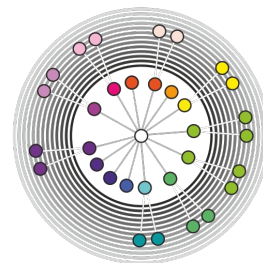


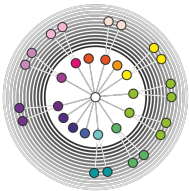
Expanding the Conceptual Description of Verbs in WordNet with Semantic and Syntactic Information

Ivelina Stoyanova and Svetlozara Leseva

Department of Computational Linguistics
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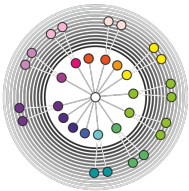


Enriching the Semantic
Network WordNet
with **Conceptual Frames**



Objectives

- **Mapping** VerbNet (VN) classes and semantic roles (SRs) and FrameNet (FN) frames and frame elements (FEs) with WordNet (WN) synsets
 - **extending** existing alignments between FrameNet and WordNet and thus enriching WordNet with **conceptual information** from FN.
- Enhancing the description of WordNet synsets and literals with **syntactic patterns** in addition to the WN **sentence frames**:
- From mapping syntactic patterns **towards** cross-linguistic analyses:
 - transferring valid patterns and adapting them for languages with limited valency and syntactic dictionaries.

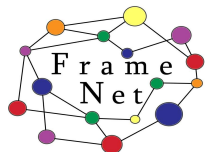


WordNet

{move:2; displace:4} 'cause to move or shift into a new position or place, both in a concrete and in an abstract sense'



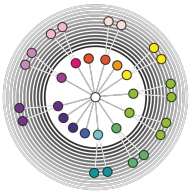
{transport:2; carry:1} 'move while supporting, either in a vehicle or in one's hands or on one's body'



lexical and conceptual knowledge represented via conceptual schemata (frames) describing types of objects, situations, or events along with their components (frame elements)



represents the syntactic and semantic patterns of English verbs. The semantic patterns (configurations of semantic roles) are projected onto syntactic structures.



Enriching the Semantic
Network WordNet
with Conceptual Frames

Resources

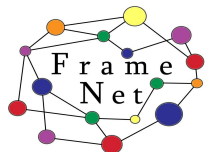
WordNet

{**move:2; displace:4**} 'cause to move or shift into a new position or place, both in a concrete and in an abstract sense'



{**transport:2; carry:1**} 'move while supporting...

FrameNet frame:



This frame concerns the movement of a **Theme** and an **Agent** and/or **Carrier**. The **Agent**, a person or other sentient entity, controls the shared **Path** by moving the **Theme** from a **Source** to a **Goal**.

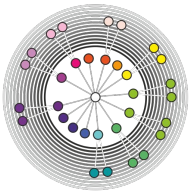
Assigned FN frame: Bringing

VerbNet PAS:



Agent VERB **Theme** {to, towards} **Destination**
Agent VERB **Theme** {PREP} **Initial_location** {to, towards} **Destination**

Assigned VN class: carry-11.4



Resources

WordNet

{**move:2; displace:4**} 'cause to move or shift into a new position or place, both in a concrete and in an abstract sense'



{**transport:2; carry:1**} 'move while supporting...'

Somebody ----s something

Somebody ----s somebody

Something ----s somebody

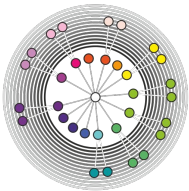
Something ----s something

Somebody ----s somebody PP

Somebody ----s something PP

WN sentence frames

← PP can express initial location (source)
or destination (goal)

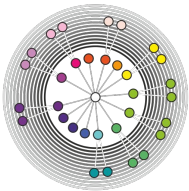


Resources

- The three resources have been aligned automatically using existing mappings, in particular:
 - a mapping of the VerbNet 3.4 verb classes to WordNet 3.0 synsets;
 - two types of mappings of FN frames and WordNet 3.0 synsets:
 - indirectly via SemLink and SemLink+;
 - directly through the system described by Laparra & Rigau (2010).

