

An Inventory of Preposition Relations

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Abstract

We describe an inventory of semantic relations that are expressed by prepositions. We define these relations by building on the word sense disambiguation task for prepositions and propose a mapping from preposition senses to the relation labels by collapsing semantically related senses across prepositions.

1 Introduction

This document defines a taxonomy of relations expressed by prepositions and serves as a companion paper for (Srikumar and Roth, 2013), which presents a computational model for predicting them. These relations are defined by collapsing related preposition senses from the inventory defined by the Preposition Project (Litkowski and Hargraves, 2005)¹. The sense inventory, which is based on the definitions of prepositions in the Oxford Dictionary of English, treats each dictionary definition of the preposition as a separate sense and has been used by the 2007 shared task of preposition sense disambiguation (Litkowski and Hargraves, 2007).

By grouping semantically related senses across prepositions into relations, we define 32 relation labels covering the 34 prepositions² considered by the Preposition Project. In addition to defining each preposition sense, the Preposition Project also indicates related prepositions. The sense definitions

¹The preposition sense inventory can be accessed online at <http://www.clres.com/prepositions.html>.

²We cover the transitive usages of the following prepositions: about, above, across, after, against, along, among, around, as, at, before, behind, beneath, beside, between, by, down, during, for, from, in, inside, into, like, of, off, on, onto, over, round, through, to, towards, with.

and the related prepositions let us identify senses that carry the same meaning across prepositions to define the relation labels. We followed this with a manual cleanup phase. Some senses do not cleanly align with a single relation because the definitions include idiomatic or figurative usage. For example, the sense **in:7(5)** of the preposition *in* includes both spatial and figurative notions of the spatial sense (that is, both *in London* and *in a film*). In such cases, we sampled 20 examples from the SemEval 2007 training set and assigned the relation label based on majority. One of the labels is a catch-all category, **Other**, which consists of many infrequent senses of prepositions and is not expected to be a semantically coherent class.

Two native speakers of English annotated 200 sentences from the SemEval training corpus using only the definitions of the labels (as listed in this document) as the annotation guidelines. This helps us validate the mapping from senses to relations. We measured Cohen’s kappa coefficient (Cohen, 1960) between the annotators to be 0.75 and also between each annotator and the original corpus to be 0.76 and 0.74 respectively.

Section 2 defines all the relations and provides examples of prepositional phrases that exhibit them. Section 3 lists the number of training and test examples obtained by converting the SemEval 2007 preposition sense data using the mapping defined in Section 2.

2 Preposition relations

For each relation that is defined in this section, we list the set of prepositions and their senses that are included as part of this relation. The sense identifiers refer to those used by the the SemEval 2007

shared task. Senses that are infrequent according to the training data for the shared task (that is, seen fewer than five times) are marked with an asterisk.

2.1 Activity

Definition: Describes the relationship between some entity and an activity, an ordeal or a process that can be a verbal noun or a gerund. Note that the object of the preposition is the activity here.

Examples:

- he is into jet-skiing
- good at boxing
- prudent in planning
- out on errands
- prelude to disaster
- struggle through it

Prep.	Senses
at	8(4a)
in	11(8)
into	9(9)*
on	19(9)*
through	8(2a)*
to	10(4a)

Comments: If there is a change of state and the object of the preposition is the final state, the preposition indicates the relation `EndState`.

2.2 Agent

Definition: The object of the preposition is the agent of the action indicated by the attachment point. This primarily covers the use of the preposition *by* in a passive construction.

Examples:

- understood by the customers
- the address by the officer
- recent discovery by nutritionists
- allegations from the FDA

Prep.	Senses
by	1(1)* 2(1a) 3(1b)
from	12(9)-1

Comments: This relation does not include prepositional phrases like *sonnet by Shakespeare* because *Shakespeare* is the agent of a verb such as write or compose, and not the word *sonnet*. This type of creator-creation relation will be labeled as `Source`.

2.3 Attribute

Definition: The object of the preposition indicates some attribute of either the governor or the subject/object of the governor in case of verb-attached prepositions.

