Stretching the Meaning of Words: Inputs for Lexical Resources and Lexical Semantic Models

Elisabetta Ježek
University of Pavia

Rome, December 11-13, 2017
Fourth Italian Conference of Computational Linguistics
CLiC-it

Tutorial Outline

- Basics on lexicon, lexical structure and lexical relations.

Tutorial Outline

- Basics on lexicon, lexical structure and lexical relations.
- Varieties of linguistic evidence in favour of context-sensitive models of lexical meaning.

Tutorial Outline

- Basics on lexicon, lexical structure and lexical relations.
- Varieties of linguistic evidence in favour of context-sensitive models of lexical meaning.
- Lexical information and its interplay with cognition and pragmatic inference.

Tutorial Outline

- Basics on lexicon, lexical structure and lexical relations.
- Varieties of linguistic evidence in favour of context-sensitive models of lexical meaning.
- Lexical information and its interplay with cognition and pragmatic inference.
- The meaning of verbs and its representation in compositional vector space models.

Tutorial Outline

- Basics on lexicon, lexical structure and lexical relations.
- Varieties of linguistic evidence in favour of context-sensitive models of lexical meaning.
- Lexical information and its interplay with cognition and pragmatic inference.
- The meaning of verbs and its representation in compositional vector space models.
- Concluding observations and lines of research.

Questions

- How is the structure of the LEXICON?

Questions

- How is the structure of the LEXICON?
- The lexicon is not a DICTIONARY.

Questions

- How is the structure of the LEXICON?
- The lexicon is not a DICTIONARY.
- How is lexical information stored (and processed) in our MIND?

Questions

- How is the structure of the LEXICON?
- The lexicon is not a DICTIONARY.
- How is lexical information stored (and processed) in our MIND?
- What is LEXICAL INFORMATION?

Questions

- How is the structure of the LEXICON?
- The lexicon is not a DICTIONARY.
- How is lexical information stored (and processed) in our MIND?
- What is LEXICAL INFORMATION?
- How does lexical information interact with grammar, PRAGMATICS and the ontological/CONCEPTUAL dimension?

How to approach these questions

- Gather evidence from large digitalized and annotated corpora, and also from speakers' judgements.

How to approach these questions

- Gather evidence from large digitalized and annotated corpora, and also from speakers' judgements.
- Combine empirical evidence with the formalisms developed in the field of general and theoretical linguistics.

How to approach these questions

- Gather evidence from large digitalized and annotated corpora, and also from speakers' judgements.
- Combine empirical evidence with the formalisms developed in the field of general and theoretical linguistics.
- Merge theoretical accounts with computational analysis.

Lexicalization 1

- Process based on which, in a given language, a certain **information content** is associated with a lexical form.

Lexicalization 1

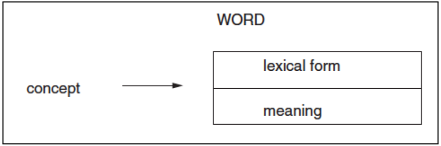
- Process based on which, in a given language, a certain **information content** is associated with a lexical form.
- The English verb *to show* lexicalizes the concept of ‘make see’.

Lexicalization 1

- Process based on which, in a given language, a certain **information content** is associated with a lexical form.
- The English verb *to show* lexicalizes the concept of ‘make see’.
- The Frisian verb *klunen* lexicalizes the concept of ‘to walk on skates avoiding those spots along the route where the ice is dangerous’.

Lexicalization 1

- Process based on which, in a given language, a certain **information content** is associated with a lexical form.
- The English verb *to show* lexicalizes the concept of ‘make see’.
- The Frisian verb *klunen* lexicalizes the concept of ‘to walk on skates avoiding those spots along the route where the ice is dangerous’.



Lexicalization 2

- Process according to which **a sequence of words** that frequently recur together in texts acquires the status of **lexical unit** with an autonomous meaning.

Lexicalization 2

- Process according to which **a sequence of words** that frequently recur together in texts acquires the status of **lexical unit** with an autonomous meaning.
- The sequence *per haps* in fifteenth-century English - with the plural of a disappeared noun *hap* we may still recognize in *happening* - has become lexicalized and has produced a new lexical item in Modern English, that is, *perhaps*.

Lexicalization 2

- Process according to which **a sequence of words** that frequently recur together in texts acquires the status of **lexical unit** with an autonomous meaning.
- The sequence *per haps* in fifteenth-century English - with the plural of a disappeared noun *hap* we may still recognize in *happening* - has become lexicalized and has produced a new lexical item in Modern English, that is, *perhaps*.
- Engl. *a happy go lucky attitude*.

Lexicalization 2

- Process according to which **a sequence of words** that frequently recur together in texts acquires the status of **lexical unit** with an autonomous meaning.
- The sequence *per haps* in fifteenth-century English - with the plural of a disappeared noun *hap* we may still recognize in *happening* - has become lexicalized and has produced a new lexical item in Modern English, that is, *perhaps*.
- Engl. *a happy go lucky attitude*.
- **Univerbation** (Cruse 2011, 82-91; Booij 2007, 19).

Lezicalization 3

- **Word forms** that acquire the status of **autonomous words**.

Lezicalization 3

- **Word forms** that acquire the status of **autonomous words**.
- Fr. *pendant*, originally the present participle of the verb *pendre* ‘to hang’, is used today primarily as a preposition, as in “pendant le diner” ‘during dinner’.

Lexicalization 4

- **Two usages** of a word become semantically distinct to the point that the link between the two is no longer available to the speaker, and they are perceived as **two separate words**.

Lexicalization 4

- **Two usages** of a word become semantically distinct to the point that the link between the two is no longer available to the speaker, and they are perceived as **two separate words**.
- Engl. *chair* 'seat' ("a comfortable chair") and *chair* 'position of authority' ("the department chair")

Lexicalization 4

- **Two usages** of a word become semantically distinct to the point that the link between the two is no longer available to the speaker, and they are perceived as **two separate words**.
- Engl. *chair* 'seat' ("a comfortable chair") and *chair* 'position of authority' ("the department chair")
- It. *penna* 'feather' ("una penna d'oca" 'a goose feather') and *penna* 'pen' ("una penna d'oro" 'a golden pen').

Lexicalization 5

- Word that **exists** in a language.

Lexicalization 5

- Word that **exists** in a language.
- English has **two lexicalizations** to express the state of being able or allowed to do what one wants to do, i.e. *liberty* and *freedom*.

Synthetic Lexicalization

- A **combination of concepts** is expressed by a single word.

Synthetic Lexicalization

- A **combination of concepts** is expressed by a single word.
- MOTION and INSTRUMENT: German *gehen* (feet), *fahren* (vehicles), *reiten* (horses); Dutch *schaatsen* (skate), *fietsen bike* (bicycles).

Synthetic Lexicalization

- A **combination of concepts** is expressed by a single word.
- MOTION and INSTRUMENT: German *gehen* (feet), *fahren* (vehicles), *reiten* (horses); Dutch *schaatsen* (skate), *fietsen bike* (bicycles).
- MOTION, MANNER and INSTRUMENT: Engl. *run* (feet, high speed), *march* (feet, with a regular measured tread), *limp* (feet, with difficulty).

Analytic Lexicalization

- A concept that can be analyzed as unitary is expressed by **multiple words**.

Analytic Lexicalization

- A concept that can be analyzed as unitary is expressed by **multiple words**.
- Engl. *have dinner*, *make an effort*, *get ready*, *get sick*, *become aware*, *fall asleep*, *be late*, *be ashamed*.

Analytic Lexicalization

- A concept that can be analyzed as unitary is expressed by **multiple words**.
- Engl. *have dinner*, *make an effort*, *get ready*, *get sick*, *become aware*, *fall asleep*, *be late*, *be ashamed*.
- Both processes present in the same language: *dine/have dinner*, *stimulate/provide a stimulus*, *consider/take into consideration*, *distinguish/make a distinction*, *exit/go out*.
- Crosslinguistic evidence: Engl. *be late* / It. *tardare*.

Descriptive Lexicalization

- The content is **described**.

Descriptive Lexicalization

- The content is **described**.
- *stone* ‘that which has become hard’, *basket* ‘that which is woven’ (Cahuilla, Uto-Aztec language of Southern California, Seiler 1975).

Descriptive Lexicalization

- The content is **described**.
- *stone* ‘that which has become hard’, *basket* ‘that which is woven’ (Cahuilla, Uto-Aztec language of Southern California, Seiler 1975).
- *table* ‘she (impersonal pronoun) prepares food on it’; *horse* ‘he drags logs’ (Cayuga, Iroquois language of Canada, Sasse 1993).

Labeling Lexicalization

- The content is **labeled**.

Labeling Lexicalization

- The content is **labeled**.
- *palace* (vs. *building*)

Labeling Lexicalization

- The content is **labeled**.
- *palace* (vs. *building*)
- *doctor* (vs. *worker*)

Word types

- Simple words.

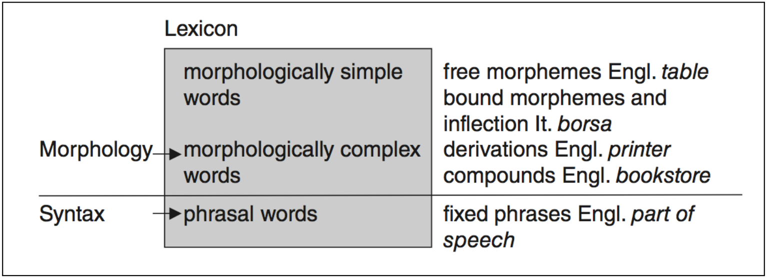
Word types

- Simple words.
- Complex words with morphological structure.

Word types

- Simple words.
- Complex words with morphological structure.
- Complex words with syntactic structure.

Word types


Lexicon
morphologically simple words
free morphemes Engl. *table*
bound morphemes and inflection It. *borsa*
Morphology
morphologically complex words
derivations Engl. *printer*
compounds Engl. *bookstore*
Syntax
phrasal words
fixed phrases Engl. *part of speech*

Word types

	Lexicon	
	incorporated compounds	Engl. *breastfeed*
Morphology →	juxtaposed compounds	Engl. *love hate, family love*
Syntax →	fixed phrases	Engl. *part of speech*
	ordinary phrases	Engl. *the first part of his speech*

Multiwords

- Expressions that are made up of multiple words and yet exhibit **a word-like behavior** (tests for wordhood, cf. Jezek, 2016, 25-28).

Multiwords

- Expressions that are made up of multiple words and yet exhibit **a word-like behavior** (tests for wordhood, cf. Jezek, 2016, 25-28).
  - Multi-word lexical units. (Zgusta 1967 and 1971)

Multiwords

- Expressions that are made up of multiple words and yet exhibit **a word-like behavior** (tests for wordhood, cf. Jezek, 2016, 25-28).
  - Multi-word lexical units. (Zgusta 1967 and 1971)
  - Multi-word expressions. (Calzolari et al 2002)

Multiwords

- Expressions that are made up of multiple words and yet exhibit **a word-like behavior** (tests for wordhood, cf. Jezek, 2016, 25-28).
  - Multi-word lexical units. (Zgusta 1967 and 1971)
  - Multi-word expressions. (Calzolari et al 2002)
  - Lexicalized phrases. (Sag et al 2002)

Multiwords

- Expressions that are made up of multiple words and yet exhibit **a word-like behavior** (tests for wordhood, cf. Jezek, 2016, 25-28).
    - Multi-word lexical units. (Zgusta 1967 and 1971)
    - Multi-word expressions. (Calzolari et al 2002)
    - Lexicalized phrases. (Sag et al 2002)
    - Idioms or idiomatic expression.

Multiwords

- Expressions that are made up of multiple words and yet exhibit **a word-like behavior** (tests for wordhood, cf. Jezek, 2016, 25-28).
    - Multi-word lexical units. (Zgusta 1967 and 1971)
    - Multi-word expressions. (Calzolari et al 2002)
    - Lexicalized phrases. (Sag et al 2002)
    - Idioms or idiomatic expression.
    - Constructional idiom (Jackendoff 2002), idiomatic construction (Nunberg et al 2004), e.g. Engl. *bring an issue* | *a concern* | *a fact into light*.

Multiwords

- Expressions that are made up of multiple words and yet exhibit **a word-like behavior** (tests for wordhood, cf. Jezek, 2016, 25-28).
  - Multi-word lexical units. (Zgusta 1967 and 1971)
  - Multi-word expressions. (Calzolari et al 2002)
  - Lexicalized phrases. (Sag et al 2002)
  - Idioms or idiomatic expression.
  - Constructional idiom (Jackendoff 2002), idiomatic construction (Nunberg et al 2004), e.g. Engl. *bring an issue* | *a concern* | *a fact into light*.
- Continuum ranging from lexicon to syntax.

Lexical Information

meaning
sound structure
morphological structure
?word class

Lexical Information

Shared by all words:

meaning
sound structure
morphological structure
?word class

Specific to words which function as predicates:

argument structure
Aktionsart

Classes in the Lexicon

- Major classes are generally defined based on lexical category: verbs, nouns, adjectives, adverbs, etc.

Classes in the Lexicon

- Major classes are generally defined based on lexical category: verbs, nouns, adjectives, adverbs, etc.
- This is **a syntactic criterion**.

Classes in the Lexicon

- Major classes are generally defined based on lexical category: verbs, nouns, adjectives, adverbs, etc.
- This is **a syntactic criterion**.
- Subclasses may be identified both on syntactic and semantic grounds, and at the interface.

Classes in the Lexicon

- Major classes are generally defined based on lexical category: verbs, nouns, adjectives, adverbs, etc.
- This is **a syntactic criterion**.
- Subclasses may be identified both on syntactic and semantic grounds, and at the interface.
- Why is it difficult to identify subclasses of words **on semantic grounds**?

Classes in the Verbal Lexicon

- The difficulties encountered in classifying verbs in semantic terms derive primarily from the fact that the meaning of verbs consists of a **bundle of features** with different **semantic prominence**.

Classes in the Verbal Lexicon

- The difficulties encountered in classifying verbs in semantic terms derive primarily from the fact that the meaning of verbs consists of a **bundle of features** with different **semantic prominence**.
- Consider verbs that describe **a change in position** such as *sit*.

Classes in the Verbal Lexicon

- The difficulties encountered in classifying verbs in semantic terms derive primarily from the fact that the meaning of verbs consists of a **bundle of features** with different **semantic prominence**.
- Consider verbs that describe **a change in position** such as *sit*.
- The action of sitting involves the motion of the person performing the action (a motion we may characterize as "internal").

Classes in the Verbal Lexicon

- The difficulties encountered in classifying verbs in semantic terms derive primarily from the fact that the meaning of verbs consists of a **bundle of features** with different **semantic prominence**.
- Consider verbs that describe **a change in position** such as *sit*.
- The action of sitting involves the motion of the person performing the action (a motion we may characterize as "internal").
- However, this is not the prominent feature in the meaning of the verb, and it would appear **odd** to classify *sit* as a **verb of motion** on a par with *enter* and *exit*.

Classes in the Verbal Lexicon

- The difficulties encountered in classifying verbs in semantic terms derive primarily from the fact that the meaning of verbs consists of a **bundle of features** with different **semantic prominence**.
- Consider verbs that describe **a change in position** such as *sit*.
- The action of sitting involves the motion of the person performing the action (a motion we may characterize as "internal").
- However, this is not the prominent feature in the meaning of the verb, and it would appear **odd** to classify *sit* as a **verb of motion** on a par with *enter* and *exit*.
- **Verb of assuming a position** in Levin 1993.

Denoted vs. Presupposed Information

- Verbs appear **to encode** only some aspects of the event they denote, while **presupposing** others.

Denoted vs. Presupposed Information

- Verbs appear **to encode** only some aspects of the event they denote, while **presupposing** others.
- *Arrive* presupposes motion but it is believed to encode the result/effect of such motion, consisting in the fact that the person or thing arrived is located in a place which differs from the one it was located in before the arriving event took place.

Denoted vs. Presupposed Information

- Verbs appear **to encode** only some aspects of the event they denote, while **presupposing** others.
- *Arrive* presupposes motion but it is believed to encode the result/effect of such motion, consisting in the fact that the person or thing arrived is located in a place which differs from the one it was located in before the arriving event took place.
- On this ground, it is reasonable to question whether *arrive* should be considered a **verb of change of location** rather than **a verb of motion**, and which criteria are eligible to distinguish between the two.

Polysemy

- A polysemous verb belongs by definition to **multiple classes**, namely, one for each of its meanings.

Polysemy

- A polysemous verb belongs by definition to **multiple classes**, namely, one for each of its meanings.
- *Sit* is a verb of assuming a position in "He sat in the chair near them" (Levin 1993, 262), while it can be regarded as a verb of spatial configuration in stative uses such as "He sits in the corner near the fire" (Levin 1993, 255).

Granularity of Classes

- Assigning verbs to semantic classes is influenced by the degree of **granularity of the classes**.

Granularity of Classes

- Assigning verbs to semantic classes is influenced by the degree of **granularity of the classes**.
- Both *run* and *roll* denote motion events with no inherent end point, but differ inasmuch as the former denotes **an intentional action** while the latter tends to describe **an involuntary movement**.

Granularity of Classes

- Assigning verbs to semantic classes is influenced by the degree of **granularity of the classes**.
- Both *run* and *roll* denote motion events with no inherent end point, but differ inasmuch as the former denotes **an intentional action** while the latter tends to describe **an involuntary movement**.
- ?"Do you feel like rolling?" vs. "Do you feel like running?".

Granularity of Classes

- Assigning verbs to semantic classes is influenced by the degree of **granularity of the classes**.
- Both *run* and *roll* denote motion events with no inherent end point, but differ inasmuch as the former denotes **an intentional action** while the latter tends to describe **an involuntary movement**.
- ?"Do you feel like rolling?" vs. "Do you feel like running?".
- Cf. Levin 1993, 264-7.

