Abstract. In this study, we explore the polysemy of da3 through the ontological conceptual structure found in SUMO. First, we divide several different senses for da3, clustering physical event senses and metaphorical event senses. In here, we only focus on physical event senses of da3. From the physical event senses of da3, we divide them into two main categories: 1) hit and 2) pump. We then use SUMO ontological concepts to identify these physical senses. Finally, we can observe the common patterns of the “hit” sense group and the “pump” sense group for da3.

Keywords: da3, Polysemy, ontology, lexical semantics

1. Introduction
In this study, we explore all possible concepts for physical event senses of da3 through the SUMO ontological concept system (Huang et al. 2004). According to previous work (Gao 2001), da3 is a basic verb in the large domain of physical action verbs in Chinese, as 1) it refers to the most basic action of the hand; and 2) at the same time it can refer to a wide-range of actions or events that involve physical contact of one kind or another. We will compare her analysis with the analysis we provide based on SUMO.

First, we collect our data from Sinica Corpus and check their senses from Chinese Wordnet. Next, we take these physical event senses of da3 into SUMO concept system (Huang et al. 2004) to find all possible concepts and distinguish them into different categories. Finally, we analyzed these concepts for semantic features which can help us to compare our analysis with the analysis in Gao’s study (2001).

2. Previous research
Regarding verb studies, previous research has focused on VV compound verbs in Modern Chinese (Hong and Huang, 2004), or on near synonyms in Modern Chinese (Chief et al, 2000; Huang et al. 2000; Liu 2002; Tsai, 2002; Huang and Hong, 2005). Also, some scholars have worked on da3 polysemy analyses. Da3 is one if the most frequently used verbs, being ranked 16 in the list of most frequently used verbs in Chinese (Bei and Zhang, 1988). Specifically, Gao (2001) explored the semantic properties of da3 and its prototypical meaning and categorized its semantic representations to show the systematic patterning of its meaning extensions.
3. **Motivation and Goals**

Language knowledge representation is a manifestation of the systematic contrasts found in human communication, which defies conventional description. Take modal verbs as examples. Modal verbs have similar semantic functions and cannot be easily distinguished in terms of their lexical senses. Therefore, they are considered to be interchangeable. Nevertheless, it is not uncommon that this kind of polysemy always has contrasts in usage, as we can see the contrast between *hui4* (know) and *hui4* (can) below:

\[(1a) \text{Taiwan factory to Germany exhibit time, so need could German and Chinese MOD persons, to communicate bridge.}\]

\*xul yao4 hui4/* neng2 de2 yu3 han4 zhong1 wen2 de5 ren2, zuo4 wei2 gou1 tong1 qiao2 liang1. communicate bridge

“When Taiwan factories exhibit in Germany, they so need some persons who could speak German and Chinese to communicate with other persons.”

\[(1b) \text{In class time, he will not speak German or Chinese with student communicate, because he worry himself no way complete express meaning.}\]

\*zhong1 wen2 han4 xue2 sheng1 gou1 tong1, yin1 wei4 ta1 pa4 zi4ji3 mei2 ban4 fa3 wan2 zheng3 biao3 da2 yi4 si1.\ no way complete express meaning.

“In the class time, he can’t communicate with his students in German or Chinese, because he worries that he can’t completely express his meaning.”

Considering the lexical sense of modal verb polysemy and its natural language use, *hui4* means both “know” or “can”. As defined, we notice that they differ from each other, even though they share similar concept.

This paper will investigate the lexical semantic relations between each sense of *da3* polysemy (excluding metaphorical senses) by studying their sense distinction, word formation collocation, and distribution pattern.

4. **SUMO**

In this study, we use Suggested Upper Merged Ontology (SUMO) to analyze all concepts for *da3*. We find out all possible concepts and divide different them into different categories.

WordNet is inspired by current psycholinguistic and computational theories of human lexical memory (Fellbaum (1998), Miller et al. (1993)). English nouns, verbs, adjectives, and adverbs are organized into synonym sets, each representing one underlying lexicalized concept. Different semantic relations link the synonym sets (synsets). The version of WordNet that Sinica BOW implemented is version 1.6, with nearly 100,000 synsets.

In Sinica BOW, each English synset was given up to 3 most appropriate Chinese translation equivalents. In cases where the translation pairs are not synonyms, their semantic relations are
marked (Huang et al. 2003). The bilingual WordNet is further linked to the SUMO ontology. We use the semantic relations in bilingual resource to expand and predict domain classification when it cannot be judged directly from a lexical lemma.