These mappings have resulted in the assignment of FrameNet frames to 4,306 verb synsets.

- On top of this: automatic procedures for assigning frames on synsets based on hierarchical relations between synsets in WordNet and between frames in FrameNet. Additional manual validation was performed.



Mapping the units of the Resources

FrameNet

Mother frame: *Cause_motion*

FEs: Agent [Sentient], Theme [Physical_object], Area, Cause, Source, Goal, Initial_state, Path, Result

Child frame: *Bringing*

FEs: Agent [Sentient], Theme [Physical_object], Carrier, Cause, Source, Goal, Path

VerbNet

Class: slide-11.2

Sem. roles: Agent, Theme, Initial_Location, Destination, Trajectory

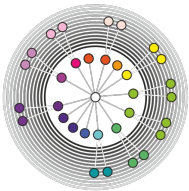
Class: carry-11.4

Sem. roles: Agent, Theme, Initial_Location, Destination

WordNet

Hypernym: eng-30-01850315-v *move*:2; *displace*:4 'cause to move or shift into a new position or place, both in a concrete and in an abstract sense'

Hyponym: eng-30-01449974-v *transport*:2; *carry*:1 'move while supporting, either in a vehicle or in one's hands or on one's body'



Mapping the units of the Resources

FrameNet

Mother frame: *Cause_motion*

FEs: Agent [Sentient], Theme [Physical_object], Area, Cause, Source, Goal, Initial_state, Path, Result

Child frame: *Bringing*

FEs: Agent [Sentient], Theme [Physical_object], Carrier, Cause, Source, Goal, Path

FN frame
assigned
to synset

WordNet

Hypernym: eng-30-01850315-v *move:2; displace:4* 'cause to move or shift into a new position or place, both in a concrete and in an abstract sense'

Hyponym: eng-30-01449974-v *transport:2; carry:1* 'move while supporting, either in a vehicle or in one's hands or on one's body'

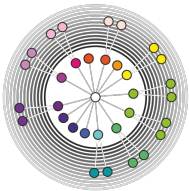
VerbNet

Class: slide-11.2

Sem. roles: Agent, Theme, Initial_Location, Destination, Trajectory

Class: carry-11.4

Sem. roles: Agent, Theme, Initial_Location, Destination



Mapping the units of the Resources

FrameNet

Mother frame: *Cause_motion*

FEs: Agent [Sentient], Theme [Physical_object], Area, Cause, Source, Goal, Initial_state, Path, Result

Child frame: *Bringing*

FEs: Agent [Sentient], Theme [Physical_object], Carrier, Cause, Source, Goal, Path

VerbNet

Class: slide-11.2

Sem. roles: Agent, Theme, Initial_Location, Destination, Trajectory

Class: carry-11.4

Sem. roles: Agent, Theme, Initial_Location, Destination

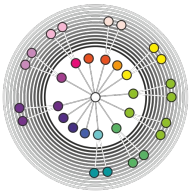
WordNet

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FN frame
assigned
to synset

VN class
assigned
to synset



Mapping the units of the Resources

FrameNet

Mother frame: *Cause_motion*

FEs: Agent [Sentient], Theme [Physical_object], Area, Cause, Source, Goal, Initial_state, Path, Result

Child frame: *Bringing*

FEs: Agent [Sentient], Theme [Physical_object], Carrier, Cause, Source, Goal, Path

