

VerbAtlas

A novel large-scale Verbal Semantic Resource
and its application to Semantic Role Labeling

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MOUSSE



SAPIENZA
UNIVERSITÀ DI ROMA



VerbAtlas

Main contribution

A novel large-scale **Verbal Semantic Resource** that aims at overcoming the **intrinsic shortcomings** of existing resources in **Semantic Role Labeling**.



Semantic Role Labeling (SRL)

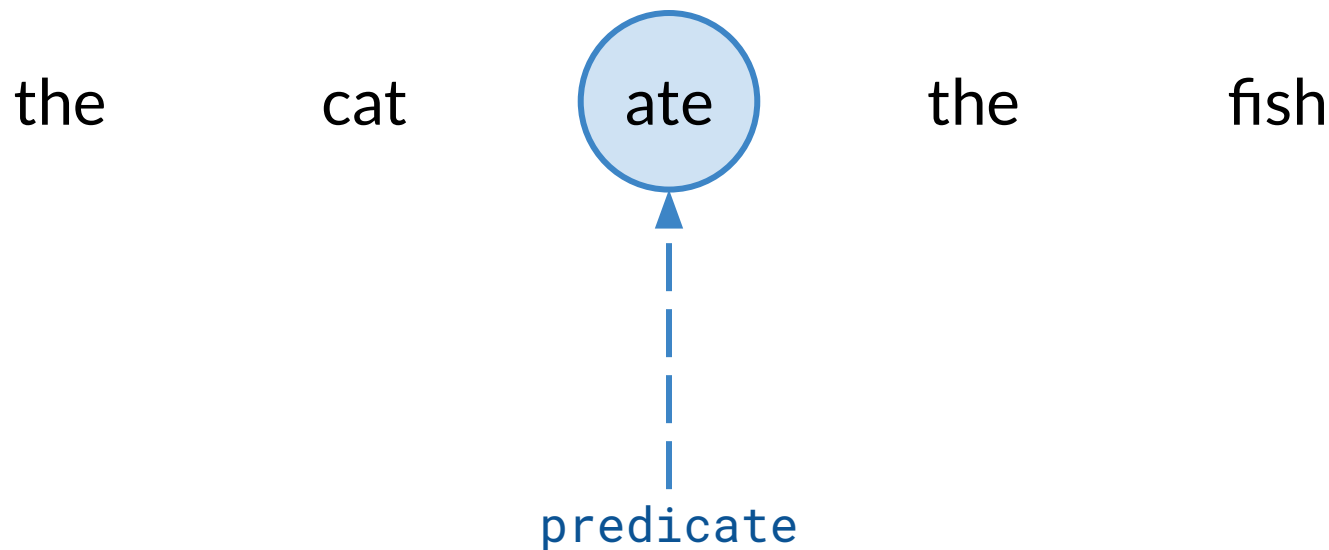
Who did what to whom?

the cat ate the fish



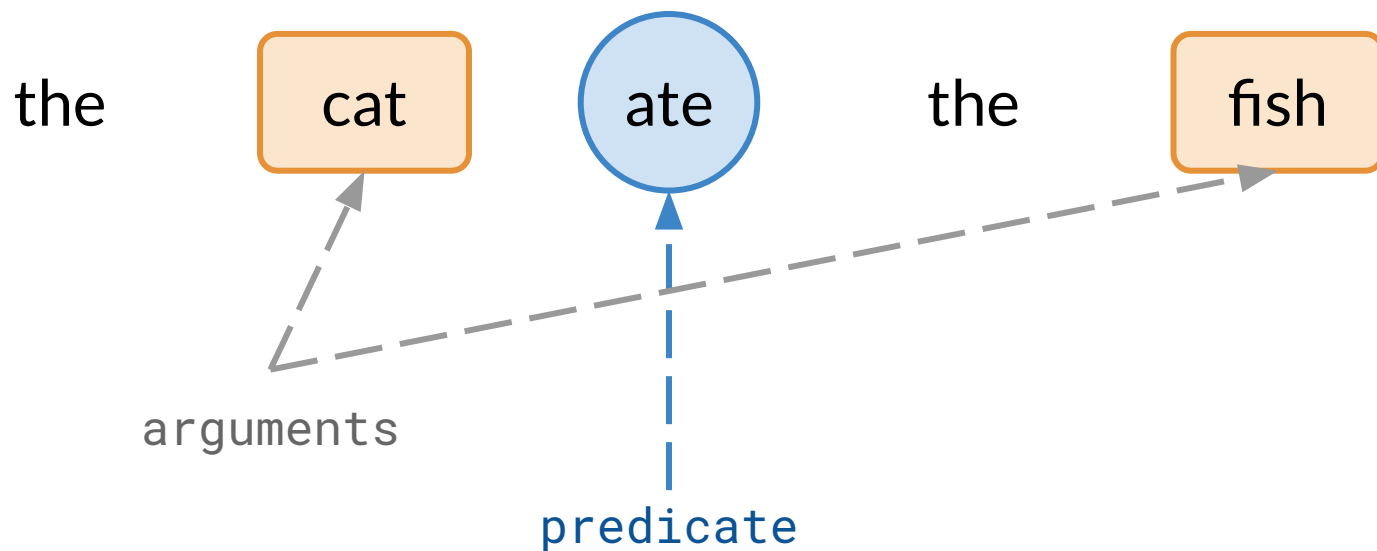
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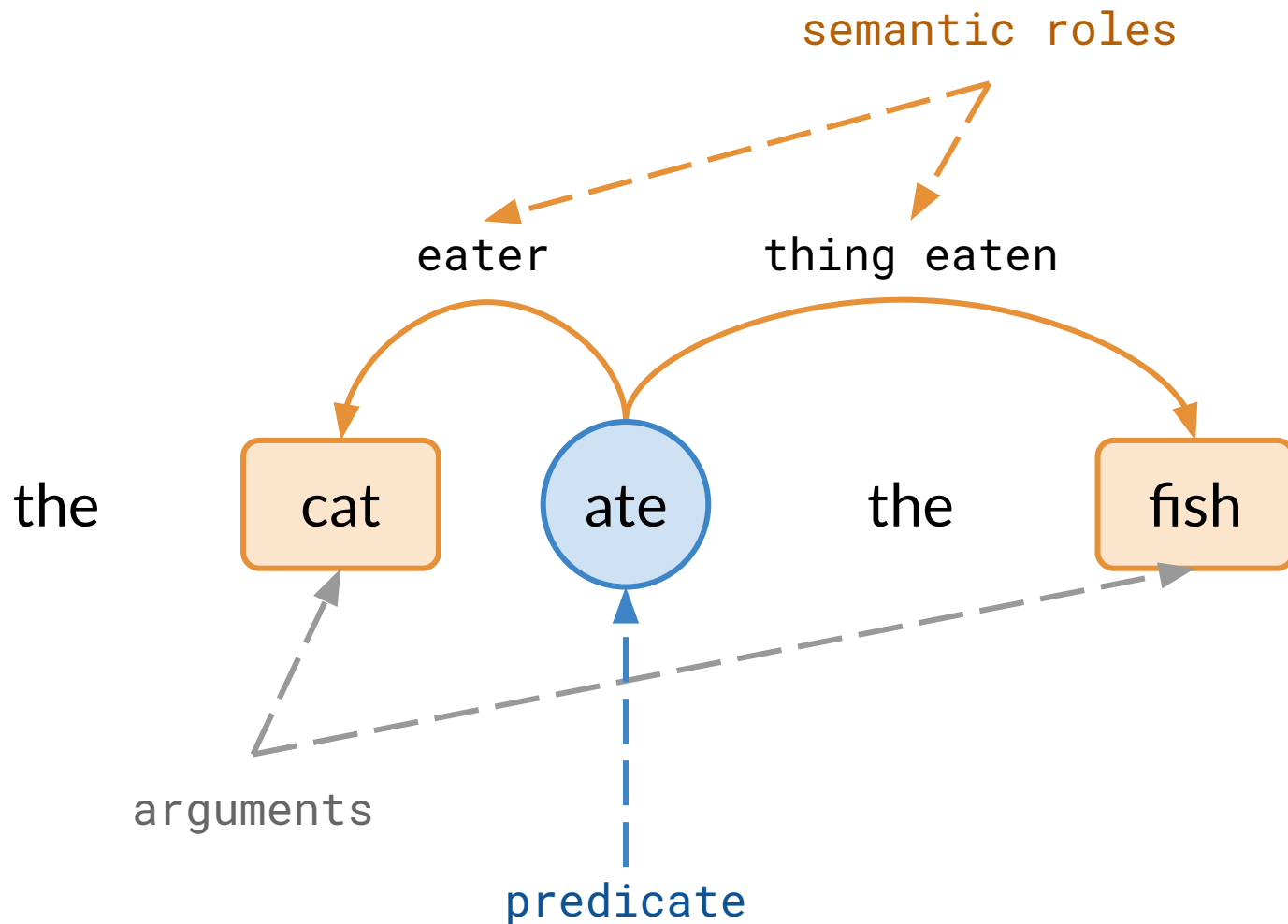
Semantic Role Labeling (SRL)

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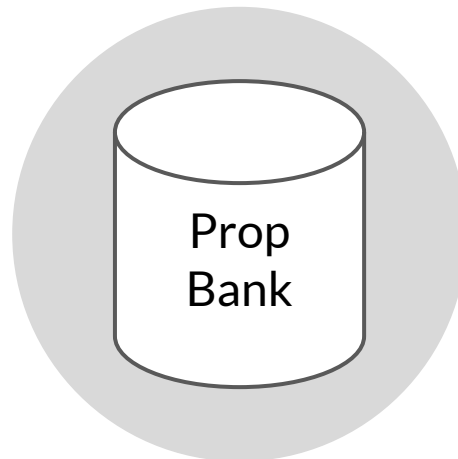
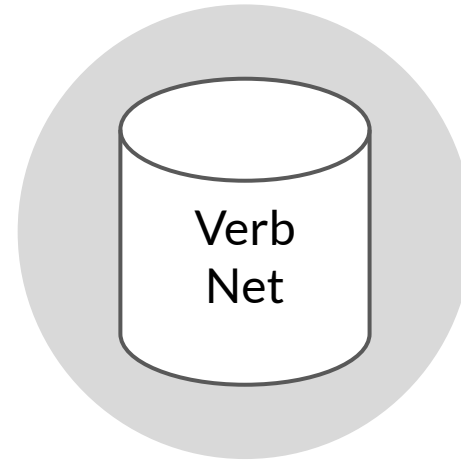
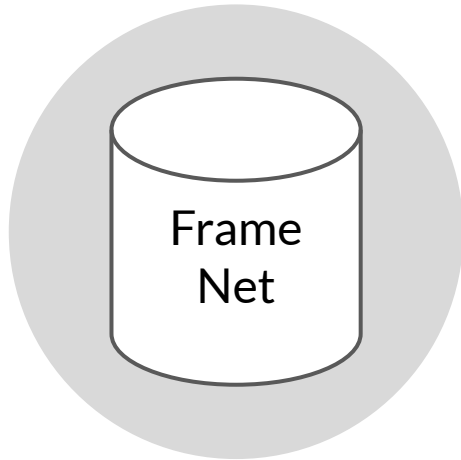