5. Data collection

From Sinica Corpus and Gigaword Corpus, we find out several patterns for da3. According to the Chinese Wordnet Group analysis (Huang et al., 2003), there are 114 senses which include physical activity senses, metaphor, metonymy and extension senses. In this study, we want to focus on physical activity senses, but not metaphor, metonymy and extension senses. Da3 has 35 physical event senses listed, along with 79 additional senses. We will take focus on the physical activity senses.

6. Data analysis

The analysis, based on the Sinica Corpus, Gigaword Corpus and the criteria proposed by Huang et al. (2003) to differentiate the lexical meaning, presents several different senses for da3.

<table>
<thead>
<tr>
<th>Table 1: The analysis of da3 from Chinese Wornet Group</th>
</tr>
</thead>
</table>
| 打1 | da3 | 乗  Rays
| 詞義1: [及物動詞・VC] 用於催促或作持物施用於某對象。 {up, 01496422V} |
| 例句1：馬上就打一下桌子，整個桌子馬上變成木屑一片。 |
| 例句2：我用他氣身子用力<fr>了踢他一下，可是，還是被他跑掉了，真是可惜。 |
| 例句3：他用扁擔用力<fr>門板軟幾下，然後說：是我幫你的人嗎？卒程來抓你的人呢？ |
| 詞義2: [及物動詞・VC] 名詞・名詞 可能的強制或作持物施用於某對象。 {hit, 00960484V} |
| 例句1: 我跟我媳婦也是從小<fr>到大。越<fr>感情越好。 |
| 例句2：但因為他<fr>人也是為了完成國家任務，所以發氣兩是會理解的。 |
| 例句3：母親忽然沉下臉<fr>他一下千卓，並告訴他不能開月亮亮娘。會顧手家的。 |
| 例句4：在少年所第四年時，年少可年必須接受<fr>儀的儀式，今年這項儀式特別放為遊客體驗。 |
| 詞義3: [及物動詞・VC] 易碎物品因受到催促而破碎。 {break, 00231588V} |
| 例句1：在高速公路不知為何天牛飛來一石，把播風的播<fr>成一個小圓洞。 |
| 例句2：在這裡，我把玻璃<fr>了，又不敬我將用它們來製造光亮，傳播光亮。 |

Among these 35 physical activity senses of da3, we divide two main physical event senses for da3: 1) hit and 2) pump such as below:
(2) 母親忽然沉下臉<打>他一下手背，並告誡他不能指月亮娘娘，會爛耳朵的。

Mother suddenly sink down face hit he one time hand,

bing4 gao4 jie4 ta1 bu4 neng2 zhi3 yue4 liang4 niang2 niang5,
and warn he can’t point moon queen,

will decayed ear MOD.

“His mother suddenly becomes long-faced and hits him on the back of his hand, then warned him that he will get rotting ears if he points to the moon.”

b. 這時每一鞭都如<打>在她的身上一般痛楚。

This time every whipped all like whip she MOD

shen1 shang4 yi1 ba1 tong4 chu3
body general pain.

“At this moment, every whipped whip pains her like she is being whipped.”

(3) 為了防止車輛陷進沙地，不要把輪胎氣<打>得太足。

For prevent cars s tuck into sand, don’t let

lun4 tai1 qi4 da3 de2 tai4 zu2.
tires gas pump too full.

“Do not pump the tires too full to avoid the cars being stuck in the sand.”

Moreover, in “hit” sense of da3, we also can divide two different categories: 1) hand and hand holdings and 2) force and impact. Then, in the second category, we can divide force and impact in additional sub-categories: 1) direct contact and 2) contact by injection.

(4) 他用力<打>門板好幾下，然後說：我是如此的人嗎？

He use force beat door plank several times, then say: I

shi4 ru3 ci3 de5 ren2 ma5?
is this MOD man.

“He beat forcefully the door plank several times and then said: Am I a person like this?”
When drug addicts take drugs, they usually rest the needle in the vein instead of injecting the drug directly.

“A happy girl full of dreams due to an injury happened, has to undergo an operation that puts nails into her spine to straighten up the wiggled spine, which is very similar to clothing being hanged on hangers.”

We follow these categories to explore the common features for these physical event senses of da3 in the SUMO concept system.

7. Data analysis

According to Gao’s study (2001), she based on sense division principle to analyze da3, generalized the patterns and features of the polysemy of da3, and obtained five major categories.

Gao (2001) mentioned the prototypical meaning of da3. She talked about in the prototypical case the most central part of the meaning of da3 is the physical contact between an agent’s hands and a concrete item. In her paper, she also mentioned that there were three different semantic elements for da3 such as 1) hand, hand holdings or instrument; 2) force direction and 3) impact.

