The Parallel Meaning Bank

A corpus of translations annotated with formal meaning representations

Lasha Abzianidze

Research seminar@CLASP

10.02.2020

joint work with
Johan Bos
Kilian Evang
Hessel Haagsma
Rik van Noord

Parallel MEANING BANK

university of groningen

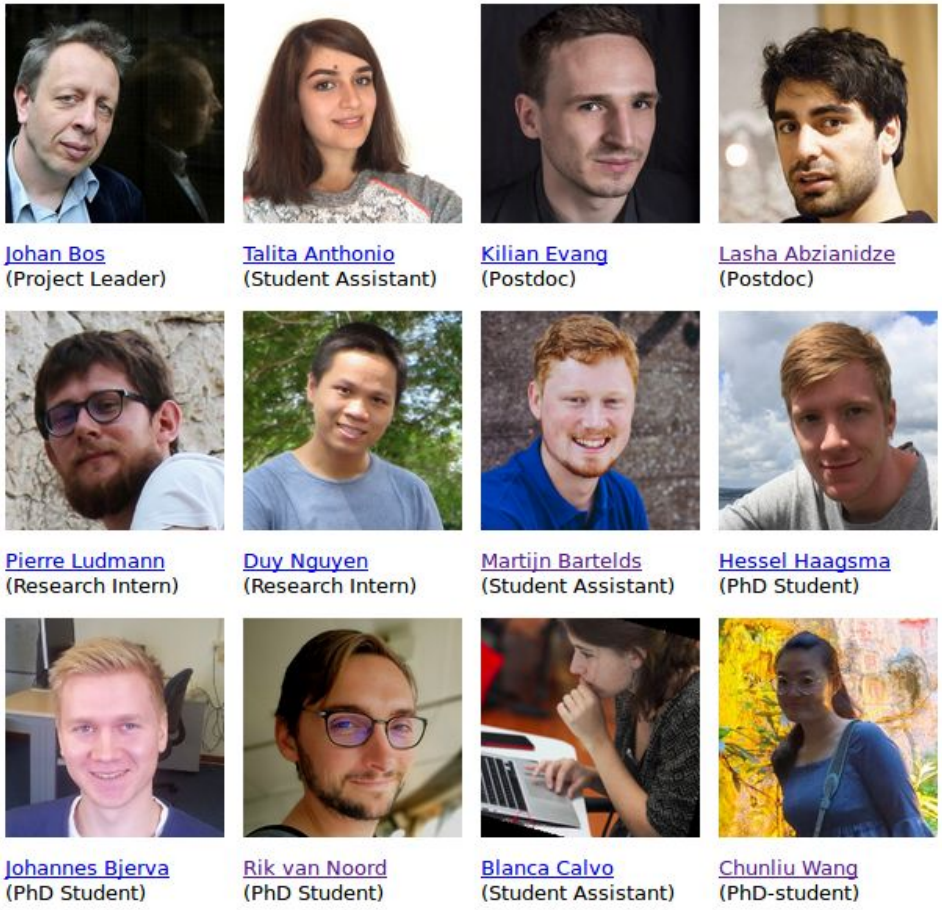
NWO

Lost in Translation - Found in Meaning

NWO
Netherlands Organisation
for Scientific Research

VICI project (2016-2020)

http://pmb.let.rug.nl



Find differences

 Alfred Nobel erfand 1866 das Dynamit.

Alfred Nobel invented dynamite in 1866. 

x1 x2 e1 t1	x1 x2 e1 t1	x1 x2 e1 t1	x1 x2 e1 t1
male.n.02(x1)	male.n.02(x1)	male.n.02(x1)	male.n.02(x1)
Name(x1, alfred~nobel)	Name(x1, alfred~nobel)	Name(x1, alfred~nobel)	Name(x1, alfred~nobel)
invent.v.01(e1)	invent.v.01(e1)	invent.v.01(e1)	invent.v.01(e1)
Time(e1, t1)	Time(e1, t1)	Time(e1, t1)	Time(e1, t1)
Result(e1, x2)	Result(e1, x2)	Result(e1, x2)	Result(e1, x2)
Agent(e1, x1)	Agent(e1, x1)	Agent(e1, x1)	Agent(e1, x1)
time.n.08(t1)	time.n.08(t1)	time.n.08(t1)	time.n.08(t1)
YearOfCentury(t1, 1866)	YearOfCentury(t1, 1866)	YearOfCentury(t1, 1866)	YearOfCentury(t1, 1866)
t1 $\prec$ now	t1 $\prec$ now	t1 $\prec$ now	t1 $\prec$ now
dynamite.n.01(x2)	dynamite.n.01(x2)	dynamite.n.01(x2)	dynamite.n.01(x2)

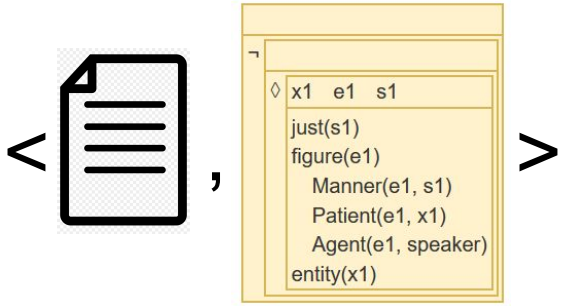
 Alfred Nobel vond in 1866 het dynamiet uit.

Alfred Nobel inventò la dinamite nel 1866. 

PMB, in general

Goals, main ideas & resources

Goals

Collect a large dataset of 

Design formal meaning representations (MR)

- wide-coverage text
- X-lingual text

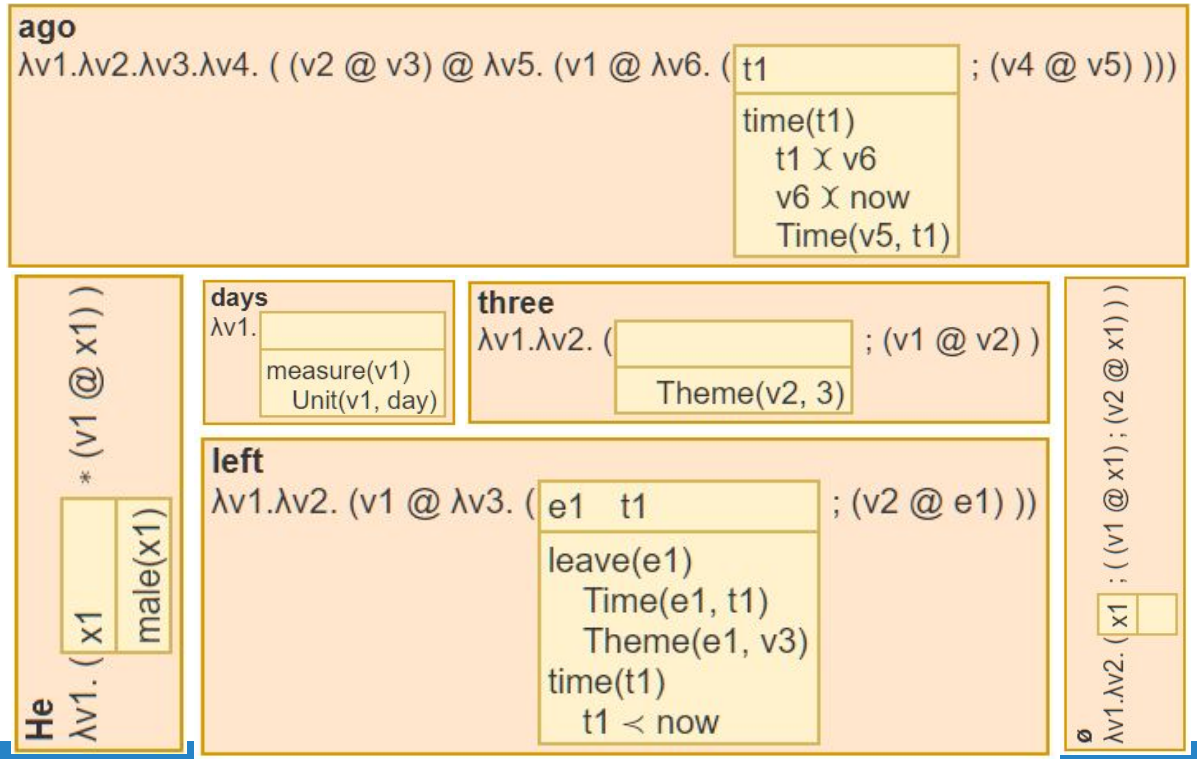
Learn (end-to-end) X-lingual semantic parsing