An overview of existing resources for SRL



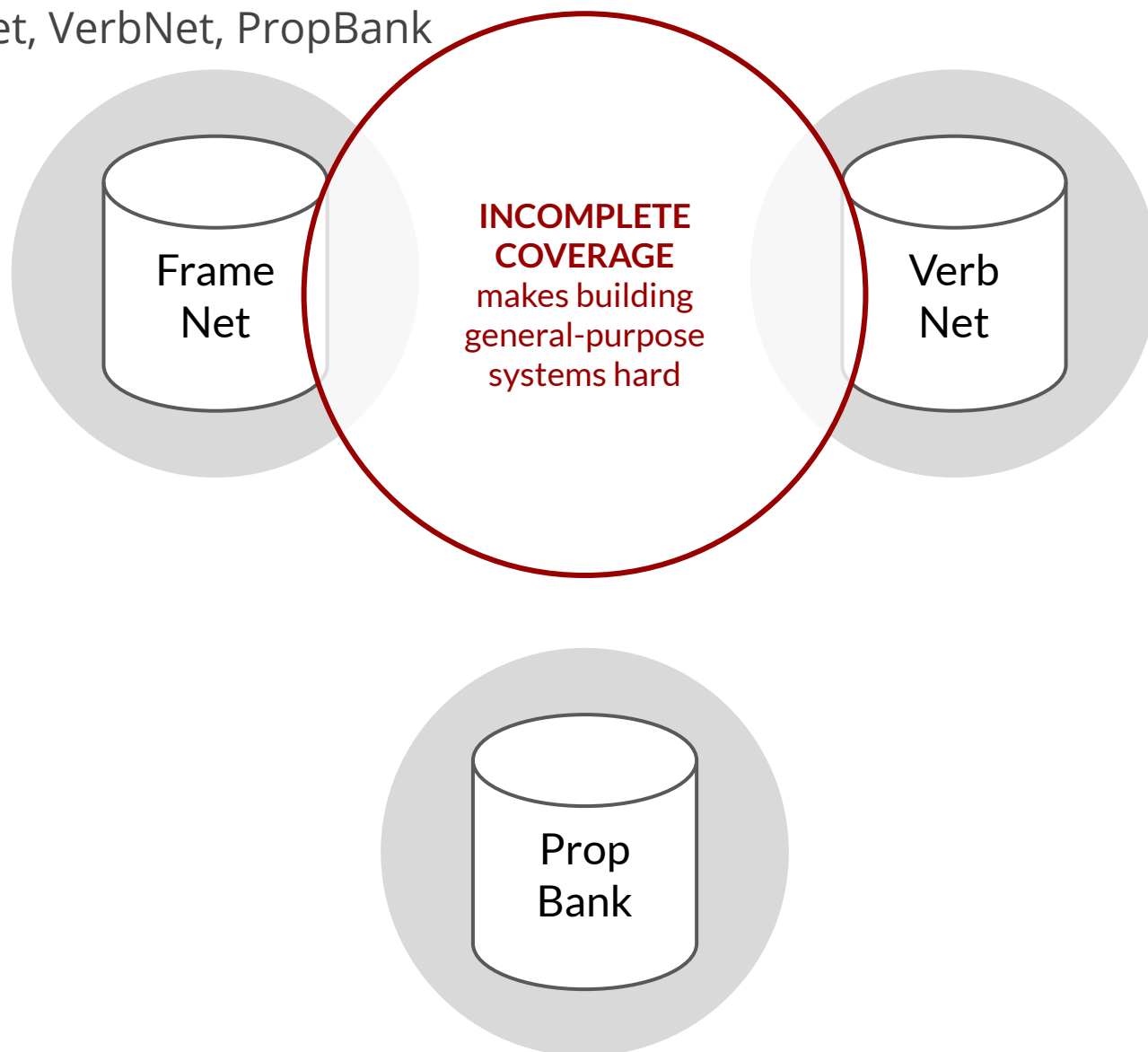
SRL: Limitations of Current Resources

FrameNet, VerbNet, PropBank



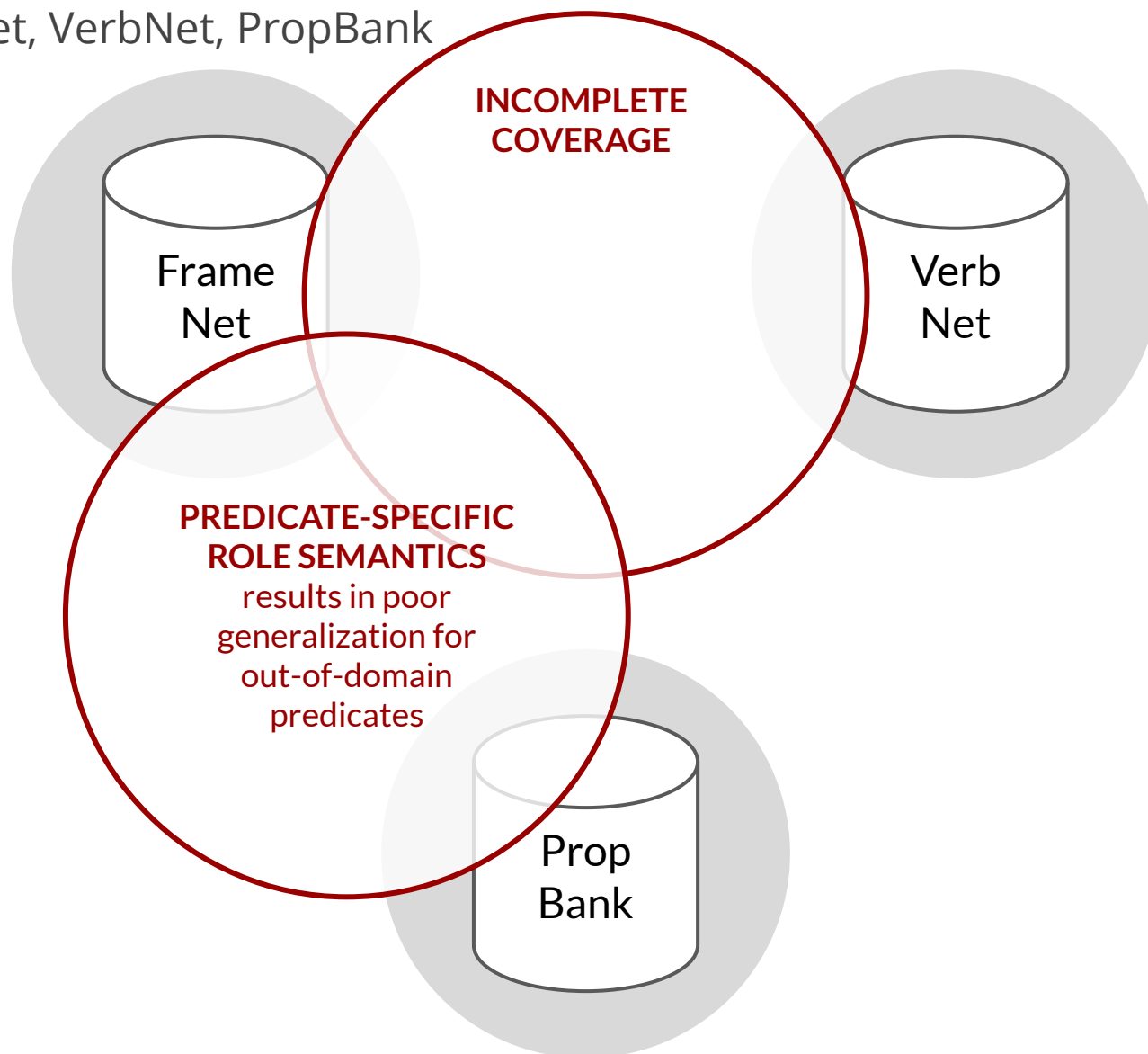
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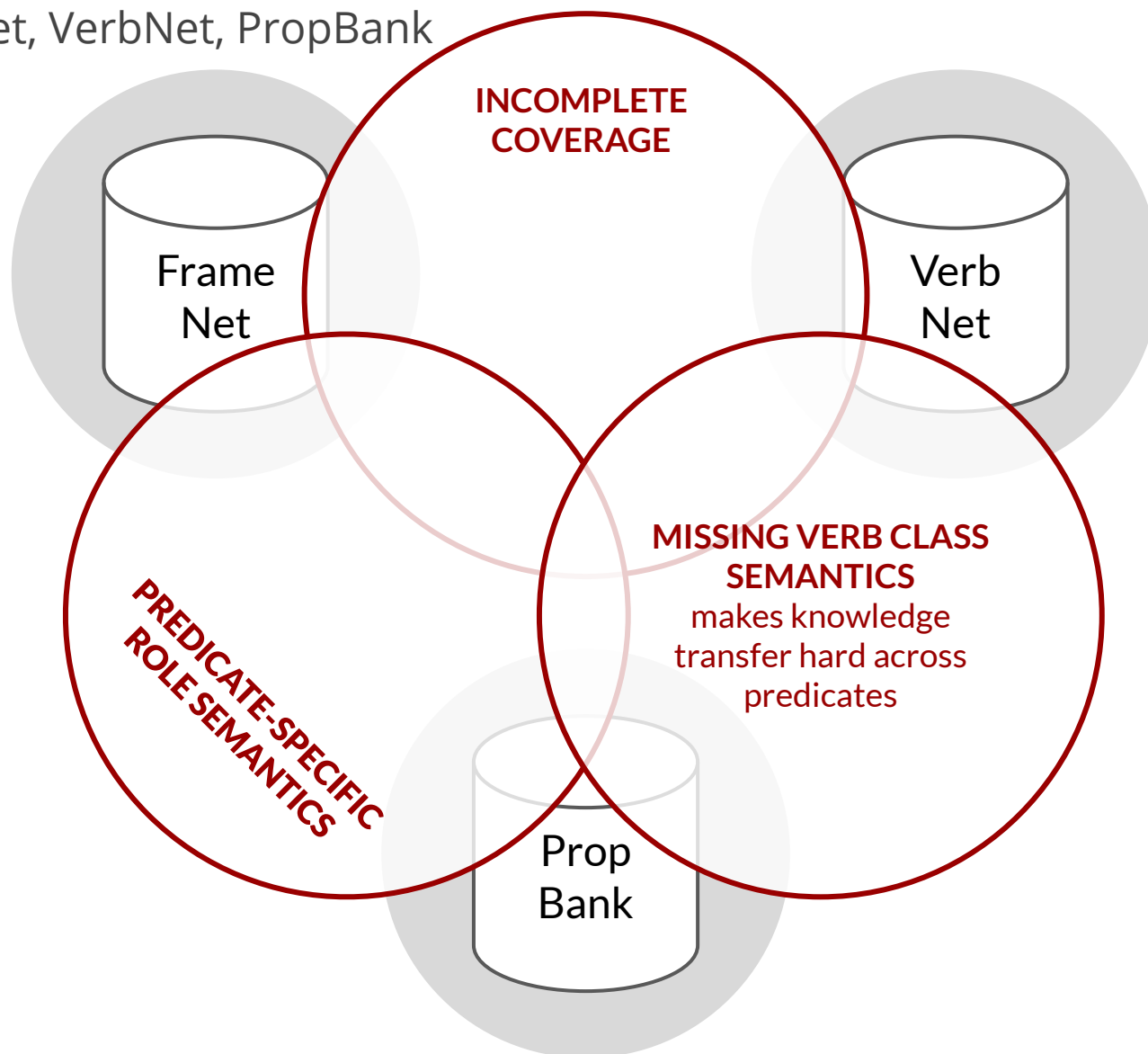
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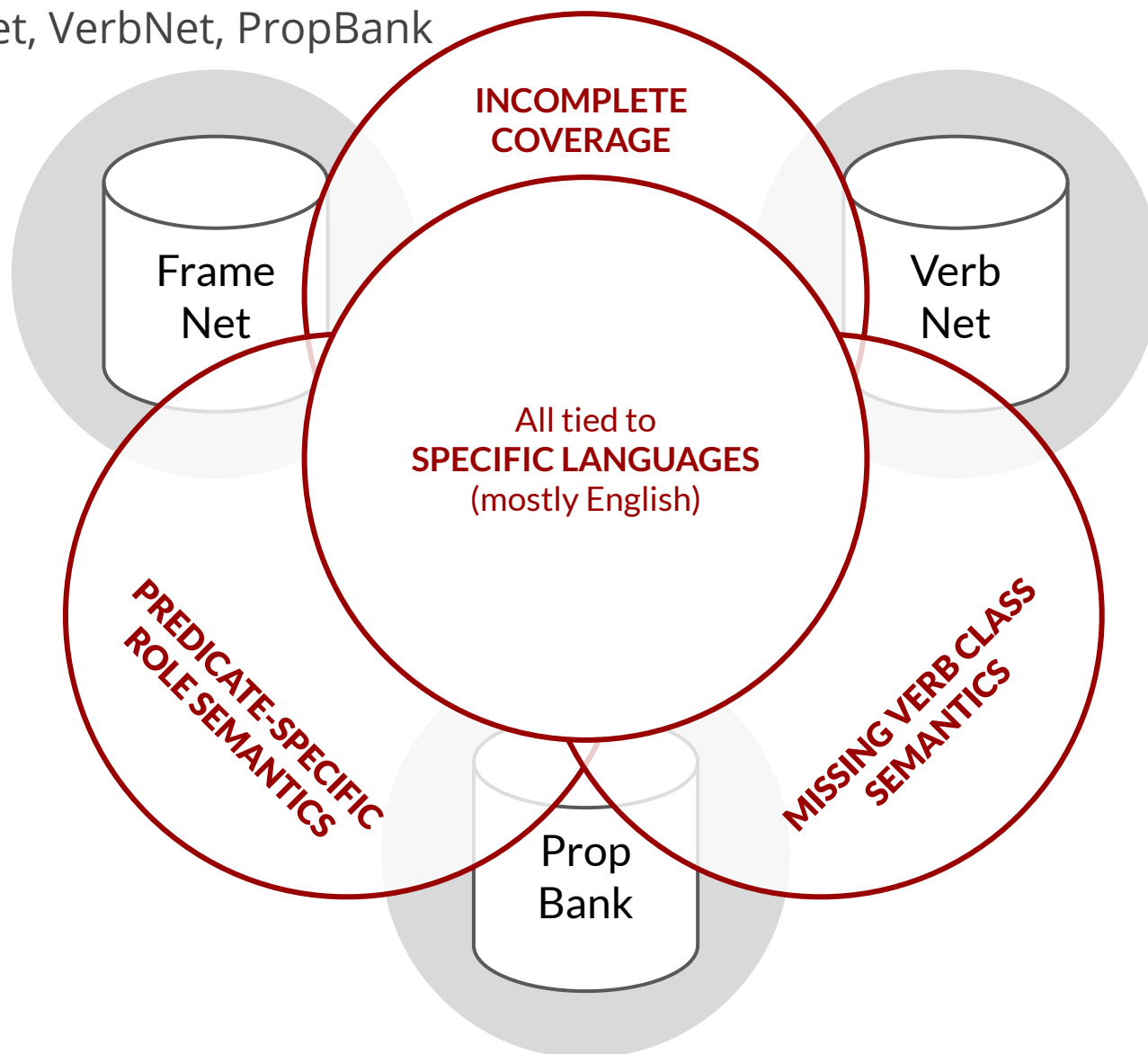
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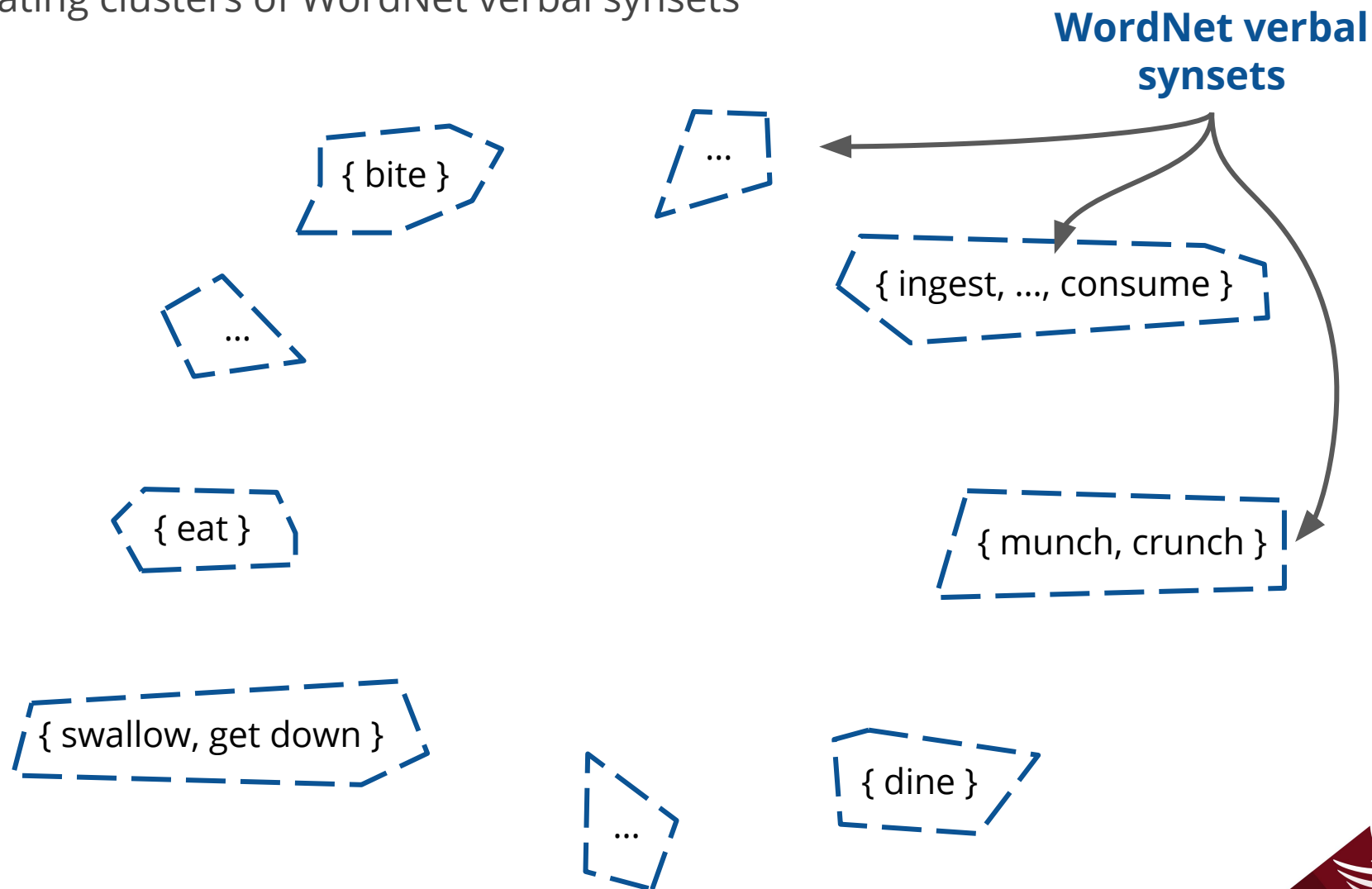


