

RECESSION: Defining Source Domains through WordNet and SUMO

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Abstract

This paper argues that the sorting of metaphorical expressions according to source domains can be verified through using the WordNet lexical knowledgebase and SUMO ontology. This study uses the examples from RECESSION and demonstrates that expressions such as ‘painful recession’ and ‘the exacerbated recovery’ are related to the decreasing physical state of organism (i.e., ECONOMY IS A DISEASE). The relatedness of these expressions can be established using WordNet and SUMO from which their related senses and ontological nodes can be identified. This study strengthens the metaphorical analyses that are carried out intuitively. This research contributes to the study of language processing and more specifically the processing of conceptual metaphors at the cognitive level.

1.0 Introduction

In an English corpus-analysis based on the 1995 Washington and Los Angeles Post (available through the Language Data Consortium), metaphorical expressions related to the target domain RECESSION were examined. These metaphorical expressions were analyzed based on the Conceptual Mapping (CM) Model (Ahrens 2002, Ahrens, Chung and Huang 2003, Chung, Ahrens and Huang, 2003a and Chung, Huang and Ahrens 2003b). In this model, a conceptual metaphor is identified when there is a mapping between the concrete source domain and the abstract target domain. Using this model, examples discussed previously are IDEA IS BUILDING and ECONOMY IS A DISEASE. As a model based on the Contemporary Theory of Metaphor (CTM) (Lakoff and Johnson, 1980), the CM model extends beyond the CTM by providing the specific Mapping Principle (MP) between the source-target domain mapping. This Mapping Principle states in specific terms which aspect of the source and target domains is mapped in conceptual metaphors.

In this paper, the discussion of RECESSION will extend from the previous work on corpora analyses of conceptual metaphors. This study aims to define the source domains related to RECESSION through examining linguistic expressions occurring within the each source domain. Expressions such as ‘recover from recession,’ ‘plagued by recession’ and ‘painful recession’ will be examined using WordNet and an upper ontology (Suggested Upper Merged Ontology or SUMO) to define the relatedness of these expressions with their respective source domain. The incorporation of computational tool reduces the manual determination when sorting out the expressions according to source domains. Chung, Ahrens and Huang (2004) examined the target domain of CAREER and CULTURE. One aim of this paper is to verify the steps operationalized in Chung et al. (2004) by investigating another target domain --- RECESSION. The steps involved are: First, extract all metaphorical expressions from the corpora. Second, select the most concrete sense from WordNet (through the Academia Sinica Bilingual Ontological WordNet (BOW; available at <http://bow.sinica.edu.tw>). The WordNet senses lead to the related ontological nodes of SUMO. Third, examine the Wordnet explanation then later the SUMO nodes to decide which source domain

these expressions belong to. For instance, in Chung et al. (2004), they found that the phrase *shiyeyouhuan yishi* 事業憂患意識 ‘the worried consciousness of career’ is mapped onto the consciousness of PERSON. Through these steps, the linguistic items were sorted into different source domains. In the following section, this paper first outlines the theoretical framework of the analysis.

2.0 Conceptual Mapping (CM) Model

In the CM Model (Ahrens 2002), a conceptual metaphor is identified when a concrete source domain is mapped onto the abstract domain such as in IDEA IS BUILDING in the example (1). The abstract notion is placed in the square box and the underlined expression is the concrete concept of the BUILDING.

- (1) *nide lun dian gen ji shi sheme*
your argument base be what
'What is the foundation of your argument?'

Based on a group of conventional examples, the CM Model proposes a Mapping Principle (MP) for each conceptual metaphor. For instance, the MP for IDEA IS BUILDING is “*Idea is understood as building because buildings involve a (physical) structure and ideas involve an (abstract) structure*” (Ahrens 2002:279),” in which the ‘structure’ of the building is found consistently mapped in most of the metaphorical expressions.

Using this model Ahrens et al. (2003) and Chung et al. (2003a and 2003b) examined corpora examples of ‘economy’ in Chinese and English. In these studies, they proposed that the most prototypical (most frequent) mapping between the source and target domains helped underline the MPs. Since domain knowledge mappings involve structures, they adopt ontology to represent and verify knowledge structure. Ahrens et al. (2004) also used SUMO and WordNet to verify the MPs in the studies. This study will incorporate WordNet in addition to the CM Model and corpus analysis.