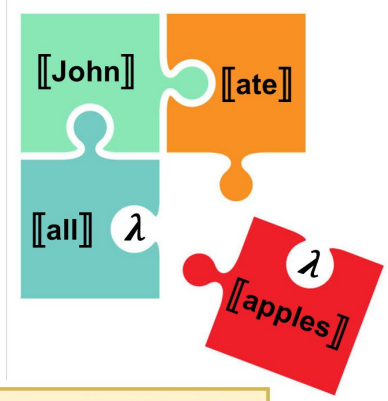
Study literal/non-literal translations from a MR perspective

Abzianidze, Bjerva, Evang, Haagsma, van Noord, Ludmann, Nguyen, Bos (2017): **The Parallel Meaning Bank: Towards a Multilingual Corpus of Translations Annotated with Compositional Meaning Representations.** EACL.

Compositional semantics

He left three days ago .





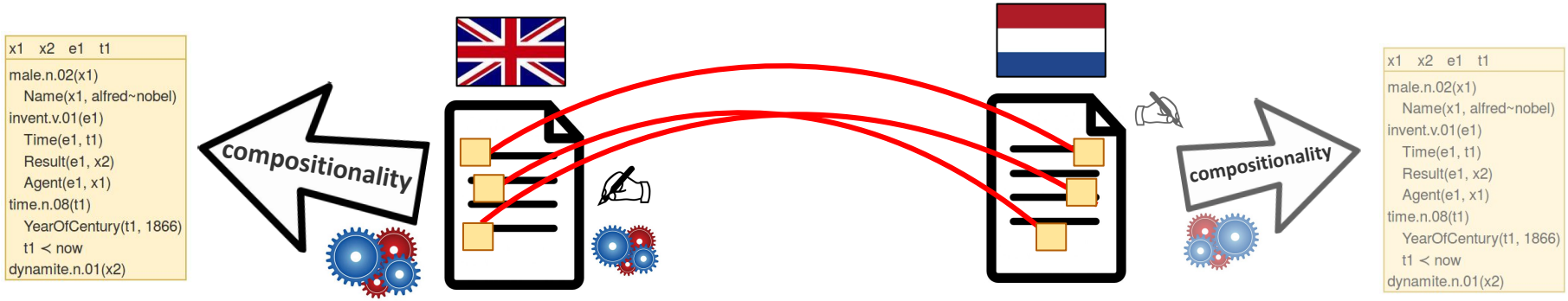
x1 e1 t1 t2

male.n.02(x1)
leave.v.01(e1)
Time(e1, t1)
Theme(e1, x1)
time.n.08(t1)
t1 ⊀ t2
t1 ≺ now
measure.n.02(t2)
t2 ⊀ now
Unit(t2, day)
Theme(t2, 3)

Idea behind the data collection

Alfred Nobel invented dynamite in 1866.

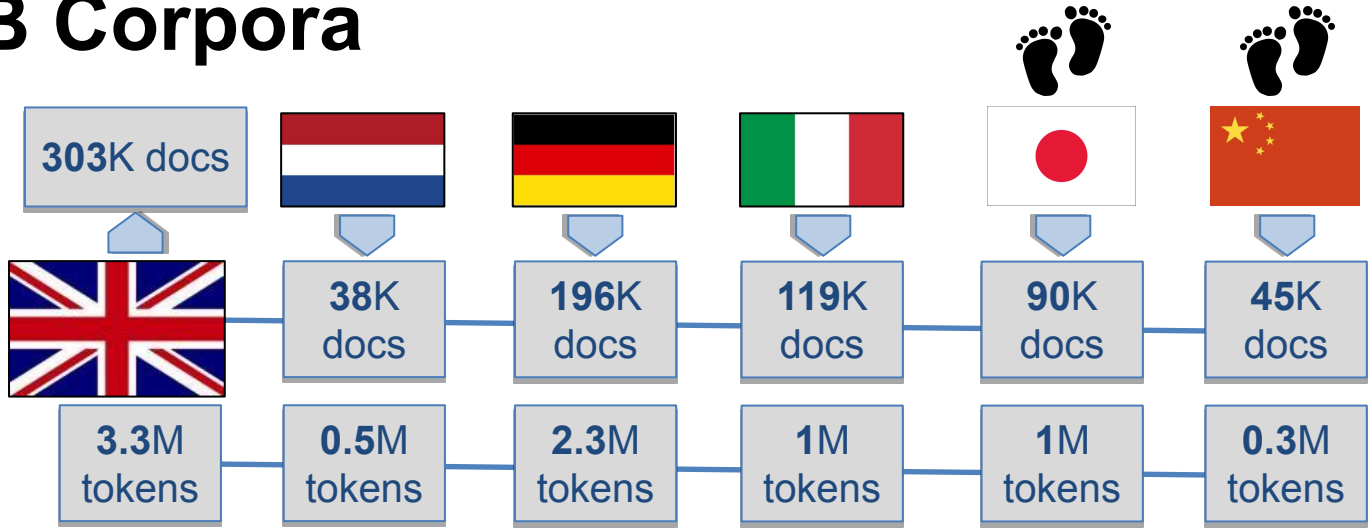
Alfred Nobel vond in 1866 het dynamiet uit.



Compositional Semantics

Projection of lexical semantics

PMB Corpora



qtleap

QA@CLEF-2004

TED

INTERSECT

From the GMB to the PMB

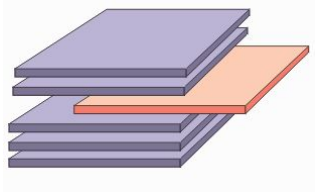
https://i.pinimg.com/originals/64/e1/46/64e146679c26524a2c43a083af2e52a0.jpg

One language	Six languages
No affixes as tokens	Affixes can be a token
Lemmatization & Normalization	Symbolization
POS-tagging	Universal semantic tagging
C&C CCG parser	EasyCCG parser
CCG lexical rules	Empty elements

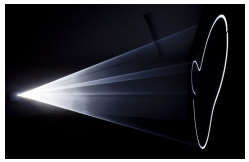
Johan Bos, Valerio Basile, Kilian Evang, Noortje Venhuizen, Johannes Bjerva (2017):
The Groningen Meaning Bank. In: Nancy Ide and James Pustejovsky (eds): Handbook of Linguistic Annotation

PMB annotation layers

What info is needed to get boxes for texts?



Parallel in PMB

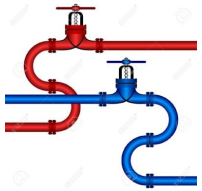


PMB Explorer

How do we annotate texts and get boxes?

PMB pipeline

From a raw text to a formal meaning representation

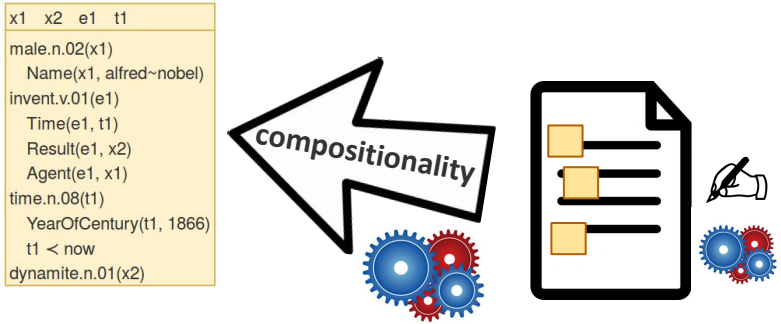


DRS parsing

End-to-end parsing & shared task

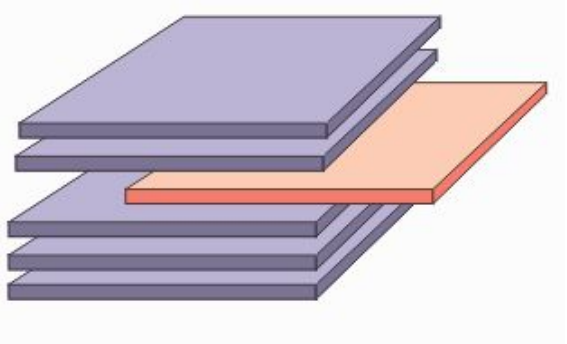
PMB annotation layers

What info is needed to get boxes for texts?