Introducing VerbAtlas



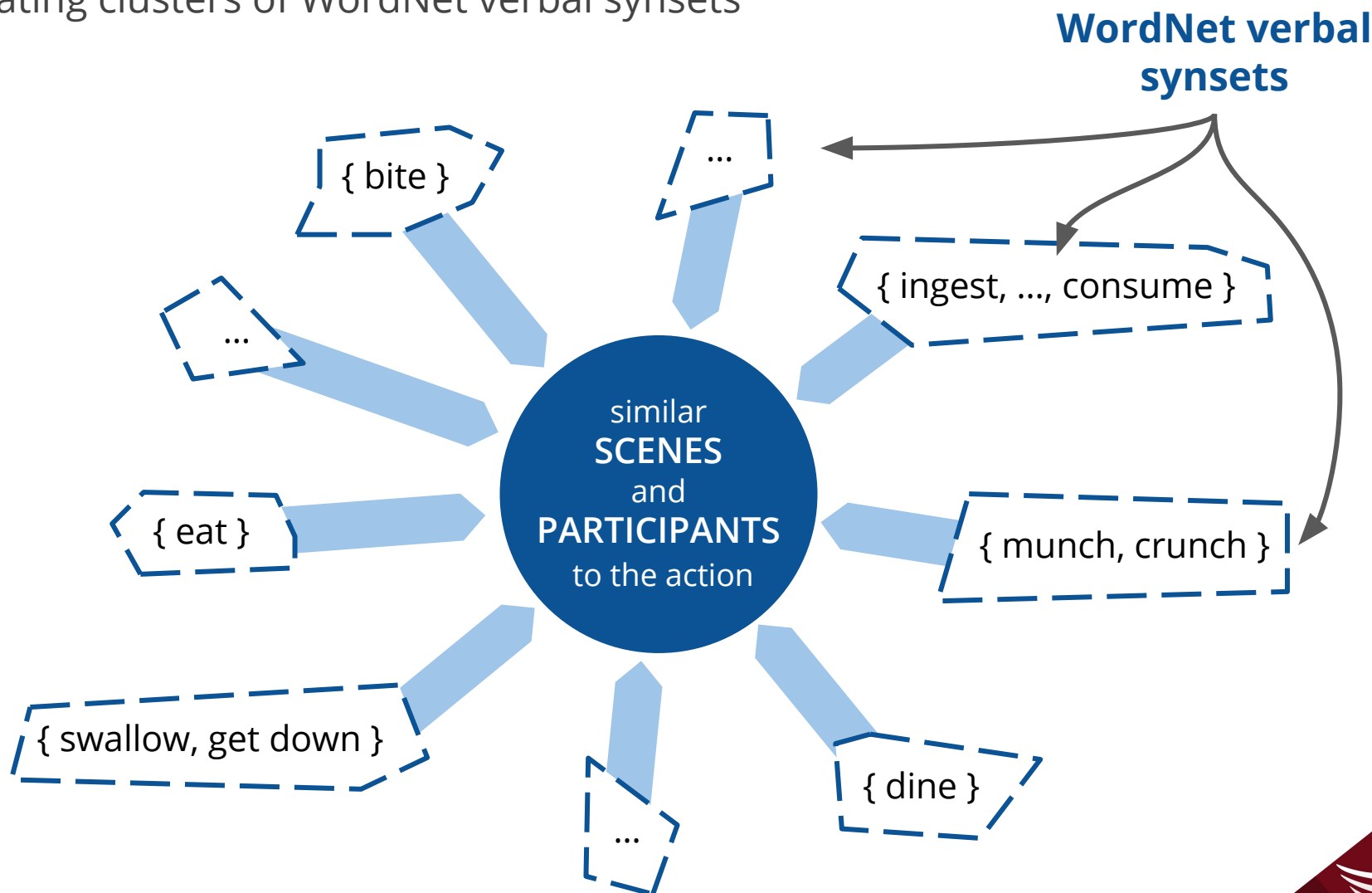
Manual Clustering of Predicates

Creating clusters of WordNet verbal synsets



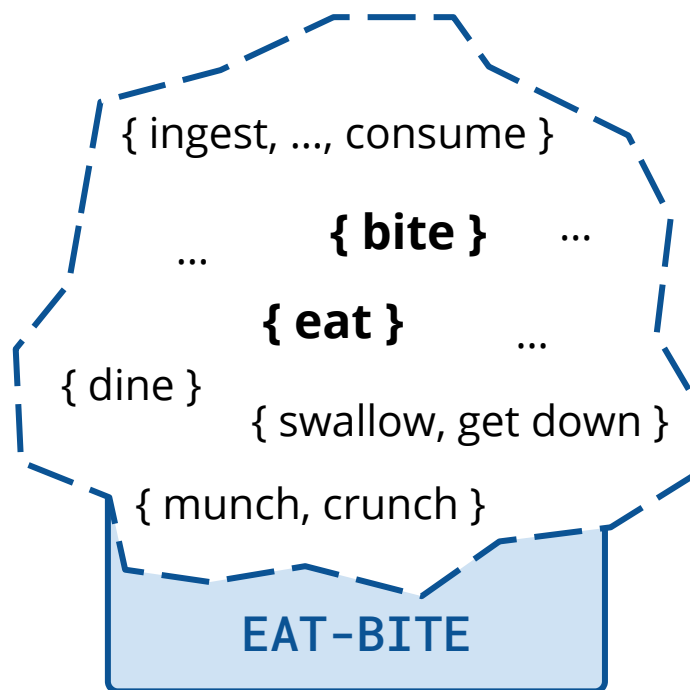
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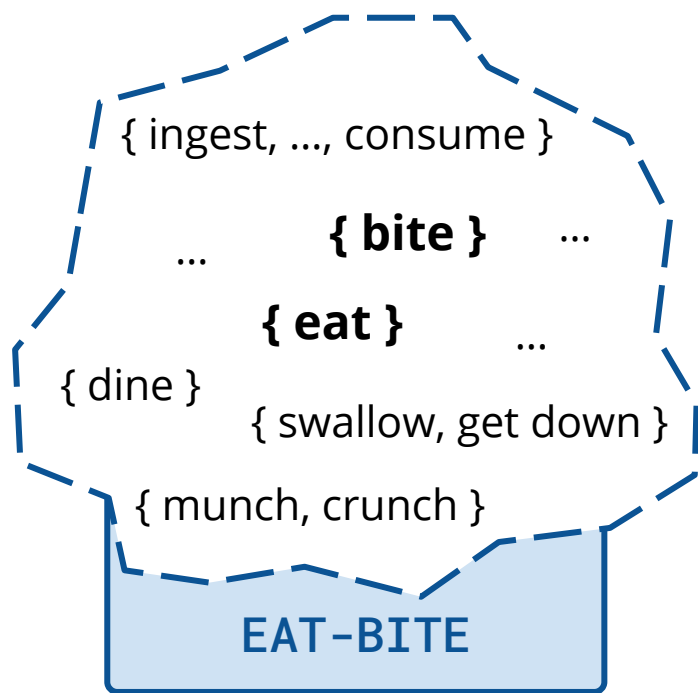
Manual Clustering of Predicates

Creating clusters of WordNet verbal synsets



Frames in VerbAtlas

All WordNet verbal synsets organized into semantic frames

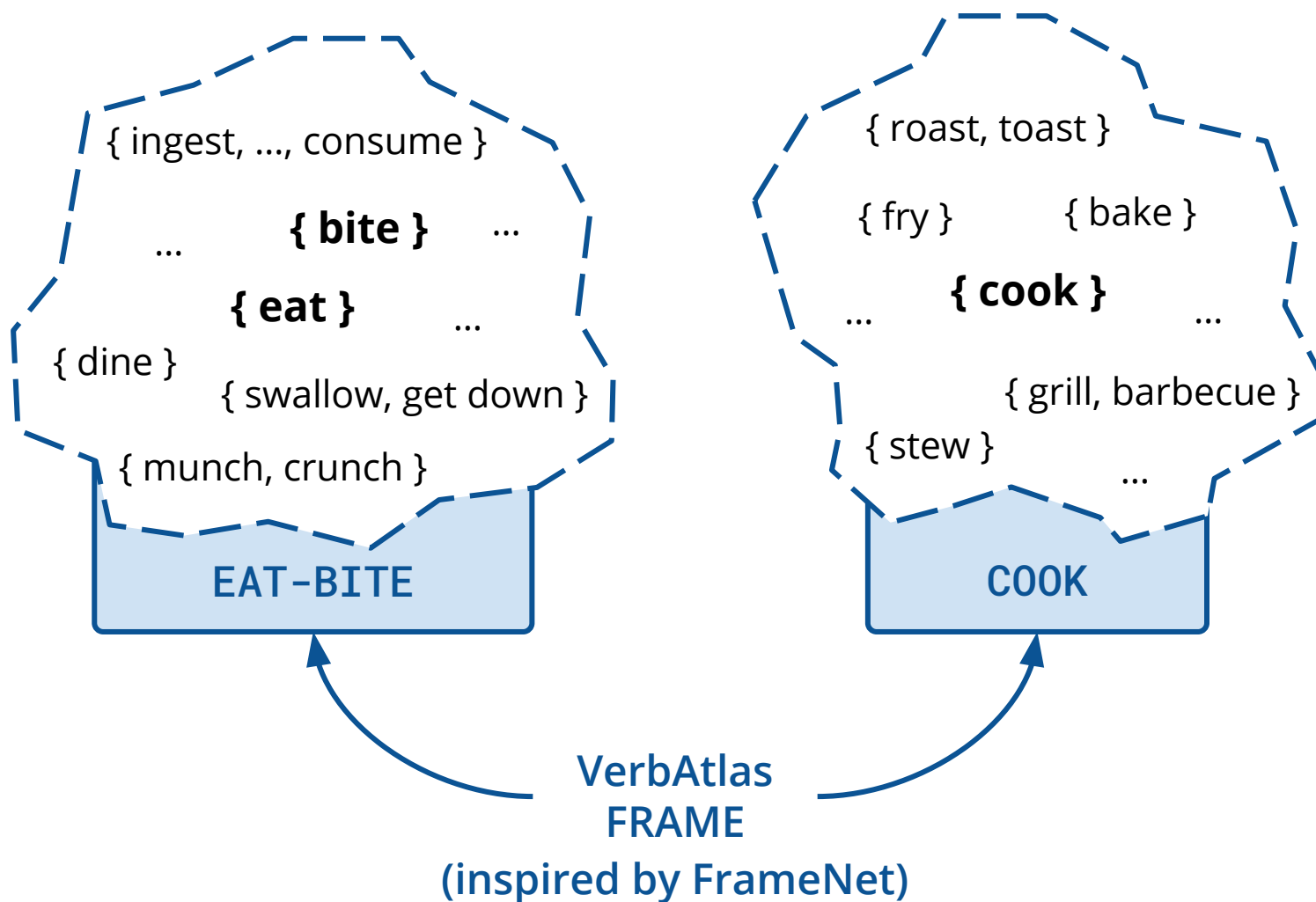


VerbAtlas
FRAME
(inspired by FrameNet)



Frames in VerbAtlas

All WordNet verbal synsets organized into semantic frames



Semantic Roles: from VerbNet to VerbAtlas

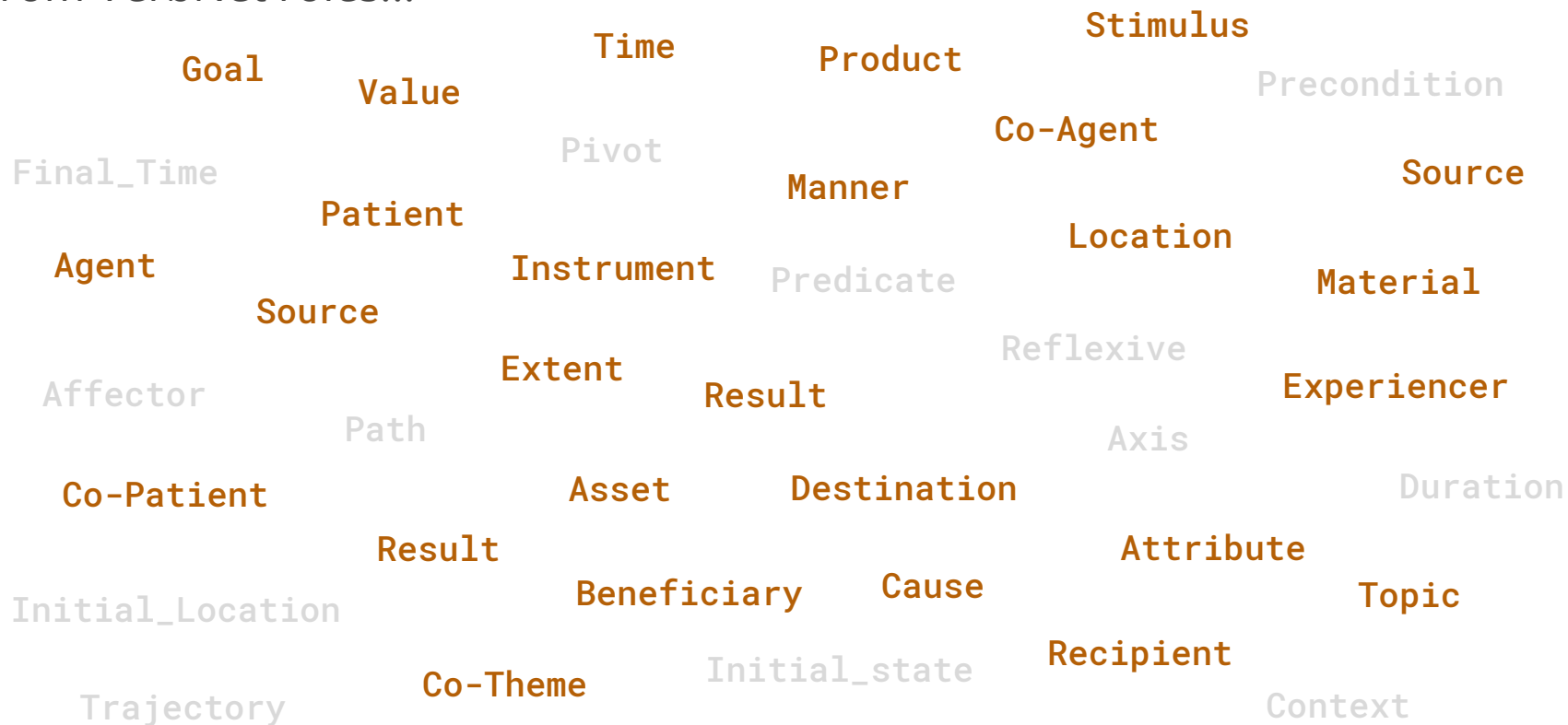
From VerbNet roles...

Goal Value Time Product Stimulus
Final_Time Patient Pivot Manner Co-Agent Precondition
Agent Source Instrument Predicate Location Source
Affector Extent Result Reflexive Material
Path Asset Destination Experienter
Co-Patient Result Beneficiary Cause Attribute Duration
Initial_Location Co-Theme Initial_state Recipient Topic
Trajectory Context



Semantic Roles: from VerbNet to VerbAtlas

From VerbNet roles...



Prototypical Argument Structures in VerbAtlas

Frame-level organization for Semantic Roles

VerbAtlas Semantic Role Set - inspired by VerbNet

Agent	Patient	Instrument	Result	Location	...	Source
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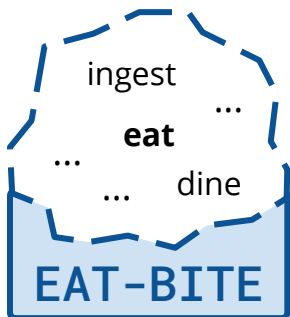


Prototypical Argument Structures in VerbAtlas

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PROTOTYPICAL ARGUMENT STRUCTURE of EAT-BITE

Agent	Patient	Instrument	Result	Location	...	Source
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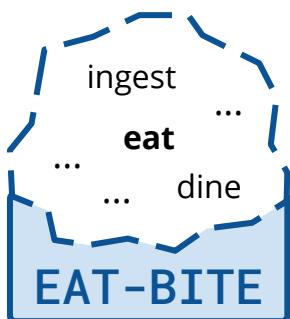


Prototypical Argument Structures in VerbAtlas

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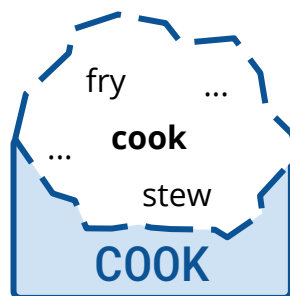
VerbAtlas Semantic Role Set - inspired by VerbNet

Agent	Patient	Instrument	Result	Location	...	Source
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PROTOTYPICAL ARGUMENT STRUCTURE of **EAT-BITE**

Agent	Patient	Instrument	Result	Location	...	Source
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PROTOTYPICAL ARGUMENT STRUCTURE of **COOK**

Agent	Patient	Instrument	Result	Location	...	Source
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VerbAtlas