Syntax-informed approach to semantic classification

- How is semantic prominence to be defined?

Syntax-informed approach to semantic classification

- How is semantic prominence to be defined?
- Several scholars contend that prominent features are those that are **transparent in the syntax**, i.e. those that influence a verb syntactic behavior (Levin and Rappaport Hovav 2005, Ch. 1).

Syntax-informed approach to semantic classification

- How is semantic prominence to be defined?
- Several scholars contend that prominent features are those that are **transparent in the syntax**, i.e. those that influence a verb syntactic behavior (Levin and Rappaport Hovav 2005, Ch. 1).
- A **syntax-informed approach** is not driven by syntax but, starting from intuitive groupings identified on a semantic basis, looks for regularities in syntactic behavior of potential members, and divides them into classes based on these regularities.

Syntax-informed approach to semantic classification

- How is semantic prominence to be defined?
- Several scholars contend that prominent features are those that are **transparent in the syntax**, i.e. those that influence a verb syntactic behavior (Levin and Rappaport Hovav 2005, Ch. 1).
- A **syntax-informed approach** is not driven by syntax but, starting from intuitive groupings identified on a semantic basis, looks for regularities in syntactic behavior of potential members, and divides them into classes based on these regularities.
- According to this methodology, two verbs with apparently similar meaning fall into different classes if they exhibit significant differences in the way they are used in the grammar of language.

- Formal.

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.
  - Sound similarity: *big*, *pig*, *fig*

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.
  - Sound similarity: *big*, *pig*, *fig*
  - Similar syntactic behavior: nouns, verbs, or adjectives.

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.
  - Sound similarity: *big*, *pig*, *fig*
  - Similar syntactic behavior: nouns, verbs, or adjectives.
- Semantic.

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.
  - Sound similarity: *big*, *pig*, *fig*
  - Similar syntactic behavior: nouns, verbs, or adjectives.
- Semantic.
  - Semantic networks: *buy*, *acquire*, *purchase*, *sell*, *negotiate*, *pay*, *own*.

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.
  - Sound similarity: *big*, *pig*, *fig*
  - Similar syntactic behavior: nouns, verbs, or adjectives.
- Semantic.
  - Semantic networks: *buy*, *acquire*, *purchase*, *sell*, *negotiate*, *pay*, *own*.
  - Semantic networks: *book*, *volume*, *dictionary*, *diary*, *album*, *novel*, *library*, *bookstore*, *read*, *consult*, *chapter*, *page*, *paper*, *index*, *publisher*, *writer*.

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.
  - Sound similarity: *big*, *pig*, *fig*
  - Similar syntactic behavior: nouns, verbs, or adjectives.
- Semantic.
  - Semantic networks: *buy*, *acquire*, *purchase*, *sell*, *negotiate*, *pay*, *own*.
  - Semantic networks: *book*, *volume*, *dictionary*, *diary*, *album*, *novel*, *library*, *bookstore*, *read*, *consult*, *chapter*, *page*, *paper*, *index*, *publisher*, *writer*.
- Both formal and semantic.

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.
  - Sound similarity: *big*, *pig*, *fig*
  - Similar syntactic behavior: nouns, verbs, or adjectives.
- Semantic.
  - Semantic networks: *buy*, *acquire*, *purchase*, *sell*, *negotiate*, *pay*, *own*.
  - Semantic networks: *book*, *volume*, *dictionary*, *diary*, *album*, *novel*, *library*, *bookstore*, *read*, *consult*, *chapter*, *page*, *paper*, *index*, *publisher*, *writer*.
- Both formal and semantic.
  - *book* (x), *bookstore* (y).

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.
  - Sound similarity: *big*, *pig*, *fig*
  - Similar syntactic behavior: nouns, verbs, or adjectives.
- Semantic.
  - Semantic networks: *buy*, *acquire*, *purchase*, *sell*, *negotiate*, *pay*, *own*.
  - Semantic networks: *book*, *volume*, *dictionary*, *diary*, *album*, *novel*, *library*, *bookstore*, *read*, *consult*, *chapter*, *page*, *paper*, *index*, *publisher*, *writer*.
- Both formal and semantic.
  - *book* (x), *bookstore* (y).
  - x = object which is sold in y.

Relations in the Lexicon

- Formal.
  - Morphological word families, such as *book*, *booking*, *booklet*, *bookstore*; *truly*, *amply*, *fortunately*, *happily*.
  - Sound similarity: *big*, *pig*, *fig*
  - Similar syntactic behavior: nouns, verbs, or adjectives.
- Semantic.
  - Semantic networks: *buy*, *acquire*, *purchase*, *sell*, *negotiate*, *pay*, *own*.
  - Semantic networks: *book*, *volume*, *dictionary*, *diary*, *album*, *novel*, *library*, *bookstore*, *read*, *consult*, *chapter*, *page*, *paper*, *index*, *publisher*, *writer*.
- Both formal and semantic.
  - *book* (x), *bookstore* (y).
  - x = object which is sold in y.
  - y = place in which x is sold.

- Manner.

Semantic Relations in the Verbal Lexicon

- Manner.
- Cause and Purpose.

Semantic Relations in the Verbal Lexicon

- Manner.
- Cause and Purpose.

Manner

- For verbs, the hyponymy relation is often known as **troponymy**, emphasizing the point that **verb inclusion** tends to be a matter of **MANNER** specification (on troponymy, see Fellbaum 2002).

Manner

- For verbs, the hyponymy relation is often known as **troponymy**, emphasizing the point that **verb inclusion** tends to be a matter of **MANNER** specification (on troponymy, see Fellbaum 2002).
- The notion of **MANNER** is the structuring principle for verb taxonomies (although recently other proposals have been put forth).

Manner

- For verbs, the hyponymy relation is often known as **troponymy**, emphasizing the point that **verb inclusion** tends to be a matter of **MANNER** specification (on troponymy, see Fellbaum 2002).
- The notion of **MANNER** is the structuring principle for verb taxonomies (although recently other proposals have been put forth).
- "to **v1** is to **v2** in a particular/certain manner"

Manner

- For verbs, the hyponymy relation is often known as **troponymy**, emphasizing the point that **verb inclusion** tends to be a matter of **MANNER** specification (on troponymy, see Fellbaum 2002).
- The notion of **MANNER** is the structuring principle for verb taxonomies (although recently other proposals have been put forth).
- "to **v1** is to **v2** in a particular/certain manner": "*to walk* is it to move in a certain manner", "*to murmur* is it to talk in a certain manner", etc.

Manner

- For verbs, the hyponymy relation is often known as **troponymy**, emphasizing the point that **verb inclusion** tends to be a matter of **MANNER** specification (on troponymy, see Fellbaum 2002).
- The notion of **MANNER** is the structuring principle for verb taxonomies (although recently other proposals have been put forth).
- "to **v1** is to **v2** in a particular/certain manner": "*to walk* is it to move in a certain manner", "*to murmur* is it to talk in a certain manner", etc.

Kinds of Troponymy

- The term **MANNER** is applicable to several aspects of the event that may be incorporated into the meaning of the hyponymous verb.
  - manner proper (to move vs. to drag, to dance)

Kinds of Troponymy

- The term **MANNER** is applicable to several aspects of the event that may be incorporated into the meaning of the hyponymous verb.
  - manner proper (to move vs. to drag, to dance)
  - instrument (to close vs. to button up, to lock, to latch, to hook, to tie, to strap)

Kinds of Troponymy

- The term **MANNER** is applicable to several aspects of the event that may be incorporated into the meaning of the hyponymous verb.
  - manner proper (to move vs. to drag, to dance)
  - instrument (to close vs. to button up, to lock, to latch, to hook, to tie, to strap)
  - speed (to move vs. to run, to dart)

Kinds of Troponymy

- The term **MANNER** is applicable to several aspects of the event that may be incorporated into the meaning of the hyponymous verb.
  - manner proper (to move vs. to drag, to dance)
  - instrument (to close vs. to button up, to lock, to latch, to hook, to tie, to strap)
  - speed (to move vs. to run, to dart)
  - medium (to move vs. to fly, to sail; to fax vs. to phone, to email)

Kinds of Troponymy

- The term **MANNER** is applicable to several aspects of the event that may be incorporated into the meaning of the hyponymous verb.
  - manner proper (to move vs. to drag, to dance)
  - instrument (to close vs. to button up, to lock, to latch, to hook, to tie, to strap)
  - speed (to move vs. to run, to dart)
  - medium (to move vs. to fly, to sail; to fax vs. to phone, to email)
  - intensity (close the door vs. slam the door, whisper vs. shout; eat vs. devour)

Manner and Temporal Structure

- Verbs participating in a troponymy relation are always temporally **CO-EXTENSIVE** with each other (Fellbaum 2002).

Manner and Temporal Structure

- Verbs participating in a troponymy relation are always temporally **CO-EXTENSIVE** with each other (Fellbaum 2002).
- *to walk* is *to move* in a certain MANNER, and the two actions described by the two verbs take place at the same time, i.e. they begin and end at the same time.

Manner and Temporal Structure

- Verbs participating in a troponymy relation are always temporally **CO-EXTENSIVE** with each other (Fellbaum 2002).
- *to walk* is *to move* in a certain MANNER, and the two actions described by the two verbs take place at the same time, i.e. they begin and end at the same time.
- "The event expressed by **v1** **IS SIMULTANEOUS WITH** the event expressed by **v2**.

Manner and Temporal Structure

- Verbs participating in a troponymy relation are always temporally **CO-EXTENSIVE** with each other (Fellbaum 2002).
- *to walk* is *to move* in a certain MANNER, and the two actions described by the two verbs take place at the same time, i.e. they begin and end at the same time.
- “The event expressed by **v1** **IS SIMULTANEOUS WITH** the event expressed by **v2**.

Cause

- A causal relation (or relation of causation) links such verb pairs as *to kill* / *to die*, *to buy* / *to own*, *to aim* / *to hit*, *to teach* / *to learn*, *to search* / *to find*.

Cause

- A causal relation (or relation of causation) links such verb pairs as *to kill* / *to die*, *to buy* / *to own*, *to aim* / *to hit*, *to teach* / *to learn*, *to search* / *to find*.
- The event expressed by **v1** **CAUSES** the event expressed by **v2** to occur:

Cause

- A causal relation (or relation of causation) links such verb pairs as *to kill* / *to die*, *to buy* / *to own*, *to aim* / *to hit*, *to teach* / *to learn*, *to search* / *to find*.
- The event expressed by **v1** **CAUSES** the event expressed by **v2** to occur: "*to kill* **CAUSES** *to die* to occur".

Causation in the Lexicon

- The causal relation is **FACTIVE** (according to Lyons' 1977 terminology) when it applies necessarily, as in the case of *to kill*, which necessarily causes *to die*.

- The causal relation is **FACTIVE** (according to Lyons' 1977 terminology) when it applies necessarily, as in the case of *to kill*, which necessarily causes *to die*.
  - *He accidentally killed the fly but the fly did not die.

Causation in the Lexicon

- The causal relation is **FACTIVE** (according to Lyons' 1977 terminology) when it applies necessarily, as in the case of *to kill*, which necessarily causes *to die*.
  - *He accidentally killed the fly but the fly did not die.
- The causal relation is **NON-FACTIVE** when it does not apply necessarily.

Causation in the Lexicon

- The causal relation is **FACTIVE** (according to Lyons' 1977 terminology) when it applies necessarily, as in the case of *to kill*, which necessarily causes *to die*.
  - *He accidentally killed the fly but the fly did not die.
- The causal relation is **NON-FACTIVE** when it does not apply necessarily.
- The event expressed by **v1** is likely to cause/may cause the event expressed by **v2** to occur:

- The causal relation is **FACTIVE** (according to Lyons' 1977 terminology) when it applies necessarily, as in the case of *to kill*, which necessarily causes *to die*.
  - *He accidentally killed the fly but the fly did not die.
- The causal relation is **NON-FACTIVE** when it does not apply necessarily.
- The event expressed by **v1** is likely to cause/may cause the event expressed by **v2** to occur: *to show* is likely to cause *to see*; *to aim* may cause *to hit*, etc.

Causation in the Lexicon

- The causal relation is **FACTIVE** (according to Lyons' 1977 terminology) when it applies necessarily, as in the case of *to kill*, which necessarily causes *to die*.
  - *He accidentally killed the fly but the fly did not die.
- The causal relation is **NON-FACTIVE** when it does not apply necessarily.
- The event expressed by **v1** is likely to cause/may cause the event expressed by **v2** to occur: *to show* is likely to cause *to see*; *to aim* may cause *to hit*, etc.
- Lexical vs. textual entailment (Dagan, Glickman and Magnini 2006).

Causation in the Lexicon

- Two main types.

Causation in the Lexicon

- Two main types.
- Between lexical entries (necessary, probable or possible).

- Two main types.
- Between lexical entries (necessary, probable or possible).
- Inside single entries (polysemy, necessary).

Causative/inchoative verbs

- These are verbs which alternate between a transitive variant and an intransitive one, where the first encodes both the *CAUSE* and the **RESULT** and the second only the **RESULT** of the reported event.

Causative/inchoative verbs

- These are verbs which alternate between a transitive variant and an intransitive one, where the first encodes both the *CAUSE* and the **RESULT** and the second only the **RESULT** of the reported event.
- *To break*, as in "Mary broke the key" vs. "the key broke".

Causal Relations in Texts

- As communication fulfils the aim of being informative, it is reasonable to guess that **an instantiation of lexical causation occurs rarely**, as it does not provide new information.

Causal Relations in Texts

- As communication fulfils the aim of being informative, it is reasonable to guess that **an instantiation of lexical causation occurs rarely**, as it does not provide new information.
- A partial exception is the possibility of using a member of the pair as a hook for new information:

Causal Relations in Texts

- As communication fulfils the aim of being informative, it is reasonable to guess that **an instantiation of lexical causation occurs rarely**, as it does not provide new information.
- A partial exception is the possibility of using a member of the pair as a hook for new information:
- "The religious fanatic killed an innocent. She died."

Causal Relations in Texts

- As communication fulfils the aim of being informative, it is reasonable to guess that **an instantiation of lexical causation occurs rarely**, as it does not provide new information.
- A partial exception is the possibility of using a member of the pair as a hook for new information:
- "The religious fanatic killed an innocent. She died."
- "An innocent died: a religious fanatic killed her."

Causal Relations in Texts

- As communication fulfils the aim of being informative, it is reasonable to guess that **an instantiation of lexical causation occurs rarely**, as it does not provide new information.
- A partial exception is the possibility of using a member of the pair as a hook for new information:
- "The religious fanatic killed an innocent. She died."
- "An innocent died: a religious fanatic killed her."

- Ponti 2016, *Identifying Causal Relations between Events with Artificial Neural Networks*, MA Thesis, Pavia.

Cause and Purpose

- The **CAUSE** relation may be seen in relation to **PURPOSE**.

- The **CAUSE** relation may be seen in relation to **PURPOSE**.
- For example, the **PURPOSE** of *searching* something is *to find* it, the **GOAL** of *trying* is *to succeed*, the **GOAL** of *teaching* is that someone *learns*, etc.

Cause and Purpose

- The **CAUSE** relation may be seen in relation to **PURPOSE**.
- For example, the **PURPOSE** of *searching* something is *to find* it, the **GOAL** of *trying* is *to succeed*, the **GOAL** of *teaching* is that someone *learns*, etc.
- The event expressed by **v1** has the event expressed by **v2** as **PURPOSE** or **INTENDED GOAL**.

Cause and Purpose

- The **CAUSE** relation may be seen in relation to **PURPOSE**.
- For example, the **PURPOSE** of *searching* something is *to find* it, the **GOAL** of *trying* is *to succeed*, the **GOAL** of *teaching* is that someone *learns*, etc.
- The event expressed by **v1** has the event expressed by **v2** as **PURPOSE** or **INTENDED GOAL**.
- Purposive constructions: *eat* in order *to nourish oneself*.

Purpose and Intentionality

- Involuntary actions lack a **PURPOSE**, i.e. *break* associates by default with no purpose, as it is typically done unintentionally.

Purpose and Intentionality

- Involuntary actions lack a **PURPOSE**, i.e. *break* associates by default with no purpose, as it is typically done unintentionally.
- "Mary broke the key."

Purpose and Intentionality

- Involuntary actions lack a **PURPOSE**, i.e. *break* associates by default with no purpose, as it is typically done unintentionally.
- "Mary broke the key."
- "Mary accidentally broke the key."

Cause and Purpose

- While many relations of non-factive **CAUSATION** can be analyzed as **PURPOSE** relation, this is not always the case.

Cause and Purpose

- While many relations of non-factive **CAUSATION** can be analyzed as **PURPOSE** relation, this is not always the case.
- For example, *to iron* may cause *to burn* and *to try* may cause *to fail*, but *to burn* is certainly not the ultimate purpose of *ironing* nor is *to fail* the goal of *to try*.

Purpose Verbs

- Fellbaum 2013 contends that next to **MANNER**, an organizing principle of verb taxonomies distinct from MANNER is **PURPOSE**.
- How is **PURPOSE** relate to **MANNER**?
- *To exercise* is defined by **subordinates** like *to swim*, *to bike*, *to jog* that are shared with another **superordinate**, i.e *to move*.
- But *to move* has any **subordinates** that are not shared with *to exercize*, such as *to fly* and *to drive*.

Purpose Verbs

- According to Fellbaum, the relation of **PURPOSE** is always **defeasible**, i.e. **PURPOSE** is not a necessary meaning component of the verbs in question : **expectation** that a biking event is an exercizing event, event though biking is not necessarily exercising.
- She compares it to the notion of role in the nominal domain (Cruse 1986).
  - *animal* vs. *pet*: "That's a dog but it is not a pet."
  - *to bike* vs. *to exercise*: ?We biked but we did not exercise.