Annotation Layers

https://www.myfirstboss.com/uploads/admin/compas/40013794.jpg



1) Segmentation
2) Symbolization (~~lemmatization~~)
3) Word sense disambiguation (Wordnet 3.0; Miller, 1994)
4) Syntactic parsing (Combinatory Categorial Grammar)
5) Semantic role labeling (Verbnet roles; Bonial et al, 2011)
6) Semantic tagging (~~part-of-speech tagging~~)
7) Coreference resolution
8) Semantic parsing (Discourse representation theory)

Segmentation (sentence & token)

https://time.com/3946461/sliced-bread-history/

Split texts into sentences

```
John said "I won't go. I am lazy".
```

Split sentences into "meaningful atoms/words"

```
San~Diego, Secretary~of~State,
Royal~Bank~of~Scotland, IFK~Göteborg,
Baseball~club, knitting~needles,
ten - year - old, as~soon~as,…
```

Segmentation (STOI labeling)

https://time.com/3946461/sliced-bread-history/

Character-based, i.e. label characters

Each character gets one of the four labels:

- **S** start of a **S**entence
- **T** start of a **T**oken
- **O** **O**utside of a token

Security sources in Yemen say tribesmen have blown up an oil p liation for
Officials say tribesman in eastern Maarib province sabotaged t
Saturday, after government forces raided the homes of tribal i to
be harboring al-Qaida operatives.
On Wednesday, more than 20 people were wounded when security i ith tribesme
Aqili is wanted for the death of a senior army officer, killed in an ambush last Saturday

- ○ S (start of sentence)
- ○ T (start of token)
- ◉ I (in token)
- ○ O (not part of token)

Symbolization

https://commons.wikimedia.org/wiki/File:Sample-national-park-service-pictographs.gif

Mapping tokens to non-logical symbols

- Lemmatization:
  morphological analysis
- Normalization:
  canonical form

token	symbol
third	3
John	john
played	play
2:30~pm	14:30
2,5~million	2500000
km	kilometer

https://linuxgazette.net/issue27/ayers3.html

Word Sense Disambiguation

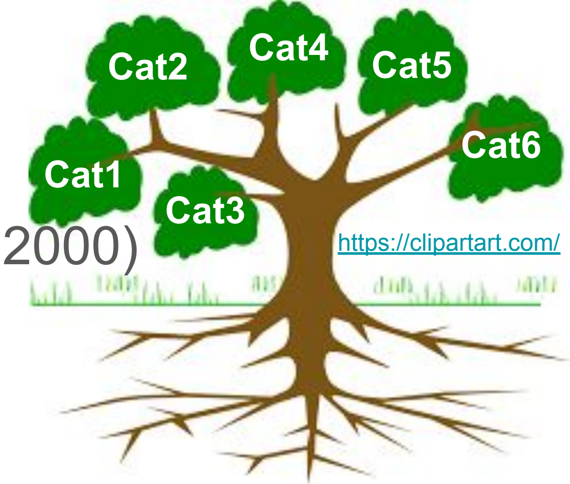
Assign sense numbers to non-logical symbols

- Noun concepts:
  - named entities
  - pronouns (gender)
- Verb concepts
- Adjective concepts
- Adverb concepts

Some token/symbols get no WN sense

token	symbol	sense
third	3	
John	john	male.n.02
played	play	play.v.03
2:30~pm	14:30	
2,5~million	2500000	
km	kilometer	

Syntactic Parsing



Combinatory Categorial Grammar (Steedman, 2000)

- Goes well with compositional semantics
- Lexicalized grammar
- Efficient and wide-coverage CCG parsers

C&C (Clark & Curran, 2007)
EasyCCG (Lewis & Steedman, 2014)
EasySRL (Lewis et al., 2016)
DepCCG (Yoshikawa et al, 2017)

His	cell~phone	is	off	.
NP/(N/PP)	N/PP	(S[dcl]\NP)/(S[adj]\NP)	S[adj]\NP	S[dcl]\S[dcl]

—————————————— > —————————————— >

His cell~phone NP **is off** S[dcl]\NP

—————————————————————— <

His cell~phone is off
S[dcl]

—————————————————————————— <

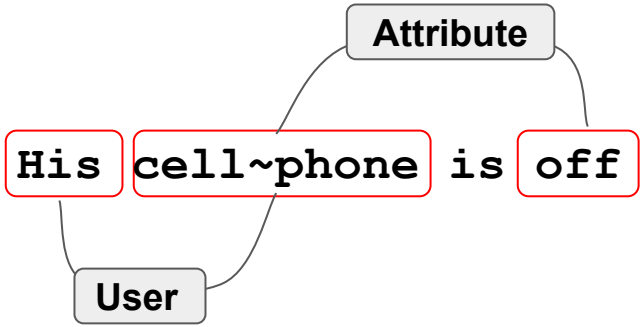
His cell~phone is off .
S[dcl]

Semantic Role Labeling

https://rayabook.net/bookid/19303

Detect what role each participant has wrt to the event

- Shallow semantic parsing
- Generalize over the order and the number of participants
- VerbNet roles* `https://uvi.colorado.edu/uvi_search`



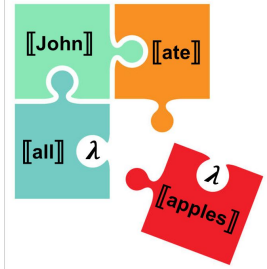
His	cell~phone	is	off	.
[User]	[]	[]	[Attribute]	[]
NP/(N/PP)	N/PP	(S[dcl]\NP)/(S[adj]\NP)	S[adj]\NP	S[dcl]\S[dcl]

His cell~phone NP — **is off** S[dcl]\NP

His cell~phone is off S[dcl]

His cell~phone is off . S[dcl]

Motivation for semantic tagging



He left three days ago .

ago
λv1.λv2.λv3.λv4. ((v2 @ v3) @ λv5. (v1 @ λv6. (t1 : (v4 @ v5))))
???
time(t1)
t1 ≺ v6
v6 ≻ now
Time(v5, t1)

days
λv1.
???
measure(v1)
Unit(v1, day)

three
λv1.λv2. (
???
: (v1 @ v2))
Theme(v2, 3)

left
λv1.λv2. (v1 @ λv3. (e1 t1 : (v2 @ e1)))
???
leave(e1)
Theme(e1, v3)
time(t1)
t1 ≺ now

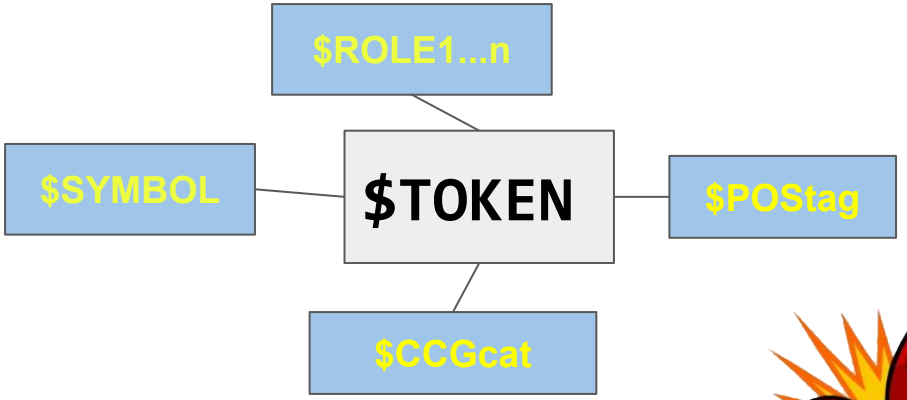
He
λv1. (x1
???
male(x1)

o
λv1.λv2. (x1
???
(v2 @ x1)))