Examples:

- interpreted their action as betrayal
- sell at a loss
- breakdown by age
- what is meant by “fair”?
- call by last name
- paint made from resin
- blinked in astonishment
- dressed in a sweater
- Mozart’s Piano Concerto in E flat
- house built of bricks
- smile of delight
- man with glasses
- blouse with white collar

Prep.	Senses
as	1(1)
at	7(4)*
by	15(3c) 6(2a)* 7(2b)*
from	9(6)
in	1(1)-1 10(7a)* 6(4a) 9(7)-1
of	17(8) 6(3)-1
with	2(2) 3(2a)

Comments:

1. Prepositions where the governor indicates an attribute are classified as `Possessor`.
2. If the object of the preposition does not indicate an attribute, this relation does not apply.

2.4 Beneficiary

Definition: The object of the preposition is a beneficiary of the action indicated by the preposition's governor.

Examples:

- fought for Napoleon
- vote for independence
- present for you
- be charming to them
- clean up after him
- throw weight behind candidate

Prep.	Senses
after	4(1c)*
behind	5(3)*
for	1(1) 3(3)
to	8(3)-1

Comments: This relation includes examples like *the power behind the throne*, where the phrase indicates that the object of the preposition gains some advantage.

2.5 Cause

Definition: The object indicates a cause for the governor.

Examples:

- in bed with flu
- shaking with anger
- wisdom comes with age
- died of cancer
- suffering from asthma
- admire for bravery
- tired after work
- disapproval at the behavior
- agony behind the decision

Prep.	Senses
after	1(1)-1
at	11(6)-1
for	6(5)
from	12(9)
of	16(7b)
with	10(7a)* 11(7b) 12(7c)

2.6 Co-Participants

Definition: The preposition indicates a choice, sharing or differentiation and involves multiple participants, represented by the object.

Examples:

- drop in tooth decay among children
- divide his kingdom among them
- links between science and industry
- the difference between income and expenditure
- choose between two options

Prep.	Senses
among	3(3) 4(4)*
between	4(4) 6(4b) 8(5)* 9(5a)*

Comments: This is different from Participant/Accompanier where the governor and the object indicate the two entities that are associated. Here, the object specifies all the participants.

2.7 Destination

Definition: The object of the preposition is the destination of the motion indicated by the governor.

Examples:

- leaving for London tomorrow
- put coal in the bath
- tucked the books inside his coat
- Sara got into her car
- crashed into a parked car
- the road led into the village
- walking to the shops

Prep.	Senses
for	7(6)*
in	2(1a)
inside	2(1a)
into	1(1) 2(2) 3(3)
to	1(1)

Comments:

1. One boundary case which is not a Destination is that of a motion that indicates that two things are attached or lined. Such cases indicate the relation Participant/Accompanier. For example, *fasten the insulator to the frame* might indicate motion of the insulator to the frame, but Participant/Accompanier is a better choice because it indicates that the two objects are linked to each other.
2. If there is not physical motion, but merely a change of state, the relation EndState is preferred.

2.8 Direction

Definition: The prepositional phrase (that is, the preposition along with the object) indicates a direction that modifies the action which is expressed by the governor.

Examples:

- crept up behind him
- shut the door after her
- driving along the road
- drive by the house
- tears streaming down her face
- wander down the road
- roll off the bed
- drive towards the house
- swim with the current

Prep.	Senses
after	5(2) 6(2a)*
along	1(1)
behind	4(2a)
by	19(5a)*
down	1(1) 2(1a) 3(1b)
off	1(1)
towards	1(1)
with	15(9)*

Comments:

1. This relation sometimes shares meaning with the relation Location.
2. This relation does not include metaphorical meaning and almost always has a spatial sense

2.9 EndState

Definition: The object of the preposition indicates the resultant state of an entity that is undergoing change. The governor of the preposition is usually a verb or noun denoting transformation.

Examples:

- protest turned into a violent confrontation
- forced the club into a special meeting
- profits dropped to \$75 million
- she was moved to tears
- smashed to smithereens
- return towards traditional Keynesianism

Prep.	Senses
into	6(6) 7(7)
to	3(1b)* 5(2)* 6(2a)
towards	2(1a)*

Comments:

1. This relation requires some change of state, where the object of the preposition indicates the final state at the end of the transformation.
2. This relation includes cases like *level fell to 3 feet*, where the object of the preposition is a numeric quantity. See note for Numeric.