Semantic Relations and Lexical Classes

- Verbs form troponymy chains that are **shallow** (four levels at most) and **tend to extend horizontally rather than vertically**.

Semantic Relations and Lexical Classes

- Verbs form troponymy chains that are **shallow** (four levels at most) and **tend to extend horizontally rather than vertically**.
- Nouns tend to organize themselves along the hypernymy and hyponymy axis and generate **deep hyponymy chains** (up to 12 levels).

Semantic Relations and Lexical Classes

- Verbs form troponymy chains that are **shallow** (four levels at most) and **tend to extend horizontally rather than vertically**.
- Nouns tend to organize themselves along the hypernymy and hyponymy axis and generate **deep hyponymy chains** (up to 12 levels).
- Adjectives rarely form hyperonymy chains and tend to organize themselves along the axis of **opposition** (polar/scalar or binary).

Semantic Relations in the Lexicon

- Paradigmatic (in absentia, same POS, share nearest neighbors): hyponymy (event/lecture), meronymy (brain/body), synonymy and near synonymy (enoug /sufficient, serious/no laughing matter), antonymy (raise/fall).

Semantic Relations in the Lexicon

- Paradigmatic (in absentia, same POS, share nearest neighbors): hyponymy (event/lecture), meronymy (brain/body), synonymy and near synonymy (enoug /sufficient, serious/no laughing matter), antonymy (raise/fall).
- Syntagmatic (in praesentia, different POS, co-occur): role (pedestrian, walk, paint, portrait), attribution (blond, hair).

Semantic Relations in the Lexicon

- Paradigmatic (in absentia, same POS, share nearest neighbors): hyponymy (event/lecture), meronymy (brain/body), synonymy and near synonymy (enoug /sufficient, serious/no laughing matter), antonymy (raise/fall).
- Syntagmatic (in praesentia, different POS, co-occur): role (pedestrian, walk, paint, portrait), attribution (blond, hair).
- Both = manner (damage, severely; to move/to walk)

Semantic Relations in the Lexicon

- Paradigmatic (in absentia, same POS, share nearest neighbors): hyponymy (event/lecture), meronymy (brain/body), synonymy and near synonymy (enoug /sufficient, serious/no laughing matter), antonymy (raise/fall).
- Syntagmatic (in praesentia, different POS, co-occur): role (pedestrian, walk, paint, portrait), attribution (blond, hair).
- Both = manner (damage, severely; to move/to walk)
- Others?

Semantic Relations in the Lexicon

- We have now understood that the two traditional Hjelmslev's structuring axes (vertical, either or vs. horizontal, both and) are useful but not mutually exclusive wrt specific dimensions.

- We have now understood that the two traditional Hjelmslev's structuring axes (vertical, either or vs. horizontal, both and) are useful but not mutually exclusive wrt specific dimensions.
- We need additional dimensions to unveil the structure of our mental lexicon, as disclosed by distributional analyses exploiting vector models.

Semantic Relations in the Lexicon

- We have now understood that the two traditional Hjelmslev's structuring axes (vertical, either or vs. horizontal, both and) are useful but not mutually exclusive wrt specific dimensions.
- We need additional dimensions to unveil the structure of our mental lexicon, as disclosed by distributional analyses exploiting vector models.
- → Saussure opposed syntagmatic to associative, not to paradigmatic.

Ambiguity in Language

- Ambiguity is **pervasive** and plays a communicative role in the language (Piantadosi et al 2012).

Ambiguity in Language

- Ambiguity is **pervasive** and plays a communicative role in the language (Piantadosi et al 2012).
- (ambiguity is not mysterious when language is considered as a cognitive system designed in part for **communication**).

Ambiguity in Language

- Ambiguity is **pervasive** and plays a communicative role in the language (Piantadosi et al 2012).
- (ambiguity is not mysterious when language is considered as a cognitive system designed in part for **communication**).
- Ambiguity results from **a pressure** for efficiency in communication.

Ambiguity in Language

- Ambiguity is **pervasive** and plays a communicative role in the language (Piantadosi et al 2012).
- (ambiguity is not mysterious when language is considered as a cognitive system designed in part for **communication**).
- Ambiguity results from **a pressure** for efficiency in communication.
- Any efficient communication system will necessarily be ambiguous when **context is informative** about what is being communicated.

Ambiguity in Language

- Ambiguity is **pervasive** and plays a communicative role in the language (Piantadosi et al 2012).
- (ambiguity is not mysterious when language is considered as a cognitive system designed in part for **communication**).
- Ambiguity results from **a pressure** for efficiency in communication.
- Any efficient communication system will necessarily be ambiguous when **context is informative** about what is being communicated.
- The units of an efficient communication system will not convey and redundantly specify information **already provided by the context**.

Polysemy in language

- What is the meaning of an individual word, out of context?

Polysemy in language

- What is the meaning of an individual word, out of context?
- Do words carry different meanings in a manner similar to the multiple interpretations that utterance may assume?

Polysemy in language

- What is the meaning of an individual word, out of context?
- Do words carry different meanings in a manner similar to the multiple interpretations that utterance may assume?
- Is there a sharp boundary between monosemy and polysemy in language?

Polysemy in language

- What is the meaning of an individual word, out of context?
- Do words carry different meanings in a manner similar to the multiple interpretations that utterance may assume?
- Is there a sharp boundary between monosemy and polysemy in language?
- Is it possibile to maintain a distinction between lexical and pragmatic ambiguity?

Polysemy in language

- What is the meaning of an individual word, out of context?
- Do words carry different meanings in a manner similar to the multiple interpretations that utterance may assume?
- Is there a sharp boundary between monosemy and polysemy in language?
- Is it possibile to maintain a distinction between lexical and pragmatic ambiguity?
- Evidence-based approach.

Context and lexical meaning

- Words are able to take on a different meaning **depending on the context** in which they are used.

Context and lexical meaning

- Words are able to take on a different meaning **depending on the context** in which they are used.
- The couple at the <u>next</u> table was laughing.

Context and lexical meaning

- Words are able to take on a different meaning **depending on the context** in which they are used.
- The couple at the <u>next</u> table was laughing.
- The <u>next</u> train is delayed.

Context and lexical meaning

- Words are able to take on a different meaning **depending on the context** in which they are used.
- The couple at the <u>next</u> table was laughing.
- The <u>next</u> train is delayed.
- The <u>next</u> costumer, the <u>next</u> slide ...

Context and lexical meaning

- The coexistence of many possible meanings for a word is traditionally referred to as **polysemy**, and it is conceived as **a list of pre-defined established senses** stored in the lexical entry.

Context and lexical meaning

- The coexistence of many possible meanings for a word is traditionally referred to as **polysemy**, and it is conceived as **a list of pre-defined established senses** stored in the lexical entry.
- **checklist theory** of lexical meaning.

Context and lexical meaning

- The coexistence of many possible meanings for a word is traditionally referred to as **polysemy**, and it is conceived as **a list of pre-defined established senses** stored in the lexical entry.
- **checklist theory** of lexical meaning.
- **sense enumeration** lexicon.

Context and lexical meaning

- The coexistence of many possible meanings for a word is traditionally referred to as **polysemy**, and it is conceived as **a list of pre-defined established senses** stored in the lexical entry.
- **checklist theory** of lexical meaning.
- **sense enumeration** lexicon.
- This is the standard way dictionaries and **resources** used for NLP tasks (i.e. WordNet for word sense detection etc.) are put together.

Types of contextual variation

Properties of objects coming into the foreground in the context.

Types of contextual variation

Properties of objects coming into the foreground in the context.

- This car *weighs* over 2,000 lbs.

Types of contextual variation

Properties of objects coming into the foreground in the context.

- This car *weighs* over 2,000 lbs.
- John started the car.

Types of contextual variation

Properties of objects coming into the foreground in the context.

- This car *weighs* over 2,000 lbs.
- John started the car.
- You should warm your car up in winter.

Types of contextual variation

Properties of objects coming into the foreground in the context.

- This car *weighs* over 2,000 lbs.
- John started the car.
- You should warm your car up in winter.
- Did you lock the car?

Types of contextual variation

Properties of objects coming into the foreground in the context.

- This car *weighs* over 2,000 lbs.
- John started the car.
- You should warm your car up in winter.
- Did you lock the car?
- The car screeched down the road.

Types of contextual variation

Properties of objects coming into the foreground in the context.

- This car *weighs* over 2,000 lbs.
- John started the car.
- You should warm your car up in winter.
- Did you lock the car?
- The car screeched down the road.

Pustejovsky and Jezek 2012 *Introducing Qualia Stucture*

Types of contextual variation

Contextual coercions

Types of contextual variation

Contextual coercions

- The flight lasted three hours.

Types of contextual variation

Contextual coercions

- The flight lasted three hours.
- The flight landed safely at about 9 a.m.

Types of contextual variation

Contextual coercions

- The flight lasted three hours.
- The flight landed safely at about 9 a.m.
- I bought the flight for Christmas.

Types of contextual variation

Contextual coercions

- The flight lasted three hours.
- The flight landed safely at about 9 a.m.
- I bought the flight for Christmas.
- You reached the house.

Types of contextual variation

Contextual coercions

- The flight lasted three hours.
- The flight landed safely at about 9 a.m.
- I bought the flight for Christmas.
- You reached the house.
- Do you want the whole house waken up?

Types of contextual variation

Contextual coercions

- The flight lasted three hours.
- The flight landed safely at about 9 a.m.
- I bought the flight for Christmas.
- You reached the house.
- Do you want the whole house waken up?
- The rest of the house was sleeping.

Types of contextual variation

Contextual coercions

- The flight lasted three hours.
- The flight landed safely at about 9 a.m.
- I bought the flight for Christmas.
- You reached the house.
- Do you want the whole house waken up?
- The rest of the house was sleeping.

Pustejovsky and Jezek 2008, Jezek and Quochi 2010, Pustejovsky et al. 2010 SemEval-2010 Task 7 Argument Selection and Coercion.

Types of contextual variations

Hidden Events

Types of contextual variations

Hidden Events

- We canceled the taxi.

Types of contextual variations

Hidden Events

- We canceled the taxi.
- From the house I heard the bell.

Types of contextual variations

Hidden Events

- We canceled the taxi.
- From the house I heard the bell.
- We took a break before dessert.

Types of contextual variations

Hidden Events

- We canceled the taxi.
- From the house I heard the bell.
- We took a break before dessert.
- They finished the beer.

Types of contextual variations

Hidden Events

- We canceled the taxi.
- From the house I heard the bell.
- We took a break before dessert.
- They finished the beer.
- They finished their cake.

Types of contextual variations

Hidden Events

- We canceled the taxi.
- From the house I heard the bell.
- We took a break before dessert.
- They finished the beer.
- They finished their cake.
- Any chocolate? Not after that cake!

Types of contextual variations

Hidden Events

- We canceled the taxi.
- From the house I heard the bell.
- We took a break before dessert.
- They finished the beer.
- They finished their cake.
- Any chocolate? Not after that cake!
- I prefer cake to biscuits.

Types of contextual variations

Hidden Events

- We canceled the taxi.
- From the house I heard the bell.
- We took a break before dessert.
- They finished the beer.
- They finished their cake.
- Any chocolate? Not after that cake!
- I prefer cake to biscuits.
- We skipped the cake and settled for another coffee.

Types of contextual variations

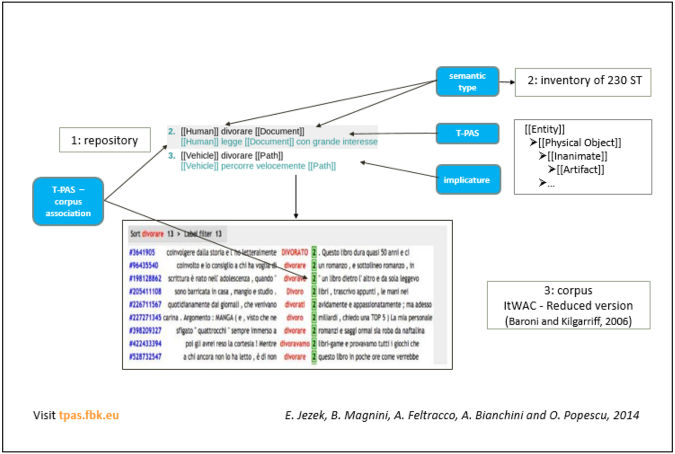
Hidden Events

- We canceled the <u>taxi</u>.
- From the house I heard the <u>bell</u>.
- We took a break before <u>dessert</u>.
- They finished the <u>beer</u>.
- They finished their <u>cake</u>.
- Any chocolate? Not after that <u>cake</u>!
- I prefer <u>cake</u> to biscuits.
- We skipped the <u>cake</u> and settled for another coffee.

Pustejovsky and Anick 1988 (later "Qualia roles"; data from Pustejovsky and Jezek 2012).

Typed Predicate-Argument Structure (T-PAS)

Jezek, Magnini, Feltracco, Bianchini, Popescu 2014



Methodology from Hanks, 2004, 2013.

Mismatch classification

- Verb classes (Levin 1993, VerbNet).

Mismatch classification

- Verb classes (Levin 1993, VerbNet).
- Targeted grammatical relation: SUBJ_OF, OBJ_OF, COMPL

Mismatch classification

- Verb classes (Levin 1993, VerbNet).
- Targeted grammatical relation: SUBJ_OF, OBJ_OF, COMPL
- Shift types: Artifact as Event, Artifact as Human, Artifact as Sound, Event as Location, Vehicle as Human.

Mismatch classification

- Verb classes (Levin 1993, VerbNet).
- Targeted grammatical relation: SUBJ_OF, OBJ_OF, COMPL
- Shift types: Artifact as Event, Artifact as Human, Artifact as Sound, Event as Location, Vehicle as Human.
- SemEval Coercion Task 7: Argument Selection and Coercion (Pustejovsky et al. 2010, Jezek and Quochi 2010).

[[Human]-subj] interrompe [[Event]-obj]

- Arriva Mirko e interrompe la conversazione.
  'Mirko arrives and interrupts the conversation' (matching)

Aspectual Verbs (Jezek, Magnini, Feltracco, Bianchini, Popescu 2014)

[[Human]-subj] interrompe [[Event]-obj]

- Arriva Mirko e interrompe la conversazione.
  'Mirko arrives and interrupts the conversation' (matching)
- Il presidente interrompe l'oratore.
  'The president interrupts the speaker' (HUMAN as EVENT)

Communication Verbs

[[Human]-subj] annuncia [[Event]-obj]

- Lo speaker annuncia la partenza.
  'The speaker announces the departure' (matching)

Communication Verbs

[[Human]-subj] annuncia [[Event]-obj]

- Lo speaker annuncia la partenza.
  'The speaker announces the departure' (matching)
- Il maggiordomo annuncia gli invitati.
  'The butler announces the guests' (Human as Event)

Communication Verbs

[[Human]-subj] annuncia [[Event]-obj]

- Lo speaker annuncia la partenza.
  'The speaker announces the departure' (matching)
- Il maggiordomo annuncia gli invitati.
  'The butler announces the guests' (HUMAN as EVENT)
- L'altoparlante annunciava l'arrivo del treno.
  'The loudspeaker announces the arrival of the train' (ARTIFACT as HUMAN)

Communication Verbs

[[Human]-subj] annuncia [[Event]-obj]

- Lo speaker annuncia la partenza.
  'The speaker announces the departure' (matching)
- Il maggiordomo annuncia gli invitati.
  'The butler announces the guests' (Human as Event)
- L'altoparlante annunciava l'arrivo del treno.
  'The loudspeaker announces the arrival of the train' (Artifact as Human)
- Una telefonata anonima avvisa la polizia.
  'An anonymous telephone call alerted the police' (Event as Human)

Avoid Verbs

[[Human]-subj] evita [[Event]-obj]

- Abbiamo evitato l'incontro.
  'We avoided the meeting' (matching)

Avoid Verbs

[[Human]-subj] evita [[Event]-obj]

- Abbiamo evitato l'incontro.
  'We avoided the meeting' (matching)
- Meglio evitare i cibi fritti.
  'It is best to avoid fried food' (ARTIFACT as EVENT)

Forbid Verbs

[[Human]-subj] vieta [[Event]-obj]

- Nell'Italia di allora la legge vietava l'aborto.
  'At that time in Italy law prohibited abortion' (matching)

Forbid Verbs

[[Human]-subj] vieta [[Event]-obj]

- Nell'Italia di allora la legge vietava l'aborto.
  'At that time in Italy law prohibited abortion' (matching)
- La Francia vieta il velo a scuola.
  'France bans the headscarf in schools' (ARTIFACT as EVENT)

Verbs of Desire (Bos 2009)

[[Human]-subj] preferire [[Event]-obj]

- Preferisco bere piuttosto che mangiare.
  'I prefer drinking to eating' (matching)

Verbs of Desire (Bos 2009)

[[Human]-subj] preferire [[Event]-obj]

- Preferisco bere piuttosto che mangiare.
  'I prefer drinking to eating' (matching)
- Preferisco la birra al vino.
  'I prefer beer to wine' (ARTIFACT as EVENT).

