an input layer, several hidden layers and an output layer. The output layer utilizes a softmax function to calculate the prediction result. Here is an instance of one hidden layer neural network of multilayer perceptron, the model use input x for a token which positions at I concatenate word embedding vectors to . Here w is the given window for the context size. Additional features enrich the input vector x by concatenation. The output layer utilizes logistic regression to calculate the and , which are the probability for metaphorical and literal usage. This work initially explored the application of neural networks on metaphor detection and somehow required to do more extension on the model.

#### 2.1.2.1 Word Embedding and WordNet for metaphor detection

Gao et al. [9] intend to resolve two problems: given a target verb and classify it whether the word is metaphorical or literal and detect all the metaphorical words in a sentence. The model utilizes a standard architecture based on bi-directional LSTMs (BiLSTM) augments with contextualized word embedding performing surprisingly well on the tasks.

For both sequence labelling and classification encoding, the model uses to represent each token by pre-trained word embedding from GloVe (Global Vectors for Word Representation) and the concatenation of ELMo (Embeddings from Language Model) vector . The combination of the two effectively reduces the word sense disambiguation.

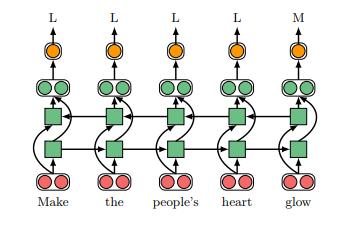
The first task refers to the Sequence Labeling Model. As shown in Figure 5, the model set the word representation to BiLSTM as input. Afterwards, the BiLSTM produces a result of contextualized representation for each token. The model then predicts a label for each word from by using a feedforward neural network.

Figure 5: A sequence labelling model for metaphor detection

*Chapter 4* **Methodology**

Methodology refers to the methods and techniques being used and adopted in your research and study. It can be either your novel research, adoption and extension of other people/researchers’ works and studies.

In case you plan to adopt and/or extend other people/researchers works, you MUST clearly quote the source of reference in the document. Also, if your works are the extension of other people/researchers’ research and studies, you MUST clearly describe and explain what is(are) your contribution(s) in this research and study in this section.

To facilitate the ease of understanding, it is highly recommended to use some illustrations, flow charts and/or schematic diagrams to explain the methodology and techniques proposed in your research and study.

*Chapter 5* **Project Schedule**

Project Schedule is the key for the success or failure of any research project. Students MUST clearly defined the timeframe and schedule for the whole life-cycle of the project undertaken.

A typical project and study should have the following key phases:

1. Phase I – Preparation Phase

The Preparation Phase should consist of: Literature review and background research/study; Problem definition and solving techniques; Data acquisition and pre-processing; Acquisition of computing facility and related equipment.

1. Phase II – System Design Phase

Based on the fundamental works done in Phase I, System Design Phase focuses on the how the problem(s) can be solved by your proposed system and/or methods. It can be achieved by either your pure innovation, or integration (extension) of other existing methods and techniques.

1. Phase III – System Implementation Phase

Based on the proposed system designed in Phase II, System Implementation Phase focuses on the actual implementation of your proposed system. For example, in a typical AI/DS project, commonly tools such as Python (with TensorFlow) can be used, which will be discussed in the DS7023 Data Mining and Machine Learning course in Semester 1.

1. Phase IV – System Evaluation and Testing Phase

Once the system is fully implemented, the next vital step to test for the system performance. Through the regulation of the system parameters during system testing and evaluation, your proposed system should be fine-tuned to improve the system performance. It is also the key feature and process of any intelligent system and application.

For the ease of description, students can use a Gantt Chart to illustrate the project schedule throughout the year.

*Chapter 6* **System Implementation**

This section is the key section in the Semester 2 AI project work. It involves the discussion of the overall system architecture; how real-world data/database are processed and integrated into your proposed system; the system flow and process interaction diagrams and the implementation details (says) using Python to implement your proposed system. Normally, system architecture diagram(s), structural diagram(s), flow charts are essential tools for illustration in this section.

*Chapter 7* **Experimental Results**

During the implementation of the AI systems, such as a financial forecast system. A critical step is the system training and fine-tuning. This section involves the discussions of all critical experimental results during the system training, testing and evaluation.

*Chapter 8* **Performance Analysis**

In a typical AI system, such as financial forecast system, a critical step is the Performance Analysis. To test for the performance of a new system, normally we will compare the proposed system with other contemporary and/or commonly used system. For example, in a typical forecast system, we normally compare the proposed system with some well-known and commonly used forecast system such as FFPBN (Feedforward Backpropagation Network), RNN (Recurrent Neural Networks)， CNN (Convolution Neural Network) or SVM (Support Vector Machine), which are provided as standard packages in Python, which will be discussed in the DS7023 Data Mining and Machine Learning course in Semester 1.

*Chapter 9* **Conclusion**

This section presents the summary of your AI project been undertaken. Basically, it discusses the overall summary of the methods and techniques been proposed in your study, and how it can be applied to real time intelligent systems and applications. You can also discuss the key features and findings being explored in your research and study. Normally half-page (about 250 – 300) words will do.

*Chapter 10* **Future Works**

As the final section of the project report, this section discusses the future research works related to your research project. Either it can the extension of your proposed methodology and techniques with other contemporary AI techniques and methodologies, or it can be the extension of your proposed AI systems to other problem domains and industries.

## Reference

Abukhousa, E., Mohamed, N. and Al-Jaroodi, J. (2012) eHealth Cloud: Opportunities and Challenges. Future Internet. 4, 621-645.

Acmen Solution. (2009) Acumen nabs ONC cloud computing contract. [http://www.cmio.net/index.php?option=com\_articles&view=article&id=20648:ac](http://www.cmio.net/index.php?option=com_articles&amp;view=article&amp;id=20648%3Aacumen-nabs-onc-cloud-computing-contract&amp;division=cmio)  [umen-nabs-onc-cloud-computing-contract&division=cmio](http://www.cmio.net/index.php?option=com_articles&amp;view=article&amp;id=20648%3Aacumen-nabs-onc-cloud-computing-contract&amp;division=cmio). Accessed on September 1st, 2011.

Ahmed, S., Raja, M.Y.A. (2010) Tackling cloud security issues and forensics model. In Proceedings of the High-Capacity Optical Networks and Enabling Technologies (HONET 2010), Cairo, Egypt, pp. 190–195.

DWreview.com (2007) Web site accessed in 2011<http://www.dwreview.com/Data_mining/Future_data_mining.html>

Kuo, M. H., Kushniruk, A.W. and Borycki, E. M. (2011) Can Cloud Computing Benefit Health Services? A SWOT Analysis. International Conference of the European Federation for Medical Informatics (MIE2011), Oslo, Norway, August, pp. 28-31.

Luk, J. M. et al. (2007) Artificial neural networks and decision tree model analysis of liver cancer proteomes. Biochemical and biophysical research communications, 361 (2) 68 -73. (more than 3 authors)

Larose, D. T. (2005) Discovering Knowledge in Data: An Introduction to Data Mining, ISBN 0-471-66657-2, London, John Wiley & Sons.

O'Neil, J. M. and Egan, J. (1992) Men's and women's gender role journeys: A metaphor for healing, transition, and transformation. In B. R. Wainrib (Ed.), Gender issues across the life cycle. New York, NY: Springer, pp. 107-123.