2.10 Experiencer

Definition: The object of the preposition denotes the entity that is target or subject of the action, thought or feeling that is usually indicated by the governor.

Examples:

- focus attention on her
- he blamed it on her
- he was warm toward her
- felt angry towards him

Prep.	Senses
on	11(5) 11(5)-1
towards	4(2) 4(2)-1

Comments: There are some examples where the relation might overlap with `Topic`. The sense `on:11(5)` includes both phrases like *focus attention on the her*, which conform to the definition of `Experiencer`, and also *deliberate on the matter*, which are better suited to be labeled `Topic`. However, in this annotation, the sense is labeled as `Experiencer`.

2.11 Instrument

Definition: The object of the preposition indicates the means or the instrument for performing an action that is typically the governor.

Examples:

- hold at knifepoint
- provide capital by borrowing
- banged his head on the beam
- voice over the loudspeaker
- heard through the grapevine
- cut the fish with a knife
- fill the bowl with water

Prep.	Senses
at	11(6)*
by	5(2)
on	3(1b)
over	15(6)* 15(6)-1*
through	13(5a)
with	4(3) 5(3a)

Comments:

1. This relation includes both the means of performing actions and instruments. Though there are subtle differences between them, they are collapsed into one category to avoid sparse labels.
2. The sense `at:11(6)` refers to idiomatic uses, where the object of the preposition can be words *knifepoint* or *gunpoint*. These are marked as `Instrument` because they indicate that the action was performed with a knife or a gun.

2.12 Location

Definition: The prepositional phrase indicates a locative meaning. This relation includes both physical and figurative aspects of location. That is, both *left it in the cupboard* and *left it in her will* are treated as `Locations`. (See note below.)

Examples:

- look about the room
- the cable runs above the duct
- the hills above the capital
- bruises above both eyes
- travel across Europe
- parked along the grass
- hidden among the roots
- large depots around the country
- live at Conway house
- she stood before her
- kept behind the screens
- labyrinths beneath Moscow
- sat beside her
- border between the countries
- discovered by the roadside
- going down the pub

- see them from here
- living in London
- waiting inside the house
- wind blowing into your face
- north of Watford
- street off Whitehall
- camp on the island
- copy onto a disk
- flames over the city
- went round the house
- stepped through the doorway
- forty miles to the south of the site

Prep.	Senses
about	3(2) 3(2)-1 4(3)*
above	1(1)* 2(1a) 3(1b)* 4(2)
across	1(1) 2(2)
along	3(2)
among	1(1)
around	1(1) 3(2) 4(3) 4(3)-1 5(4)
at	1(1)
before	2(2) 3(2a)
behind	1(1) 3(2)
beneath	1(1) 2(1a) 3(2)
beside	1(1)
between	1(1)
by	18(5)
down	4(1c)*
from	8(5)
in	1(1) 7(5)
inside	1(1) 3(1b)
into	4(4)
of	8(4)*
off	2(2)* 3(2a)
on	2(1a)* 7(2)
onto	1(1)
over	1(1)* 11(4) 12(4a)* 13(4b) 2(1a) 3(1b) 4(2)
round	1(1) 3(2) 4(2a) 5(3) 6(3a) 8(4)
through	1(1) 12(5)-1* 2(1a) 3(1b) 4(1c) 5(1d) 6(1e)*
to	2(1a)

Comments: Categorizing preposition senses as Locations is not always easy. Some senses may indicate multiple relations based on the specific sentence and the sense could have ideally been split into two different labels. For example, at:1(1) includes both destinations (e.g. *they stopped at a small trattoria*) and locations (e.g. they live at Conway House). In such ambiguous cases, the sense has been categorized as Location. The preposition *in*, in the sense in:7(5) includes figurative meanings like *read it in a book* and has been included here because this is the closest meaning. The same holds for inside:3(1b), which includes phrases like *anger simmered inside me*. An alternative relation could be PartWhole. Some examples that are not a Location relation are:

1. when there is a comparison to a norm or a number (eg. *the food was above average*), which is an Other relation;
2. when there is a notion of something being attached to or coming into physical contact with something else, where Participant/Accompanier is a better fit;
3. when one argument of the preposition is indicated to be a member of the other, where PartWhole is a better fit;
4. when one object is physically supported by a surface or another object, where PhysicalSupport is a better choice.