Perception Verbs

[[Human]-subj] ascolta [[Sound]-obj]

- Rilassarsi ascoltando il rumore della pioggia.
  'Relax while listening to the sound of rain' (matching)

Perception Verbs

[[Human]-subj] ascolta [[Sound]-obj]

- Rilassarsi ascoltando il rumore della pioggia.
  'Relax while listening to the sound of rain' (matching)
- Ascoltava la radio con la cuffia.
  'He listened to the radio with his earphones' (ARTIFACT as SOUND)

Perception Verbs

[[Human]-subj] ascolta [[Sound]-obj]

- Rilassarsi ascoltando il rumore della pioggia.
  'Relax while listening to the sound of rain' (matching)
- Ascoltava la radio con la cuffia.
  'He listened to the radio with his earphones' (ARTIFACT as SOUND)
- Rimasi a lungo ad ascoltare il suo respiro.
  'I stayed for a long while listening to his breath' (EVENT as SOUND)

Perception Verbs

[[Human]-subj] ascolta [[Sound]-obj]

- Rilassarsi ascoltando il rumore della pioggia.
  'Relax while listening to the sound of rain' (matching)
- Ascoltava la radio con la cuffia.
  'He listened to the radio with his earphones' (ARTIFACT as SOUND)
- Rimasi a lungo ad ascoltare il suo respiro.
  'I stayed for a long while listening to his breath' (EVENT as SOUND)
- Non ho potuto ascoltare tutti i colleghi
  'I could not listen to all colleagues' (HUMAN as SOUND)

Directed Motion Verbs 1/3

[[Human]-subj] raggiunge [[Location]-obj]

- Abbiamo raggiunto l'isola alle 5.
  'We reached the island at 5' (matching)

Directed Motion Verbs 1/3

[[Human]-subj] raggiunge [[Location]-obj]

- Abbiamo raggiunto l'isola alle 5.
  'We reached the island at 5' (matching)
- Ho raggiunto il semaforo e ho svoltato a destra.
  'I reached the traffic light and turned right' (ARTIFACT as LOCATION).

Directed Motion Verbs 2/3

[[Human]-subj] arriva (Adv [[Location]])

- Alla fine, ormai col buio, sono arrivata a una radura.
  'Finally in the dark I came upon a clearing.' (matching)

Directed Motion Verbs 2/3

[[Human]-subj] arriva (Adv [[Location]])

- Alla fine, ormai col buio, sono arrivata a una radura.
  'Finally in the dark I came upon a clearing.' (matching)
- Gli invitati arrivano al concerto in ritardo.
  'The guests arrived late at the concert' (EVENT as LOCATION).

Motion using a Vehicle

[[Flying Vehicle]-subj] atterra ([Adv [Location]])

- Il nostro aereo atterra alle 21.
  'Our plane lands at 9pm' (matching)

Motion using a Vehicle

[[Flying Vehicle]-subj] atterra ([Adv [Location]])

- Il nostro aereo atterra alle 21.
  'Our plane lands at 9pm' (matching)
- Il pilota e' regolarmente atterrato senza problemi.
  'The pilot landed regularly with no problems' (HUMAN as VEHICLE).

Motion using a Vehicle

[[Flying Vehicle]-subj] atterra ([Adv [Location]])

- Il nostro aereo atterra alle 21.
  'Our plane lands at 9pm' (matching)
- Il pilota e' regolarmente atterrato senza problemi.
  'The pilot landed regularly with no problems' (HUMAN as VEHICLE).
- Tutti i voli civili sono atterrati.
  'All civilian flights landed' (EVENT as VEHICLE).

Vehicle Verbs

[[Human]-subj] parcheggiare ([[Vehicle]-obj])

- Luca ha parcheggiato sotto casa.
  'Luca parked near the house' (matching)

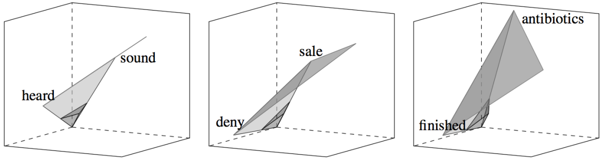
Vehicle Verbs

[[Human]-subj] parcheggiare ([[Vehicle]-obj])

- Luca ha parcheggiato sotto casa.
  'Luca parked near the house' (matching)
- L'ambulanza ha parcheggiato lontano.
  'The ambulance parked far away' (VEHICLE as HUMAN)

Detecting Mismatches

- We have recently performed a distributional analysis and developed a geometric method for detecting mismatches in corpora.



(a) selectional (b) ambiguous (c) coercive

Figure 2: Spectrum of Coercion: Verb-object pairs deemed most selectional, ambiguous, and coercive are projected into subspaces using the INDY technique, with key geometric features preserved here.

McGregor, Jezek, Purver and Wiggins 2017 *A Geometric Method for Detecting Semantic Coercion*, IWCS Montpellier, Sept. 2017

Detecting Mismatches

- The work is based on the projection in space of context sensitive distributional semantic subspaces generated through selection techniques of the set of co-occurrence features that are salient for the input terms (model originally developed in McGregor et al 2015).

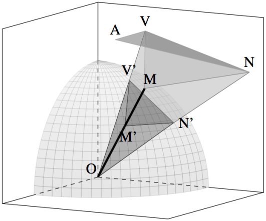


Figure 1: Semantics in Space: Verb-object pairs are projected into a subspace in which the geometric features of the relationship between the word-vectors, the origin, and salient points in the subspace are expected to collectively indicate semantic relationships such as coerciveness.

McGregor, Jezek, Purver and Wiggins 2017 *A Geometric Method for Detecting Semantic Coercion*, IWCS Montpellier, Sept. 2017

Types of contextual variations

Systematic polysemies (Apresjan 1973)

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two glasses.

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two glasses.
  - I drank two glasses.

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two glasses.
  - I drank two glasses.
- institution/place/people

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two <u>glasses</u>.
  - I drank two <u>glasses</u>.
- institution/place/people
  - The <u>university</u> hired a new professor.

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two glasses.
  - I drank two glasses.
- institution/place/people
  - The university hired a new professor.
  - The university is close to the station.

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two glasses.
  - I drank two glasses.
- institution/place/people
  - The university hired a new professor.
  - The university is close to the station.
  - This is a friendly university.

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two glasses.
  - I drank two glasses.
- institution/place/people
  - The university hired a new professor.
  - The university is close to the station.
  - This is a friendly university.
- process/result

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two glasses.
  - I drank two glasses.
- institution/place/people
  - The university hired a new professor.
  - The university is close to the station.
  - This is a friendly university.
- process/result
  - The building was beginning to take place.

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two glasses.
  - I drank two glasses.
- institution/place/people
  - The university hired a new professor.
  - The university is close to the station.
  - This is a friendly university.
- process/result
  - The building was beginning to take place.
  - The building was burned down.

Types of contextual variations

Systematic polysemies (Apresjan 1973)

- container/content
  - I broke two glasses.
  - I drank two glasses.
- institution/place/people
  - The university hired a new professor.
  - The university is close to the station.
  - This is a friendly university.
- process/result
  - The building was beginning to take place.
  - The building was burned down.

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

- object and information

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

- object and information
  - Jess almost dropped the book, then hastily replaced it on the shelf.

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

- object and information
  - Jess almost dropped the <u>book</u>, then hastily replaced it on the shelf.
  - The author will be discussing her new <u>book</u>.

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

- object and information
  - Jess almost dropped the book, then hastily replaced it on the shelf.
  - The author will be discussing her new book.
  - This is a bulky and demanding *book*. (**copredication**)

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

- object and information
  - Jess almost dropped the <u>book</u>, then hastily replaced it on the shelf.
  - The author will be discussing her new <u>book</u>.
  - This is a <u>bulky</u> and <u>demanding</u> *book*. (**copredication**)
- event and food

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

- object and information
  - Jess almost dropped the book, then hastily replaced it on the shelf.
  - The author will be discussing her new book.
  - This is a bulky and demanding *book*. (**copredication**)
- event and food
  - It was a long lunch.

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

- object and information
    - Jess almost dropped the book, then hastily replaced it on the shelf.
    - The author will be discussing her new book.
    - This is a bulky and demanding *book*. (**copredication**)
- event and food
    - It was a long lunch.
    - It was a heavy lunch.

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

- object and information
  - Jess almost dropped the book, then hastily replaced it on the shelf.
  - The author will be discussing her new book.
  - This is a bulky and demanding *book*. (**copredication**)
- event and food
  - It was a long lunch.
  - It was a heavy lunch.
  - We had a quick and tasty lunch on the terrace. (**copredication**)

Types of contextual variation

Inherent polysemies (Pustejovsky 1995)

- object and information
  - Jess almost dropped the book, then hastily replaced it on the shelf.
  - The author will be discussing her new book.
  - This is a bulky and demanding *book*. (**copredication**)
- event and food
  - It was a long lunch.
  - It was a heavy lunch.
  - We had a quick and tasty lunch on the terrace. (**copredication**)

Cruse 1995's *nouns with facets*, Asher's 2011 *dual aspect nouns*.

What counts as a copredication?

- Typically, **copredication** has been restricted to classic **coordinative construction**.

What counts as a copredication?

- Typically, **copredication** has been restricted to classic **coordinative construction**.
- Very few hits of coordination patterns **and** and **but** in corpora; when present, they do not frequently mix different aspect but tends to predicate on a single aspect.

What counts as a copredication?

- Typically, **copredication** has been restricted to classic **coordinative construction**.
- Very few hits of coordination patterns **and** and **but** in corpora; when present, they do not frequently mix different aspect but tends to predicate on a single aspect.
  - It. La costruzione fu lenta e paziente.
    'The construction was slow and patient.'

What counts as a copredication?

- Typically, **copredication** has been restricted to classic **coordinative construction**.
- Very few hits of coordination patterns **and** and **but** in corpora; when present, they do not frequently mix different aspect but tends to predicate on a single aspect.
  - It. La <u>costruzione</u> fu lenta e paziente.
    'The construction was slow and patient.'
  - It. La <u>costruzione</u> era solida e stabile.
    'The building was solid and stable.'

What counts as a copredication?

- Typically, **copredication** has been restricted to classic **coordinative construction**.
- Very few hits of coordination patterns **and** and **but** in corpora; when present, they do not frequently mix different aspect but tends to predicate on a single aspect.
  - It. La costruzione fu lenta e paziente.
    'The construction was slow and patient.'
  - It. La costruzione era solida e stabile.
    'The building was solid and stable.'

Jezek and Melloni 2011.

What counts as a copredication?

- Corpus work shows that several patterns are available **beyond coordination**.

What counts as a copredication?

- Corpus work shows that several patterns are available **beyond coordination**.
  - The book on the shelf is boring.

What counts as a copredication?

- Corpus work shows that several patterns are available **beyond coordination**.
  - The book on the shelf is boring.
  - The cat was climbing through the open window.

What counts as a copredication?

- Corpus work shows that several patterns are available **beyond coordination**.
  - The book on the shelf is boring.
  - The cat was climbing through the open window.
  - Fr. La construction, qui a commencé hier, sera très jolie.
    'The building, which started yesterday, will be very nice.
    Jacquey 2001, 155

What counts as a copredication?

- Corpus work shows that several patterns are available **beyond coordination**.
  - The book on the shelf is boring.
  - The cat was climbing through the open window.
  - Fr. La construction, qui a commencé hier, sera très jolie.
    'The building, which started yesterday, will be very nice.
    Jacquey 2001, 155
  - It. Una volta completata, la traduzione si può caricare in una sezione apposita del sito.
    'Once completed, the translation may be uploaded in a special section of the site'.
    Jezek and Melloni 2011, 27

Experimental setting

- We conduct a research to automatically extract copredication contexts from corpora and identify a list of candidate inherently polysemous nouns for each pattern (Jezek and Vieu 2014).

Experimental setting

- We conduct a research to automatically extract copredication contexts from corpora and identify a list of candidate inherently polysemous nouns for each pattern (Jezek and Vieu 2014).
- We use the tagged Italian ItTenTen10 (2,5 Gigawords) corpus queried through Sketch Engine and its API.

Experimental setting

- We conduct a research to automatically extract copredication contexts from corpora and identify a list of candidate inherently polysemous nouns for each pattern (Jezek and Vieu 2014).
- We use the tagged Italian ItTenTen10 (2,5 Gigawords) corpus queried through Sketch Engine and its API.
- We focus on the copredication pattern $[V[Det\_N\_Adj]]$ and on the inherent polysemy scheme physical_object•information.

Experimental setting

- We conduct a research to automatically extract copredication contexts from corpora and identify a list of candidate inherently polysemous nouns for each pattern (Jezek and Vieu 2014).
- We use the tagged Italian ItTenTen10 (2,5 Gigawords) corpus queried through Sketch Engine and its API.
- We focus on the copredication pattern $[V[Det\_N\_Adj]]$ and on the inherent polysemy scheme physical_object•information.
  - It. Consultare un libro voluminoso.
    'Consult a bulky book'

Experimental setting

- We conduct a research to automatically extract copredication contexts from corpora and identify a list of candidate inherently polysemous nouns for each pattern (Jezek and Vieu 2014).
- We use the tagged Italian ItTenTen10 (2,5 Gigawords) corpus queried through Sketch Engine and its API.
- We focus on the copredication pattern $[V[Det\_N\_Adj]]$ and on the inherent polysemy scheme physical_object•information.
  - It. Consultare un libro voluminoso.
    'Consult a bulky book'
  - It. ...bruciavano i libri controversi.
    '...they burned the controversial books'.

Experimental setting

- We conduct a research to automatically extract copredication contexts from corpora and identify a list of candidate inherently polysemous nouns for each pattern (Jezek and Vieu 2014).
- We use the tagged Italian ItTenTen10 (2,5 Gigawords) corpus queried through Sketch Engine and its API.
- We focus on the copredication pattern $[V[Det\_N\_Adj]]$ and on the inherent polysemy scheme physical_object•information.
  - It. Consultare un libro voluminoso.
    'Consult a bulky book'
  - It. ...bruciavano i libri controversi.
    '...they burned the controversial books'.

Distributional analysis of copredication in Jezek and Vieu 2014, Vieu, Jezek and VanDeCruys 2015.

Predicate selection

- Effective copredication contexts extraction require identification of predicates that select the different aspects of the noun (i.e. adjective and verbs selecting for either the **information** or the **physical_object** aspect to be tested).

Predicate selection

- Effective copredication contexts extraction require identification of predicates that select the different aspects of the noun (i.e. adjective and verbs selecting for either the **information** or the **physical_object** aspect to be tested).
- Here, we need 4 lists: **VPhys**, **AdjInfo**, **VInfo**, **AdjPhys**.

Predicate selection

- Effective copredication contexts extraction require identification of predicates that select the different aspects of the noun (i.e. adjective and verbs selecting for either the **information** or the **physical_object** aspect to be tested).
- Here, we need 4 lists: **VPhys**, **AdjInfo**, **VInfo**, **AdjPhys**.
- Manual extraction of predicates is costly and time-consuming.

Predicate selection

- Effective copredication contexts extraction require identification of predicates that select the different aspects of the noun (i.e. adjective and verbs selecting for either the **information** or the **physical_object** aspect to be tested).
- Here, we need 4 lists: **VPhys**, **AdjInfo**, **VInfo**, **AdjPhys**.
- Manual extraction of predicates is costly and time-consuming.
- We exploit distributional semantics to extract predicates.

Predicate selection

- Effective copredication contexts extraction require identification of predicates that select the different aspects of the noun (i.e. adjective and verbs selecting for either the **information** or the **physical_object** aspect to be tested).
- Here, we need 4 lists: **VPhys**, **AdjInfo**, **VInfo**, **AdjPhys**.
- Manual extraction of predicates is costly and time-consuming.
- We exploit distributional semantics to extract predicates.
- We use a model that relies on latent dimensions computed by non-negative matrix factorization.

Semi-automatic predicate extraction

- Latent semantic distributional model to semi-automatically extract predicates from corpus.

Semi-automatic predicate extraction

- Latent semantic distributional model to semi-automatically extract predicates from corpus.
  Hypothesis: the **latent dimensions** obtained hint at particular predication contexts, such as `Phys`, `Info` or both.

Semi-automatic predicate extraction

- Latent semantic distributional model to semi-automatically extract predicates from corpus.
  Hypothesis: the **latent dimensions** obtained hint at particular predication contexts, such as `Phys`, `Info` or both.
- Method: extension of non-negative matrix factorization (Van de Cruys, 2008)

Semi-automatic predicate extraction

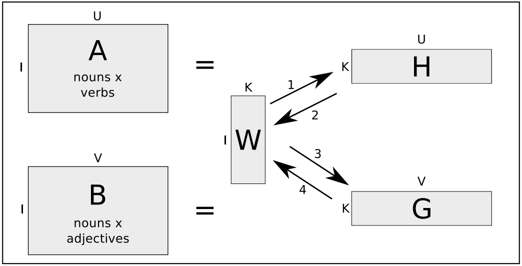
- Latent semantic distributional model to semi-automatically extract predicates from corpus.
  Hypothesis: the **latent dimensions** obtained hint at particular predication contexts, such as `Phys`, `Info` or both.
- Method: extension of non-negative matrix factorization (Van de Cruys, 2008)
  - NMF: Non-negative matrix **A** is factorized into two other non-negative matrices:

$$A_{i \times j} \approx W_{i \times k} H_{k \times j} \tag{1}$$

where k is much smaller than i, j (Lee, 2001)

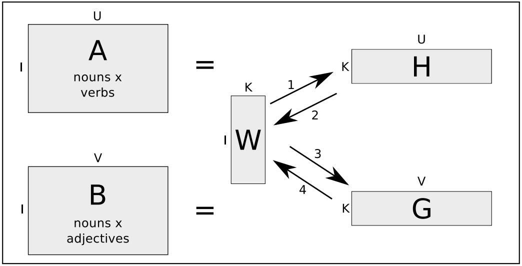
Semi-automatic predicate extraction

- Extension of NMF to jointly induce latent factors for 3 modes (N, V, Adj) in the co-predication pattern [V [Det N Adj]] by interleaved factorizations



Semi-automatic predicate extraction

- Extension of NMF to jointly induce latent factors for 3 modes (N, V, Adj) in the co-predication pattern [V [Det N Adj]] by interleaved factorizations



- Exploits syntactic constraints to obtain semantic similarity, not just topic similarity.

Extracting the latent dimensions

- Extract co-occurrence frequencies from freely available ItWaC corpus (Baroni et al, 2009), using most frequently occurring 1K verbs, 4K nouns and 2K adjectives.