Comparative examples



FrameNet vs VerbAtlas

The cat swiftly ate the fish

FrameNet

Ingestor

INGESTION

Ingestible

FrameNet

Cook

APPLY_HEAT

Food

The

cook

baked

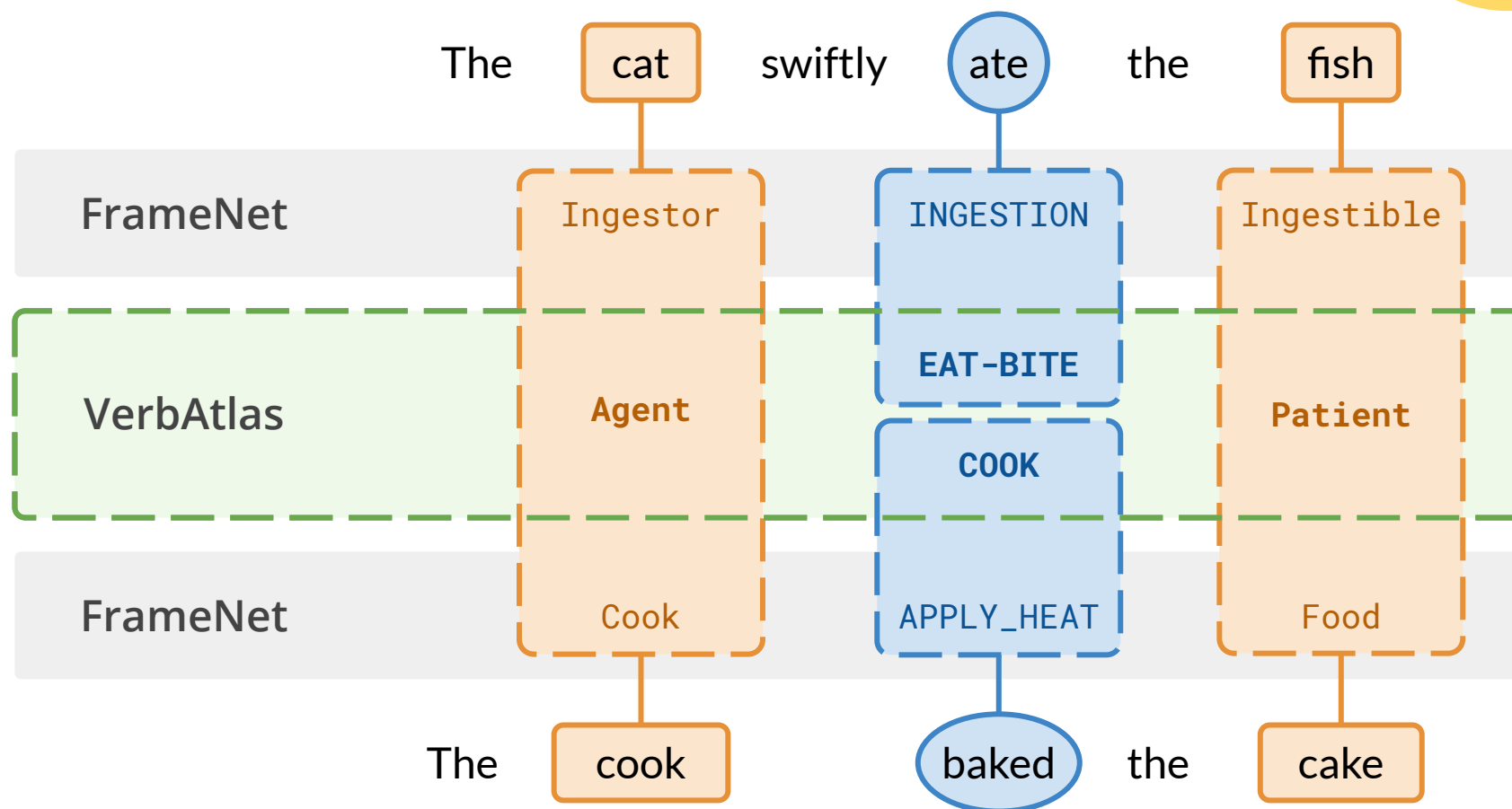
the

cake



FrameNet vs VerbAtlas

CROSS-DOMAIN ROLES



VerbNet vs VerbAtlas

The Spaniards conquered the Incas

VerbNet

Agent

Subjugate-42.3

Patient

VerbNet

Agent

Subjugate-42.3

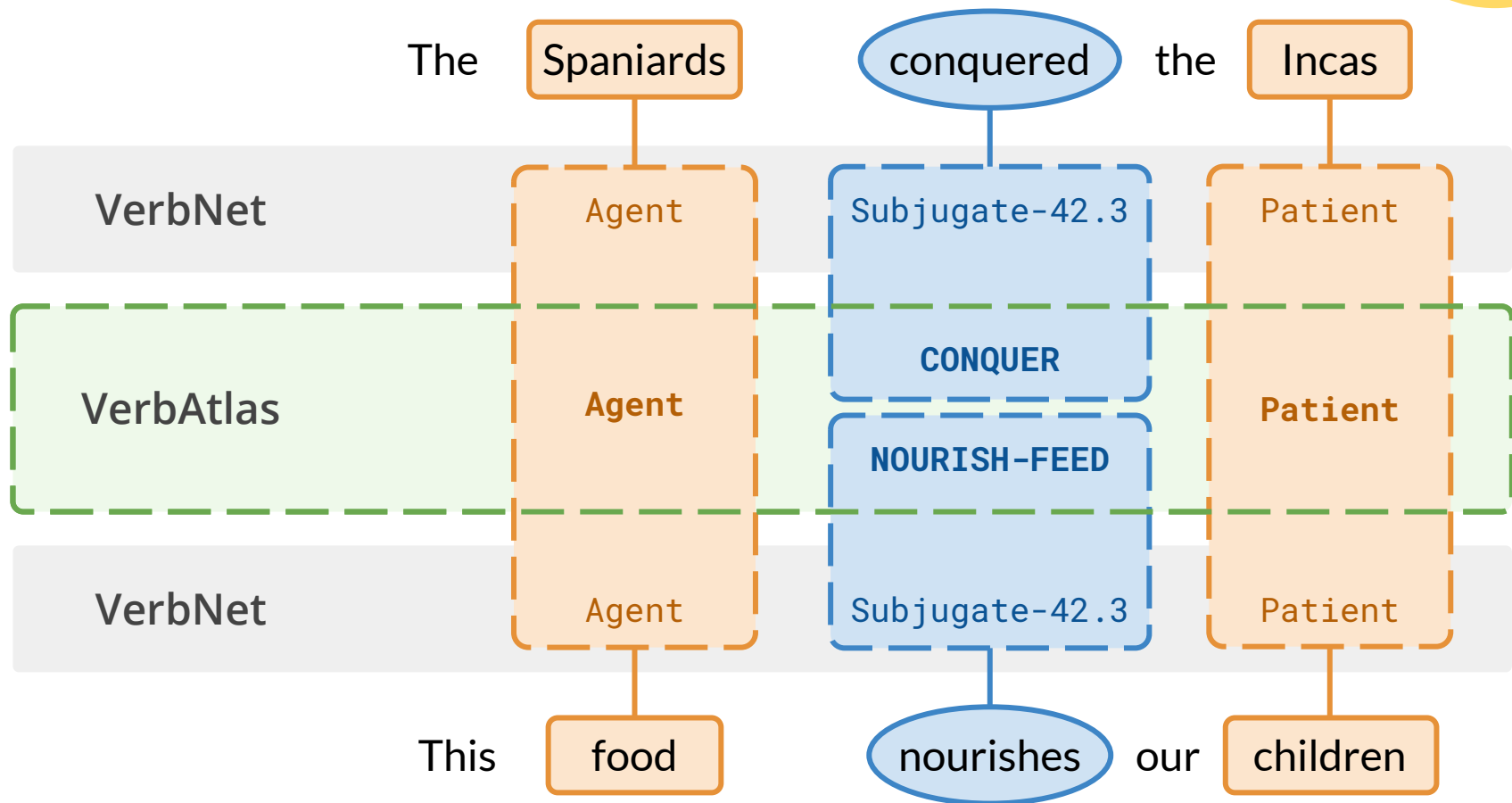
Patient

This food nourishes our children



VerbNet vs VerbAtlas

Semantically-
CONSISTENT
FRAMES



PropBank vs VerbAtlas

The cat swiftly ate the fish

PropBank

ARG0

eat.01

ARG1

PropBank

ARG0

smell.01

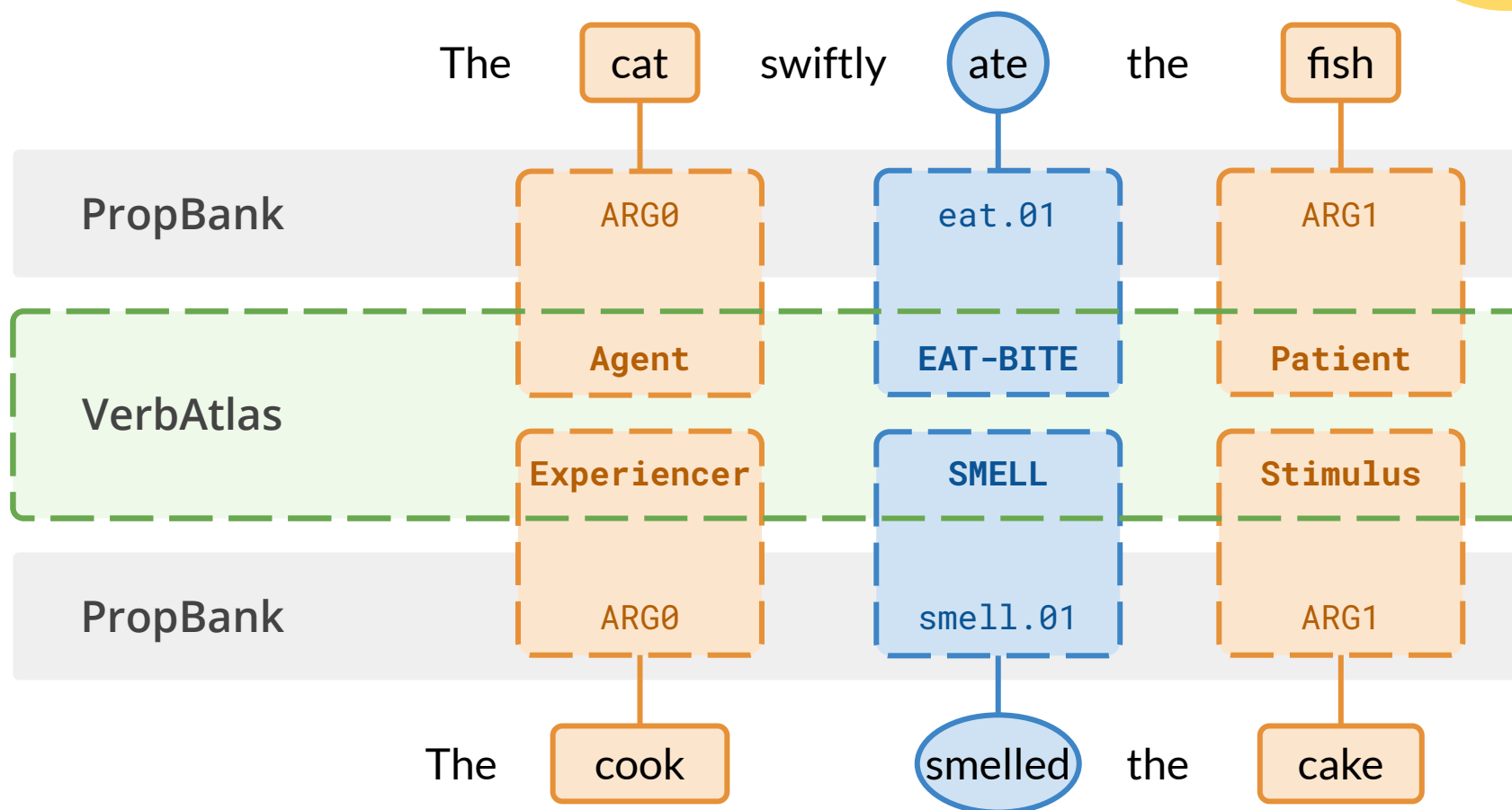
ARG1

The cook smelled the cake



PropBank vs VerbAtlas

INFORMATIVE
ROLE LABELS



VerbAtlas

Statistics & Scalability



Some Statistics

Direct comparison: FrameNet vs VerbNet vs PropBank

	Meaning units	#
FrameNet	Lexical units	5,200
VerbNet	Senses	6,791
PropBank	Framesets	10,687

VerbAtlas	Synsets	13,767
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FULL
COVERAGE
of verbal
meanings



Some Statistics

Direct comparison: FrameNet vs VerbNet vs PropBank

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FULL COVERAGE of verbal meanings

COARSE FRAMES reduce data sparsity



Some Statistics

Direct comparison: FrameNet vs VerbNet vs PropBank

	Meaning units	#	Cluster type	#	Argument Roles	#
FrameNet	Lexical units	5,200	Frames	1,224	Frame elements	10,542
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FULL
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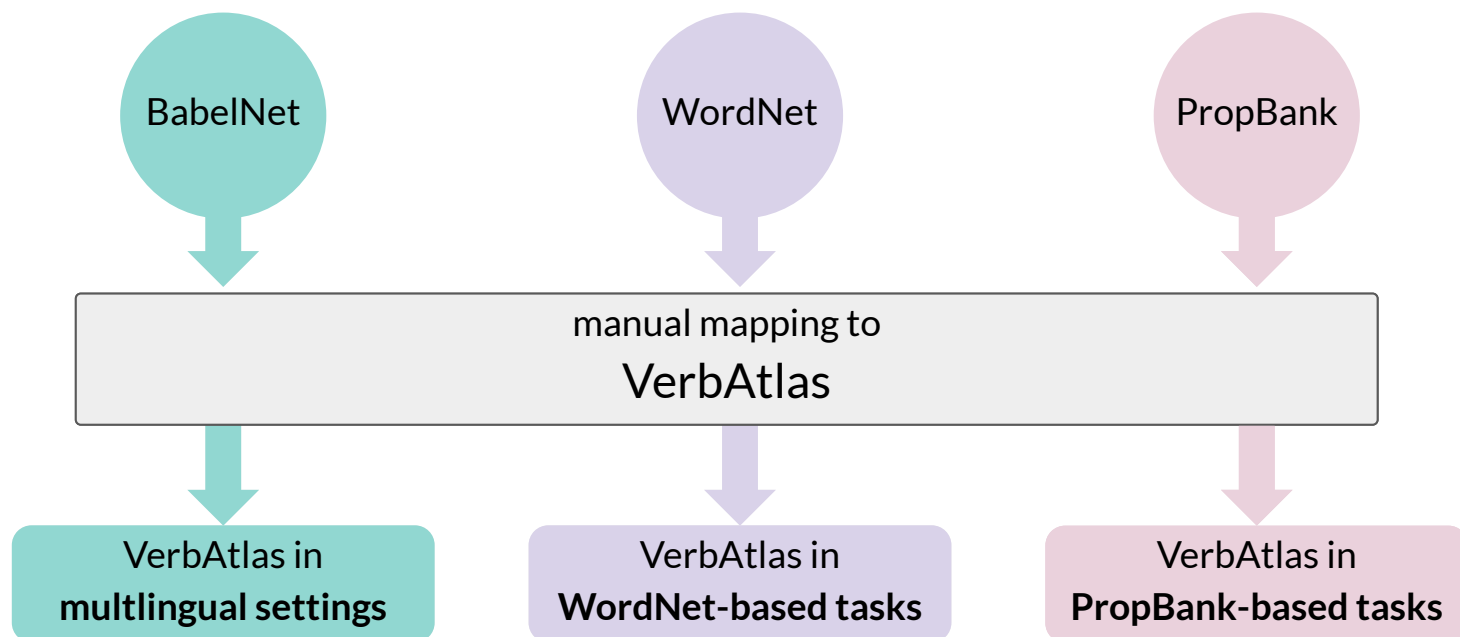
COARSE
FRAMES
reduce data
sparsity