2.13 Manner

Definition: The prepositional phrase indicates the manner in which an action is performed. The action is typically the governor of the preposition.

Examples:

- frame the definition along those lines
- blinked in astonishment
- disappear in a flash
- plummet like a dive-bomber
- obtained through fraudulent means
- shout with pleasure

Prep.	Senses
along	4(3)*
in	5(4) 6(4a)-1
like	1(1) 2(1a) 3(1b) 4(1c)* 5(1d) 6(2)*
through	12(5)
with	7(5)

Comments: There may be some overlap of meaning between Manner, Attribute and Cause, stemming from the preposition sense in:5(4). For example, consider the following phrases that are included in this sense: *pursed her lips in a silent whistle*, *shrugged in embarrassment* and *seething in outrage*.

2.14 MediumOfCommunication

Definition: The prepositional phrase indicates the medium or language of some form of communication or idea. The object is, in a general sense, a ‘mode of communication’. This includes languages (eg. *say it in French*), media like TV or the Internet (eg. *saw it on a website*), or specific instances of these (eg. *saw it on the Sopranos*).

Examples:

- say it in French
- put your idea down on paper
- saw the new series on TV

Prep.	Senses
in	9(7)
on	12(6) 13(6a)

Comments: In boundary cases between MediumOfCommunication and Attribute (as in *Shakespeare’s plays in comic book form*), the former is a better choice if it is a specific case of Attribute. The same argument holds for the boundary cases with Manner.

2.15 Numeric

Definition: The object of the preposition indicates a numeric quantity (age, price, percentage, etc).

Examples:

- driving at 50mph
- missed the shot by miles
- crawled for 300 yards

- a boy of 15

Prep.	Senses
at	5(3) 6(3a)*
between	3(3)
by	12(3) 13(3a)* 16(3d)*
for	10(8a) 13(11) 14(12)*
into	8(8)*
of	4(2) 5(2a)*
on	23(13)*
to	11(4b)* 12(4c)*

Comments:

1. Several senses included in this relation do not have any examples in the training set.
2. The prepositions in phrases such as *drop from \$105 million to \$75 million* are not labeled as Numeric. Instead, the *from* is labeled as StartState and the *to* is labeled as EndState.

2.16 ObjectOfVerb

Definition: The object of the preposition is an object of the verb or the nominalization that is the governor of the preposition. This includes cases like *construction of the library*, where the object of the preposition is an object of the underlying verb.

Examples:

- inquired after him
- chase after something
- sipped at his coffee
- considerations for the future
- saved from death
- the wedding of his daughter
- it was kind of you
- she tells of her marriage
- presided over the meeting
- scan through document
- a threat to world peace
- a grant towards the cost
- cross with her.

Prep.	Senses
after	7(3)
at	10(5a) 9(5)
for	2(2) 2(2)-1
from	11(8)
of	11(6) 12(6a) 13(6b) 14(7) 15(7a)
on	9(3a)
over	6(2b)
round	7(3b)*
through	10(3) 10(3)-1*
to	14(6)
towards	5(3)*
with	15(9)-1 4(3)-1 9(7),

Comments:

1. Many of the other relations can be considered to be an object of the verb in question. However, if the sense of a preposition was better suited to a different relation, that relation has been chosen. With this caveat, we expect the object of the preposition to be a core argument for the governor according to the PropBank or the NomBank schemes.
2. This relation includes the senses for:2(2), of:13(6b), to:14(6) and with:9(7) which are very vaguely defined in the Preposition Project. This contributes to some noise in the data.
3. It is possible that some of the senses from the Other category could be grouped into this relation, if there is more evidence in the data.

Some examples which are not ObjectOfVerb are: 1. when there is a notion of connection or physical contact between entities, Participant/Accompanier is a better fit, and 2. when the object of the preposition is the target of an action or is affected by it, Recipient or Beneficiary is preferred over this label.