Extracting the latent dimensions

- Extract co-occurrence frequencies from freely available ItWaC corpus (Baroni et al, 2009), using most frequently occurring 1K verbs, 4K nouns and 2K adjectives.
- Set the number of latent dimensions to k 100.

Extracting the latent dimensions

- Extract co-occurrence frequencies from freely available ItWaC corpus (Baroni et al, 2009), using most frequently occurring 1K verbs, 4K nouns and 2K adjectives.
- Set the number of latent dimensions to k 100.
- Select dimensions and take their first 20 items.

Extracting the latent dimensions

- Extract co-occurrence frequencies from freely available ItWaC corpus (Baroni et al, 2009), using most frequently occurring 1K verbs, 4K nouns and 2K adjectives.
- Set the number of latent dimensions to *k* 100.
- Select dimensions and take their first 20 items.
  Yields 4 lists of predicates VPhys, AdjInfo, VInfo, and AdjPhys

Extracting the latent dimensions

- Extract co-occurrence frequencies from freely available ItWaC corpus (Baroni et al, 2009), using most frequently occurring 1K verbs, 4K nouns and 2K adjectives.
- Set the number of latent dimensions to k 100.
- Select dimensions and take their first 20 items.
  Yields 4 lists of predicates VPhys, AdjInfo, VInfo, and AdjPhys
  Two alternative methods:

Extracting the latent dimensions

- Extract co-occurrence frequencies from freely available ItWaC corpus (Baroni et al, 2009), using most frequently occurring 1K verbs, 4K nouns and 2K adjectives.
- Set the number of latent dimensions to k 100.
- Select dimensions and take their first 20 items.
  Yields 4 lists of predicates VPhys, AdjInfo, VInfo, and AdjPhys
  Two alternative methods:
  - Manually review the 15 dimensions most associated with the 10 Info•Phys **seed nouns** to pick between 2 and 5 dimensions for each list (DimsN).

Extracting the latent dimensions

- Extract co-occurrence frequencies from freely available ItWaC corpus (Baroni et al, 2009), using most frequently occurring 1K verbs, 4K nouns and 2K adjectives.
- Set the number of latent dimensions to k 100.
- Select dimensions and take their first 20 items.
  Yields 4 lists of predicates VPhys, AdjInfo, VInfo, and AdjPhys
  Two alternative methods:
  - Manually review the 15 dimensions most associated with the 10 Info•Phys **seed nouns** to pick between 2 and 5 dimensions for each list (DimsN).
  - Automatically pick the 5 dimensions most associated with 10 **seed predicates** (manually chosen) for each list (DimspP).

Verbs	Adjectives	Nouns
narrare (narrate)	*antico* (ancient)	*leggenda* (legend)
raccontare (tell)	*greco* (Greek)	*favola* (fable)
imparare (learn)	*volgare* (vulgar)	*fiaba* (fable)
conoscere (know)	*latino* (Latin)	*storia* (story)
inventare (invent)	*crudele* (cruel)	*latino* (Latin)
evocare (evoke)	*medievale* (medieval)	*greco* (Greek)
apprendere (learn)	*saggio* (wise)	*dialetto* (dialect)
credere (believe)	*triste* (sad)	*mito* (myth)
sognare (dream)	*medioevale* (medieval)	*antico* (ancient)
insegnare (teach)	*romantico* (romantic)	*mestiere* (profession)
recitare (recite)	*napoletano* (Neapolitan)	*eroe* (hero)
sapere (know)	*italico* (Italic)	*poesia* (poetry)
tradurre (translate)	*eroico* (heroic)	*lingua* (tongue)
parlare (talk)	*nobile* (noble)	*poeta* (poet)
amare (love)	*parlato* (spoken)	*danza* (dance)
ispirare (inspire)	*indiano* (Indian)	*arabo* (Arab)
dipingere (paint)	*popolare* (popular)	*comico* (comic)
adorare (adore)	*orientale* (eastern)	*accento* (accent)
diventare (become)	*moderno* (modern)	*spagnolo* (Spaniard)
vivere (live)	*cinese* (Chinese)	*dramma* (drama)

A dimension picked for both VInfo and AdjInfo

Verbs	Adjectives	Nouns
compilare (compile)	*cartaceo* (of paper)	*fotocopia* (photocopy)
allegare (attach)	*elettronico* (electronic)	*copia* (copy)
spedire (send)	*allegato* (attached)	*certificato* (certificate)
corredare (equip)	*inviato* (sent)	*documento* (document)
inviare (send)	*apposito* (specific)	*ricevuta* (receipt)
inoltrare (forward)	*modulistico* (of form)	*modulo* (form)
stampare (print)	*leggibile* (readable)	*questionario* (questionnaire)
copiare (copy)	*firmato* (signed)	*autocertificazione* (self-certification)
archiviare (file)	*informatico* (of computer)	*pdf* (pdf)
ricevere (receive)	*digitale* (digital)	*documentazione* (documentation)
modulare (modulate)	*valido* (valid)	*informazione* (information)
certificare (certify)	*scaricabile* (downloadable)	*E-mail* (e-mail)
trasmettere (transmit)	*On-line* (on-line)	*dato* (datum)
consegnare (deliver)	*telematico* (telematic)	*posta* (mail)
depositare (deposit)	*redatto* (written)	*verbale* (report)
reperire (find)	*disponibile* (available)	*originale* (original)
redigere (write)	*lino* (of linen)	*scheda* (card)
sottoscrivere (sign)	*postale* (postal)	*certificazione* (certificate)
pervenire (reach)	*reperibile* (available)	*autenticazione* (authentication)
munire (provide)	*identificativo* (identifying)	*formato* (format)

A dimension picked for both VPhys and AdjPhys

Results of predicate extraction

- We started with 10 seed nouns (*articolo* ‘article’, *diario* ‘diary’, *documento* ‘document’, *etichetta* ‘label’, *fumetto* ‘comic’, *giornale* ‘newspaper’, *lettera* ‘letter’, *libro* ‘book’, *racconto* ‘short novel’, *romanzo* ‘novel’).

Results of predicate extraction

- We started with 10 seed nouns (*articolo* ‘article’, *diario* ‘diary’, *documento* ‘document’, *etichetta* ‘label’, *fumetto* ‘comic’, *giornale* ‘newspaper’, *lettera* ‘letter’, *libro* ‘book’, *racconto* ‘short novel’, *romanzo* ‘novel’).
- We applied an extension of NMF to jointly induce latent factors for three different modes (N, V, and A).

Results of predicate extraction

- We started with 10 seed nouns (*articolo* 'article', *diario* 'diary', *documento* 'document', *etichetta* 'label', *fumetto* 'comic', *giornale* 'newspaper', *lettera* 'letter', *libro* 'book', *racconto* 'short novel', *romanzo* 'novel').
- We applied an extension of NMF to jointly induce latent factors for three different modes (N, V, and A).
- We produced matrixes with the pairwise co-occurrence frequencies for the different modes and then **interleaved** then.

Results of predicate extraction

- We started with 10 seed nouns (*articolo* 'article', *diario* 'diary', *documento* 'document', *etichetta* 'label', *fumetto* 'comic', *giornale* 'newspaper', *lettera* 'letter', *libro* 'book', *racconto* 'short novel', *romanzo* 'novel').
- We applied an extension of NMF to jointly induce latent factors for three different modes (N, V, and A).
- We produced matrixes with the pairwise co-occurrence frequencies for the different modes and then **interleaved** then.
- With the aid of manual selection, we obtained 4 lists containing from 37 **AdjPhys** to 91 **AdjInfo**, which we used as fillers for the pattern to extract copredications contexts.

Results of predicate extraction

- We started with 10 seed nouns (*articolo* 'article', *diario* 'diary', *documento* 'document', *etichetta* 'label', *fumetto* 'comic', *giornale* 'newspaper', *lettera* 'letter', *libro* 'book', *racconto* 'short novel', *romanzo* 'novel').
- We applied an extension of NMF to jointly induce latent factors for three different modes (N, V, and A).
- We produced matrixes with the pairwise co-occurrence frequencies for the different modes and then **interleaved** then.
- With the aid of manual selection, we obtained 4 lists containing from 37 **AdjPhys** to 91 **AdjInfo**, which we used as fillers for the pattern to extract copredications contexts.

Results

- We started with 10 seed nouns.
  - *articolo* ‘article’, *diario* ‘diary’, *documento* ‘document’, *etichetta* ‘label’, *fumetto* ‘comic’, *giornale* ‘newspaper’, *lettera* ‘letter’, *libro* ‘book’, *racconto* ‘short novel’, *romanzo* ‘novel’.

Results

- We started with 10 seed nouns.
  - *articolo* 'article', *diario* 'diary', *documento* 'document', *etichetta* 'label', *fumetto* 'comic', *giornale* 'newspaper', *lettera* 'letter', *libro* 'book', *racconto* 'short novel', *romanzo* 'novel'.
- We applied an extension of NMF to jointly induce latent factors for three different modes (N, V, and A).

Results

- We started with 10 seed nouns.
  - *articolo* 'article', *diario* 'diary', *documento* 'document', *etichetta* 'label', *fumetto* 'comic', *giornale* 'newspaper', *lettera* 'letter', *libro* 'book', *racconto* 'short novel', *romanzo* 'novel'.
- We applied an extension of NMF to jointly induce latent factors for three different modes (N, V, and A).
- We produced matrixes with the pairwise co-occurrence frequencies for the different modes and then **interleaved** then.

Results

- We started with 10 seed nouns.
  - *articolo* 'article', *diario* 'diary', *documento* 'document', *etichetta* 'label', *fumetto* 'comic', *giornale* 'newspaper', *lettera* 'letter', *libro* 'book', *racconto* 'short novel', *romanzo* 'novel'.
- We applied an extension of NMF to jointly induce latent factors for three different modes (N, V, and A).
- We produced matrixes with the pairwise co-occurrence frequencies for the different modes and then **interleaved** then.
- With the aid of manual selection, we obtained 4 lists containing from 37 **AdjPhys** to 91 **AdjInfo**, which we used as fillers for the pattern to extract copredications contexts.

Results

- We started with 10 seed nouns.
  - *articolo* 'article', *diario* 'diary', *documento* 'document', *etichetta* 'label', *fumetto* 'comic', *giornale* 'newspaper', *lettera* 'letter', *libro* 'book', *racconto* 'short novel', *romanzo* 'novel'.
- We applied an extension of NMF to jointly induce latent factors for three different modes (N, V, and A).
- We produced matrixes with the pairwise co-occurrence frequencies for the different modes and then **interleaved** then.
- With the aid of manual selection, we obtained 4 lists containing from 37 **AdjPhys** to 91 **AdjInfo**, which we used as fillers for the pattern to extract copredications contexts.
- We successfully merged manually-based, pattern-based and distributionally-based methodologies to gather data for the investigation of the theoretical construct of **inherent polysemy**.

Context-sensitive model of lexical semantics

- The data analysed so far provide evidence that **semantic flexibility** is a property of natural language.

Context-sensitive model of lexical semantics

- The data analysed so far provide evidence that **semantic flexibility** is a property of natural language.
- The meaning of each word is expected to vary from occurrence to occurrence as a function of the interaction with the other words it combines with, and of the situation of utterance (Recanati 2012).

Context-sensitive model of lexical semantics

- The data analysed so far provide evidence that **semantic flexibility** is a property of natural language.
- The meaning of each word is expected to vary from occurrence to occurrence as a function of the interaction with the other words it combines with, and of the situation of utterance (Recanati 2012).
- **Functional notion** of polysemy.

Context-sensitive model of lexical semantics

- The data analysed so far provide evidence that **semantic flexibility** is a property of natural language.
- The meaning of each word is expected to vary from occurrence to occurrence as a function of the interaction with the other words it combines with, and of the situation of utterance (Recanati 2012).
- **Functional notion** of polysemy.
- Formal models propose that context-sensitivity is not confined to words with functional roles (traditionally verbs and adjectives), but extends e.g. to nouns (see Pustejovsky's qualia theory).

Models and methods for context-sensitive lexical semantics

- What is the best model (formal, distributional, probabilistic) to predict the observed contextual variation in word meanings?

Models and methods for context-sensitive lexical semantics

- What is the best model (formal, distributional, probabilistic) to predict the observed contextual variation in word meanings?
- Can a single model serve both linguistic and computational purposes?

Models and methods for context-sensitive lexical semantics

- What is the best model (formal, distributional, probabilistic) to predict the observed contextual variation in word meanings?
- Can a single model serve both linguistic and computational purposes?
- To what extent statistics about word context and exploitation of co-occurrence information (distributionally-represented knowledge) can serve as a proxy for semantic grounding – and how can it inform us about compositionality in language?

Requirements for models context-sensitive lexical semantics

- We argue that a basic requirement of a context-sensitive lexical semantic model is, above all, a clear standpoint with respect to the interplay between the lexicon, cognition and pragmatic processes.

- Words denote classes of entities and are associated with conceptual categories, for example a *dog* denotes an *animal*, a *table* denotes an *artifact*, *bread* denotes a kind of *food*, a *park* denotes a *location*, *run* denotes a *process*, *love* denotes a *state*, and so forth.

- Words denote classes of entities and are associated with conceptual categories, for example a *dog* denotes an *animal*, a *table* denotes an *artifact*, *bread* denotes a kind of *food*, a *park* denotes a *location*, *run* denotes a *process*, *love* denotes a *state*, and so forth.
- A conceptual category may be analyzed as a set of salient attributes or properties, for example the concept *dog* has properties: breathes, barks, wags its tail, has fur, and so forth (Baroni and Lenci, 2008, Poesio and Almuhareb 2008).

- Words denote classes of entities and are associated with conceptual categories, for example a *dog* denotes an *animal*, a *table* denotes an *artifact*, *bread* denotes a kind of *food*, a *park* denotes a *location*, *run* denotes a *process*, *love* denotes a *state*, and so forth.
- A conceptual category may be analyzed as a set of salient attributes or properties, for example the concept *dog* has properties: breathes, barks, wags its tail, has fur, and so forth (Baroni and Lenci, 2008, Poesio and Almuhareb 2008).
- But which properties of a concept are genuinely distinctive and enter into the **lexical make-up** of a word and which ones do not?

Lexicon and world knowledge

- There are deep controversies regarding what piece of information associated with a word should enter into its definition, and constitute what is called its **lexical information**.

Lexicon and world knowledge

- There are deep controversies regarding what piece of information associated with a word should enter into its definition, and constitute what is called its **lexical information**.
- Traditionally, it is assumed that **world / commonsense / encyclopedic knowledge** should be excluded.

Lexicon and world knowledge

- There are deep controversies regarding what piece of information associated with a word should enter into its definition, and constitute what is called its **lexical information**.
- Traditionally, it is assumed that **world / commonsense / encyclopedic knowledge** should be excluded.
- This amounts to the large body of knowledge that people possess about the entities and events denoted by words as a result of their experience of the world.

Lexicon and world knowledge

- There are deep controversies regarding what piece of information associated with a word should enter into its definition, and constitute what is called its **lexical information**.
- Traditionally, it is assumed that **world / commonsense / encyclopedic knowledge** should be excluded.
- This amounts to the large body of knowledge that people possess about the entities and events denoted by words as a result of their experience of the world.
- It has to do with the speaker's perception of the world, and the analogies speakers establish between objects and events, rather than with their linguistic knowledge.

Lexicon and world knowledge

- The distinction is very difficult to draw.

Lexicon and world knowledge

- The distinction is very difficult to draw.
- According to some authors, it is not even necessary.

Lexicon and world knowledge

- The distinction is very difficult to draw.
- According to some authors, it is not even necessary.
- Others believe it should be conceived as a continuum rather than a dichotomy.

Lexicon and world knowledge

- The distinction is very difficult to draw.
- According to some authors, it is not even necessary.
- Others believe it should be conceived as a continuum rather than a dichotomy.
- Opinions differ because there is **no consensus about what criteria** must be satisfied for a piece of information to qualify as encyclopedic knowledge instead of linguistic meaning, or vice versa.

Lexicon and world knowledge

- The distinction is very difficult to draw.
- According to some authors, it is not even necessary.
- Others believe it should be conceived as a continuum rather than a dichotomy.
- Opinions differ because there is **no consensus about what criteria** must be satisfied for a piece of information to qualify as encyclopedic knowledge instead of linguistic meaning, or vice versa.
- Those who make a distinction take different positions on the subject.

Minimalism

- According to the **minimalist position**, nothing of what we know about, say, the entity called *dog* is part of the lexical information associated with the word *dog*, except for those features that are necessary to define it as a domestic animal (as opposed to a wild one) and allow us to distinguish it from other entities falling into the same category.

Maximalism

- According to the **maximalist position**, the opposite is instead true, that is, the lexical information associated with the word *dog* incorporates our knowledge that dogs can be aggressive (and therefore bite and attack), that they have an acute sense of smell, that they like to chase cats, and so on.

Maximalism

- According to the **maximalist position**, the opposite is instead true, that is, the lexical information associated with the word *dog* incorporates our knowledge that dogs can be aggressive (and therefore bite and attack), that they have an acute sense of smell, that they like to chase cats, and so on.
- This additional knowledge about dogs is what we know from our individual experience.

No distinction

- A radical position is that taken by those who hold that the distinction between lexical information and world / encyclopedic / commonsense knowledge is artificial or useless, and should be eliminated.

No distinction

- A radical position is that taken by those who hold that the distinction between lexical information and world / encyclopedic / commonsense knowledge is artificial or useless, and should be eliminated.
- According to this position, words **give access to concepts**, and all the properties that enter into the constitution of a concept can in principle be exploited in language through the use of words.

No distinction

- A radical position is that taken by those who hold that the distinction between lexical information and world / encyclopedic / commonsense knowledge is artificial or useless, and should be eliminated.
- According to this position, words **give access to concepts**, and all the properties that enter into the constitution of a concept can in principle be exploited in language through the use of words.
- The contexts in which words are used determine which property/ies of the concept is/are activated in the specific case.