FEW &
EXPLICIT
semantic
roles



Linkage to existing resources

Multiple tasks and multiple languages

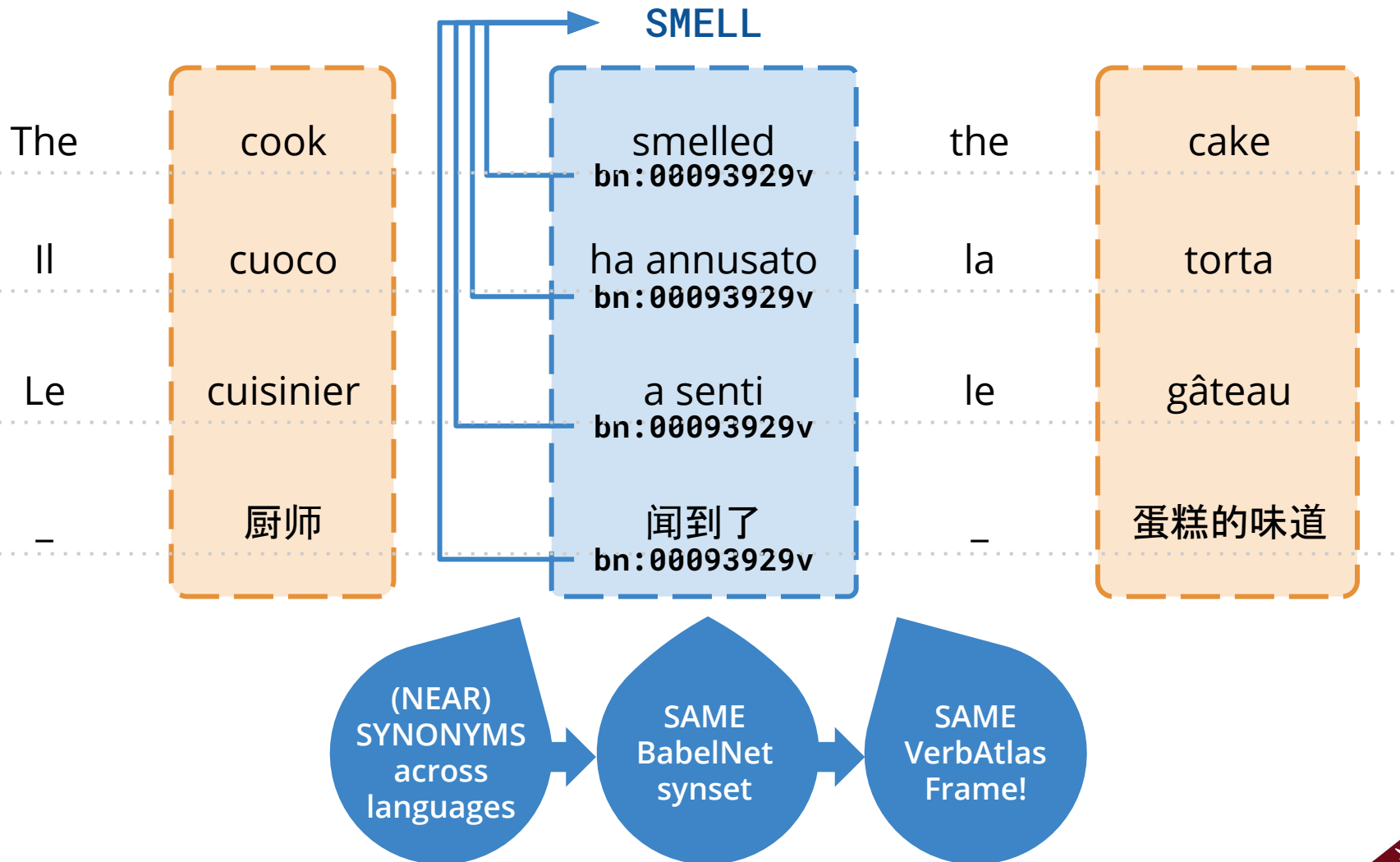


Easy Multilinguality with BabelNet

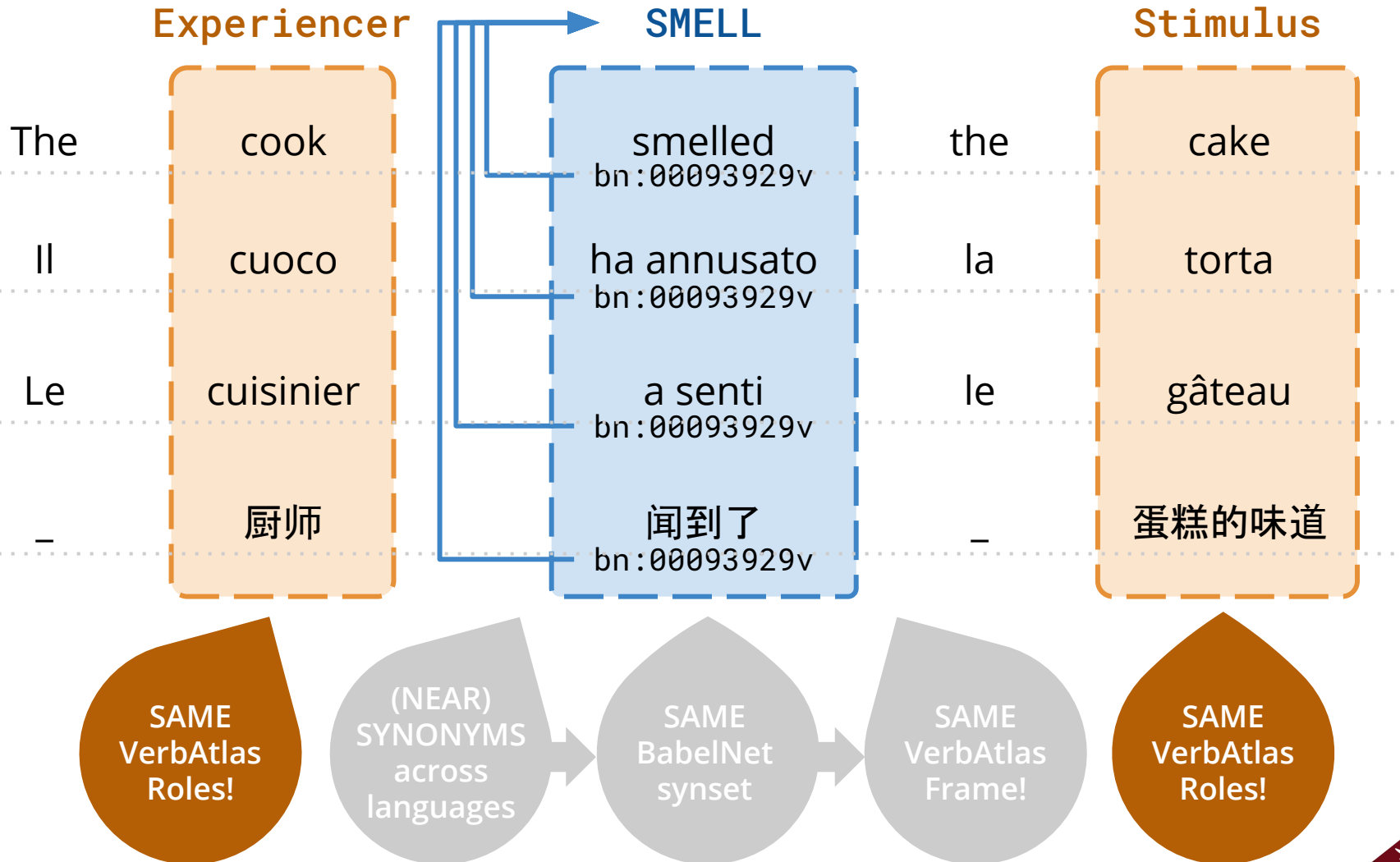
The	cook	smelled	the	cake
Il	cuoco	ha annusato	la	torta
Le	cuisinier	a senti	le	gâteau
—	厨师	闻到了	—	蛋糕的味道



Easy Multilinguality with BabelNet



Easy Multilinguality with BabelNet



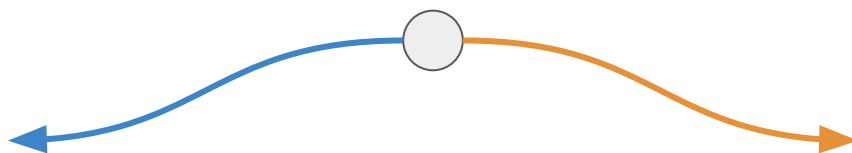
VerbAtlas and SRL

Experimental Validation



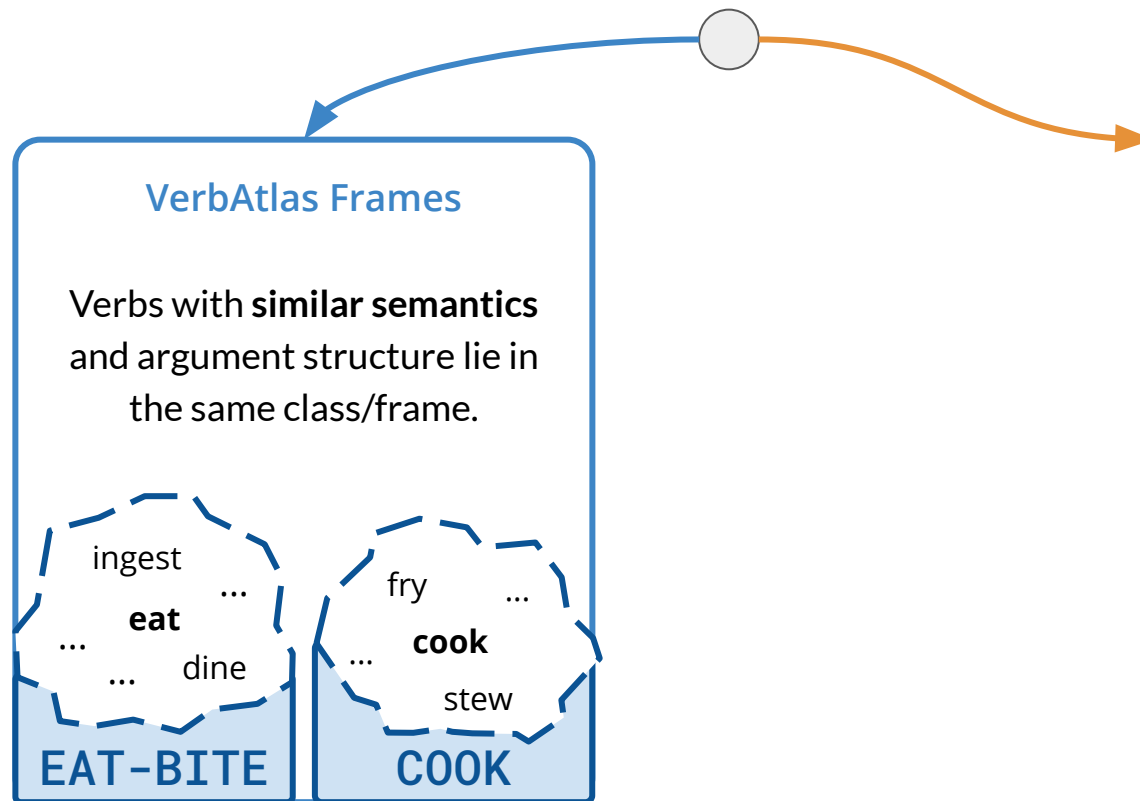
VerbAtlas and SRL

VerbAtlas abstractions for SRL



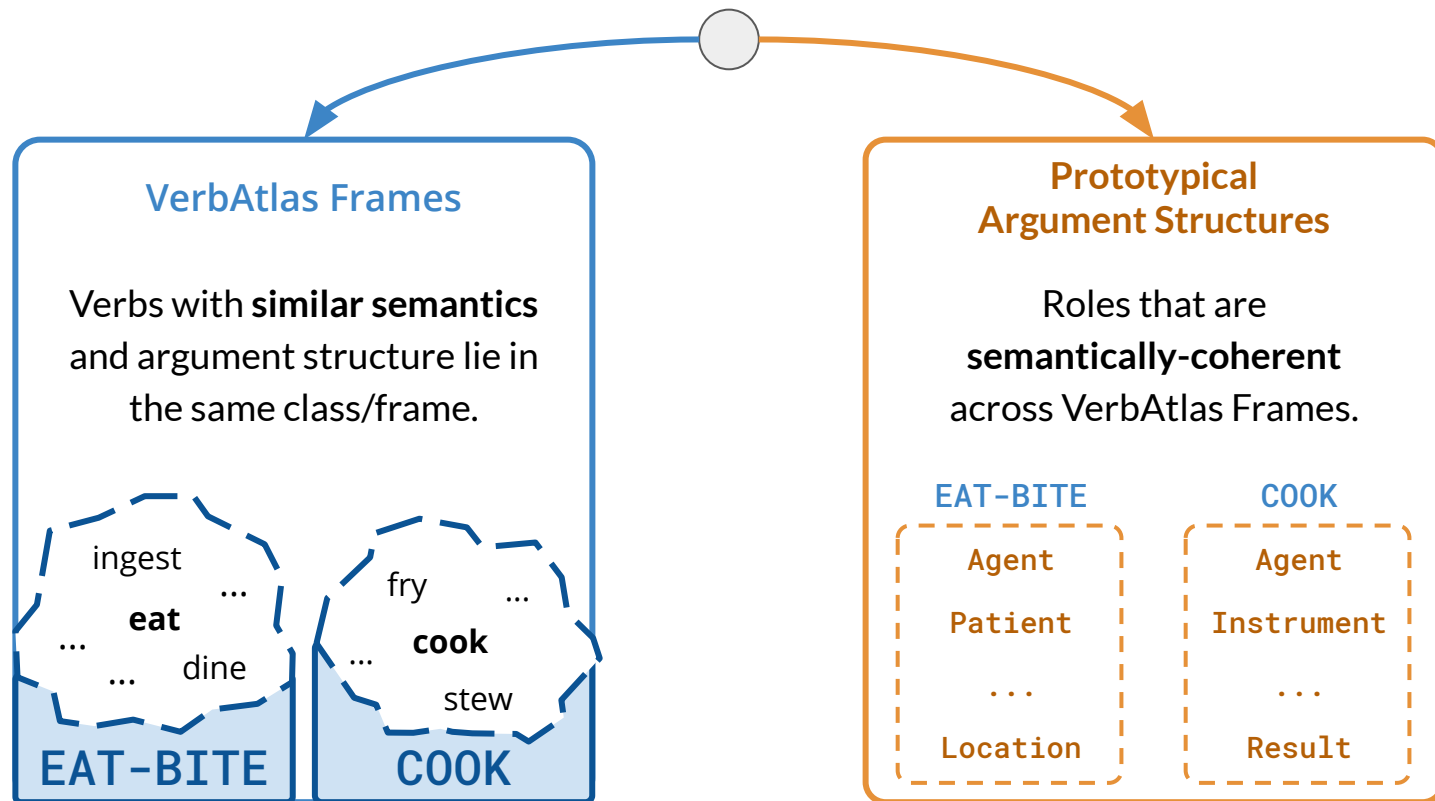
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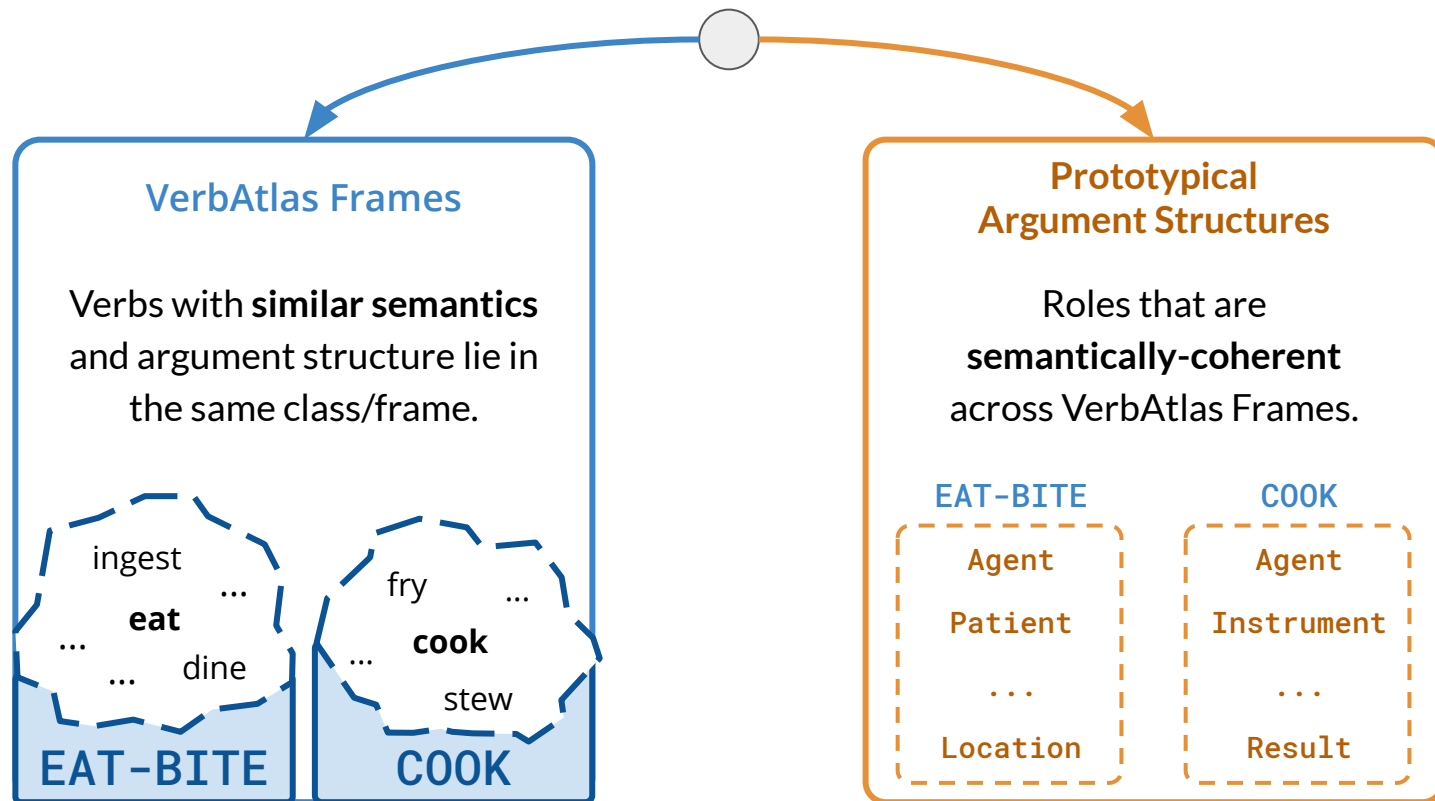
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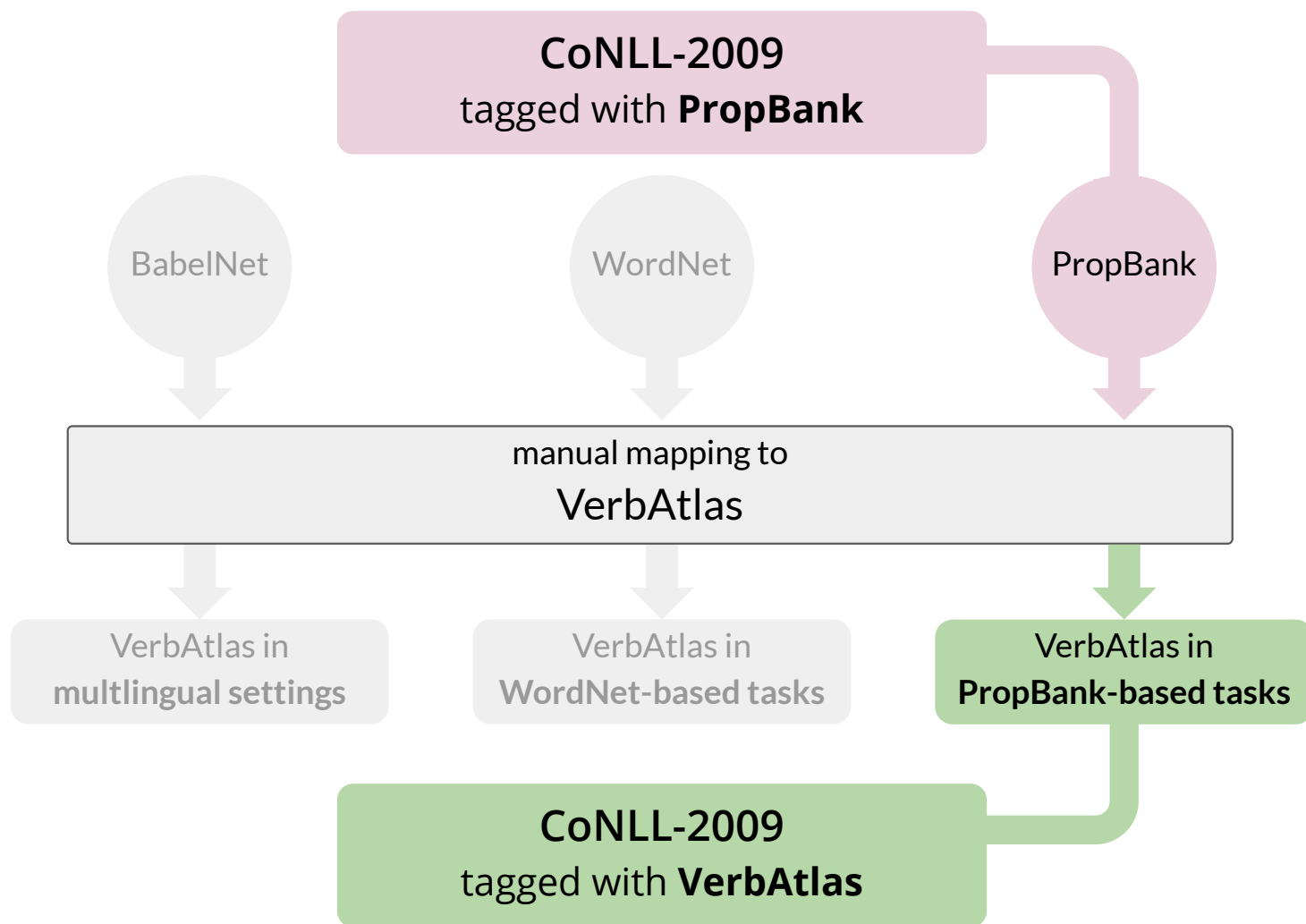