➤➤➤

x1 e1 t1 t2
male.n.02(x1)
leave.v.01(e1)
Time(e1, t1)
Theme(e1, x1)
time.n.08(t1)
t1 ⊀ t2
t1 ≺ now
measure.n.02(t2)
t2 ⊀ now
Unit(t2, day)
Theme(t2, 3)

Detecting lexical semantics

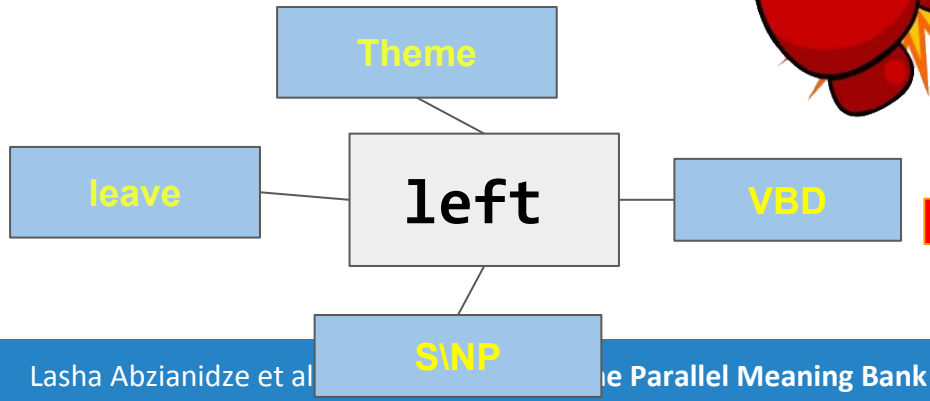


$TOKEN

λv1.λv2. (v1 @ λv3. (e1 t1 ; (v2 @ e1)))

$SYMBOL(e1)
Time(e1, t1)
$ROLE1(e1, v3)
time(t1)
t1 ≺ now

Boxer (Bos, 2008)

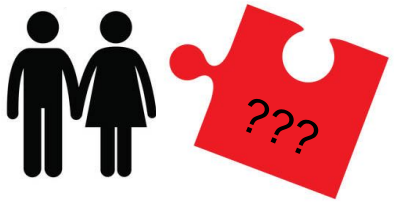


left

λv1.λv2. (v1 @ λv3. (e1 t1 ; (v2 @ e1)))

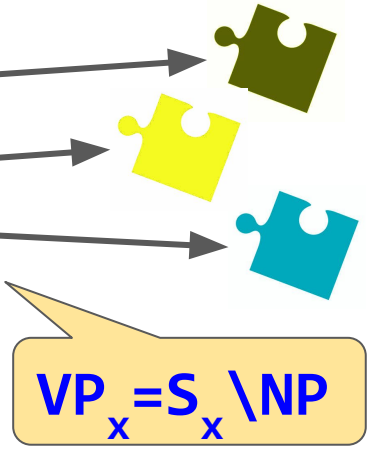
leave(e1)
Time(e1, t1)
Theme(e1, v3)
time(t1)
t1 ≺ now

POS and CCG tags



Which lexical semantics to assign to word tokens?

- 07/1937 I **have** gone to the cinema **VBP** VP_{dcl}/VP_{pt}
- 00/1564 I **have** a big dog **VBP** VP_{dcl}/NP
- 00/2206 I **have** to warn him **VBP** VP_{dcl}/VP_{to}

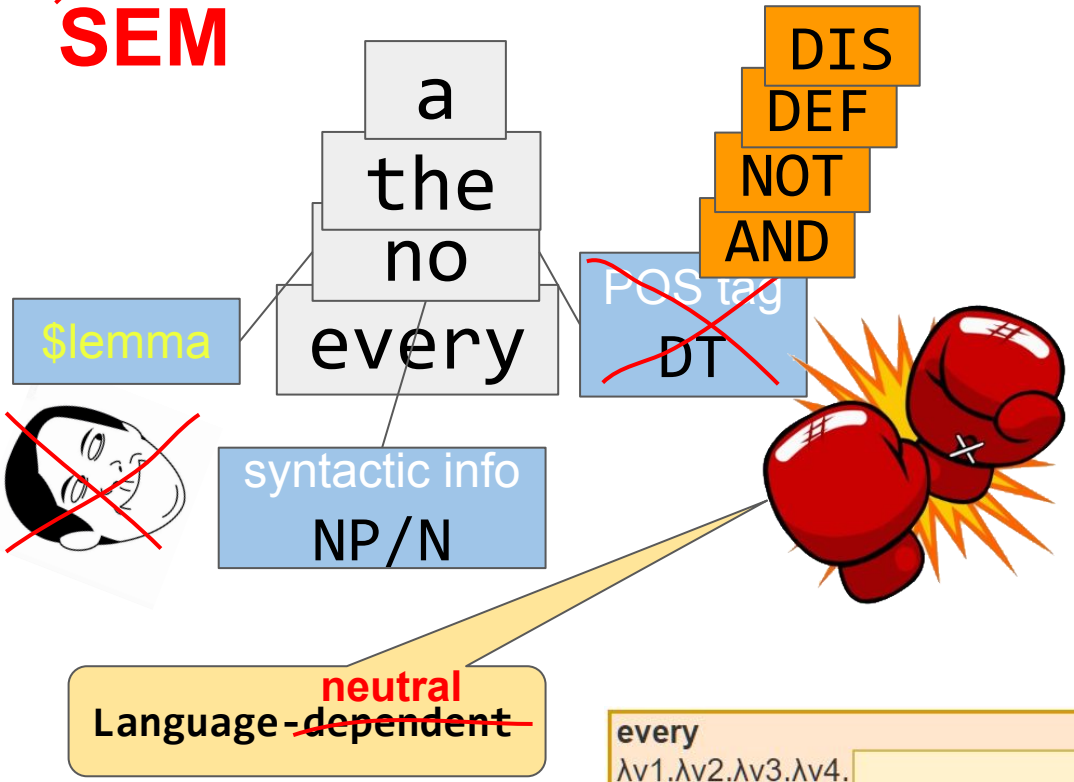


But what about these cases?

- **and**, **or**, **but** **CC** **conj**
- **a(n)**/**every**/**no**/**the**/**some**/**each**/**that**/**these**/**(n)either...** **DT** **NP/N**
- **ill** / **skillful** / **fake** professor **JJ** **N/N**

~~POS~~ and CCG tags (2)

SEM



a
λv1.λv2. (x1 ; ((v1 @ x1) ; (v2 @ x1)))

the
λv1.λv2. ((x1 ; (v1 @ x1)) ∗ (v2 @ x1))

No
λv1.λv2. ¬ (x1 ; ((v1 @ x1) ; (v2 @ x1)))

every
λv1.λv2.λv3.λv4. (x1 ; (v1 @ x1)) ⇒ ((v2 @ v3) @ λv5. (Time(v5, x1) ; (v4 @ v5)))

Semantic Tagging

Semantic tags define semantic contribution of a token wrt formal compositional semantics

They are more informative for comp. sem. than POS tags

token	symbol	sense	semtag
third	3		ORD
John	john	male.n.02	PER
played	play	play.v.03	EPS
2:30~pm	14:30		CLO
2,5~million	2500000		QUC
km	kilometer		UOM

- Generalizes over POS tags and Named Entity classes
- Specially designed for semantics
- Better complements CCG categories

