Lecture 7: Verb Classes

Lexical Semantics and Discourse Processing
MPhil in Advanced Computer Science

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Reading:

- Jurafsky and Martin, chapters 19.4 and 12.4.2
- Cruse, page 139, 4.12; 10.5; 10.7; p279ff
- Lin and Korhonen (EMNLP, 2009)

Aspects of similarity in verbs

In terms of phenomena, Cruse (1979) notes that. . .

- They can be (near) **synonyms**, such as *pass away–die*
- They can be **hyponyms** of each other, such as *walk–move*
- They can be **opposites**
  - in the sense of **reversives** such as *enter–leave*, *mount–dismount*; chapter 10.5; 11.3 (polarity aspect)
  - in the sense of **indirect converses** such as *bequeath–inherit*; *give–receive*; chapter 10.7

WordNet: Verbal Relations

Wordnet distinguishes four types of lexical relations between verbs:

- Hyponymy (*murder – kill*)
- Troponymy (*lisp – talk*)
- Entailment (*snore – sleep*); this includes causal relationships

Verbal meronymy exists, but is rare (and not encoded in WN):

- *Washing consists of soaking, scrubbing, wringing out, (possibly) drying.*

Lexical relationships between verbs in WordNet (and in the world!) are weak and unsystematic in comparison to those in operation between nouns.

Hyponymy, Troponymy, Entailment

X is a verbal **hyponym** of *Y* if the following test frame succeeds: *"To X is necessarily to Y"*:

- *To murder someone is necessarily to kill them.*
- *To strangle someone is necessarily to kill them.*

Troponymy: subtype of hyponymy; being a manner of an action. (Cruse (1979) calls this property **verbal taxonomy**.)

- Test frame: *"To X is a way of Y-ing"*
- *To strangle/?murder somebody is a way of killing.*
- *To crawl/?travel is a way of moving.*

Thus, *murder* is not a troponym of *kill*, but *strangle* is. *Murder* is a troponym of *commit a crime*.
Entailment: *kill* is in a causal relationship with *die*.

Overview: Verb classes in NLP

- Verbs with similar semantics often undergo the same **diathesis alternations**. → **Levin (1993)** has exploited this when manually deriving a semantic classification of verbs.
- Verbs with similar semantics often have similar **subcategorisation** behaviour → Automatic approaches for clustering verbs by their subcategorisation patterns; e.g., Schulte (2006); Lin and Korhonen (2009)
- Verbs with similar semantics tend to have similar **selectional restrictions**. → Automatic methods for quantifying the difference between two verbs' **selectional restrictions**; e.g., Resnik (1995)
- Verbs with similar semantics often have similar participants in the actions they denote – (more about **thematic roles** and **semantic role labelling** in lecture 8)

Linguistic Selection and Selectional Restrictions

Linguistic selection is a phenomenon which operates in different constructions differently (cf. Cruse, chapter 4.12).

- In **head–complement constructions**, a verb (selector) selects its arguments (selectees).
- In **head–modifier constructions**, a modifier (selector) selects its head (selectee).
- In **verb–subject constructions**, things are not as clear, but there are arguments that the verb is the selector (cf. Cruse page 106)

Selectors presuppose semantic traits in their selectees.

Collocational restrictions vs selectional restrictions

Selectional restrictions: Violation of selector's presuppositions results in paradox or incongruity.

- This cannot be resolved by replacement with synonym
- But it can be resolved by replacement with near hypernym (in the case of paradox). Examples:
- *my male ?aunt/relation* – paradox; resolvable.
- *the ?cat/animal barked* – paradox; resolvable.
- *a lustful ?affix/(?)thing* – inconguity; unresolvable (unless by very abstract concept).

Collocational restrictions: Violation of selector's presuppositions results in inappropriateness.

- Inappropriateness can be resolved by replacement with synonym.
- *The aspidistra ?kicked the bucket/died.*

Unpredictability of collocational restrictions

	unblemished	spotless	flawless	immaculate	impeccable
performance	-	-	X	X	X
argument	-	-	X	-	?
complexion	?	?	X	-	-
behaviour	-	-	-	-	X
kitchen	-	X	-	X	-
record	X	X	X	?	X
reputation	?	X	-	?	-
taste	-	-	X	?	X
order	-	-	-	X	X
credentials	-	-	-	-	X

Quantifying selectional preferences: Resnik 1995

- **Selectional preference strength** $S_R(v)$ **of verb** v: the degree of selectiveness of a predicate about the semantic class of its arguments; expressed in bits of information.
- Semantic classes c are WordNet synsets
- $S_R(v)$ is based on difference in distribution between
  - $P(c)$ – likelihood of direct object of falling into semantic class c
  - $P(c|v)$ – likelihood of direct object of falling into semantic class c if associated with verb v
- Use KL divergence to determine $S_R(v) = D(P(c|v)||P(c))$:

$$S_R(v) = \sum_c P(c|v) log \frac{P(c|v)}{P(c)}$$

Resnik (1995), ctd

- Selectional association between a verb and a class (synset) is the **relative** contribution to the overall selectionality of the verb

$$A_R(v,c) = \frac{1}{S_R(v)} P(c|v) log \frac{P(c|v)}{P(c)}$$

Example result:

Verb	Dir. Obj. (preferred)	Assoc	Dir Obj. (dispreferred)	Assoc
read	WRITING	6.80	ACTIVITY	-0.20
write	WRITING	7.26	COMMERCE	0
see	ENTITY	5.79	METHOD	-0.01

- The Resnik algorithm can be used to perform WSD.

Diathesis alternations

- *John broke the window.*
- *The window broke.*
- *John broke the window with a rock.*
- *The rock broke the window.*
- *The window was broken by John.*

Other verbs following this pattern?

Dative alternation

- *Doris gives flowers to the headmistress.*
- *Doris gives the headmistress flowers.*

This pattern is meaning-preserving and covers several semantic classes:

- verbs of "future having": *advance, allocate, offer, owe, lend*
- verbs of "sending": *forward, hand, mail*
- verbs of "throwing": *kick, pass, throw*

Strong correlation between syntactic behaviour and semantic class.

Levin's (1993) Verb Classification

- Based on 79 diathesis alternations
- Covers 3200 verbs in 48 main classes (191 subdivided ones)
- *break* class contains: *break, chip, crack, crash, crush, fracture, rip, shatter, smash, snap, splinter, split* and *tear.*
- Diathesis alternations are difficult to detect automatically
- But: we can use the fact that similar alternations result in similar SCF (subcategorisation frames).

Clustering according to subcategorisation frames

- Lin Sun, Anna Korhonen: Improving Verb Clustering with Automatically Acquired Selectional Preferences. EMNLP 2009.
- Use features such as 168 Subcategorisation frames, lexical cooccurrence (4 words before and after verb), type and frequency of nouns and prepositions in the subject, object, and indirect object relation; type and frequency of prepositions in indirect object relation; SCP with tense.
- Use selectional preferences, which are acquired prior to verb clustering in a separate clustering step.
- Use spectral clustering algorithm
- Far superior results to previous literature (unsupervised); 0.58 F-measure (previously 0.31) on standard testset T1; 0.80 F-measure on T2 (previously best unsupervised 0.51)

Reading

- Selectional restrictions: J&M; 19.4 and 20.4.2
- Phenomena: Cruse 4.12 (selection); 10.5 (reversives) 10.7 (indirect converses) and p. 279ff (collocational selections)
- Lin and Korhonen (2009)