Hypothesis: VerbAtlas Frames and Roles lead to better SRL performance



Dataset: CoNLL-2009

Retagging the dataset with VerbAtlas

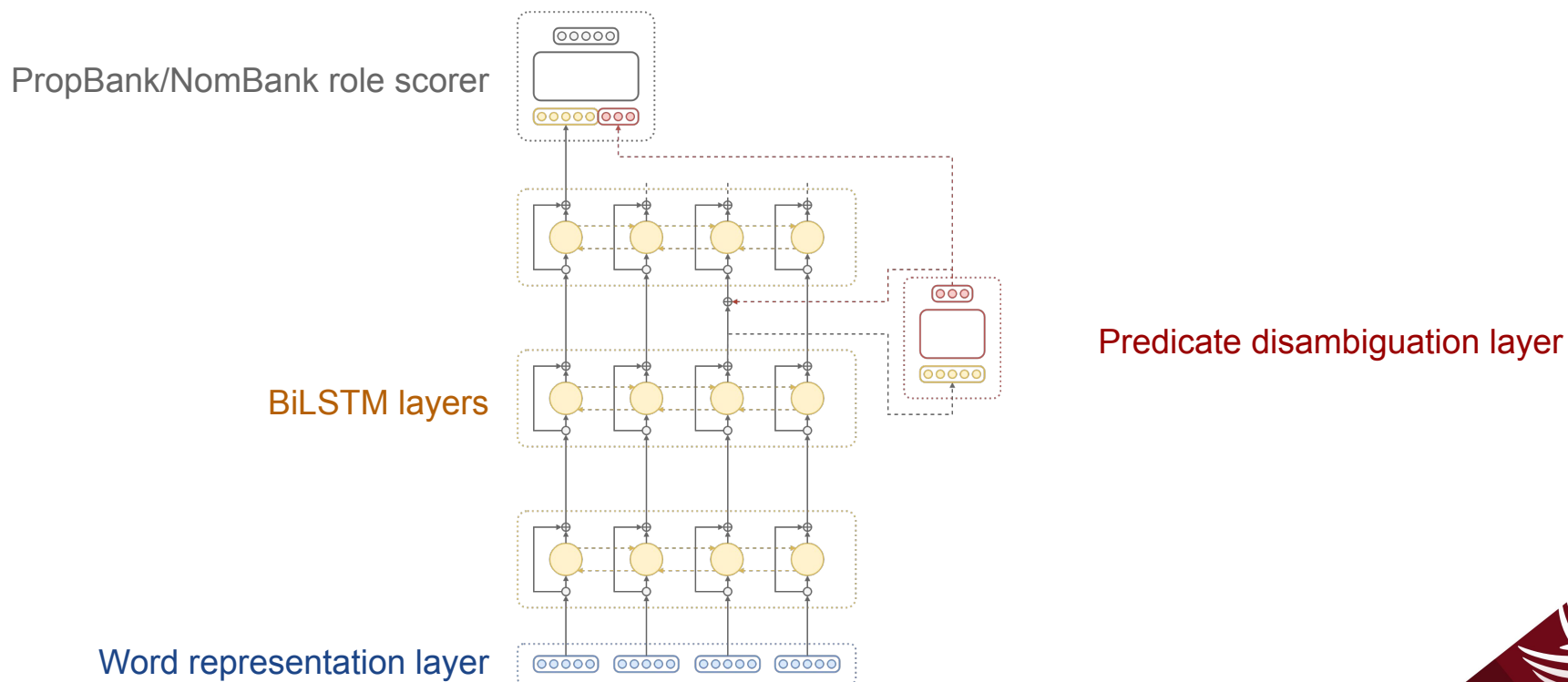


Model architecture

1 An existing SRL system, from Cai et al. (2018)

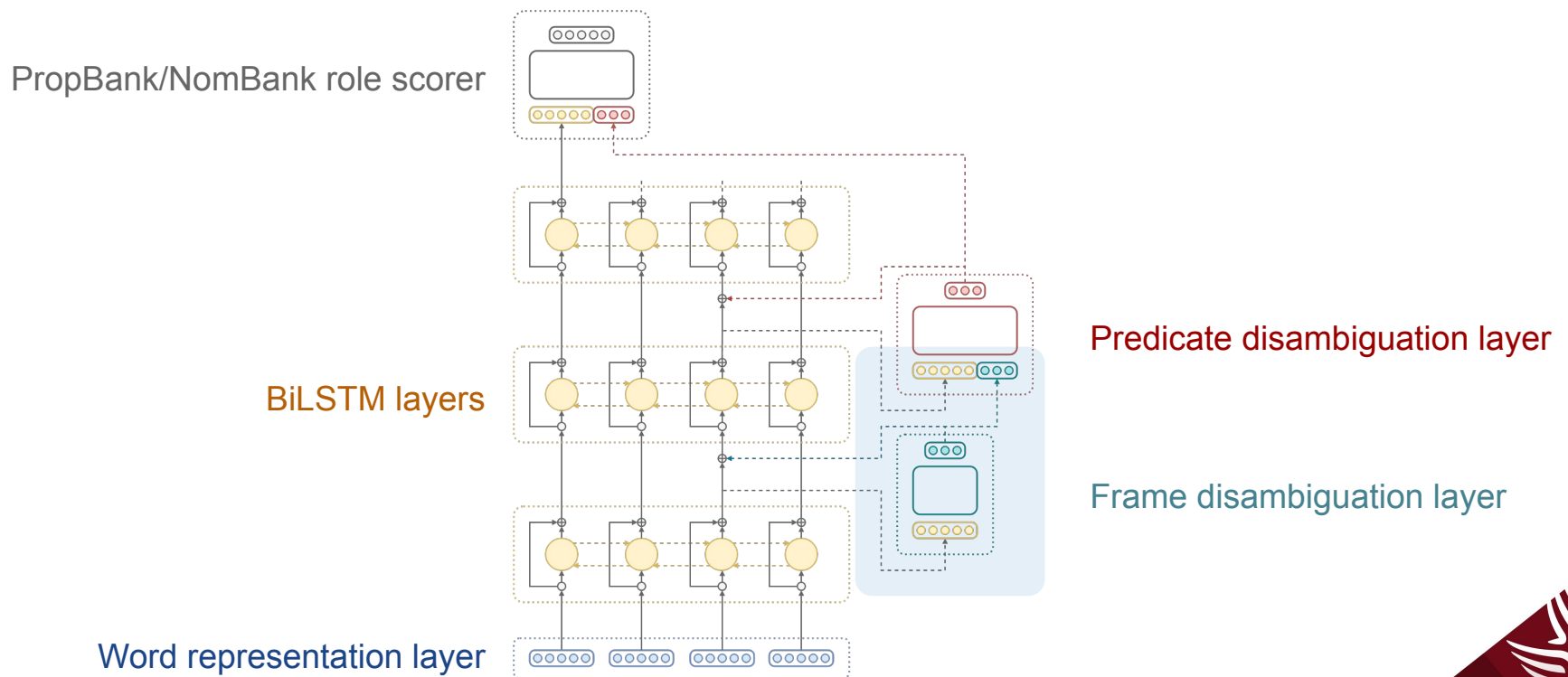
2

3



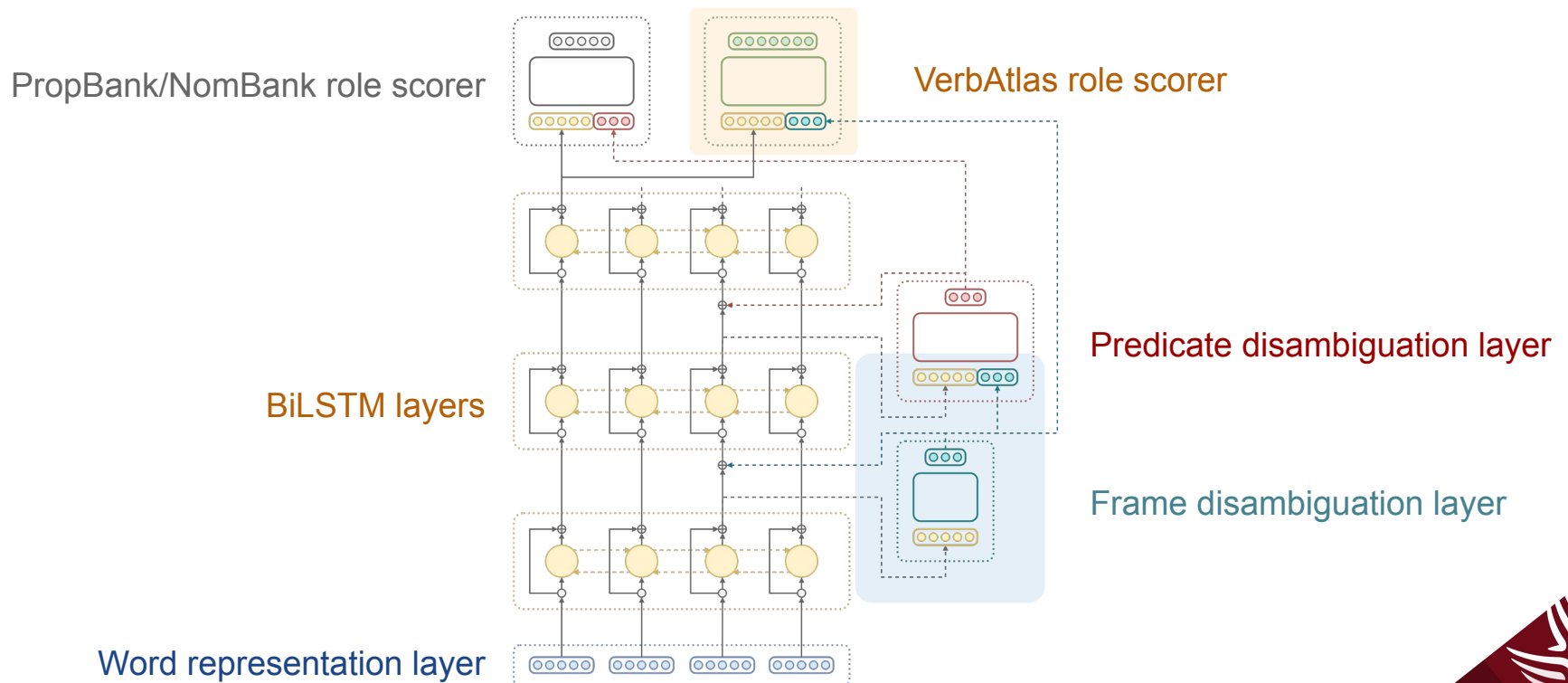
Model architecture

- 1 An existing SRL system, from Cai et al. (2018)
- 2 Aiding predicate disambiguation with frame disambiguation
- 3