3.0 WordNet and SUMO

In the proposal of Niles and Pease (2003), the lexicons in WordNet and the SUMO nodes were linked and the semantic definitions to the SUMO nodes were provided. In SUMO, nodes are arranged hierarchically to represent human knowledge representation. Huang, Chang and Lee (2004) further developed the WordNet and SUMO system by providing a Chinese-English bilingual version of the system (BOW or Academia Sinica Bilingual Ontological WordNet (available at <http://bow.sinica.edu.tw>). This paper makes use of BOW in the analysis of conceptual metaphors.

4.0 Methodology

There were two main steps in the analysis of the metaphorical instances of RECESSION in this paper. The first step involved identifying the metaphorical expressions in the corpus. The second step involved verification of these linguistic expressions through WordNet and SUMO.

In the first step, a search based on the target term RECESSION was carried out in the 1995 Washington and Los Angeles Post through the Language Data Consortium (available at <http://www.ldc.upenn.edu/ldc/online/index.html>). The first 400 instances were extracted from the search and these instances were examined manually to determine the source domains within which a conceptual metaphor occurred. All the metaphorical expressions and their tokens are shown in Table 1.

Within the total 400 instances of ‘recession,’ 119 conceptual metaphors were found. As in Chung et al. (2004), the items were not sorted according to source domains at this stage. This is to avoid grouping the items manually to their respective source domains.

Table 1 : Metaphorical expressions related to RECESSION

Conceptual Metaphors	Tokens	Conceptual Metaphors	Tokens	Conceptual Metaphors	Tokens
burst out of	1	slide into	1	severe	5
climbing out of	1	slip back	1	recovery	4
deep	6	slip into	7	suffer	4
deepening	1	throw into	2	recover	3
deepest	2	thrust into	1	painful	2
drag into	1	tip into	2	exacerbate	1
drive back into	1	tip over	1	plague	1
drop into	2	tumbling into	1	derailed	1
emerging from	1	buffeted	1	transitory	1
enter	2	hit	4	(drive) up	1
fall into	2	bore the brunt	1	send	1
go down into	1	battered by	1	fuel	1
go into	4	protected	1	crushed by	1
in	3	protections	2	headed for	2
lapse back into	1	struggling	1	enmeshed	1
mire in	2	cushion	1	fueled by	2
out of	3	battling	1	to forestall	1
pitch back into	1	fending off	1	put into	3
push into	5	plunged...into	7	protracted	1
stung by	1	bit in	1	keep out of	2
nasty	1	healthy	1	growing	1

In the second step, all the linguistic expressions related to RECESSION were searched for in WordNet and SUMO using BOW. For each search, the most concrete sense of the linguistic item was selected. Each sense will lead to the related SUMO node and an examination of these nodes helps determine whether the list of words belong to the same source domain or not. An example of selected expressions (shaded) from Table 1 is shown in Table 2.

The highlighted expressions are the key phrases that help to determine to which source domains the expressions belong to. For instance, ‘fuel’ belongs to TRANSPORTATION and its process involves ‘Putting’ something into the transportation. ‘Buffeted’ and ‘battling’ are related to FIGHTING and their corresponding ontological nodes are ‘Motion’ and ‘Impacting’ (on the person being hit). ‘Plunged..into’ belongs to WATER and this is further proven with its ontological node of ‘Wetting.’ Lastly, ‘derailed’ belongs to TRANSPORTATION as well and the related ontological node is ‘Motion.’

Through this step, the expressions are sorted into their respective categories and this reduces the manual determination in the categorization process.

Table 2: WordNet Senses and SUMO Nodes Related to RECESSION

Expressions	WordNet Sense	Explanation of Meanings from WordNet	Related SUMO Nodes
fuel	5: obtain fuel*	provide with fuel; as of aircraft, ships, and cars	Putting(放置)
buffeted	1: strike	strike, beat repeatedly	Motion(移動)
battling	2: strike	strike violently and repeatedly	Impacting(影響)
plunged... into	5: soak	immerse into a liquid	Wetting(濕潤)
derailed	1: off track	of trains	Motion(移動)

[*Since BOW is a bilingual database, all English expressions that were searched in BOW will be provided with senses in Chinese. This paper translates the Chinese senses into English.]