Universal Semantic Tagset

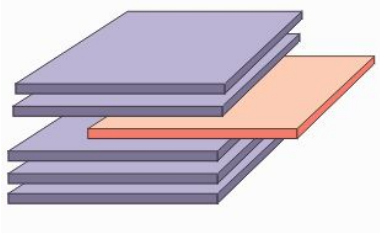
71 semantic tags into 13 groups

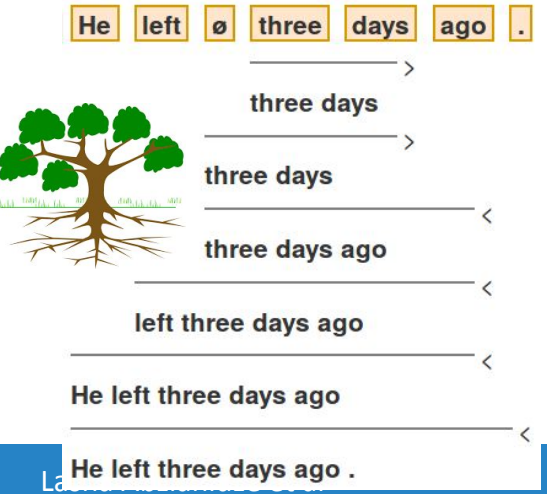
Coreference Resolution

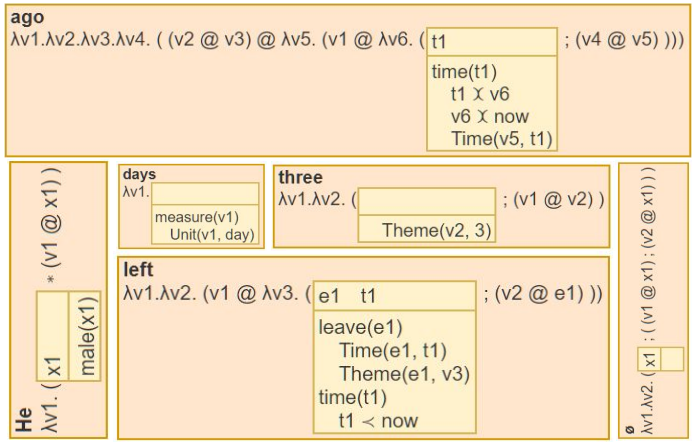
Link pronouns, named entities and definite noun phrases to their antecedents

Semantic Parsing (i.e. boxing)

He	left	ø	three	days	ago	.
PRO	EPS	DIS	QUC	UOM	PST	NIL
male	leave	ø	3	day	ago	.
male.n.02	leave.v.01	O	O	day.n.01	O	O
[]	[Theme]	[]	[Quantity]	[]	[]	[]
O				O		
NP	S[dcl]\NP	NP/N	N/N	N	((S\NP)\(S\NP))\NP	S[dcl]\S[dcl]

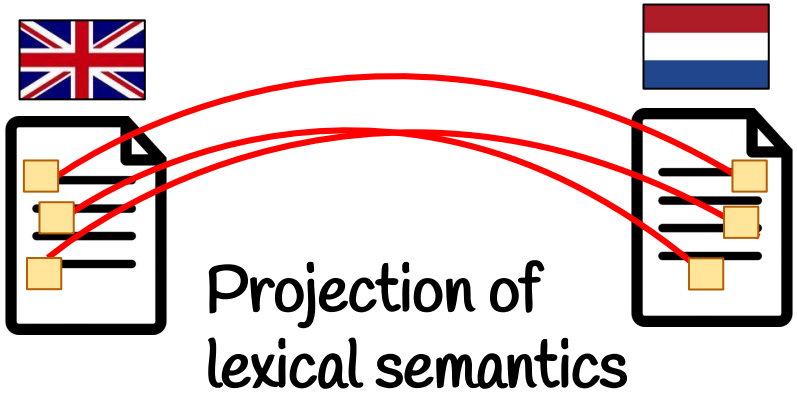






x1	e1	t1	t2
male.n.02(x1)			
leave.v.01(e1)			
Time(e1, t1)			
Theme(e1, x1)			
time.n.08(t1)			
t1 ⊐ t2			
t1 ≺ now			
measure.n.02(t2)			
t2 ⊐ now			
Unit(t2, day)			
Theme(t2, 3)			

What about the word **Parallel** in PMB?



Compositionality  Projection

64/2196 You must get up at six.

You	must	get	up	at	ø	six	.
PRO	NEC	EXS	REL	REL	DEF	CLO	NIL
hearer	must	get~up	up	at	ø	06:00	.
O	O	get_up.v.02	O	O	O	O	O
[]	[]	[Agent]	[]	[Time]	[]	[]	[]
O				O			
NP	(S[dcl]\NP)/(S[b]\NP)	(S[b]\NP)/PR	PR	((S\NP)\(S\NP))/NP	NP/N	N	S[dcl]\S[dcl]

get up S[b]\NP

six NP

at six (S[b]\NP)\(S[b]\NP)

get up at six S[b]\NP

must get up at six S[dcl]\NP

You must get up at six S[dcl]

You must get up at six . S[dcl]

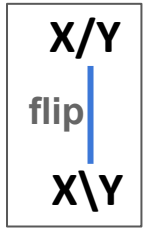
b1 :: b2 ::

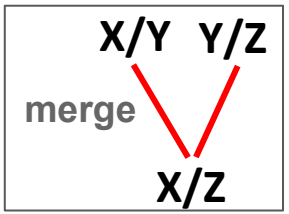
e1 t1

get_up.v.02(e1)
Time(e1, t1)
Agent(e1, hearer)
time.n.08(t1)
ClockTime(t1, 06:00)

NECESSITY(b1, b2)

Compositionality Projection (2)

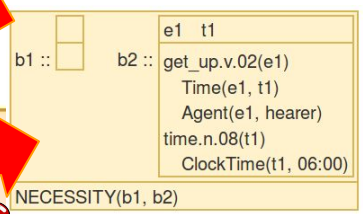




64/2196 You must get up at six.

You	must	get	up	at	ø	six	.
PRO	NEC	EXS	REL	REL	DEF	CLO	NIL
hearer	must	get~up	up	at	ø	06:00	.
O	O	get_up.v.02	O	O	O	O	O
[]	[]	[Agent]	[]	[Time]	[]	[]	[]
O				O			
NP	(S[dcl]\NP)/(S[b]\NP)	(S[b]\NP)/PR	PR	((S\NP)\(S\NP))/NP	NP/N	N	S[dcl]\S[dcl]

Du	musst	um	ø	sechs	aufstehen	.
PRO	NEC	REL	DEF	CLO	EXS	NIL
hearer	must	at	ø	06:00	get~up	.
O	O	O	O	O	get_up.v.02	O
[]	[]	[Time]	[]	[]	[Agent]	[]
O						
NP	(S[dcl]\NP)/(S[b]\NP)	((S[b]\NP)/(S[b]\NP))/NP	NP/N	N	S[b]\NP	S[dcl]\S[dcl]



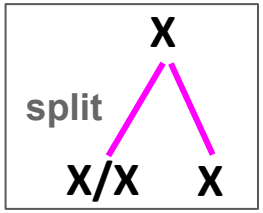
64/2196 Du musst um sechs aufstehen.

Evang & Bos (COLING 2016)

Compositionality Projection (3)

22/1871 He left three days ago

He	left	ø	three	days	ago	.
PRO	EPS	DIS	QUC	UOM	PST	NIL
male	leave	ø	3	day	ago	.
male.n.02	leave.v.01	O	O	day.n.01	O	O
[]	[Theme]	[]	[Quantity]	[]	[]	[]
O				O		
NP	S[dcl]\NP	NP/N	N/N	N	((S\NP)\(S\NP))\NP	S[dcl]\S[dcl]



Hij	is	ø	drie	dagen	geleden	vertrokken	.
PRO	NOW	DIS	QUC	UOM	PST	EXT	NIL
male	is	ø	3	day	ago	leave	.
male.n.02	O	O	O	day.n.01	O	leave.v.01	O
[]	[]	[]	[Quantity]	[]	[]	[Theme]	[]
O				O			
NP	(S[dcl]\NP)/(S[pt]\NP)	NP/N	N/N	N	((S[dcl]\NP)\(S[dcl]\NP))\NP	S[pt]\NP	S[dcl]\S[dcl]

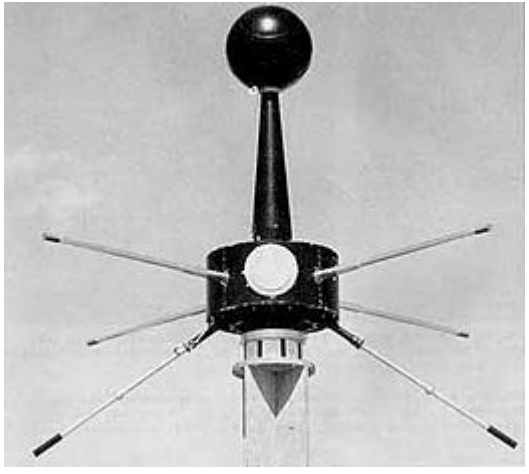
22/1871 Hij is drie dagen geleden vertrokken.