FN $\longleftrightarrow$ VN
mapping

VerbNet

Class: slide-11.2

Sem. roles: Agent, Theme, Initial_Location, Destination, Trajectory

Class: carry-11.4

Sem. roles: Agent, Theme, Initial_Location, Destination

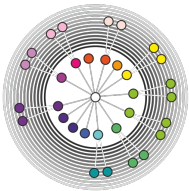
WordNet

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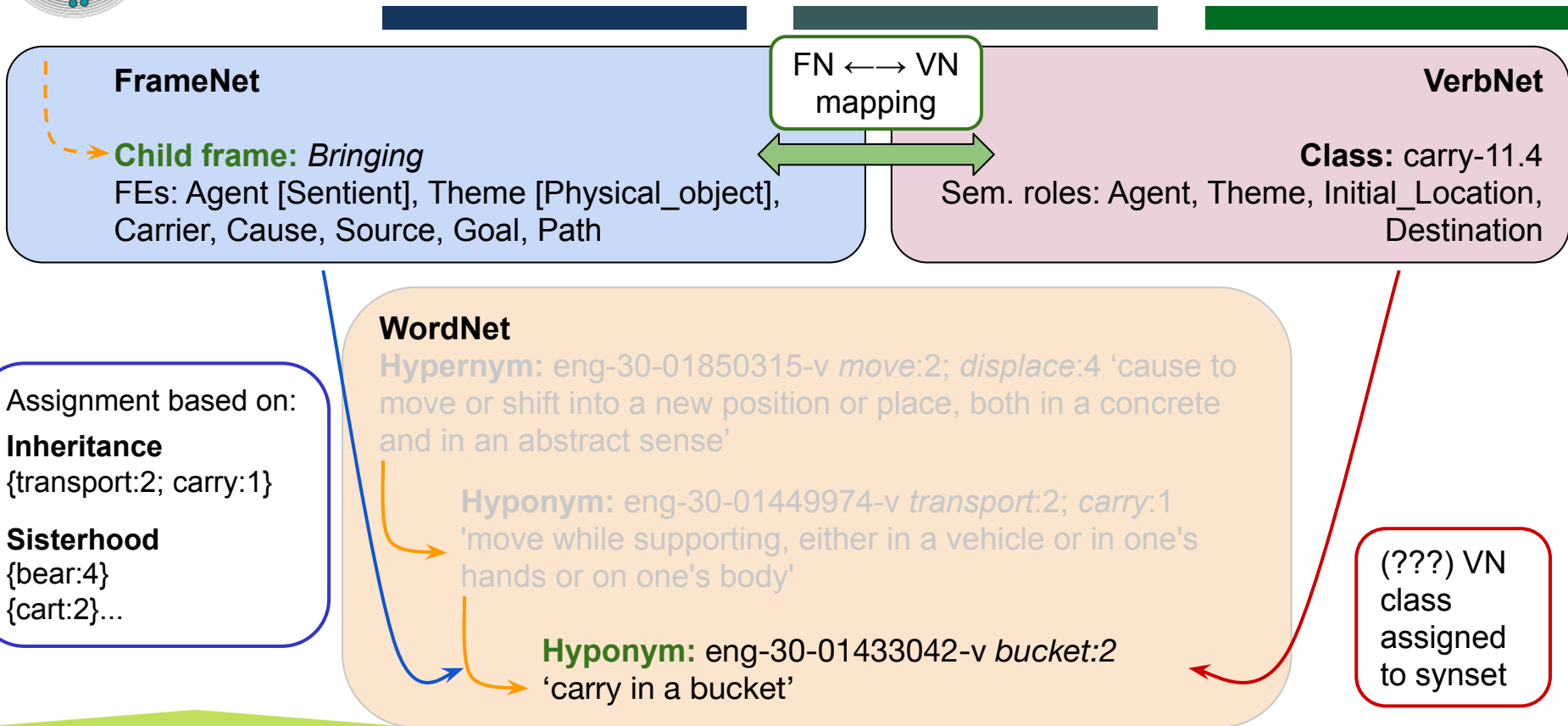
FN frame
assigned
to synset

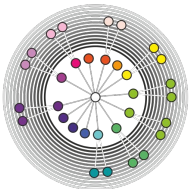
VN class
assigned
to synset



Enriching the Semantic
Network WordNet
with Conceptual Frames

Mapping the units of the Resources

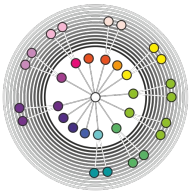




Mapping syntactic patterns

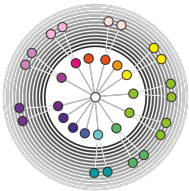
Mapping syntactic patterns in the resources aiming at **providing a syntactic layer** to the conceptual description of verbs in WordNet.