2.17 Opponent/Contrast

Definition: This relation indicates a collision, conflict or contrast and the object of the preposition refers to one or more entities involved.

Examples:

- fight against crime
- gave evidence against him
- the match against Somerset

- turned up his collar against the wind
- the wars between Russia and Poland
- fees are distinct from expenses
- fought with another man

Prep.	Senses
against	1(1) 2(1a) 3(1b) 6(2b)
between	5(4a) 7(4c)
from	14(11)
with	6(4)

Comments: The main distinguishing criterion is that there are one or more antagonists in a conflict or in opposition. This includes cases like *pulled up the collar against the wind*. Some near misses include:

1. when there is no explicit conflict, the relation Co-Participants is a better fit, and
2. when there is a hint of a conflict, without mention of the entities involved (like *turn away from appeasement* and *stagger from crisis to crisis*), the relation Source would be a better fit.

2.18 Other

Definition: This is the catch-all category, which includes infrequent senses of prepositions that do not fit any other category. A preposition being labeled as Other does not mean that there is no relation expressed by it. Neither does it indicate that there is no shared meaning across prepositions that can be abstracted. In most cases, there is such little support from the training set for this label that either adding it to an existing relation or creating a new one cannot be justified.

Examples:

- at a level above the people
- married above her
- heard above the din
- a drawing after Millet's The Reapers
- health comes after housing
- named her Pauline after her mother
- gritted his teeth against the pain

- odds were 5-1 against them
- money loaned against the property
- benefits weighed against the costs
- picked up tips along the way
- been ill as a child
- placed duty before everything
- years behind them
- he was rather beneath the princess
- tragic life beneath the gloss
- felt clumsy beside her
- right by me
- swear by God
- 'F' is for fascinating
- swap for that
- tall for her age
- works like Animal Farm
- he is on morphine
- drinks are on me
- married for over a year
- the director is over him
- he smiled to her astonishment
- leave it with me

Prep.	Senses
above	5(2a)* 6(2b)* 7(2c)* 8(2d) 9(3)
after	10(5a)* 8(4)* 9(5)*
against	4(2) 5(2a)* 7(2c)* 8(3)* 9(3a)*
along	2(1a)*
as	2(2)*
before	4(3)*
behind	2(1a)* 6(3a)* 8(5)* 9(6)*
beneath	4(2a)* 5(2b)* 6(2c)*
beside	2(1a)* 3(2)*
by	21(7)* 22(8)*
for	11(9) 8(7) 9(8)
inside	4(1c)*
like	7(3)*
on	20(10)* 21(11)* 22(12)* 9(3a)-1*
over	10(3)* 5(2a)* 7(2c)* 8(2d)* 9(2e)*
to	15(7)* 16(8)* 7(2b)*
with	8(6)*

Comments: Even though this label includes many senses, as we see in 3, this relation is has a very small representation in the data. Being a very infrequent category, this label would apply only when none of the other relations hold.

2.19 PartWhole

Definition: This relation indicates that one argument is a part or member of another. It includes two distinct cases: (1) the governor of the preposition (or the subject of the governor, if the governor is a verb) is a part of the object, *and* (2) the governor is a number, a partitive noun or a container and the object is a group or substance that is modified by the governor.

Examples:

- see a friend among them
- sleeve of the coat
- a slice of the cake
- group of monks
- cup of soup

Prep.	Senses
among	2(2)
in	12(9)*
of	1(1)* 2(1a) 3(1b) 3(1b)-1

Comments:

1. The two cases were clubbed together because both indicate a notion of an object or substance being divided into parts or groups. This is distinct from the `POSSessor` relation, where neither argument is divided to define the other.
2. This label indicates all quantifiers and partitive nouns that are connected to entities via the preposition. For example, *hundreds of people, a piece of cake, many of the protesters.*
3. This label also includes cases where the object of the preposition is a set of entities (or a container) and the governor is an element of that set (or the contents of the container), as in the example, snakes are among the most feared animals.

2.20 Participant/Accompanier

Definition: The object of the preposition indicates an entity which accompanies another entity or participates in a relation with another entity, which is typically indicated by either the governor of the preposition or the subject of the governor.