Evang & Bos (COLING 2016)

PMB Explorer

How do we annotate texts and get boxes?

https://commons.wikimedia.org/wiki/File:Explorer_10.jpg



The PMB explorer

Online annotation environment

`https://pmb.let.rug.nl/explorer`

Collaborative annotation:

- Machines — The PMB pipeline
- Experts
- The crowd — Any registered user can annotate documents; Non-registered users can only view certain documents

Distinguish Gold/Silver/Bronze annotation layers:

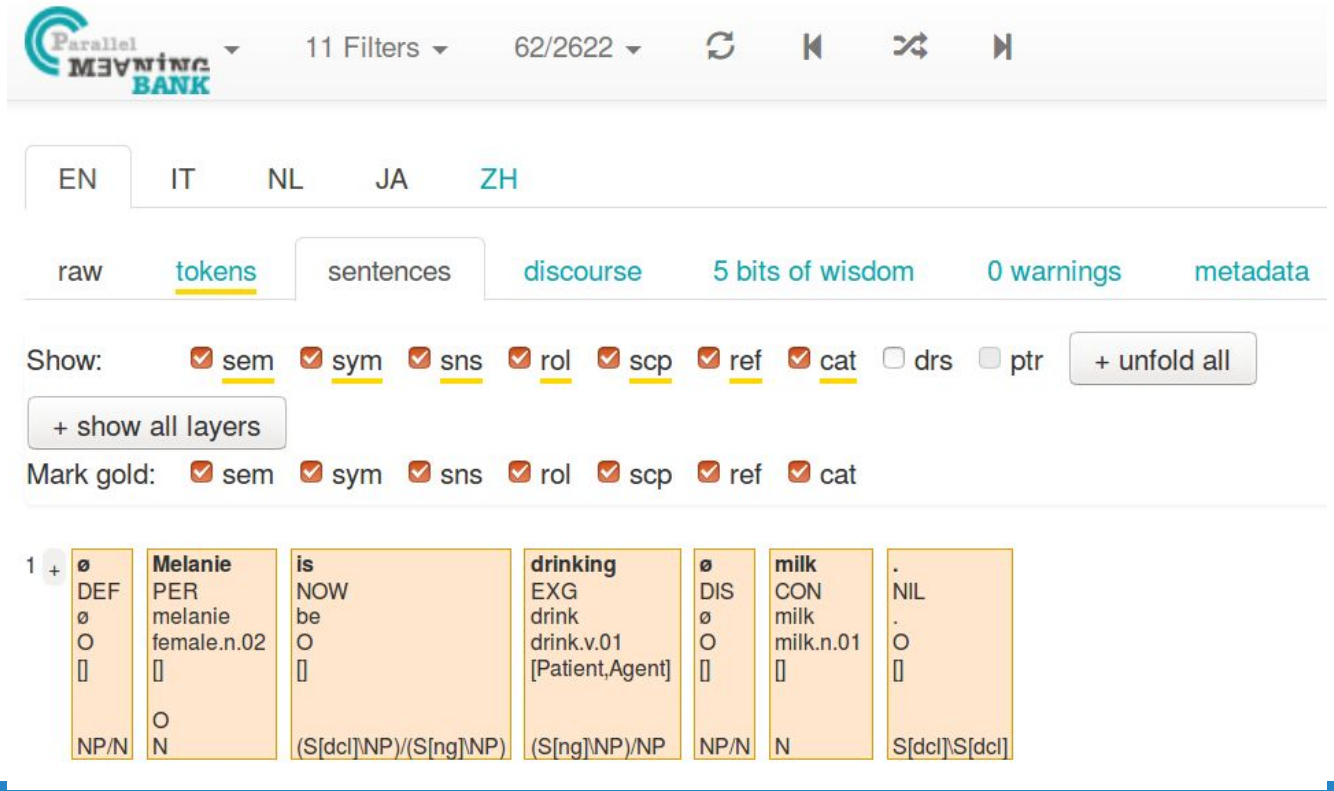
Manually verified

Has a BoW

Has no BoWs

Explorer interface

62/2622 Melanie is drinking milk.



Semantic comparison of translations

62/2622

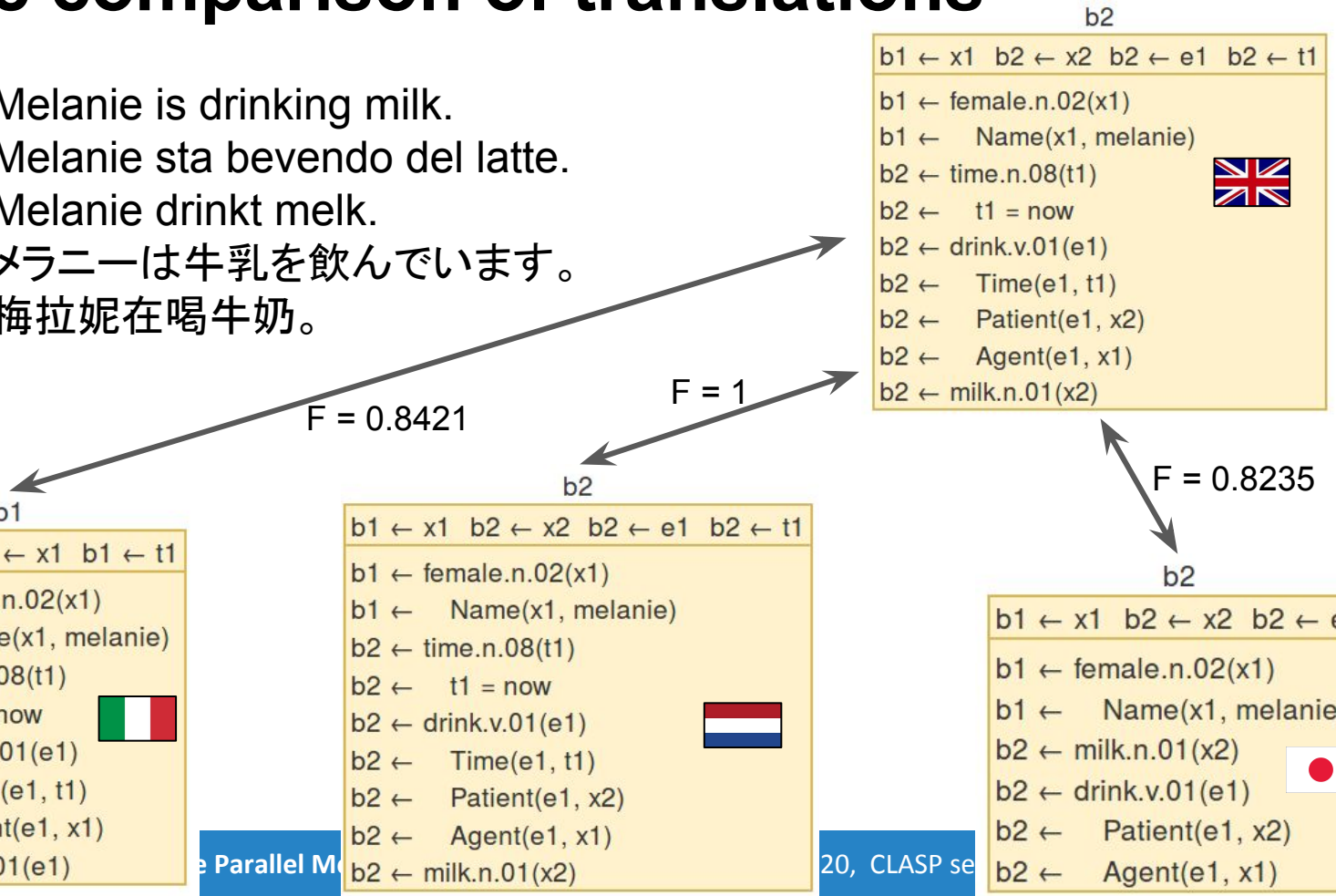
Melanie is drinking milk.