In this following section, this paper first displays the sorting of items within the source domain of DISEASE based on manual analysis, and also points out the problems with manual sorting of source domains.

5.0 Manual Sorting of the Source Domains

The sorting of items in Table 1 is shown in Table 3 (see the next page). Focusing specifically on DISEASE, one finds that some expressions are ambiguous. For instance, ‘healthy,’ ‘discovery,’ ‘suffer,’ ‘recover’ and ‘painful’ can both apply to PERSON as well as DISEASE. A healthy patient can refer to both PERSON and DISEASE. Given this problems with the manual analysis, this paper proposes to use WordNet and SUMO to find out the relationships between related source domains (such as that between PERSON and DISEASE). This can be done through examining the WordNet and SUMO nodes, as demonstrated in Table 2.

Table 3 : Manually Sorted Metaphorical expressions According to Source Domains ION

Source Domains	Metaphorical Expressions Related to RECESSION
HOLE	burst out of, climbing out of, deep, deepening, deepest, drag into, drive back, into, drop into, emerging from, enter, fall into, go down into, go into, in, lapse back into, mire in, out of, pitch back into, push into, slide into, slip back, slip into, throw into, thrust into, tip into, tip over, tumbling into, put into, keep out of
WAR	buffeted, hit, bore the brunt, battered by, protected, protections, struggling, cushion, battling, fending off, to forestall
TRANSPORTATION	derailed, transitory, (drive) up, send, fuel, crushed by, headed for, enmeshed fueled by
PERSON	nasty, growing
DISEASE	protracted, severe, exacerbate, plague
PERSON/ DISEASE (?)	recovery, healthy, suffer, recover, painful
WATER	plunged...into
ANIMAL	stung by, bit in

The next section shows the results of analyses using BOW. The results of the finally sorted list for RECESSION IS DISEASE are shown first and the discussion will explain how the decision was made during the sorting process using BOW. This paper argues that the use of BOW helps to reduce

the ambiguity encountered by manual analyses.

6.0 Defining the Source Domains Using WordNet and SUMO

The results of the finally sorted list for RECESSION IS DISEASE will be discussed in the next sub-section, followed by RECESSION IS A PERSON.

6.1 RECESSION IS A DISEASE

In Table 4, all the expressions related to the conceptual metaphor RECESSION IS A DISEASE are listed.

Table 4: Expressions related to RECESSION IS DISEASE (See Appendix for examples)

Metaphors	Frequency	Metaphors	Frequency
severe	5	painful	2
recovery	4	exacerbate	1
suffer	4	plague	1
recover	3	healthy	1

Most of the expressions in Table 4 occur more than once in the corpus searched. Their WordNet and SUMO definitions in BOW were shown in Table 5.

Table 5: WordNet Senses and SUMO Nodes Related to RECESSION IS DISEASE

Expressions	WordNet Sense	Explanation of Meanings from WordNet	Related SUMO Nodes
severe	1: dangerous	causing fear or anxiety by threatening great harm	SubjectiveAssessmentAttribute
recovery	3: recovery	gradual healing (through rest) after sickness or injury	PhysiologicProcess
suffer	1: pain	feel pain or be in pain	PhysiologicProcess
recover	1: recover	get over an illness or shock	DiseaseOrSyndrome
painful	1: painful	causing physical discomfort	PathologicProcess
exacerbate	1: deteriorate	make worse	Decreasing
plagued	3: plague	a serious (sometimes fatal) infection transmitted by the bite of an infected rat flea (especially bubonic plague)	DiseaseOrSyndrome
healthy	2: healthy	having or indicating good health in body or mind; free from infirmity or disease	DiseaseOrSyndrome

From Table 5, all the related SUMO nodes are listed again in (2) below, with regrouping under their upper nodes.