No distinction

- The lexicon is interpreted as the **access node** into the vast repository of information associated with conceptual categories.

No distinction

- The lexicon is interpreted as the **access node** into the vast repository of information associated with conceptual categories.
- This position is dominant in cognitive semantics and pragmatics (Sperber and Wilson 1995; Carston 2002), where **context-dependency** is dealt with at the conceptual level (instead of at the lexical level).

No distinction

- The lexicon is interpreted as the **access node** into the vast repository of information associated with conceptual categories.
- This position is dominant in cognitive semantics and pragmatics (Sperber and Wilson 1995; Carston 2002), where **context-dependency** is dealt with at the conceptual level (instead of at the lexical level).

Ad-hoc concepts (Barsalou 1983, 2010; Wilson and Carston 2007)
General extenders ("whales, candlelight and stuff like that" Overstreet 1999).

Meaning Eliminativism (ME)

- Extreme version of contextualism (Recanati, 2004).

Meaning Eliminativism (ME)

- Extreme version of contextualism (Recanati, 2004).
- We don't need abstract scheme in the form of context-independent linguistic meaning as input to the composition process.

Meaning Eliminativism (ME)

- Extreme version of contextualism (Recanati, 2004).
- We don't need abstract scheme in the form of context-independent linguistic meaning as input to the composition process.
- This can proceed **without the help of conventionalized context-independent word meanings**.

Meaning Eliminativism (ME)

- Extreme version of contextualism (Recanati, 2004).
- We don't need abstract scheme in the form of context-independent linguistic meaning as input to the composition process.
- This can proceed **without the help of conventionalized context-independent word meanings**.
- ME gets rid of abstract meaning in favour of observed occasion of particular uses.

Why the ME and the no-distinction are not tenable

- We argue that the position according to which there is no distinction between lexical meaning and conceptual content and that the construction of interpretation is entirely a matter of context is not tenable.

Why the ME and the no-distinction are not tenable

- We argue that the position according to which there is no distinction between lexical meaning and conceptual content and that the construction of interpretation is entirely a matter of context is not tenable.
- Language models which follow this view are deemed to fail in accounting for semantic composition in natural language. There are at least three different types of arguments for this claim.

Why the ME and the no-distinction are not tenable

- First, if we allow that context does <u>all</u> the work required to obtain the assignment of explicit semantic values to word occurrences, the range of interpreted values assignable to a given lexical entry is in principle unlimited.

Why the ME and the no-distinction are not tenable

- First, if we allow that context does <u>all</u> the work required to obtain the assignment of explicit semantic values to word occurrences, the range of interpreted values assignable to a given lexical entry is in principle unlimited.
- In this perspective, there is nothing preventing speakers from uttering a word instead of another in their speech, which is obviously not the case.

Why the ME and the no-distinction are not tenable

- Second, there clearly is stability in the assignment of semantic values to lexical items across speakers.

Why the ME and the no-distinction are not tenable

- Second, there clearly is stability in the assignment of semantic values to lexical items across speakers.
- Language users converge in their judgments regarding conditions of applications of words.

Why the ME and the no-distinction are not tenable

- Second, there clearly is stability in the assignment of semantic values to lexical items across speakers.
- Language users converge in their judgments regarding conditions of applications of words.
- Both these aspects support the idea that lexical meanings have a robust psychological reality.

Why the ME and the no-distinction are not tenable

- Second, there clearly is stability in the assignment of semantic values to lexical items across speakers.
- Language users converge in their judgments regarding conditions of applications of words.
- Both these aspects support the idea that lexical meanings have a robust psychological reality.

Why the ME and the no-distinction are not tenable

- Third, there are constraints to the way we can stretch the meaning of words in the context of use.

Why the ME and the no-distinction are not tenable

- Third, there are constraints to the way we can stretch the meaning of words in the context of use.
- These constraints do not appear to be systematically predictable on the basis of conceptual knowledge, suggesting that constraints operate not only at the cognitive level but also at the **lexical semantics level**, and there exists a distinction between the two.

- Consider the the concepts expressed by the following words and the relations existing among them: *museo* ‘museum’, *quadro* ‘painting’ and *collezione* ‘collection’.

Corpus Investigation

- Consider the the concepts expressed by the following words and the relations existing among them: *museo* 'museum', *quadro* 'painting' and *collezione* 'collection'.
- *museo* denotes both the LOCATION where paintings are stored, and the INSTITUTION which is in charge of exhibiting them;

Corpus Investigation

- Consider the the concepts expressed by the following words and the relations existing among them: *museo* 'museum', *quadro* 'painting' and *collezione* 'collection'.
- *museo* denotes both the LOCATION where paintings are stored, and the INSTITUTION which is in charge of exhibiting them;
- *quadro* is the prototypical OBJECT associated with the EXHIBIT event; specifically, the participant playing the role of Theme;

Corpus Investigation

- Consider the the concepts expressed by the following words and the relations existing among them: *museo* 'museum', *quadro* 'painting' and *collezione* 'collection'.
- *museo* denotes both the LOCATION where paintings are stored, and the INSTITUTION which is in charge of exhibiting them;
- *quadro* is the prototypical OBJECT associated with the EXHIBIT event; specifically, the participant playing the role of Theme;
- *collezione* refers to a GROUP of accumulated paintings, usually considered as a whole because of the way it was put together.

Corpus Investigation

- The concepts expressed by these three words are clearly related.

Corpus Investigation

- The concepts expressed by these three words are clearly related.
- There exists:

Corpus Investigation

- The concepts expressed by these three words are clearly related.
- There exists:
- a **containment** relation between *quadro* and *museo*;

Corpus Investigation

- The concepts expressed by these three words are clearly related.
- There exists:
- a **containment** relation between *quadro* and *museo*;
- a **part_of** relation between *quadro* and *collezione*;

Corpus Investigation

- The concepts expressed by these three words are clearly related.
- There exists:
- a **containment** relation between *quadro* and *museo*;
- a **part_of** relation between *quadro* and *collezione*;
- a relation of **participation** between *quadro* and the relational concept expressed by EXHIBIT.

Corpus data

(1) a. “Il museo apre alle alle 9.00”. (1627 hits)
'The museum opens at 9.00
b. “La collezione apre alle 9.00. (446 hits)
'The collection opens at 9.00.
c. “I quadri aprono alle 9.00”. (0 hits)
'The paintings open at 9.00'.

Corpus ItTenTen (4.9 billion words) queried through the Sketch Engine (Kilgarriff et al 2014) using CQL.

Results

- Words which are cognitively related such as *collezione* and *quadro* (being collection a word that denotes both the act and the result of gathering together a number of painting) exhibit in the data different semantic behaviors in composition with respect to the extent to which their meaning is stretched.

Results

- Words which are cognitively related such as *collezione* and *quadro* (being collection a word that denotes both the act and the result of gathering together a number of painting) exhibit in the data different semantic behaviors in composition with respect to the extent to which their meaning is stretched.
- There appear to be constraints to the way we stretch the meaning of words, which are not necessarily motivated cognitively.

Results

- One might argue that this is related to conventions in language.

Results

- One might argue that this is related to conventions in language.
- We content that this is precisely the argument in favour of distinguishing conceptual knowledge from the actual knowledge associated with lexical items of a specific language, and constitutes its semantics.

Gradability

- We theorize that besides being constrained, stretching phenomena are **graded**, that is, they vary depending on how much the lexical content is **exploited** or **enriched** in the context of use.

Jezek, E. 2017 "Stretching the Meaning of Words", Logic and Machine Learning in Natural Language, Gothenburg.

Human judgments

- We run an experiment to obtain human judgements on a total of 100 verb-object and subj-verb contextualised dyads, where 2 annotators were asked to rate **how literal the interpretation of the highlighted noun in the given dyad was**, within a span of 1 (literal) to 5 (shifted in context), and a tag for semantically not acceptable (odd).

Annotation Task

- We proposed the task as follows:

Annotation Task

- We proposed the task as follows:
- "How literal is the interpretation of the highlighted word in the contexts below? Rate it from 1 (literal) to 5 (shifted in context) and use the last column if you think the example is semantically odd or non interpretable."

Dataset

- The dyads consist of corpus-derived examples of matching (42) and mismatching (58) taken from T-PAS study outlined above from the Italian section of the dataset of the SemEval 2010 Task 7 on Argument Coercion (Pustejovsky et al 2010).

Dataset

- The dyads consist of corpus-derived examples of matching (42) and mismatching (58) taken from T-PAS study outlined above from the Italian section of the dataset of the SemEval 2010 Task 7 on Argument Coercion (Pustejovsky et al 2010).
- Additional examples were constructed manually with the goal of testing acceptability.

Sample of the dataset

Sample of the dataset for the It. verb *annunciare* 'announce'. The noun to be annotated is the one in subject position that is assumed to be typed as [[Human]] by the selecting verb.

13	lo speaker annuncia la partenza del treno
14	Una tromba annuncia un parlamentare
15	Questa tromba annuncia una sventura
16	i telegiornali annunciano la ricomparsa della madre
17	una telefonata annuncia la presenza di un ordigno
18	L' altoparlante annuncia ritardi a catena
19	La voce metallica dell'altoparlante ha annunciato che il regionale sarebbe arrivato in ritardo
20	il premier spagnolo annuncia il ritiro immediato delle truppe
21	Washington ha annunciato un programma di aiuti
22	Il governo coreano ha annunciato la vendita della Dae-woo
23	Il comunicato annuncia la nomina del consiglio di amministrazione
24	Una voce dalla radio annuncia lo sciopero generale
25	Gli organizzatori annunciano una sorpresa

Table: Sample of the dataset

Interannotator Agreement

- The two annotators marked the same judgements in 57 cases out of the 100 proposed (57% of observed agreement).

Interannotator Agreement

- The two annotators marked the same judgements in 57 cases out of the 100 proposed (57% of observed agreement).
- The agreement (IAA) we computed using Cohen's Kappa is 0.38.

Interannotator Agreement

- The two annotators marked the same judgements in 57 cases out of the 100 proposed (57% of observed agreement).
- The agreement (IAA) we computed using Cohen's Kappa is 0.38.
- Cohen's kappa (K) takes into account the possibility of the agreement occurring by chance; the formula subtracts the probability of agreement by chance from the observed agreement.

Qualitative Analysis

- Overall, the results show that the two annotators express a variety of graded judgments on coercions when allowed to do so by the task.

Qualitative Analysis

- Overall, the results show that the two annotators express a variety of graded judgments on coercions when allowed to do so by the task.
- Both annotators make extensive use of tag 1 (52 tags for ANN 1 and 49 tags for ANN 2), and their agreement on this tag - identifying the most literal reading - is higher than on any other tag (41 agreement on tag 1; 6 on tag 2; 2 on tag 3; 4 on tag 4, 1 on tag 5; 3 on odd).

Conventionalized coercions

Agreements on tag 1 do not include conventionalized coercions:

Conventionalized coercions

Agreements on tag 1 do not include conventionalized coercions:

- “aprire il *vino* rosso in anticipo”
  ‘open the red wine in advance’ (tag 3, 4)

Conventionalized coercions

Agreements on tag 1 do not include conventionalized coercions:

- "aprire il *vino* rosso in anticipo"
  'open the red wine in advance' (tag 3, 4)
- "finire il *bicchiere* prima di andarsene"
  'finish the glass before leaving' (tag 4, 4)

Conventionalized coercions

Agreements on tag 1 do not include conventionalized coercions:

- “aprire il *vino* rosso in anticipo”
  ‘open the red wine in advance’ (tag 3, 4)
- “finire il *bicchiere* prima di andarsene”
  ‘finish the glass before leaving’ (tag 4, 4)
- “divorare *Asterix*”
  ‘devour Asterix’ (tag 3, 5)

Conventionalized coercions

Agreements on tag 1 do not include conventionalized coercions:

- "aprire il *vino* rosso in anticipo"
  'open the red wine in advance' (tag 3, 4)
- "finire il *bicchiere* prima di andarsene"
  'finish the glass before leaving' (tag 4, 4)
- "divorare *Asterix*"
  'devour Asterix' (tag 3, 5)
- "*Freuds* è in edicola"
  'Freud is at the newsstand' (tag 5, 5)

Conventionalized coercions

Agreements on tag 1 do not include conventionalized coercions:

- "aprire il *vino* rosso in anticipo"
  'open the red wine in advance' (tag 3, 4)
- "finire il *bicchiere* prima di andarsene"
  'finish the glass before leaving' (tag 4, 4)
- "divorare *Asterix*"
  'devour Asterix' (tag 3, 5)
- "*Freuds* è in edicola"
  'Freud is at the newsstand' (tag 5, 5)
- . "*Washington* ha annunciato un programma di aiuti"
  'Washington announced an aid campaign' (tag 4,5)

Conventionalized coercions

Agreements on tag 1 do not include conventionalized coercions:

- “aprire il *vino* rosso in anticipo”
  ‘open the red wine in advance’ (tag 3, 4)
- “finire il *bicchiere* prima di andarsene”
  ‘finish the glass before leaving’ (tag 4, 4)
- “divorare *Asterix*”
  ‘devour Asterix’ (tag 3, 5)
- “*Freuds* è in edicola”
  ‘Freud is at the newsstand’ (tag 5, 5)
- . “*Washington* ha annunciato un programma di aiuti”
  ‘Washington announced an aid campaign’ (tag 4,5)
- “L’*altoparlante* annuncia ritardi a catena”
  ‘The loudspeaker announces successive delays’ (tag 5,5)

Conventionalized coercions

Agreements on tag 1 do not include conventionalized coercions:

- "aprire il *vino* rosso in anticipo"
  'open the red wine in advance' (tag 3, 4)
- "finire il *bicchiere* prima di andarsene"
  'finish the glass before leaving' (tag 4, 4)
- "divorare *Asterix*"
  'devour Asterix' (tag 3, 5)
- "*Freuds* è in edicola"
  'Freud is at the newsstand' (tag 5, 5)
- . "*Washington* ha annunciato un programma di aiuti"
  'Washington announced an aid campaign' (tag 4,5)
- "L'*altoparlante* annuncia ritardi a catena"
  'The loudspeaker announces successive delays' (tag 5,5)

Overall Variation

- The largest variation between the two annotators is to be found in tags higher than 1.

Overall Variation

- The largest variation between the two annotators is to be found in tags higher than 1.
- Compared to ANN 2, ANN1 underuses tag 3 (total of 5 annotations), perhaps under the suggestion that it is a "neutral" score and does not disambiguate clearly between literal and non literal.

Odd

- There is agreement between the annotators on the oddness (tag: odd) of the following two expressions, validating the corpus-based analysis in section 4, according to which the It. noun *quadro* is not successfully used as a coercion to Institution.

Odd

- There is agreement between the annotators on the oddness (tag: odd) of the following two expressions, validating the corpus-based analysis in section 4, according to which the It. noun *quadro* is not successfully used as a coercion to Institution.

(3) a. "i quadri aprono alle 9.00".
'The paintings open at 9.00'
b. "visitare i quadri".
'visit the paintings'

Concluding thoughts

- Although the annotations span over all degrees, their total between 1 and 3 (151) is much higher than the total between 3 and 5 (55).

Concluding thoughts

- Although the annotations span over all degrees, their total between 1 and 3 (151) is much higher than the total between 3 and 5 (55).
- In light of the ratio between selection and coercion in the dataset (42/58), this result suggest that coercion mechanisms is perhaps not perceived as highly non literal by speakers, whereas this could not be the case with metaphorical uses.

Moderate Minimalism in Lexical Semantics

- Stretching phenomena in semantics are both **graded** and **constrained**, as shown by corpus evidence and data about human judgements.

Moderate Minimalism in Lexical Semantics

- Stretching phenomena in semantics are both **graded** and **constrained**, as shown by corpus evidence and data about human judgements.
- The presence of constraints on stretching phenomena constitutes linguistic evidence that points towards a rejection of meaning eliminativism and towards moderate minimalism in lexical semantics.

Words as Collections of Pointers

- Although context can stretch the meaning of words, some combinations are uninterpretable, and others are highly unlikely, because **words do carry a meaning on their own**, and the construction of interpretation is **not entirely a matter of context**.

Words as Collections of Pointers

- Although context can stretch the meaning of words, some combinations are uninterpretable, and others are highly unlikely, because **words do carry a meaning on their own**, and the construction of interpretation is **not entirely a matter of context**.
- A word can be seen as a collection of "pointers" to "fragments" of conceptual knowledge.

Words as Collections of Pointers

- Although context can stretch the meaning of words, some combinations are uninterpretable, and others are highly unlikely, because **words do carry a meaning on their own**, and the construction of interpretation is **not entirely a matter of context**.
- A word can be seen as a collection of "pointers" to "fragments" of conceptual knowledge.
- The way conceptual knowledge is packed into lexical items and available for exploitation in actual use presupposes the existence of a specific mental entity, lexical meaning, which acts as interface between concepts and words.

The meaning of verbs and their representation in a vector-based model of compositionality

- Three components in verb's denotation, which together constitute different aspect of the same object, i.e. an eventuality.

The meaning of verbs and their representation in a vector-based model of compositionality

- Three components in verb's denotation, which together constitute different aspect of the same object, i.e. an eventuality.
- Time and time structure.

The meaning of verbs and their representation in a vector-based model of compositionality

- Three components in verb's denotation, which together constitute different aspect of the same object, i.e. an eventuality.
- Time and time structure.
- Argumenthood.

The meaning of verbs and their representation in a vector-based model of compositionality

- Three components in verb's denotation, which together constitute different aspect of the same object, i.e. an eventuality.
- Time and time structure.
- Argumenthood.
- Inherent Meaning.