Melanie sta bevendo del latte.

Melanie drinkt melk.

メラニーは牛乳を飲んでいます。

梅拉妮在喝牛奶。



Additional features of the explorer

Word search (for search & batch annotation)

Phrase search

Statistics page

Monitoring errored documents

The PMB Doctor: identify potentially sick annotations

Annotation conflict detection

Division of gold/silver/bronze documents

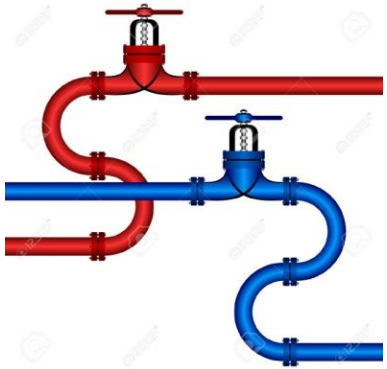
All documents:

	All layers gold	All layers at least silver	At least one layer silver	All layers bronze
English	9,103	407	120,516	173,182
German	2,143	20	7,657	186,380
Italian	1,167	15	4,804	113,221
Dutch	1,135	14	2,219	35,106
Japanese	2	0	991	89,048
Chinese	0	0	0	0

6474 warnings for English:

# Docs	Example
2659	ERROR Counter for en: Type clash
959	ERROR Counter for en: More than one non-subordinating boxes
883	ERROR Counter for en: Subordinate relation has a loop
504	ERROR Counter for en: unknown clause
458	ERROR: recipe failed: 'set -e set -o pipefail mkdir -p log/easyccg cat out/pNN/dNNNN/de.tok | ./src/python/add_supertag_constraints.py
208	ERROR Counter for en: Expected to be visually independent
183	□ERROR: unable to preprocess derivation N□
64	ERROR: recipe failed: 'set -e set -o pipefail mkdir -p log/easyccg cat out/pNN/dNNNN/nl.tok | ./src/python/add_supertag_constraints.py
60	WARNING: no syntax for sentence N.
58	WARNING: Tok/sym/sem/ccg layers do not have same amount of lines - apply rule-based role labeling

https://www.gograph.com/clipart/different-pipelines-gg60697880.html



PMB pipeline

From a raw text to a formal meaning representation

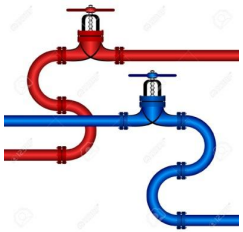
(Language-neutral) annotation tools

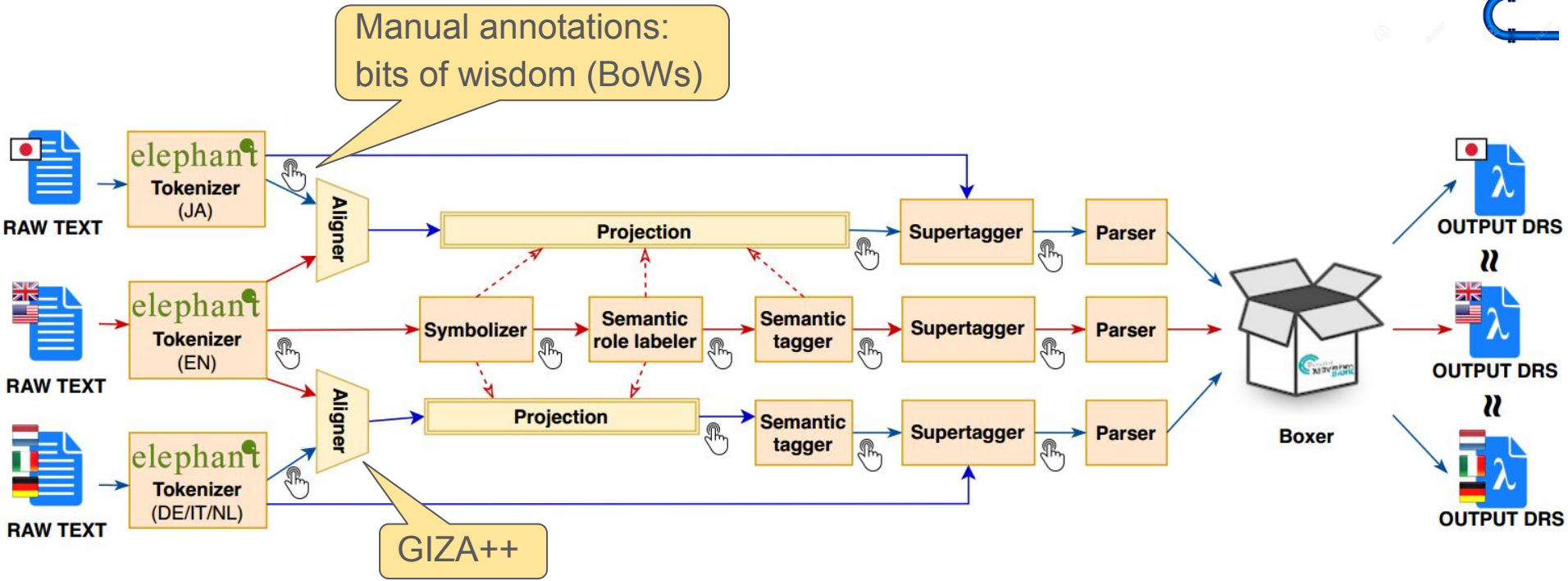
http://clipart-library.com/clipart/1818449.htm

- Segmentation: elephant (Evang et al., 2013)
- Symbolization: **Morpha** (+ rule-based)
- Word sense disambiguation (Wordnet 3.0): rule-based
- Syntactic parsing: **EasyCCG** (Lewis & Steedman, 2014)
- Semantic role labeling (Verbnet roles): **CRF tagger**
- Semantic tagging: **TnT tagger** (Brants, 2000)
- Semantic parsing with DRT: **Boxer** (Bos, 2008; 2015)

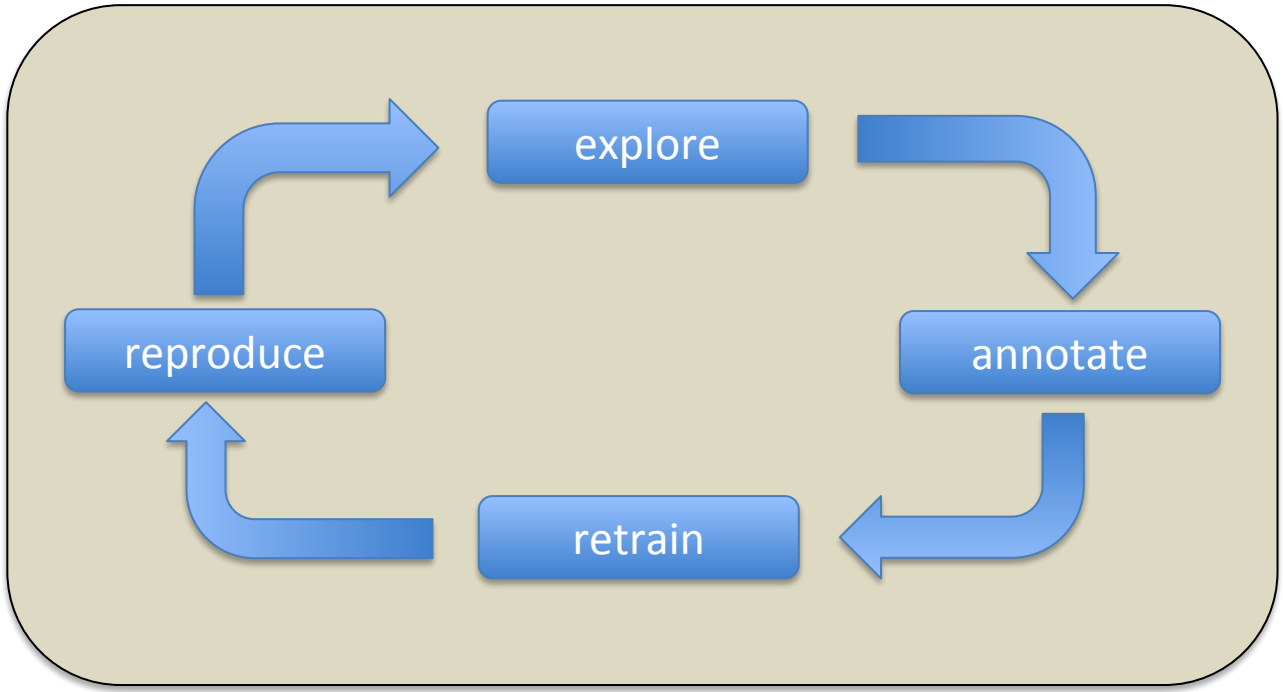
Language neutral: same system with language-specific models