2. (a) Biological Attribute/Processes

[PhysiologicProcess](#)
[DiseaseOrSyndrome](#)
[PathologicProcess](#)

(b) Physical Quantity

[Decreasing](#)

(c) Nominative Attribute

[SubjectiveAssessmentAttribute](#)

From (2) above, most of the expressions in Table 5 refer to a physical state that is becoming worse or sick. The only exceptional case is ‘severe,’ which is categorized under ‘SubjectiveAssessmentAttribute.’ The problematic category of ‘severe’ suggested another possible source domain for these expressions, i.e., PERSON. In fact, PERSON and DISEASE are closely related as ‘physical discomfort’ or ‘harm’ and ‘fear’ are part of the feeling of a person when someone is unwell. In order to find out whether DISEASE is subsumed under a general source domain of PERSON, this paper examines the definitions of the ontological nodes in (2), as shown in Table 6.

Table 6: Source Domain of DISEASE: Related SUMO Nodes and Their Definitions

SUMO Nodes	Definitions
PhysiologicProcess	A normal process of an Organism or part of an Organism .
DiseaseOrSyndrome	A BiologicalAttribute which qualifies something that alters or interferes with a normal process, state or activity of an Organism . It is usually characterized by the abnormal functioning of one or more of the host's systems, parts, or Organs.
PathologicProcess	A disordered process, activity, or state of the Organism as a whole, of a body system or systems, or of multiple Organs or Tissues. Included here are normal responses to a negative stimulus as well as pathologic conditions or states that are less specific than a disease. Pathologic functions frequently have systemic effects.
Decreasing	Any QuantityChange where the PhysicalQuantity is decreased.
SubjectiveAssessment Attribute	The Class of NormativeAttributes which lack an objective criterion for their attribution, i.e. the attribution of these Attributes varies from subject to subject and even with respect to the same subject over time. This Class is, generally speaking, only used when mapping external knowledge sources to the SUMO. If a term from such a knowledge source seems to lack objective criteria for its attribution, it is assigned to this Class.

Indeed, we find that most of the expressions in Table 4 are related to the ‘BiologicalAttribute’ or ‘PhysicalQuantity’ of the ‘Organism.’ In addition, this ‘Organism’ is one that is with the state of mind, i.e., one who has ‘SubjectiveAssessmentAttribute’ and can make subjective judgment. In our previous work on ECONOMY IS A PERSON (Ahrens et al. 2003, Chung et al. 2003a), there are nodes relating to DISEASE but they are subsumed under PERSON. This can be seen in Table 7 (see the next page), in which the expressions related to DISEASE (*symptom*, *dysfunctional*, *deteriorate* and *recover*) are ambiguous expressions that can relate to DISEASE or PERSON. In the previous work, they were not separated from the source domain of PERSON. There could be one reason behind this decision, i.e., the percentages of occurrences for these few items are low. Therefore, they do not form a separate source domain by themselves.

Upon discovering the relatedness of PERSON and DISEASE, the next step is to find out other expressions that belong to the source domain of PERSON, in addition to those in Table 4. The following section will deal with this part.

Table 7: ECONOMY IS A PERSON: Definitions from WordNet and SUMO

Items	WordNet Senses	Explanations	%	SUMO Nodes
<i>chengzhang</i> (growth)	6: growth	the process of an individual organism growing organically; a purely biological unfolding of events involved in an organism changing gradually from a simple to a more complex level	67 (55%)	Growth(生長)
<i>shuaitui</i> (dysfunction)	4: atrophy	any weakening or degeneration (especially through lack of use)	8 (7%)	PathologicProcess (病理歷程)
<i>chengzhangchi</i> (growth period)	x		2(2%)	
<i>bingzhuang</i> (symptoms)	2: disease	an impairment of health or a condition of abnormal functioning	1(1%)	DiseaseOrSyndrome (疾病或症候群)
<i>mingmai</i> (lifeblood)	1: lifeblood	the blood considered as the seat of vitality	2 (2%)	Blood(血液)
<i>shuaitui</i> (weakness and degeneration)	1: deterioration	a symptom of reduced quality or strength	1 (1%)	Damaging(損害)
<i>chengzhang</i> (grow)	2: age	grow old or older	21 (17%)	Growth(生長)
<i>shuaitui</i> (to become dysfunctional)	1: atrophy	undergo atrophy	5 (4%)	DiseaseOrSyndrome (疾病或症候群)
<i>fusu</i> (regain consciousness)	4: resuscitation	a revival of consciousness	9 (7%)	OrganismProcess (生命歷程)
<i>ehua</i> (deteriorate)	1: deteriorate	grow worse	4 (3%)	DiseaseOrSyndrome (疾病或症候群)
<i>huifu</i> (recover)	2: recuperate	get over an illness or shock	1 (1%)	DiseaseOrSyndrome (疾病或症候群)
		Total	121 (100%)	

Note: 'x' indicates that the related WordNet sense was not found in the SinicaBOW.