Time and time structure

- The denotation of a verb is an eventuality, and an eventuality is located and structured in time.
- states (own)

Time and time structure

- The denotation of a verb is an eventuality, and an eventuality is located and structured in time.
- states (own)
- processes (work, sleep)

Time and time structure

- The denotation of a verb is an eventuality, and an eventuality is located and structured in time.
- states (own)
- processes (work, sleep)
- punctual events (find, arrive)

Time and time structure

- The denotation of a verb is an eventuality, and an eventuality is located and structured in time.
- states (own)
- processes (work, sleep)
- punctual events (find, arrive)
- degree achievements (ripen), incremental theme verbs (fill), multi-scalar verbs (increase)

Time and time structure

- The denotation of a verb is an eventuality, and an eventuality is located and structured in time.
- states (own)
- processes (work, sleep)
- punctual events (find, arrive)
- degree achievements (ripen), incremental theme verbs (fill), multi-scalar verbs (increase)
- semelfactives or points (cough, knock)

Time and time structure

- The denotation of a verb is an eventuality, and an eventuality is located and structured in time.
- states (own)
- processes (work, sleep)
- punctual events (find, arrive)
- degree achievements (ripen), incremental theme verbs (fill), multi-scalar verbs (increase)
- semelfactives or points (cough, knock)

- The Vendler-Dowty taxonomy, Smith 1991.

Event Structure

- Events may be complex, i.e. they may be include subevents (Parsons 1990, Pustejovsky 1991).

Event Structure

- Events may be complex, i.e. they may be include subevents (Parsons 1990, Pustejovsky 1991).
- Causal, temporal relations between event parts (subevents).

Event Structure

- Events may be complex, i.e. they may be include subevents (Parsons 1990, Pustejovsky 1991).
- Causal, temporal relations between event parts (subevents).
- *Kill* includes an action (cause die) which precedes a **necessary** effect (be dead).

Event Structure

- Events may be complex, i.e. they may be include subevents (Parsons 1990, Pustejovsky 1991).
- Causal, temporal relations between event parts (subevents).
- *Kill* includes an action (cause die) which precedes a **necessary** effect (be dead).
- *Show* includes an action (make visible) which is followed by a **likely** effect (see).

Event Structure

- Events may be complex, i.e. they may be include subevents (Parsons 1990, Pustejovsky 1991).
- Causal, temporal relations between event parts (subevents).
- *Kill* includes an action (cause die) which precedes a **necessary** effect (be dead).
- *Show* includes an action (make visible) which is followed by a **likely** effect (see).

Argumenthood

- Argumenthood is the propriety of requiring (a certain number and type of) slots to express the grammatically relevant participants in the event.

Argumenthood

- Argumenthood is the propriety of requiring (a certain number and type of) slots to express the grammatically relevant participants in the event.
- ?no argument, only predication (snow, rain)

Argumenthood

- Argumenthood is the propriety of requiring (a certain number and type of) slots to express the grammatically relevant participants in the event.
- ?no argument, only predication (snow, rain)
- one argument (run, swim)

Argumenthood

- Argumenthood is the propriety of requiring (a certain number and type of) slots to express the grammatically relevant participants in the event.
- ?no argument, only predication (snow, rain)
- one argument (run, swim)
- two arguments (know, participate)

Argumenthood

- Argumenthood is the propriety of requiring (a certain number and type of) slots to express the grammatically relevant participants in the event.
- ?no argument, only predication (snow, rain)
- one argument (run, swim)
- two arguments (know, participate)
- three arguments (put, give)

Argumenthood

- Argumenthood is the propriety of requiring (a certain number and type of) slots to express the grammatically relevant participants in the event.
- ?no argument, only predication (snow, rain)
- one argument (run, swim)
- two arguments (know, participate)
- three arguments (put, give)

- Levin Rappaport 2005, Argument Realization.

Inherent Meaning

- Events are complex arrays of properties, and verbs and verb classes encode them capitalising on specific ones.

Inherent Meaning

- Events are complex arrays of properties, and verbs and verb classes encode them capitalising on specific ones.
- motion verbs (go, walk, climb, ?sit)

Inherent Meaning

- Events are complex arrays of properties, and verbs and verb classes encode them capitalising on specific ones.
- motion verbs (go, walk, climb, ?sit)
- manner verbs (wipe, scrub)

Inherent Meaning

- Events are complex arrays of properties, and verbs and verb classes encode them capitalising on specific ones.
- motion verbs (go, walk, climb, ?sit)
- manner verbs (wipe, scrub)
- perception verbs (see, smell, hear, listen)

Inherent Meaning

- Events are complex arrays of properties, and verbs and verb classes encode them capitalising on specific ones.
- motion verbs (go, walk, climb, ?sit)
- manner verbs (wipe, scrub)
- perception verbs (see, smell, hear, listen)
- verbs of cognition (understand, grasp)

Inherent Meaning

- Events are complex arrays of properties, and verbs and verb classes encode them capitalising on specific ones.
- motion verbs (go, walk, climb, ?sit)
- manner verbs (wipe, scrub)
- perception verbs (see, smell, hear, listen)
- verbs of cognition (understand, grasp)
- verbs of communication (talk, tell, whisper)

Inherent Meaning

- Events are complex arrays of properties, and verbs and verb classes encode them capitalising on specific ones.
- motion verbs (go, walk, climb, ?sit)
- manner verbs (wipe, scrub)
- perception verbs (see, smell, hear, listen)
- verbs of cognition (understand, grasp)
- verbs of communication (talk, tell, whisper)
- verbs expressing measures (cost, weigh)

Inherent Meaning

- Events are complex arrays of properties, and verbs and verb classes encode them capitalising on specific ones.
- motion verbs (go, walk, climb, ?sit)
- manner verbs (wipe, scrub)
- perception verbs (see, smell, hear, listen)
- verbs of cognition (understand, grasp)
- verbs of communication (talk, tell, whisper)
- verbs expressing measures (cost, weigh)

- Event Ontologies.

Co-composition

- Verb meaning is co-dependent on those of its arguments.

Co-composition

- Verb meaning is co-dependent on those of its arguments.
- take a tablet | a train.

Co-composition

- Verb meaning is co-dependent on those of its arguments.
- take a tablet | a train.
- like pizza | my sister.

Co-composition

- Verb meaning is co-dependent on those of its arguments.
- take a tablet | a train.
- like pizza | my sister.
- open the door | a letter | a restaurant | a bank account | a debate.

Co-composition

- Verb meaning is co-dependent on those of its arguments.
- take a tablet | a train.
- like pizza | my sister.
- open the door | a letter | a restaurant | a bank account | a debate.

- Cf. "intersective method of combination is well-known to fail in many cases", Baroni and Zamparelli 2010.

Co-composition

- Verb meaning is co-dependent on those of its arguments.
- take a tablet | a train.
- like pizza | my sister.
- open the door | a letter | a restaurant | a bank account | a debate.

- Cf. "intersective method of combination is well-known to fail in many cases", Baroni and Zamparelli 2010.
- Formal mechanism of co-composition in Pustejovsky 1995.

Verbs as tensors

- Function application captures one aspect of a verb semantics, i.e. its relational aspect.

Verbs as tensors

- Function application captures one aspect of a verb semantics, i.e. its relational aspect.
- The verb introduces **a whole event**.

Verbs as tensors

- Function application captures one aspect of a verb semantics, i.e. its relational aspect.
- The verb introduces **a whole event**.
- How do we capture an event in vector-space models?

Verbs as tensors

- Function application captures one aspect of a verb semantics, i.e. its relational aspect.
- The verb introduces **a whole event**.
- How do we capture an event in vector-space models?
- Corpus-harvested vectors encoding aspectual/temporal properties?

Verbs as tensors

- Function application captures one aspect of a verb semantics, i.e. its relational aspect.
- The verb introduces **a whole event**.
- How do we capture an event in vector-space models?
- Corpus-harvested vectors encoding aspectual/temporal properties?
- Build vectors/conceptual spaces representative of the type restrictions verb place on their arguments?

Verbs as tensors

- Function application captures one aspect of a verb semantics, i.e. its relational aspect.
- The verb introduces **a whole event**.
- How do we capture an event in vector-space models?
- Corpus-harvested vectors encoding aspectual/temporal properties?
- Build vectors/conceptual spaces representative of the type restrictions verb place on their arguments?
- Ponti, Jezek and Magnini 2016. *Grounding the lexical sets of causative/inchoative verbs with word embedding*. DSALT at ESSLLI 2016.

Verbs as tensors

- Function application captures one aspect of a verb semantics, i.e. its relational aspect.
- The verb introduces **a whole event**.
- How do we capture an event in vector-space models?
- Corpus-harvested vectors encoding aspectual/temporal properties?
- Build vectors/conceptual spaces representative of the type restrictions verb place on their arguments?
- Ponti, Jezek and Magnini 2016. *Grounding the lexical sets of causative/inchoative verbs with word embedding*. DSALT at ESSLLI 2016.
- Cf. Grefenstette and Sadrzadeh 2015, McGregor, Purver and Wiggins 2015.

Augmented Verb Vectors

- In distributional semantics, verbs have often been represented through vectors built on **verbs themselves** or on the **sum of the arguments vectors** (see for the latter Grefenstette and Sadrzadeh, 2011; Kartsaklis and Sadrzadeh, 2013).

Augmented Verb Vectors

- In distributional semantics, verbs have often been represented through vectors built on **verbs themselves** or on the **sum of the arguments vectors** (see for the latter Grefenstette and Sadrzadeh, 2011; Kartsaklis and Sadrzadeh, 2013).
- In Bundell, Sadrzadeh and Jezek 2017, we propose to build vectors for verbs by **augmenting** the verb vector with the vector of the argument(s), with the goal of providing a better distributional representation for the verb itself.

Augmented Verb Vectors

- In distributional semantics, verbs have often been represented through vectors built on **verbs themselves** or on the **sum of the arguments vectors** (see for the latter Grefenstette and Sadrzadeh, 2011; Kartsaklis and Sadrzadeh, 2013).
- In Bundell, Sadrzadeh and Jezek 2017, we propose to build vectors for verbs by **augmenting** the verb vector with the vector of the argument(s), with the goal of providing a better distributional representation for the verb itself.
- We base our proposal on the theoretical assumption that **argument structure is part of the meaning of the verb** and not external to it (Pustejovsky, 1995, Van Valin, 2005, Levin and Rappaport Hovav, 2005).

Similarity task

- We test our augmented vectors on a similarity task using the SimVerb-3500 dataset (Gerz et al 2016), designed to represent the complexity of verb meanings and to gain a better understanding of verb semantics in distributional models.

Similarity task

- We test our augmented vectors on a similarity task using the SimVerb-3500 dataset (Gerz et al 2016), designed to represent the complexity of verb meanings and to gain a better understanding of verb semantics in distributional models.
- The dataset contains 3500 verb pairs (827 distinct verbs) with at least 10 human ratings for the similarity for each pair (0-10).
- *respond*/*reply* 9.79 vs. *run*/*hit* 0.17.
- Annotated relations: antonyms, synonyms, hyper/hyponyms, no relation.

Similarity task

- We analyse the dataset in three different ways based on the number of the

Models

- We use **four** different argument combination models to augment the verb vectors in **two** different conjunctive and disjunctive ways.

Models

- We use **four** different argument combination models to augment the verb vectors in **two** different conjunctive and disjunctive ways.
  - **Disjunctive Operations**: summation, point-wise maximum.

Models

- We use **four** different argument combination models to augment the verb vectors in **two** different conjunctive and disjunctive ways.
  - **Disjunctive Operations**: summation, point-wise maximum.
  - **Conjunctive Operations**: point-wise multiplication, point-wise minimum, and Kronecker tensor product.

Vector spaces

- The resulting representations are evaluated on the verb similarity task in three different vector spaces, trained on the parsed version of the UKWacky corpus.
  - **Tensor Flow Skip-gram**

Vector spaces

- The resulting representations are evaluated on the verb similarity task in three different vector spaces, trained on the parsed version of the UKWacky corpus.
  - **Tensor Flow Skip-gram**
  - **Word2vec CBOW**

Vector spaces

- The resulting representations are evaluated on the verb similarity task in three different vector spaces, trained on the parsed version of the UKWacky corpus.
  - **Tensor Flow Skip-gram**
  - **Word2vec CBOW**
  - **Count -based model** (PPMI-normalized co-occurrence count).

Subj-Obj combination Formulae

Label	Formula	Label	Formula
Arguments Only		**Verbs Augmented by Arguments**	
Sum	$\overrightarrow{Verb}^{+}_{tv} = (\sum_i^n \overrightarrow{Sbj}_i) + (\sum_i^n \overrightarrow{Obj}_i)$	Sum-Sum	$\overrightarrow{Verb}^{+}_{tv} + \overrightarrow{Verb}$
Kronecker	$\overrightarrow{Verb}^{\otimes}_{tv} := \sum_i^n \overrightarrow{Sbj}_i \otimes \overrightarrow{Obj}_i$	Sum-Mult	$\overrightarrow{Verb}^{+}_{tv} \odot \overrightarrow{Verb}$
		Kron-Sum	$\overrightarrow{Verb}^{\otimes}_{tv} + (\overrightarrow{Verb} \otimes \overrightarrow{Verb})$
		Kron-Mult	$\overrightarrow{Verb}^{\otimes}_{tv} \odot (\overrightarrow{Verb} \otimes \overrightarrow{Verb})$

Table 1: Subjects/ objects combination formulae

Subject combination Formulae

Label	Formula	Label	Formula
Arguments Only		**Verbs Augmented by Arguments**	
Sum	$\overrightarrow{Verb}^{+}_{itv} := \sum_i^k \overrightarrow{Sbj}_i$	Sum-Sum	$\overrightarrow{Verb}^{+}_{itv} + \overrightarrow{Verb}$
Minimum	$\overrightarrow{Verb}^{\min}_{itv} := argmin(\overrightarrow{Sbj}_1, \cdots, \overrightarrow{Sbj}_k)$	Sum-Mult	$\overrightarrow{Verb}^{+}_{itv} \odot \overrightarrow{Verb}$
Maximum	$\overrightarrow{Verb}^{\max}_{itv} := argmax(\overrightarrow{Sbj}_1, \cdots, \overrightarrow{Sbj}_k)$	Min-Sum	$\overrightarrow{Verb}^{\min}_{itv} + \overrightarrow{Verb}$
Kronecker	$\overrightarrow{Verb}^{\otimes}_{itv} := \sum_i^k \overrightarrow{Sbj}_i \otimes \overrightarrow{Sbj}_i$	Min-Mult	$\overrightarrow{Verb}^{\min}_{itv} \odot \overrightarrow{Verb}$
		Max-Sum	$\overrightarrow{Verb}^{\max}_{itv} + \overrightarrow{Verb}$
		Max-Multiply	$\overrightarrow{Verb}^{\max}_{itv} \odot \overrightarrow{Verb}$
		Kron-Sum	$\overrightarrow{Verb}^{\otimes}_{itv} + (\overrightarrow{Verb} \otimes \overrightarrow{Verb})$
		Kron-Multiply	$\overrightarrow{Verb}^{\otimes}_{itv} \odot (\overrightarrow{Verb} \otimes \overrightarrow{Verb})$

Table 2: Subject combination Formulae

500 Development Set

Model	Verb	Sum	Kronecker	Sum-Sum	Sum-Multiply	Kronecker-Sum	Kronecker-Multiply
The Original Setting							
Skip-gram	0.0094	0.0076	0.0348	0.0188	0.0224	**0.0465**	0.0187
CBOW	0.1497	**0.2013**	0.1374	0.2008	0.1684	0.1383	0.1767
Count	0.2382	0.1270	0.1457	0.1398	**0.2773**	0.1516	**0.2657**
Verbs with Top 5% of Subjects/Objects Removed							
Skip-gram	0.0141	0.0109	0.0501	0.0108	0.0188	**0.0503**	0.0223
CBOW	0.1757	0.1865	0.1003	0.1861	**0.1909**	0.1014	0.1864
Count	0.3613	0.2792	0.2772	0.2792	0.3880	0.2772	**0.4206**
Synonyms Only							
Skip-gram	**0.4119**	0.0784	0.1029	0.0736	0.3409	0.1029	0.3495
CBOW	0.1437	0.0491	0.0085	0.0491	0.3587	0.0085	**0.3832**
Count	**0.3613**	0.1270	0.1457	0.1398	0.2773	0.1516	0.2657
All But Antonyms							
Skip-gram	0.0143	0.0281	0.0669	0.0280	0.0146	**0.06721**	0.0110
CBOW	0.1693	**0.2059**	0.1338	0.2049	0.1706	0.1346	0.1790
Count	0.2309	0.1331	0.1484	0.1336	**0.2787**	0.1486	0.2650

Table 3: Degrees of correlation between human rankings and cosine distances on the **500 development set** of SimVerb-3500. Baseline is the verb-only model: the first column on the models row.

3000 Test Set

Model	Verb	Sum	Kronecker	Sum-Sum	Sum-Multiply	Kronecker-Sum	Kronecker-Multiply
The Original Setting							
Count	0.1490	0.1183	0.1014	0.1135	**0.1632**	0.1014	**0.1623**
Verbs with Top 5% of Subjects/Objects Removed							
Count	0.1558	0.1557	0.1414	0.1568	**0.2055**	0.1415	**0.2046**
Synonyms Only							
Count	0.1503	0.0245	0.0093	0.0251	**0.0265**	0.0093	**0.0236**
All But Antonyms							
Count	0.1533	0.1208	0.1074	0.1209	**0.1682**	0.1075	**0.1681**

Table 4: Degrees of correlation between human rankings and cosine distances on the **3000 test set** of SimVerb-3500 for the best model of the development set. Baseline is the verb-only model: the first column on the models row.

Results

- In line with Pado and Erk 2008, we show that **argument augmented models perform between than only verb base models in similarity task**.