Examples:

- stick the drawings onto a large map
- he is married to Emma
- a map pinned to the wall
- his marriage with Emma

Prep.	Senses
by	11(2f)*
onto	3(3)
to	13(5) 9(4)
with	1(1)

Comments:

1. In this relation, the object indicates only one of the participating entities. In contrast, in the `Co-Participants` relation, the object defines all the participating entities, typically in the form of a plural or a conjunction.
2. The sense `by:11(2f)` is included here based on the notes on the treatment of the preposition in the Preposition Project. However, there are no examples to support this inclusion, and this may be moved to the relation `Other`.
3. All cases where something is joined to something else should be treated as `Participant/Accompanier`. There might be some confusion between this label and `ObjectOfVerb`, `Destination` or `Location`. Whenever there is the notion of connection between entities, this label is a better choice.

2.21 PhysicalSupport

Definition: The object of the preposition is physically in contact with and supports the governor (if it is an entity) or the subject of the governor (if it is a verb or a nominalization).

Examples:

- stood with her back against the wall
- a water jug on the table

Prep.	Senses
against	10(4)
on	1(1) 4(1c) 5(1d)

Comments: This may often overlap with `Location`. It is the preferred label if there is the notion of one object being in physical contact with and supported by an surface or another object. Examples include *knelt on the cold stone floor* and *placed the jug on the table*.

2.22 Possessor

Definition: The governor of the preposition is something belonging to the object or an inherent quality of the object. This relation includes familial relations.

Examples:

- a look about her
- a black filly by Guldfuerst
- his son by his third wife
- son of a friend
- a photograph of a bride
- a few pounds on her.

Prep.	Senses
about	5(3a)*
by	10(2e)* 9(2d)*
of	6(3)
on	6(1e)*

Comments:

1. Note that the `Possessor` relation is largely represented in the training set via the preposition *of* in the sense of:6(3).
2. This relation is different from the `Attribute` relation, where the governor specifies the attribute or quality of the object.

2.23 ProfessionalAspect

Definition: This relation signifies a professional relationship between the governor (or the subject of the governor, if the governor is a verb) and the object of preposition, which is an employer, a profession, an institution or a business establishment.

Examples:

- began performing at the university
- tutor for the University
- works in publishing
- serve on committees
- she is with Inland Revenue
- bank with TSB

Prep.	Senses
at	4(2b)*
for	4(3a)
in	8(6)
on	10(4)*
with	13(8) 14(8a)*

Comments: This is an infrequent relation that could have been merged into the Other category, but has been separated because it forms a distinct cluster.

2.24 Purpose

Definition: The object of the preposition specifies the purpose (i.e., a result that is desired, intention or reason for existence) of the governor.

Examples:

- networks for the exchange of information
- tools for making the picture frame.

Prep.	Senses
for	5(4)

2.25 Recipient

Definition: The object of the preposition identifies the person or thing receiving something.

Examples:

- unkind to her
- donated to the hospital

Prep.	Senses
to	8(3)

Comments: The difference between a Recipient and the Beneficiary is that in the latter case, the recipient gets some advantage from the action or event.

2.26 Separation

Definition: The relation indicates separation or removal. The object of the preposition is the entity that is removed.

Examples:

- the party was ousted from power
- tear the door off its hinges
- burden off my shoulders
- I stay off alcohol
- part with possessions

Prep.	Senses
from	10(7)
off	4(3) 5(3a)* 6(3b)* 7(4)*
with	16(10)

2.27 Source

Definition: The object of the preposition indicates the provenance of the governor or the subject of the governor. This includes cases where the object is the place of origin, the source of information or the creator of an artifact.

Examples:

- I am from Hackney
- paintings of Rembrandt
- book by Hemmingway
- information from books

Prep.	Senses
by	4(1c)
from	1(1) 13(10) 2(1a) 4(3)
of	7(3a)

Comments:

1. While it might be possible to split this into multiple sub-relations (location, source of information and creator-creation), all but the first will end up being infrequent.
2. Some figurative uses are included into this category, such as *turning them away from appeasement* and *stagger from crisis to crisis*.

2.28 Species

Definition: This expresses the relationship between a general category or type and the thing being specified which belongs to the category. The governor is a noun indicating the general category and the object is an instance of that category.