- Step 1: Identifying **FN frame-to-WN synsets** alignments and selecting only manually validated ones so as to ensure the quality of the dataset.
- Step 2: Identifying **VN class-to-WN synsets** alignments. Out of these, as a matter of validation, we select only those that have been aligned to FrameNet frames.
- Step 3: Aligning syntactic pattern from the FN frame and VN class mapped to the same synsets.
- Step 4: Aligning patterns from FN and VN to the generalised sentence frames in WordNet.



Mapping semantic components

- In order to do that, we first need to map FN frame elements to VN semantic roles
 - on the basis of identity, similarity or correspondence in the naming of elements and roles, and comparing their definitions using heuristic procedures or by
 - inferring knowledge from the structure of FrameNet, many frame elements being more specific than VerbNet semantic roles, and trying to map FrameNet FEs to VerbNet SR:
 - based on a shallow frame-specific hierarchy of FEs.



Mapping semantic components

FrameNet frame:
Breathing



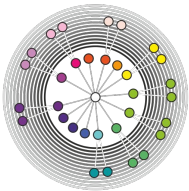
VerbNet verb class:
breathe-40.1.2

- Assigned to WN synsets:

breathe:1; take a breath:1; respire:1; suspire:1

'draw air into, and expel out of, the lungs'

- respire:3* *'breathe easily again, as after exertion or anxiety'*
- hyperventilate:1* *'breathe excessively hard and fast'*



Enriching the Semantic
Network WordNet
with Conceptual Frames

Mapping semantic components

FrameNet frame:
Breathing



VerbNet verb class:
breathe-40.1.2

Agent The Agent's breathing causes the motion of the Air. Agent is generally the External Argument. Lee breathed the hot desert air.

Air Air is the substance that the Agent causes to move. Lee breathed the hot desert air.

Source Source identifies the starting point of the Air. Lee exhaled from the bottom of his lungs.

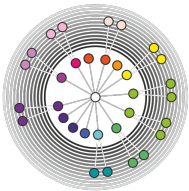
Goal This FE identifies the point at which the Air ends up as a result of the motion. Lee breathed into Ann's mouth.

Agent Actor in an event who initiates and carries out the event intentionally or consciously, and who exists independently of the event.

Theme Undergoer that is central to an event or state that does not have control over the way the event occurs, is not structurally changed by the event...

Source The starting point (possibly metaphoric) of an action; it exists independently of the event.

Destination Goal that is a concrete, physical location.



Mapping semantic components

Identity of naming + semantic
correspondence acc. to the definitions

Agent The Agent's breathing causes the motion of the Air. Agent is generally the External Argument. Lee breathed the hot desert air.

Agent Actor in an event who initiates and carries out the event intentionally or consciously, and who exists independently of the event.

Air Air is the substance that the Agent causes to move. Lee breathed the hot desert air.

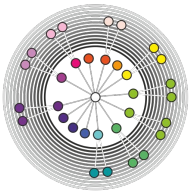
Theme Undergoer that is central to an event or state that does not have control over the way the event occurs, is not structurally changed by the event...

Source Source identifies the starting point of the Air. Lee exhaled from the bottom of his lungs.

Source The starting point (possibly metaphoric) of an action; it exists independently of the event.

Goal This FE identifies the point at which the Air ends up as a result of the motion. Lee breathed into Ann's mouth.

Destination Goal that is a concrete, physical location.



Mapping semantic components

mapping based on established general (frame/class non-specific) correspondences in the naming conventions adopted in the two resources

Agent The Agent's breathing causes the motion of the Air. Agent is generally the External Argument. Lee breathed the hot desert air.

Air Air is the substance that the Agent causes to move. Lee breathed the hot desert air.

Source Source identifies the starting point of the Air. Lee exhaled from the bottom of his lungs.