Model architecture

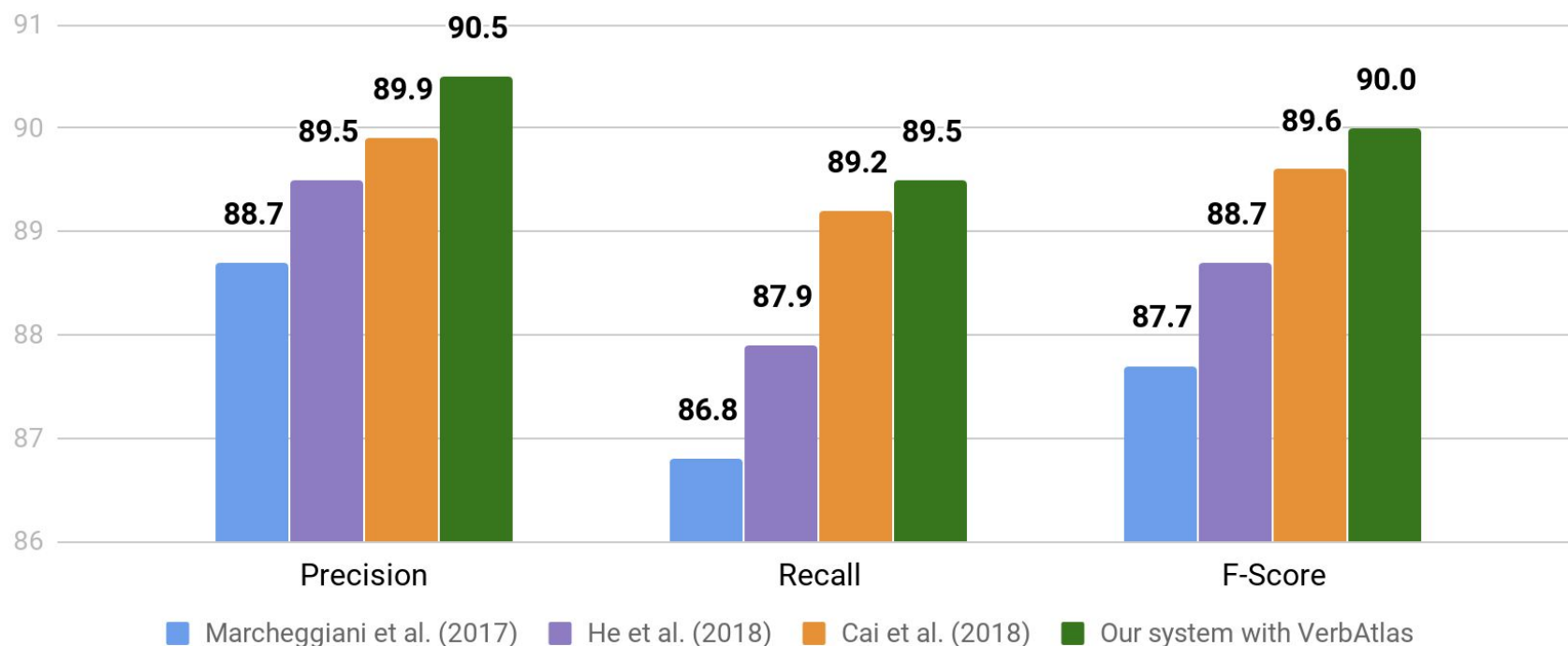
- 1 An existing SRL system, from Cai et al. (2018)
- 2 Aiding predicate disambiguation with frame disambiguation
- 3 Achieving a deeper understanding thanks to finer-grained semantically-coherent roles



Results in CoNLL-2009 (1)

In-domain evaluation

VerbAtlas
+
PropBank
>
PropBank



The integration of VerbAtlas leads to significant improvements in the in-domain test set...

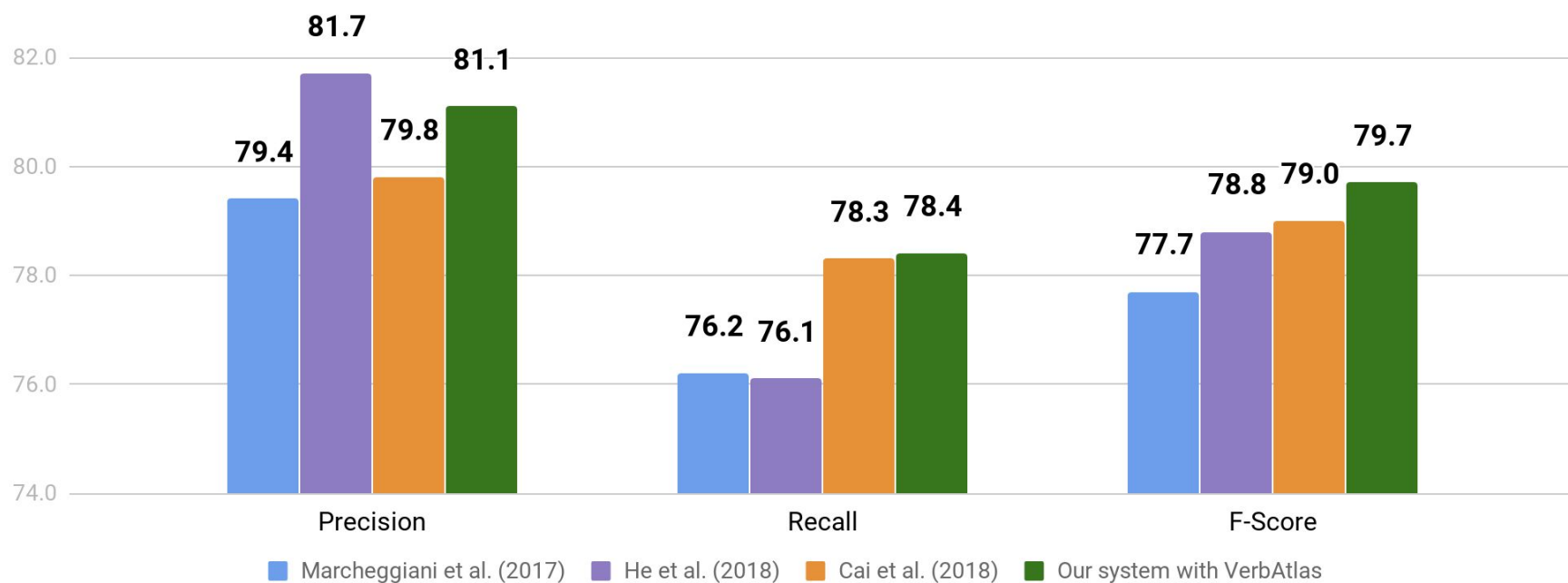
*improvements are statistically significant ($p < 0.05$)



Results in CoNLL-2009 (2)

GENERALIZES
BETTER
ACROSS
DOMAINS

Out-of-domain evaluation



... showing improvements in the out-of-domain test set as well.

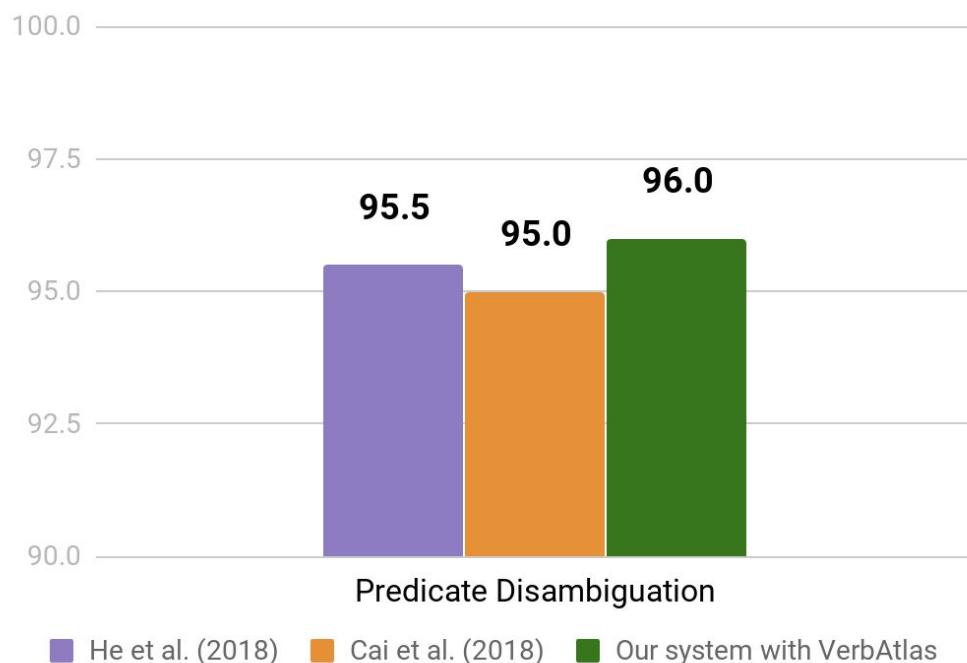
*improvements are statistically significant ($p < 0.05$)



Results in CoNLL-2009 (3)

Predicate sense disambiguation

VERBATLAS
FRAMES HELP
DISAMBIGUA-
TION



Bonus point

Outperforming the (pre-BERT) state-of-the-art in predicate disambiguation.

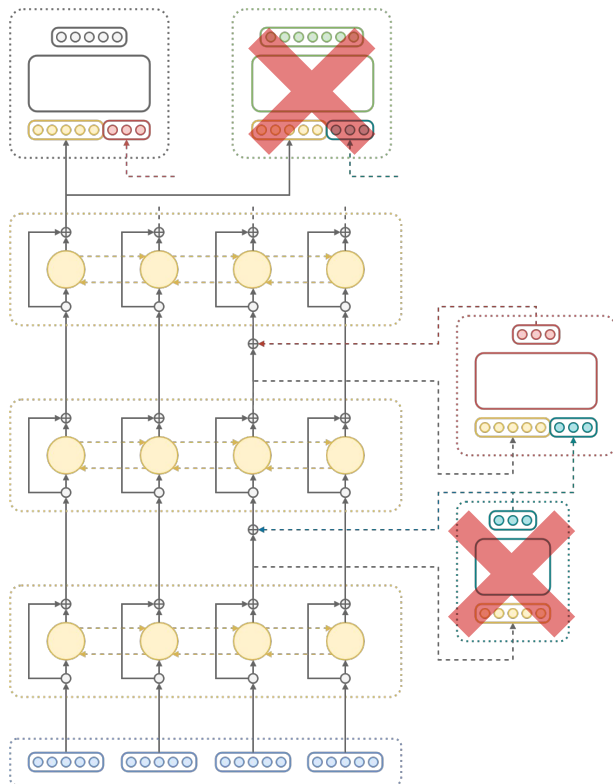
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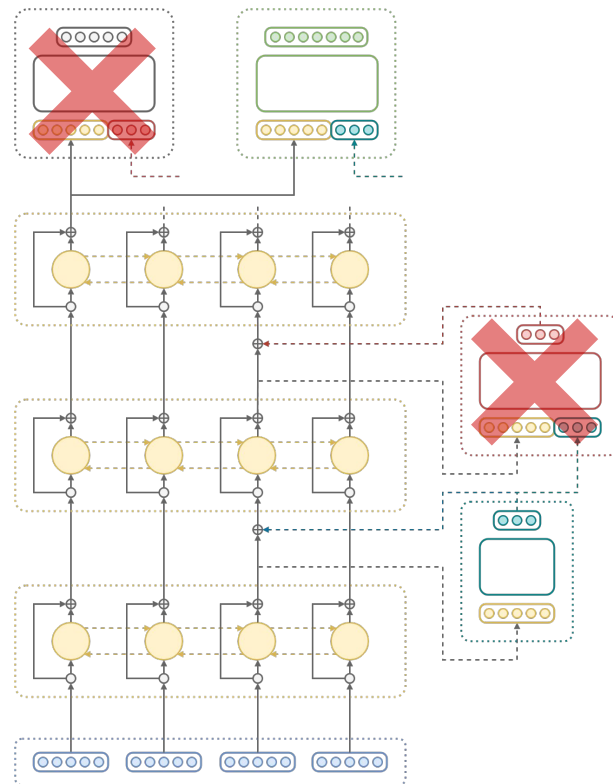
Contribution of VerbAtlas to the Results

An Ablation Study

NO VerbAtlas



VS



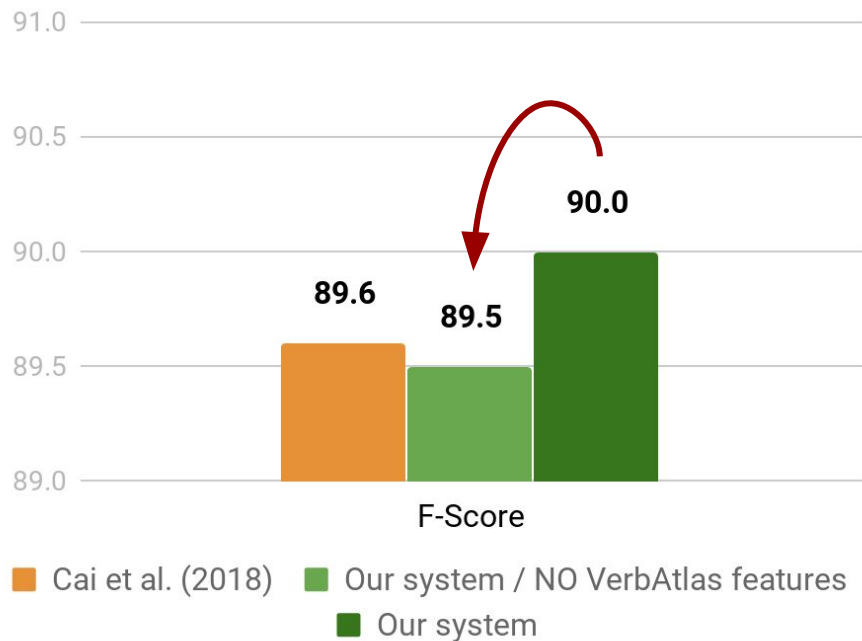
NO PropBank/NomBank



Contribution of VerbAtlas to the Results

An Ablation Study

Verbs+Nouns Evaluation



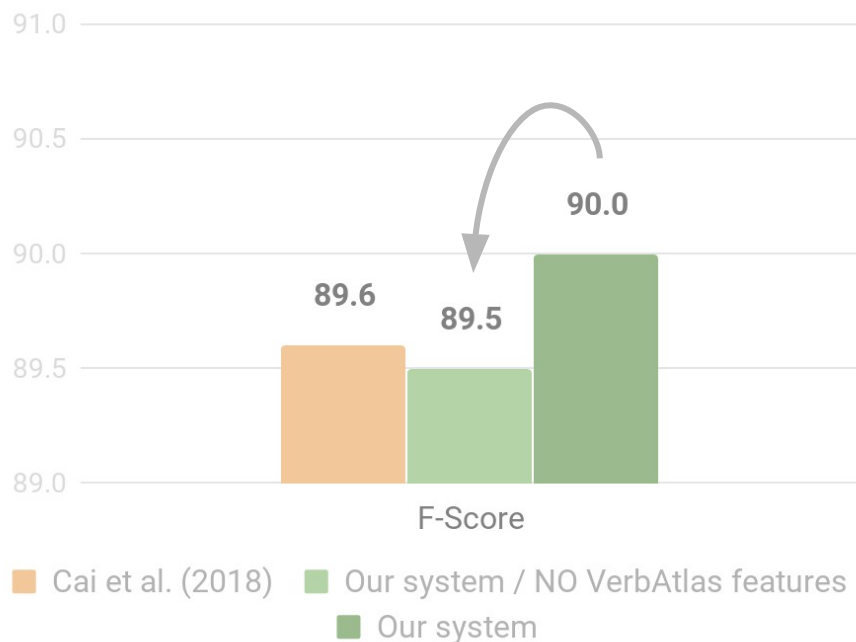
When VerbAtlas is **removed**, our system falls in line with Cai et al. (2018).