6.2 RECESSION IS A PERSON

In addition to the expressions in Table 3, two more expressions are related to PERSON. These expressions are shown in Table 8.

Table 8: Expressions related to RECESSION IS DISEASE (See the Appendix for examples)

RECESSION IS DISEASE	Frequency
grow	1
nasty	1

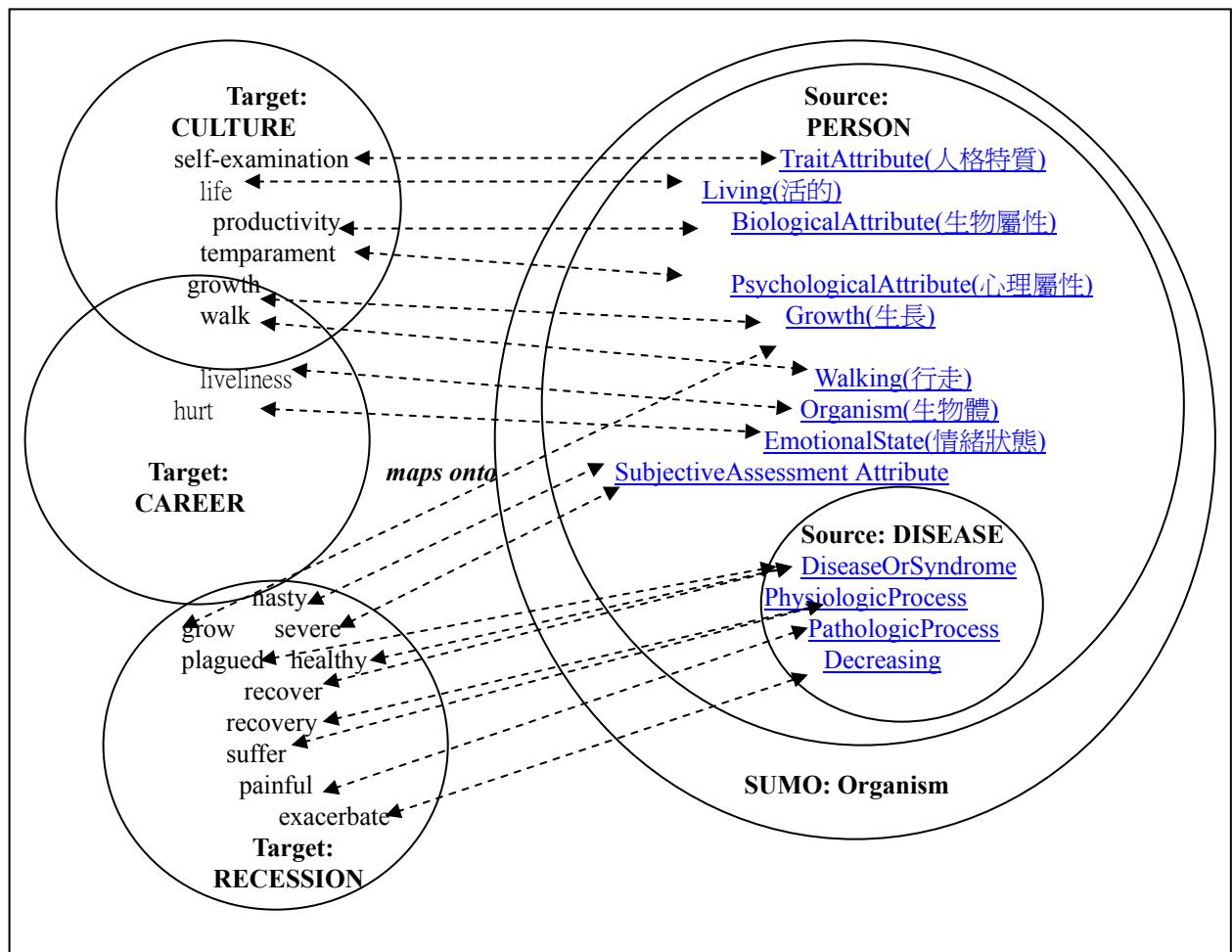
The search in Wordnet and SUMO shows the following results in Table 9.