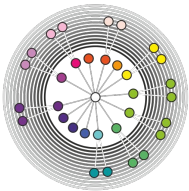
Goal This FE identifies the point at which the Air ends up as a result of the motion. Lee breathed into Ann's mouth.

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Theme Undergoer that is central to an event or state that does not have control over the way the event occurs, is not structurally changed by the event...

Source The starting point (possibly metaphoric) of an action; it exists independently of the event.

Destination Goal that is a concrete, physical location.



Mapping semantic components

Inferring knowledge about the relations between more general and more concrete FEs

Obtained from a shallow
hierarchy of frame elements:

based on chain of inheritance
between frames:

Air

> Fluid

> Theme

Breathing > Fluidic_motion > Motion

Agent The Agent's breathing causes the motion of the Air. Agent is generally the External Argument. Lee breathed the hot desert air.

Agent Actor in an event who initiates and carries out the event intentionally or consciously, and who exists independently of the event.

Air Air is the substance that the Agent causes to move. Lee breathed the hot desert air.

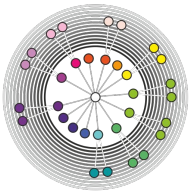
Theme Undergoer that is central to an event or state that does not have control over the way the event occurs, is not structurally changed by the event...

Source Source identifies the starting point of the Air. Lee exhaled from the bottom of his lungs.

Source The starting point (possibly metaphoric) of an action; it exists independently of the event.

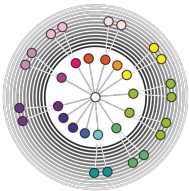
Goal This FE identifies the point at which the Air ends up as a result of the motion. Lee breathed into Ann's mouth.

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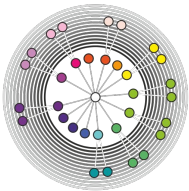
Mapping syntactic patterns

- The criteria for equivalence between **two syntactic patterns** include:
- correspondence between the **core** FrameNet **frame elements** and VerbNet **semantic roles** expressed in a syntactic pattern;
 - correspondence in the **syntactic restrictions** (PP heads, clause types or subordinating elements) defined for the mapped frame elements and semantic roles;
 - correspondence between the **syntactic expression of each mapped frame element and semantic role** – both in terms of the type of syntactic phrase by means of which they are expressed (NP, PP, etc.), and the syntactic position in which they are projected (e.g. subject, object).



Alignment between syntactic patterns

- Taking into consideration these prerequisites, we implement the syntactic pattern alignment procedure devised as set of mapping rules.
- As a result of their application, we obtain a list of the equivalent syntactic models for a given FrameNet frame and VerbNet class.
- Where no correspondence is discovered, the patterns are included as unmapped (marked as **NONE**).

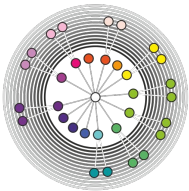


Dataset

➤ The resulting dataset includes:

- **1,121** WordNet synsets and a total of **5,264** verb literals;
- each synset is assigned a pair <FN frame : VN class>.
- a total of **329** such pairs involving **195** FrameNet frames and **165** VerbNet classes.
- There are VerbNet classes that participate in **more than one** pair of alignments, as well as FrameNet frames that correspond to **more than one** semantic class.

○



Alignment between syntactic patterns

<Breathing : breathe-40.1.2>

breathe; take a breath; respire; suspire

WN	Somebody	—s
VN	NP(Agent)	V
FN	*NP.Ext(Agent)	V

WN	Somebody	—s
VN	NP(Agent)	V
FN	*NP.Ext(Agent)	V

PP.destination[on,onto]
(Destination)
INC(Air) PP[in,on](Goal)

WN	Somebody	—s	something
VN	NP(Agent)	V	NP(Theme)
FN	*NP.Ext(Agent)	V	NP(Air)

WN	Somebody	—s	something
VN	NP(Agent)	V	NP(Theme)
			PP.destination[on,onto] (Destination)
FN	*NP.Ext(Agent)	V	NP(Air)
			PP[in,on](Goal)