Results

- In line with Pado and Erk 2008, we show that **argument augmented models perform between than only verb base models in similarity task**.
- Specifically, the conjunctive model based on **point-wise multiplication and the Kronecker tensor product** performs better than the base line of verb-only vectors and the other operations.

Results

- In line with Pado and Erk 2008, we show that **argument augmented models perform between than only verb base models in similarity task**.
- Specifically, the conjunctive model based on **point-wise multiplication and the Kronecker tensor product** performs better than the base line of verb-only vectors and the other operations.
- The best model is **the count-based model**.

Results

- In line with Pado and Erk 2008, we show that **argument augmented models perform between than only verb base models in similarity task**.
- Specifically, the conjunctive model based on **point-wise multiplication and the Kronecker tensor product** performs better than the base line of verb-only vectors and the other operations.
- The best model is **the count-based model**.
- The best optimization of the dataset is **the subset with the top 5 percent of the number of Subject/Objects removed**.

Results

- In line with Pado and Erk 2008, we show that **argument augmented models perform between than only verb base models in similarity task**.
- Specifically, the conjunctive model based on **point-wise multiplication and the Kronecker tensor product** performs better than the base line of verb-only vectors and the other operations.
- The best model is **the count-based model**.
- The best optimization of the dataset is **the subset with the top 5 percent of the number of Subject/Objects removed**.

- Blundell, Sadrzadeh, Jezek 2017 "Experimental results on Exploiting Predicate-Argument Structure for Verb Similarity in Distributional Semantics", Logic and Machine Learning in Natural Language (LAML, Gothenburg).

Distributional Analysis of Argument Fillers

Ponti, Jezek, Magnini 2016

- In a different study we use distributional techniques to examine the fillers of the argument positions in order to verify whether they constitute **homogeneous groupings from a semantic point of view**.

Distributional Analysis of Argument Fillers

Ponti, Jezek, Magnini 2016

- In a different study we use distributional techniques to examine the fillers of the argument positions in order to verify whether they constitute **homogeneous groupings from a semantic point of view**.
- We start from he assumption that the set of fillers that occupy the argument positions of a verb in a specific verb sense in its contexts of use (**lexical sets**, Hanks 1996, Hanks and Pustejovky 2005) can ground the semantic types associated with argument positions empirically.

Distributional Analysis of Argument Fillers

Ponti, Jezek, Magnini 2016

- In a different study we use distributional techniques to examine the fillers of the argument positions in order to verify whether they constitute **homogeneous groupings from a semantic point of view**.
- We start from he assumption that the set of fillers that occupy the argument positions of a verb in a specific verb sense in its contexts of use (**lexical sets**, Hanks 1996, Hanks and Pustejovky 2005) can ground the semantic types associated with argument positions empirically.
- For example the lexical set {*gun*, *rifle*, *pistol*, *weapon*, ...} grounds the semantic type *Firearm* for the object position of *to fire* in its **'to shoot'** sense, whereas the lexical set {*employer*, *teacher*, *attorney*, *manager*...} grounds the semantic type *Human* for the same position in its **'to dismiss'** sense.

Case study

We focus on Italian **Causative/Incoative** verbs: *suonare* (ring, play), *rompere* (break), *riempire* (fill), *seccare* (dry), *affondare* (sink), *finire* (finish)...

Case study

We focus on Italian **Causative/Incoative** verbs: *suonare* (ring, play), *rompere* (break), *riempire* (fill), *seccare* (dry), *affondare* (sink), *finire* (finish)...

- Un uomo ha suonato il campanello/la campana/la sveglia.
  A man rang the door bell/the bell/*the alarm clock.

Case study

We focus on Italian **Causative/Incoative** verbs: *suonare* (ring, play), *rompere* (break), *riempire* (fill), *seccare* (dry), *affondare* (sink), *finire* (finish)...

- Un uomo ha suonato il campanello/la campana/la sveglia.
  A man rang the door bell/the bell/*the alarm clock.
- Il campanello/la campana/la sveglia ha suonato.
  The door bell/the bell/the alarm clock rang.

Case study

We focus on Italian **Causative/Incoative** verbs: *suonare* (ring, play), *rompere* (break), *riempire* (fill), *seccare* (dry), *affondare* (sink), *finire* (finish)...

- Un uomo ha suonato il campanello/la campana/la sveglia.
  A man rang the door bell/the bell/*the alarm clock.
- Il campanello/la campana/la sveglia ha suonato.
  The door bell/the bell/the alarm clock rang.

Montemagni, Pirrelli, Ruimi 1995, Ringing things that nobody can ring.

Harvest fillers

- We harvest the list of fillers for the different argument positions - **subject of transitive (A)**, **subject of intransitive (S)**, **object (0)** - from the ITWac corpus.

Fillers as vectors

- We then transform the fillers for the different argument positions from the ITWaC corpus (A, S, O) into **vectors** using the Word2Vec Continuous Bag of Words (CBOW) Distributional Semantic Model (Mikolov et al, 2013).

Fillers as vectors

- We then transform the fillers for the different argument positions from the ITWaC corpus (A, S, O) into **vectors** using the Word2Vec Continuous Bag of Words (CBOW) Distributional Semantic Model (Mikolov et al, 2013).
- DSMs are based on the assumption that the meaning of words can be inferred by the neighbouring words (**distributional hypothesis**, Harris 1954, Firth 1957); they represent the similarity of meaning between words as geometric distance in multi-dimensional **vector spaces**.

Distributional approach to lexical sets

- Vectors created by these means are then fed to an algorithm (k-means) to obtain **clusters** to be contrasted with the **expected semantic types** associated with the argument positions in specific verb senses.

Distributional approach to lexical sets

- Vectors created by these means are then fed to an algorithm (k-means) to obtain **clusters** to be contrasted with the **expected semantic types** associated with the argument positions in specific verb senses.
- The underlying hypothesis is that there is a correlation between the **clusters** obtained via **vector quantization** and the **semantic types**, and that semantic type grounding can benefit from the distributional procedure.

Distributional approach to lexical sets

- Vectors created by these means are then fed to an algorithm (k-means) to obtain **clusters** to be contrasted with the **expected semantic types** associated with the argument positions in specific verb senses.
- The underlying hypothesis is that there is a correlation between the **clusters** obtained via **vector quantization** and the **semantic types**, and that semantic type grounding can benefit from the distributional procedure.

Ponti, Jezek, Magnini 2016. Grounding the Lexical Sets in Causative / Inchoative Verbs with word Embedding.

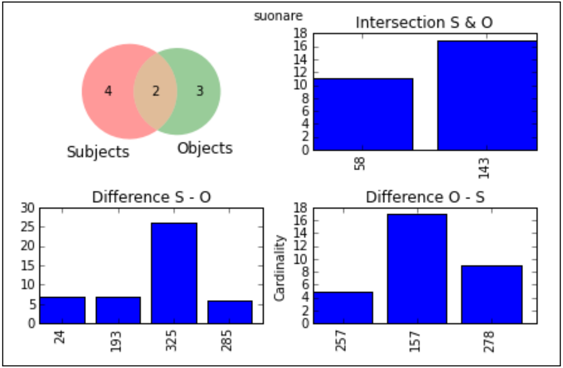
Vector Quantization

- **Vector quantization** is the operation of defining k clusters in a model and then assessing vector membership - abiding the rule that every vector is assigned to one and only one cluster.

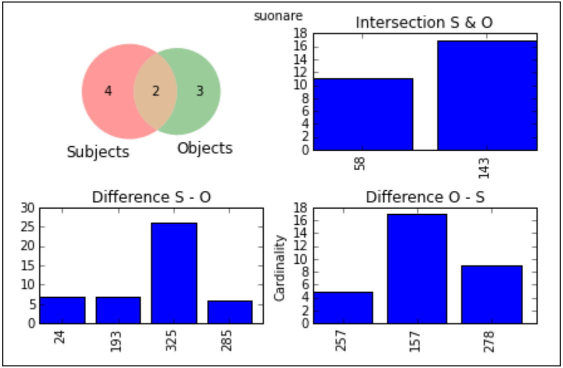
Vector Quantization

- **Vector quantization** is the operation of defining *k* clusters in a model and then assessing vector membership - abiding the rule that every vector is assigned to one and only one cluster.
- The best trade-off is reached by **minimising cluster numbers** and **maximizing their internal similarity**.

Semantic Types and Lexical Sets



Semantic Types and Lexical Sets



Ponti, Jezek, Magnini 2016. Grounding the Lexical Sets in Causative / Inchoative Verbs with word Embedding.

cluster	prototype	closeness	label
24	storie	0.708	stories
58	album	0.789	disks
143	clarinetto	0.736	orchestra
157	brontolio	0.807	noises
193	rockabilly	0.758	genres
257	palermo	0.686	towns
278	cornamuse	0.726	instruments
285	aggettivo	0.736	language
325	scemenza	0.801	judgements

Semantic Types and Lexical Sets

cluster	prototype	closeness	label
24	storie	0.708	stories
58	album	0.789	disks
143	clarinetto	0.736	orchestra
157	brontolio	0.807	noises
193	rockabilly	0.758	genres
257	palermo	0.686	towns
278	cornamuse	0.726	instruments
285	aggettivo	0.736	language
325	scemenza	0.801	judgements

Ponti, Jezek, Magnini 2016. Grounding the Lexical Sets in Causative / Inchoative Verbs with word Embedding.

List of fillers of suonare_object in cluster 157

157 chiasso muto grida tuoni tuono brontolio folla cicale agitarsi fischi strepiti baccano clacson fracasso rintocchi fruscio grido frastuono eco silenzio brusio sbadiglio campanello ululati ululato sordo urlando campanacci orecchio gemito gemiti andirivieni sommesso ronzio timpani ruggito ruggiti squillo fragore fragori gorgoglio mormorio rumore rumori urla urlo rantolo stridore udito miagolio tonfo tumulto spari rincorrersi voce sospiri detonazioni singhiozzo campane fischio risa udiva muezzin sirena sirene lamento lamenti tam battito battiti

List of fillers of suonare_object in cluster 157

157 chiasso muto grida tuoni tuono brontolio folla cicale agitarsi fischi strepiti baccano clacson fracasso rintocchi fruscio grido frastuono eco silenzio brusio sbadiglio campanello ululati ululato sordo urlando campanacci orecchio gemito gemiti andirivieni sommesso ronzio timpani ruggito ruggiti squillo fragore fragori gorgoglio mormorio rumore rumori urla urlo rantolo stridore udito miagolio tonfo tumulto spari rincorrersi voce sospiri detonazioni singhiozzo campane fischio risa udiva muezzin sirena sirene lamento lamenti tam battito battiti

Ponti, Jezek, Magnini 2016. Grounding the Lexical Sets in Causative / Inchoative Verbs with word Embedding.

Heatmaps

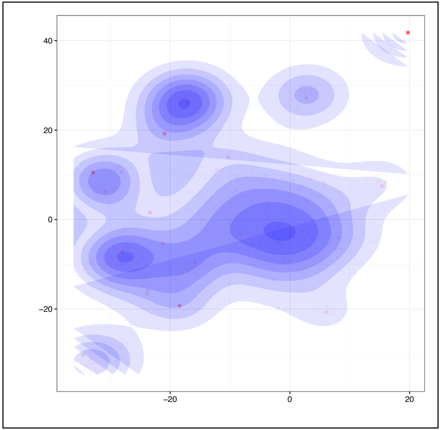
- Through **heatmaps** (low is white and high is blue) of the density of vectors reduced to 2 dimensions through t-SNE (Maaten and Hinton 2008), it is possible to observe spots in isolation and aggregation for the different argument positions.

Heatmaps

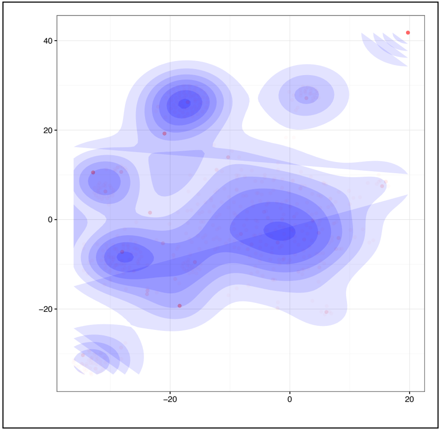
- Through **heatmaps** (low is white and high is blue) of the density of vectors reduced to 2 dimensions through t-SNE (Maaten and Hinton 2008), it is possible to observe spots in isolation and aggregation for the different argument positions.

Ponti, Jezek, Magnini 2016. Distributed Representations of Lexical Sets and Prototypes in Causal Alternation Verbs.

Heatmap finire_object

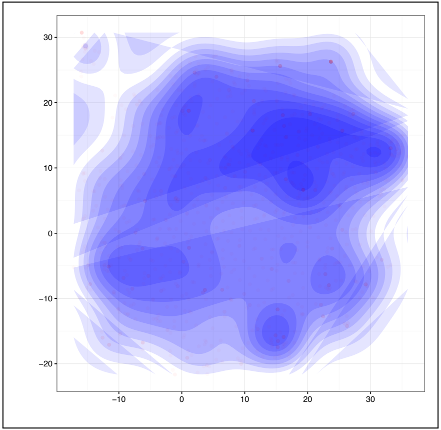


Heatmap finire_object

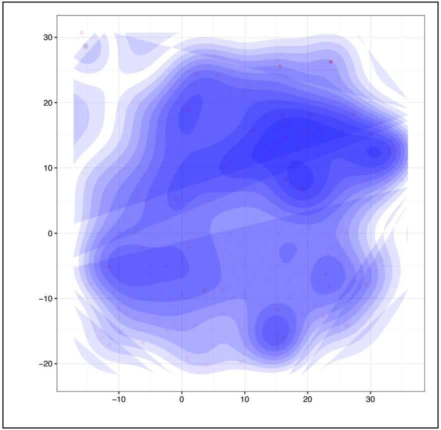


Ponti, Jezek, Magnini 2017. Distributed Representations of Lexical Sets and Prototypes in Causal Alternation Verbs.

Heatmap finire_subject

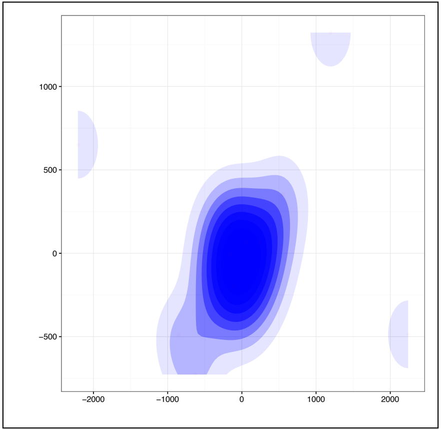


Heatmap finire_subject

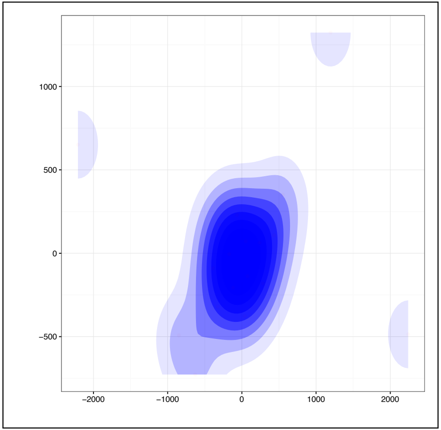


Ponti, Jezek, Magnini 2017. Distributed Representations of Lexical Sets and Prototypes in Causal Alternation Verbs.

Heatmap affondare_subject

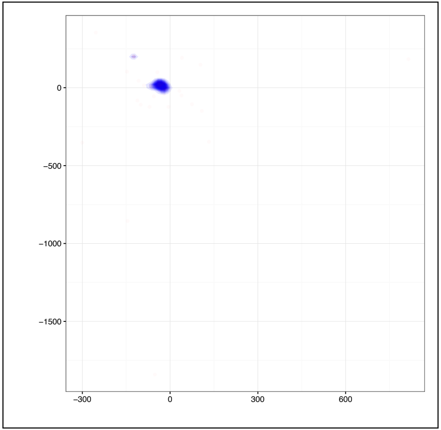


Heatmap affondare_subject

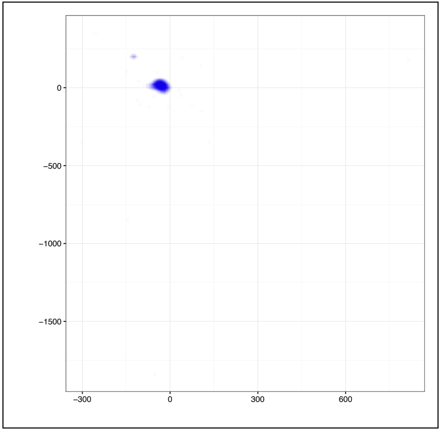


Ponti, Jezek, Magnini 2017. Distributed Representations of Lexical Sets and Prototypes in Causal Alternation Verbs.

Heatmap affondare_object



Heatmap affondare_object



Ponti, Jezek, Magnini 2017. Distributed Representations of Lexical Sets and Prototypes in Causal Alternation Verbs.

Concluding observations and lines of research

- A plea for moderate minimalism in lexical semantics.
- Enriched and dynamic model of composition (beyond sum) in formal semantics, incorporating gradience and constraints in semantic phenomena.
- Probabilistic approach to identify the degree of stability of meaning components in the lexicon.
- Distributional methodology and geometric representations to gain a better understanding of the structure of our mental lexicon.
- Language properties such as semantic context-sensitivity are not solved in formal semantics: merging formal, distributional and probabilistic approaches represents a multi-side benefit.

- THANK YOU FOR LISTENING!

The Lexicon

An Introduction

By **Elisabetta Ježek**, Associate Professor of Linguistics, University of Pavia

Oxford Textbooks in Linguistics

9780199601530| Hardback| £65.00 | January 2016
9780199601547| Paperback| £24.99 | January 2016