Contribution of VerbAtlas to the Results

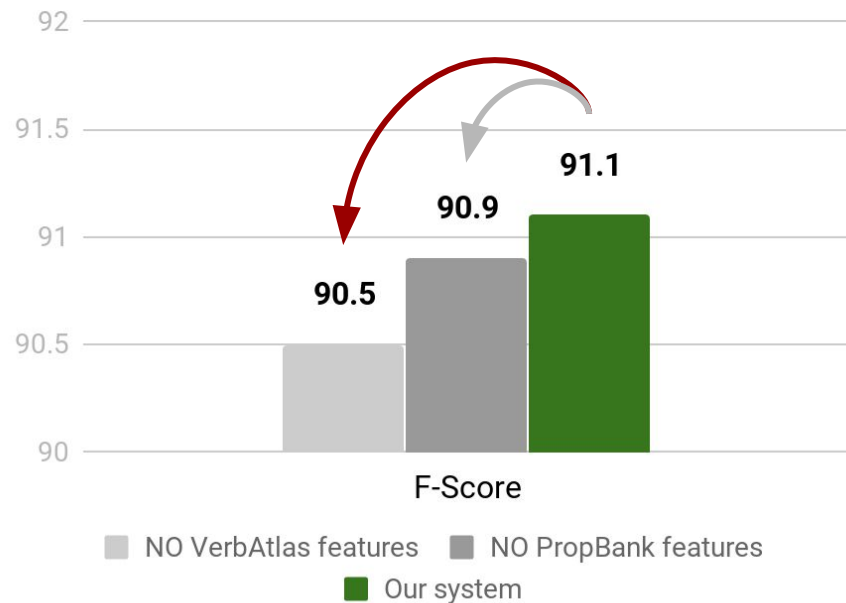
An Ablation Study

Verbs+Nouns Evaluation



When VerbAtlas is **removed**, our system falls in line with Cai et al. (2018).

Verbs-only Evaluation



Removing VerbAtlas causes a larger drop in performance.



Conclusions...

VerbAtlas: a novel large-scale verbal semantic resource, featuring:

FRAMES

to organize verbs
into semantic
clusters

ROLES

that generalize
across verbs and
frames

LINKING

to WordNet,
BabelNet and
PropBank

MORE!

e.g. additional
synset-level
information, ...



Conclusions...

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LINKING
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MORE!
e.g. additional
synset-level
information, ...

...and Future Work

**GOING
MULTILINGUAL**
with BabelNet

**LANGUAGE
MODELS**
+ VerbAtlas

SYNTAGNET
+ VerbAtlas

Tomorrow (15:00-16:18)
Poster session!



VerbAtlas is online! Check it out at:
<http://verbatlas.org>

VerbAtlas

ABOUT

SEARCH

eat bite

forage

Wander and feed

go down

Be ingested

pop

Take drugs, especially orally

gum • mumble

Grind with the gums; chew without teeth and with great difficulty

victual

eat bite

LOCATION



location

PATIENT



food

AGENT



individual



fauna

Thank you!

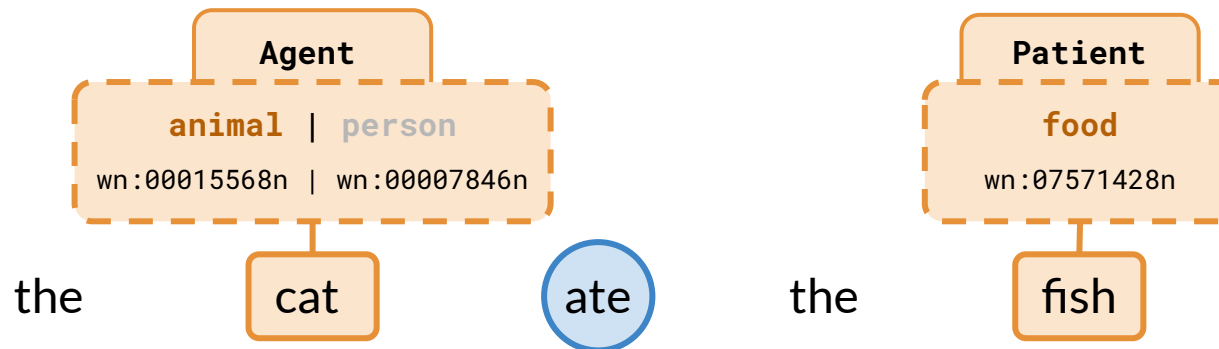
VerbAtlas: Additional Features

Not only frames and semantic roles!

Synset-level Information

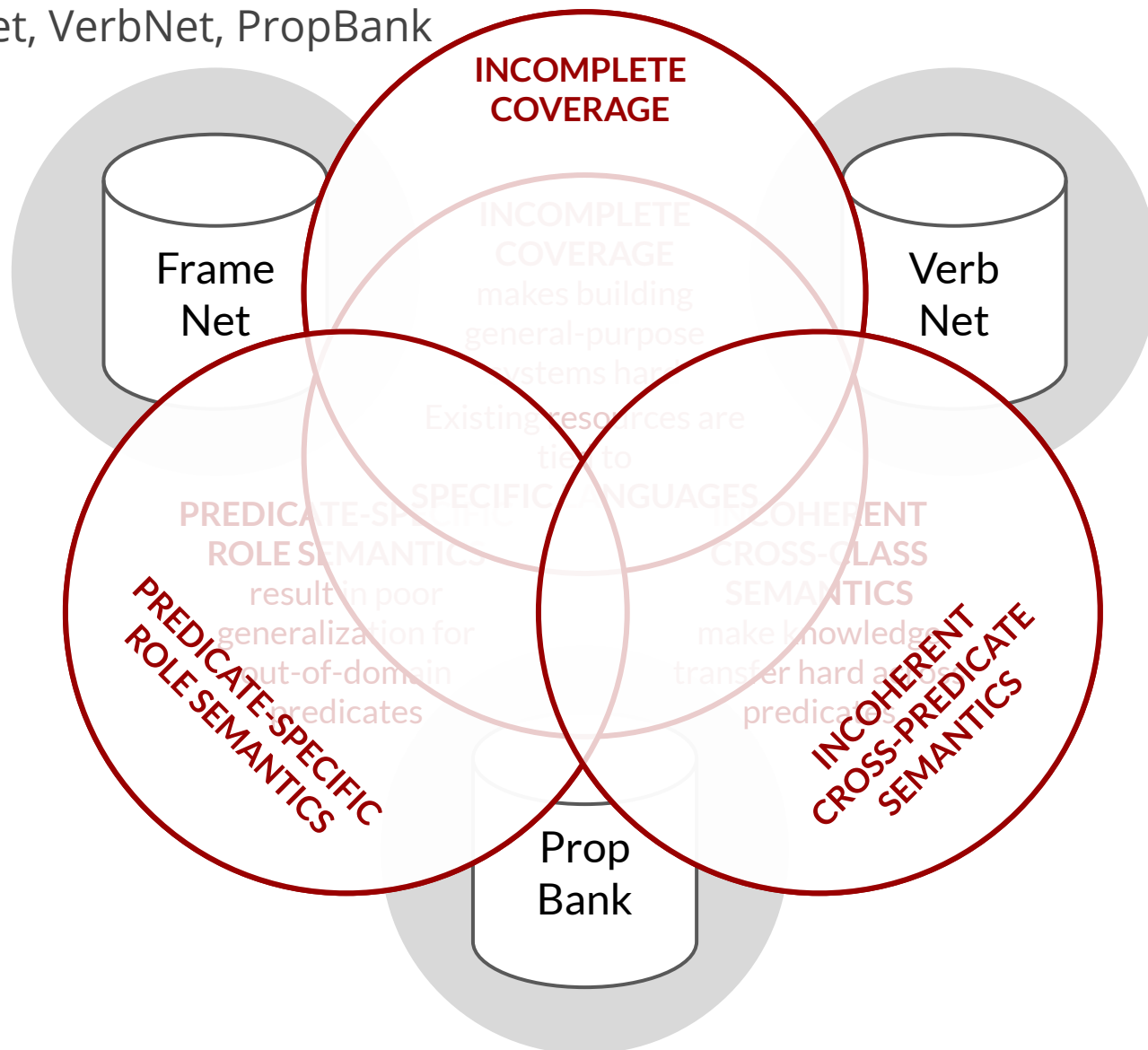


Selectional Preferences



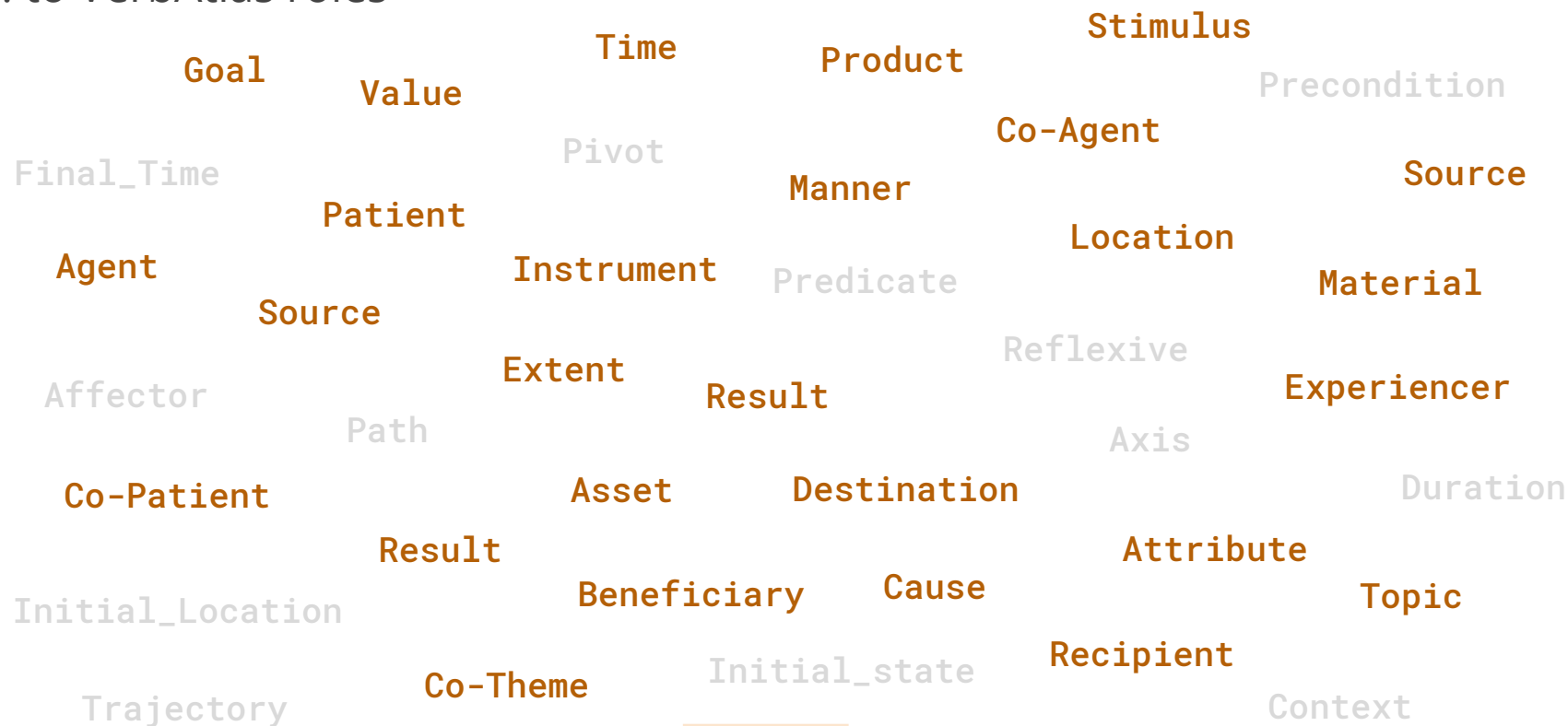
SRL: Limitations of Current Resources

FrameNet, VerbNet, PropBank



Semantic Roles: from VerbNet to VerbAtlas

... to VerbAtlas roles



VerbAtlas Semantic Role Set

Agent Patient Instrument Result Location ... Source



Some Statistics

Direct comparison: FrameNet vs VerbNet vs PropBank

	Cluster type	#
FrameNet	Frames	1,224
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PropBank	Verbs	5,649

VerbAtlas	Frames	466
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COARSE
FRAMES
as semantic
clusters



Some Statistics

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Few
HUMAN-
READABLE
semantic roles



Some Statistics

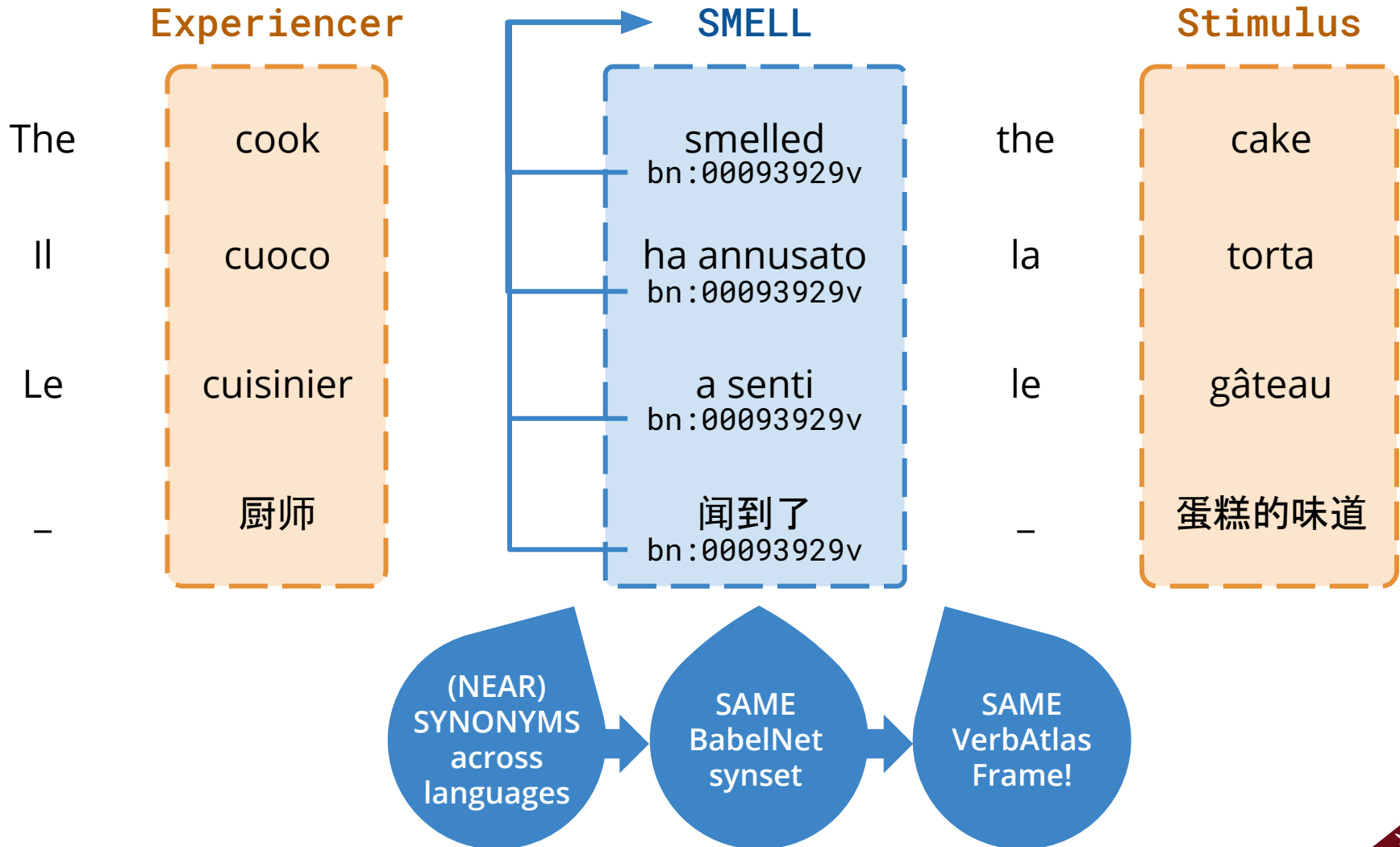
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**FULL
COVERAGE** of
verbal meanings
+ linkage to
WordNet



Easy Multilinguality with BabelNet



Easy Multilinguality with BabelNet