WN	Somebody	—s
----	----------	----

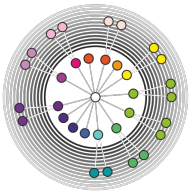
VN	NONE
----	------

FN	NP.Ext(Agent)	V	INC(Air) PP[down] (Path)
	NP.Ext(Agent)	V	INC(Air) PP[in] (Place)
	*NP.Ext(Agent)	V	INC(Air) PP[at] (External_cause)
	*NP.Ext(Agent)	V	INC(Air) AVP (Manner)
	NP.Ext(Agent)	V	INC(Air) PP[by,without] (Means)
	NP.Ext(Agent)	V	INC(Air) PP[as] (Depictive)
	NP.Ext(Agent)	V	INC(Air) PP[from,out] (Source)
	NP.Ext(Agent)	V	INC(Air) VPto (Purpose)

WN	Somebody	—s	something
----	----------	----	-----------

VN	NONE
----	------

FN	NP.Ext(Agent)	V	NP(Air) PP[down] (Path)
	NP.Ext(Agent)	V	NP(Air) AVP (Manner)
	NP.Ext(Agent)	V	NP(Air) PP[in](Goal)
			PP[from,out] (Source)
	NP.Ext(Agent)	V	NP(Air) PP[in](Goal)
			PP[through] (Instrument)



Alignment between syntactic patterns

<Killing

:

murder-42.1>

kill

WN	Somebody	—s	somebody	
VN	NP(Agent)	V	NP(Patient)	
FN	NP.Ext(Killer)	V	NP.Obj(Victim)	
WN	Somebody	—s	somebody	
VN	NP(Agent)	V	NP(Patient)	{ with }
				PP.instrument
				(Instrument)
FN	NP.Ext(Killer)	V	NP.Obj(Victim)	PP[with].Dep
				(Instrument)
WN	Something	—s	somebody	
VN	NP.instrument	V	NP(Patient)	
	(Instrument)			
FN	NP.Ext	V	NP.Obj(Victim)	
	(Instrument)			
WN	Something	—s	somebody	
VN	NONE			
FN	NP.Ext(Cause)	V	NP.Obj(Victim)	

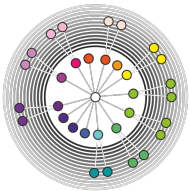
<Killing

:

suffocate-40.7>

asphyxiate, choke, suffocate

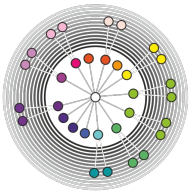
WN	Somebody	—s	somebody	
VN	NP(Agent)	V	NP(Patient)	
FN	NP.Ext(Killer)	V	NP.Obj(Victim)	
WN	Somebody	—s	somebody	
VN	NP(Agent)	V	NP(Patient)	{ with }
				PP.instrument
				(Instrument)
FN	NP.Ext(Killer)	V	NP.Obj(Victim)	PP[with].Dep
				(Instrument)
WN	Something	—s	somebody	
VN	NONE			
FN	NP.Ext	V	NP.Obj(Victim)	
	(Instrument)			
WN	Something	—s	somebody	
VN	NONE			
FN	NP.Ext(Cause)	V	NP.Obj(Victim)	
WN	Somebody	—s	somebody	
VN	NP(Agent)	V	NP(Patient)	{ to, into }
				PP.result(Result)
FN	NONE			



Results

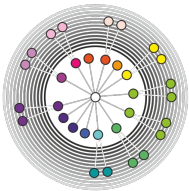
➤ The resulting dataset covers:

- the VerbNet classes in the dataset include **32** unique SRs matched to a total of **217** FrameNet frame elements;
- **29** (out of the 35) generalised WordNet sentence frames
 - aligned to **451** VerbNet syntactic patterns and **13,884** FrameNet syntactic patterns;
- FN patterns have been filtered based on frequency (of examples exhibiting the pattern included in the FN dataset), resulting in **811** FrameNet syntactic patterns with frequency of 3 or more.