From all our senses of da3, we can divide two main categories: 1) physical event senses such as da3 zhuo1 zi5 (to tap the table), da3 shou3 bei4 (to hit the back of a hand), ba3 wan3 da3 po4 (to break a bowl)... and so on and 2) metaphorical event senses such as da3 jiao1 dao4 (to develop the interpersonal relationship/ to come into contact with), da3 dian4 hua4 (to call), da3 ke1 shui4 (to nod)... and so on. However, in this study, we just focus on physical event senses. Based on Gao’s analysis (2001), we know that physical event senses of da3 include these features such as hand, hand holdings, instrument; force and impact, so we thoroughly examine our physical event senses by SUMO concept system. In here, we can observe that there are several concept of SUMO for physical event senses of da3 such as below table:
Table 2: SUMO concept for physical event senses of *da3*

<table>
<thead>
<tr>
<th>The phrase of <em>da3</em> in Chinese</th>
<th>Translation in English</th>
<th>SUMO concept</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>da3</em> shou3 bei4</td>
<td>to <em>hit</em> the back of a hand</td>
<td>impacting</td>
</tr>
<tr>
<td><em>da3</em> zhuo1 zi5</td>
<td>to <em>tap</em> the table</td>
<td>touching</td>
</tr>
<tr>
<td>ba3 wan3 <em>da3</em> po4</td>
<td>to <em>break</em> a bowl</td>
<td>impacting</td>
</tr>
<tr>
<td>lun4 tai1 <em>da3</em> qi4</td>
<td>to <em>pump</em> gas into tire</td>
<td>putting</td>
</tr>
<tr>
<td><em>da3</em> shi1 li4 kang1</td>
<td>to <em>inject</em> silicon</td>
<td>putting</td>
</tr>
</tbody>
</table>

We follow SUMO concept system to obtain these concepts of *da3*. These concepts are such as impacting, touching, putting. We also know that the SUMO concept identifications correspond with the divisions and definitions in WordNet. For this reason, we need make sure the WordNet definitions of these concepts for physical event senses of *da3*.

Table 3: WordNet definition and SUMO concept for physical event senses of *da3*

<table>
<thead>
<tr>
<th>The English lemma of <em>da3</em></th>
<th>WordNet definition</th>
<th>SUMO concept</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>hit</em></td>
<td>deal a blow to, either with the hand or with an instrument</td>
<td>impacting</td>
</tr>
<tr>
<td><em>tap</em></td>
<td>a light touch or stroke</td>
<td>touching</td>
</tr>
<tr>
<td><em>break</em></td>
<td>destroy the integrity of; usually by force; cause to separate into pieces or fragments</td>
<td>impacting</td>
</tr>
<tr>
<td><em>pump</em></td>
<td>deliver forth</td>
<td>putting</td>
</tr>
<tr>
<td><em>inject</em></td>
<td>force or drive (a fluid or gas) into by piercing</td>
<td>putting</td>
</tr>
</tbody>
</table>

In this way, we obtain the common semantic elements from SUMO concepts for physical event senses of *da3*. The semantic features are hand, instrument, and force. In addition, we can detect when we do these actions, the manners are impact, direct contact or contact by injection. We may visual this as:

1. Agent + hand, hand holding or instrument --> Patient or Object

2. Agent --> impact (direct contact) --> Object

3. Agent --> force (contact by injection) --> Patient or Object

From the SUMO concept system for the physical event senses of *da3*, we see these concepts imply the following semantic features: hand, hand holdings, instrument; force and impact (direct contact or contact by injection). We use SUMO concept system to find out all possible concepts for the physical event senses of *da3*, while Gao (2001) used semantic features to analyze and explain physical actions of *da3*. Following our analyses, explanations, comparison...
and demonstrations, we discover that our analyses correspond with Gao’s study result for the physical event senses of da3.

8. Conclusion
In this study, we explore all possible concepts for physical event senses of da3 through the SUMO concept system. These concepts imply some semantic features: hand, hand holdings, instrument; force and impact. We use concept-based approach, while Gao (2001) took a semantic-feature-based approach to examine the physical event senses of da3. We also compare our analysis with Gao’s (2001) and find our results are very similar. This leads us to propose that a concept-base approach is a viable one when exploring the sense of polysemous verbs in Chinese.

References
蔡美智. 2002。 講「清楚」、說「明白」—漢語動詞近義、多義、詞義劃分研究。第三屆中文詞彙語意學研討會。台北，南港：中央研究院。
**Website Resources**


English Word Sketch Engine: [http://www.sketchengine.co.uk/](http://www.sketchengine.co.uk/)