Table 9: WordNet Senses and SUMO Nodes Related to RECESSION IS DISEASE

Expressions	WordNet Sense	Explanation of Meanings from WordNet	Related SUMO Nodes
grow	Sense 4	increase in size by natural process; of living matter, such as plants and animals	Growth
nasty	Sense 2	characterized by obscenity	SubjectiveAssessmentAttribute

In Table 9, one finds that ‘grow’ is related to the ‘living matter’ and the SUMO node of ‘Growth,’ which is defined as ‘The Process of biological development in which an Organism or part of an Organism changes its form or its size.’ Therefore, this expression is categorized under PERSON. For ‘nasty,’ the same ontological node is found with ‘severe,’ namely ‘SubjectiveAssessmentAttribute.’ As discussed earlier, this node reflects the ‘state of mind,’ and therefore is also related to PERSON. To produce a more complete picture, the relationship between PERSON and DISEASE as well as ‘Organism’ can be shown in Figure 2.

Figure 2: Representations of the Metaphorical Instances According to Source and Target Domains and their Relationship with SUMO



In this figure, DISEASE is subsumed under PERSON and both of these source domains have the corresponding node of ‘Organism.’ Since in this section, we have not included the examples related to RECESSION IS A PERSON. The following section will provide the other expressions from the source domain of PERSON.

7.0 Relatedness of DISEASE and PERSON

Ahrens et al. (2003) pointed out that WAR is related to COMPETITION by sharing the concept of ‘ViolentContest’ in SUMO. In this paper, we found that DISEASE is related to PERSON by sharing the concept of ‘Growth’ and ‘SubjectiveAssessmentAttribute.’ These discoveries about the overlapping of concepts are crucial in understanding human cognition.

8.0 Conclusion

From the analysis of the metaphorical expressions related to RECESSION, this paper found the interrelatedness of human concepts in expressing metaphors. The relationship is complex and through linguistic analysis, the model of human conceptualization becomes more understandable. The future aim of this study is to link all the source and target domains with their related concepts. Work in this direction will lead to systematizing the extraction of conceptual metaphors in the form of a lexical resource such as WordNet.

To summarize, the analysis in this paper, metaphorical expressions are found reflecting the metaphors RECESSION IS A DISEASE and RECESSION IS A PERSON. The sorting of the linguistic expressions into their respective source domains can be carried out through two main steps. First is the extracting of metaphors through corpora and second is the sorting out of source domains through WordNet and SUMO. In addition to these, the most important finding in this paper is the discovery of the relatedness between PERSON and DISEASE. This discovery can be referred back to our previous work in examining the metaphor ECONOMY IS A PERSON, in which there are nodes relating to DISEASE but they are subsumed under PERSON. Through this paper, we find the reason why both of these concepts are related, i.e., they are both referring to the physical condition of the ‘Organism’ and this ‘Organism’ is not any ordinary ‘Organism’ but that that has the state of mind with ‘SubjectiveAssessmentAttribute.’ Therefore, the source domain of PERSON is suggested rather than any other forms of living things.

To conclude, this study refines the examination of the conceptual metaphors using the CM Model by verifying the source domains using WordNet and SUMO. This study proposes a way to prove that a list of linguistic expressions can be found within a single source domain through observing the similar ontological nodes where these expressions occur. Such method provides linguistic evidence to identify specifically the knowledge representation when a conceptual metaphor is expressed. This study has implications on understanding language processing in cognitive science through using linguistic corpora.

For future work, we would like to incorporate psycholinguistic experiments to verify the metaphorical expressions that have been extracted through corpora. If the metaphorical expressions are found by the subjects to be related to the source and target domains chosen, this will help verifying the workability of the CM Model in predicting the occurrences of metaphors in corpora as well as textual analyses.