Results

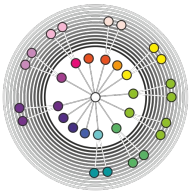
- The greater number of FN syntactic realisations is due to:
 - the large number of **peripheral and extra-thematic frame elements** (the syntactic patterns we analysed include some peripheral and extra-thematic elements with high frequency) and the variety of configurations they enter in the different realisations;
 - the representations of **alternations and variations** (e.g., passives, incorporation of FEs, various prepositions in PPs, etc.).



Semantically annotated corpora

Additionally, we employ semantically annotated corpora to use as a source for usage examples of the syntactic patterns:

- SemCor (Miller et al., 1993) – used for observing syntactic patterns in English and comparing syntactic patterns for verbs in the same FN frame and VN class;
- BulSemCor (Koeva et al., 2010) – provides material for comparative analysis between syntactic patterns in English and Bulgarian for the investigation of possible syntactic knowledge transfer.



Alignment between syntactic patterns

<Becoming_aware : see-30.1>

learn; hear; get word; discover; see
'get to know or become aware of, usually accidentally'

*Williams is **learning** the difficulties of diplomacy rapidly.*

*Have you ever **heard** of thuggee?*

*I was anxious to **hear** about those dazzling days on the Great White Way.*

*We **learned** this year that our older son, Daniel, is autistic.*

*We want to **find out** who knew about it.*

*We had merely been **discovered** by the pool sharks.*

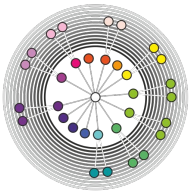
*What obsessions had she **picked up** during these long nights of talk?*

Most frequent aligned patterns:

VN: NP (Experiencer) V NP (Stimulus)
FN: NP (Cognizer) V NP (Phenomenon)

VN: NP (Experiencer) V
PP.stimulus[about,of] (Stimulus)
FN: NP (Cognizer) V PP (Phenomenon)

VN: NP (Experiencer) V
S[that,wh*,∅] (Stimulus)
FN: NP (Cognizer) V
S[that,wh*,∅] (Phenomenon)



Alignment between syntactic patterns

<Becoming_aware : see-30.1>

learn; hear; get word; discover; see
'get to know or become aware of, usually accidentally'

Williams is **learning** the difficulties of diplomacy rapidly.

Have you ever **heard** of thuggee?

I was anxious to **hear** about those dazzling days on the Great White Way.

We **learned** this year that our older son, Daniel, is autistic.

We want to **find out** who knew about it.

We had merely been **discovered** by the pool sharks.

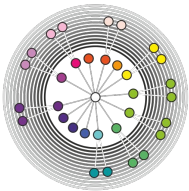
What obsessions had she **picked up** during these long nights of talk?

Most frequent aligned patterns:

VN: NP (Experiencer) V NP (Stimulus)
FN: NP (Cognizer) V NP (Phenomenon)

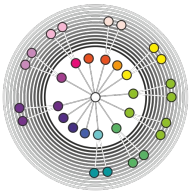
VN: NP (Experiencer) V
PP.stimulus[about,of] (Stimulus)
FN: NP (Cognizer) V PP (Phenomenon)

VN: NP (Experiencer) V
S[that,wh*,∅] (Stimulus)
FN: NP (Cognizer) V
S[that,wh*,∅] (Phenomenon)



Results

- The dataset is supplemented with a set of **16,059** SemCor corpus examples illustrating the annotated synsets (on average, **14** examples per synset).
- + the **usage examples** provided in all of the resources: WordNet examples and FrameNet and VerbNet illustrative examples.
- The newly developed resource containing pairs of a FrameNet frame and a VerbNet class with their corresponding syntactic patterns for realisation of FEs and semantic roles is distributed under a CC by 4.0 license.



Enriching the Semantic
Network WordNet
with Conceptual Frames

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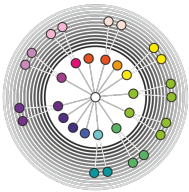
Ministry of Education and Science

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Thank you!

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