Examples:

- the city of Prague
- this type of book

Prep.	Senses
of	10(5a) 9(5)

2.29 StartState

Definition: The object of the preposition indicates the state or condition that an entity has left.

Examples:

- recovered from the disease
- a growth from \$2.2 billion to \$2.4 billion

Prep.	Senses
from	10(7)-1 6(4) 7(4a)*

Comments:

1. This relation requires some entity to change state, with the object of the preposition indicating the initial state before the transformation.
2. This relation also includes cases where the preposition indicates the first element in a numeric or conceptual range.

Some examples that are not StartState are: 1. *the ball fell from his hands*, which is a Source relation because the object indicates the original physical *location* of the ball, 2. *came back from a holiday*, which is also a Source relation, and 3. *a steady increase from June*, which is a Temporal relation because the object of the preposition is a temporal expression.

2.30 Temporal

Definition: The *object* of the preposition specifies the time of when an event occurs, either as an explicit temporal expression or by indicating another event as a reference. In some prepositional phrases, the governor may indicate a temporal expression. These do not express a Temporal relation.

Examples:

- shortly after Christmas
- go to bed at nine o'clock
- cooler at night
- rest before dinner
- open during the party
- jailed for 12 years
- the show will run from ten to two
- met in 1985
- reported on September 26

Prep.	Senses
across	1(1)-1*
after	1(1) 2(1a)* 3(1b)*
at	2(2) 3(2a)*
before	1(1)
behind	7(4)*
between	2(2)*
by	14(3b)* 17(4)* 20(6)*
down	5(2)*
during	1(1) 2(1a)
for	12(10)
from	3(2) 5(3a)
in	3(2) 4(3)*
inside	5(2)*
into	1(1)-1*
of	18(9)*
on	17(8) 18(8a)*
over	14(5)*
through	11(4)* 7(2)* 9(2b)
to	4(1c)*
towards	3(1b)*

2.31 Topic

Definition: The object of the preposition denotes the subject or topic under consideration. In many cases, the preposition can be replaced by the phrase *on the subject of*. The governor of the preposition can be a verb or nominalization that implies an action or analysis or a noun that indicates an information store.

Examples:

- thinking about you
- book on careers

- insight into what was involved
- debate over unemployment

Prep.	Senses
about	1(1) 2(1a)*
around	2(1a)
into	5(5)*
on	8(3)
over	16(7)
round	2(1a)*

2.32 Via

Definition: This is an infrequent relation where the object of the preposition indicates a mode of transportation or a path for travel. The governor can be action indicating movement or travel or a noun denoting passengers.

Examples:

- traveling by bus
- he is on his way
- sleep on the plane
- got on the train
- go through the tube

Prep.	Senses
by	8(2c)
on	14(7) 15(7a) 16(7b)*
onto	2(2)*
through	5(1d)-1

Comments: This relation applies only when there is evidence of a physical travel or a mode of conveyance.

3 Statistics

Table 1 shows the number of training and test examples for each relation, obtained by applying the mapping defined in Section 2 to the training and test data of the SemEval-2007 shared task.

Note that even though the label `Other` is associated with the highest number of senses, it has a comparatively small number of examples associated with it. The relations that have fewer examples than `Other` have considerably fewer senses that define it, indicating that they are more coherent classes.

Relation	Train	Test
Activity	63	39
Agent	367	159
Attribute	510	266
Beneficiary	205	105
Cause	591	289
Co-Participants	112	58
Destination	1054	526
Direction	909	441
EndState	188	104
Experiencer	116	54
Instrument	565	290
Location	3096	1531
Manner	457	245
MediumOfCommunication	57	30
Numeric	113	48
ObjectOfVerb	1801	882
Opponent/Contrast	233	131
Other	72	42
PartWhole	958	471
Participant/Companion	292	142
PhysicalSupport	399	202
Possessor	508	269
ProfessionalAspect	45	22
Purpose	261	113
Recipient	378	190
Separation	345	172
Source	740	357
Species	394	198
StartState	69	37
Temporal	331	157
Topic	886	462
Via	61	26
Total	16176	8058

Table 1: Number of training and test examples

References

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