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Appendix

RECESSION IS DISEASE

- a) the budget in seven years might cause or exacerbate a RECESSION
- b) This isn't because a painful RECESSION
- c) the region's long and painful RECESSION
- d) His government has been plagued by an economic RECESSION
- e) many industries within it have recovered nicely from the RECESSION
- f) airline traffic began to recover from the RECESSION
- g) Japan's recovery from a long and harsh RECESSION
- h) recovery after four years of RECESSION
- i) The world's recovery from the global RECESSION
- j) since the economy was recovering from a RECESSION
- k) economists said that a severe RECESSION

- l) Mexico had entered a severe RECESSION

- m) the peso crisis results in a severe RECESSION
- n) as a result of the severe 1981-82 RECESSION

- o) Mexico also suffered a RECESSION

- p) Mexico also suffered a RECESSION

- q) and the nation suffered RECESSION

- r) One reason is a stronger economy and the recovery from the RECESSION

- s) The Japanese economy is suffering from a protracted RECESSION

- r) plunged the economy into a severe RECESSION

RECESSION IS A PERSON

- a) a growing RECESSION

- b) A healthy RECESSION

- c) The economy could by then be in a nasty RECESSION

References

- Ahrens, Kathleen. 2002. "When Love is Not Digested: Underlying Reasons for Source to Target Domain Pairings in the Contemporary Theory of Metaphor." In Yuchau E. Hsiao (ed.). *Proceedings of the First Cognitive Linguistics Conference*. Cheng-Chi University, pp. 273-302.
- Ahrens, Kathleen, Siaw-Fong Chung and Chu-Ren Huang. 2004. "From Lexical Semantics to Conceptual Metaphors: Mapping Principle Verification with WordNet and SUMO." In the *Proceedings of the 5th Chinese Lexical Semantics Workshop (CLSW-5)*, Singapore. pp. 99-106.
- Ahrens, Kathleen, Siaw-Fong Chung and Chu-Ren Huang. 2003. "Conceptual Metaphors: Ontology-based Representation and Corpora Driven Mapping Principles." In the *Proceedings of the ACL Workshop on the Lexicon and Figurative Language*. pp. 35-41.
- Chung, Siaw-Fong, Kathleen Ahrens and Chu-Ren Huang. 2004. "Using WordNet and SUMO to Determine Source Domains of Conceptual Metaphors." In the *Proceedings of the 5th Chinese Lexical Semantics Workshop (CLSW-5)*, Singapore. pp. 91-98.
- Chung, Siaw Fong, Kathleen Ahrens and Chu-Ren Huang. 2003a. "ECONOMY IS A PERSON: A Chinese-English Corpora and Ontological-based Comparison Using the Conceptual Mapping Model." In the *Proceedings of the 15th ROCLING Conference for the Association for Computational Linguistics and Chinese Language Processing*, National Tsing-Hwa University, Taiwan. pp. 87-110.
- Chung, Siaw-Fong, Chu-Ren Huang and Kathleen Ahrens. 2003b. "ECONOMY IS A TRANSPORTATION_DEVICE: Contrastive Representation of Source Domain Knowledge in English and Chinese." In *Proceedings of the special session of Upper Ontologies and Natural Language Processing (UONLP), 2003 International Conference on Natural Language Processing and Knowledge Engineering (NLP-KE)*, Beijing, China. pp. 790-796.
- Lakoff, George and Mark Johnson. 1980. *Metaphors We Live By*. Chicago and London: The University of Chicago Press.
- Huang, Chu-Ren, Ru-Ying Chang, Shiang-Bin Lee. 2004. "Sinica BOW (Bilingual Ontological Wordnet): Integration of Bilingual WordNet and SUMO." In the *Proceedings of the 4th International Conference on Language Resources and Evaluation (LREC2004)*, Lisbon, Portugal.
- Niles, I. and A Pease. 2003. "Linking Lexicons and Ontologies: Mapping WordNet to the Suggested Upper Merged Ontology." In *Proceedings of the 2003 International Conference on Information and Knowledge Engineering*, Las Vegas, Nevada.