The PMB pipeline

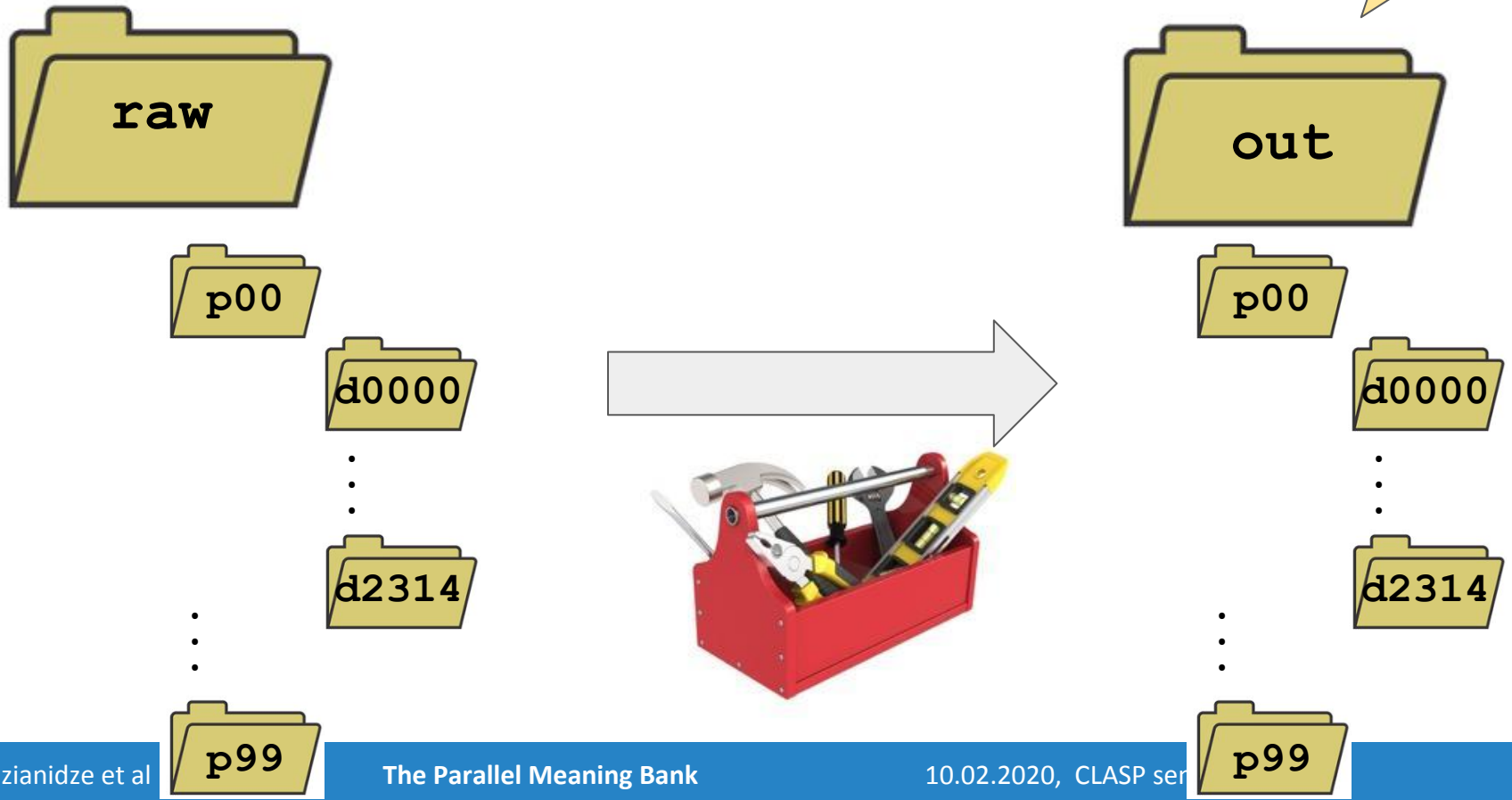




Semantic Annotation: the REAR cycle

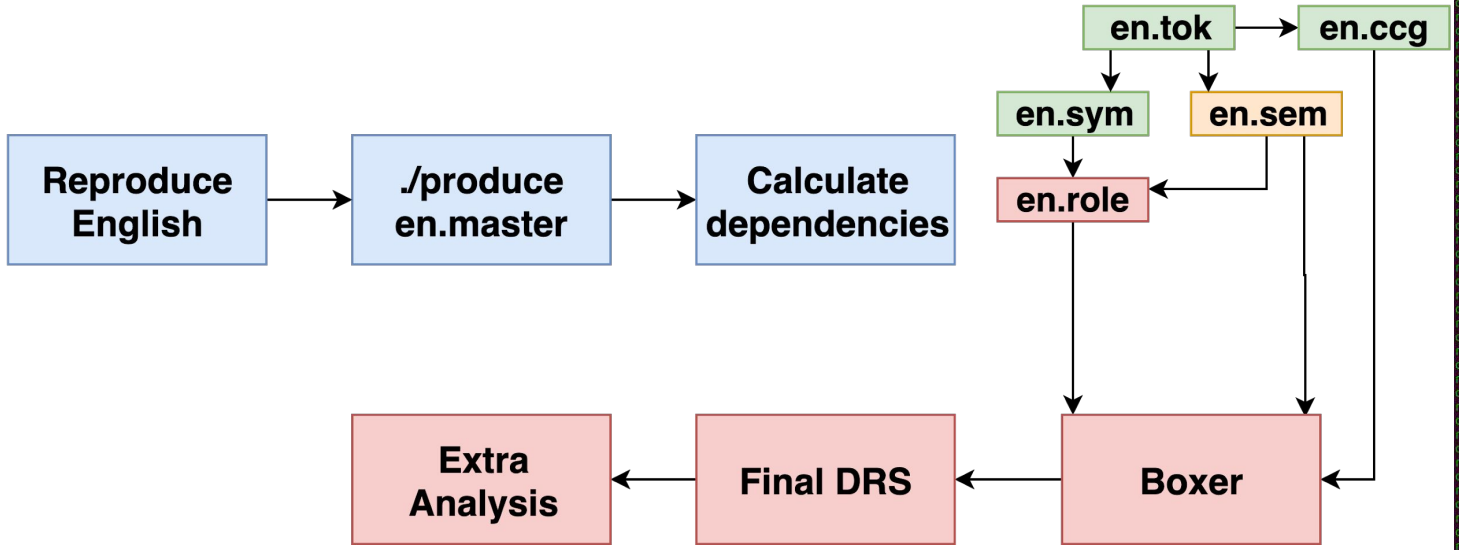


Input & Output



Pipeline of tasks

Reprocessing a document



PRODUCE

https://github.com/texttheater/produce

By Kilian Evang

Annotation conflicts

Initial tokenizer output

Tom bought a new book in New York

Annotate to fix New~York

Tom bought a new book in New~York

Label as gold standard

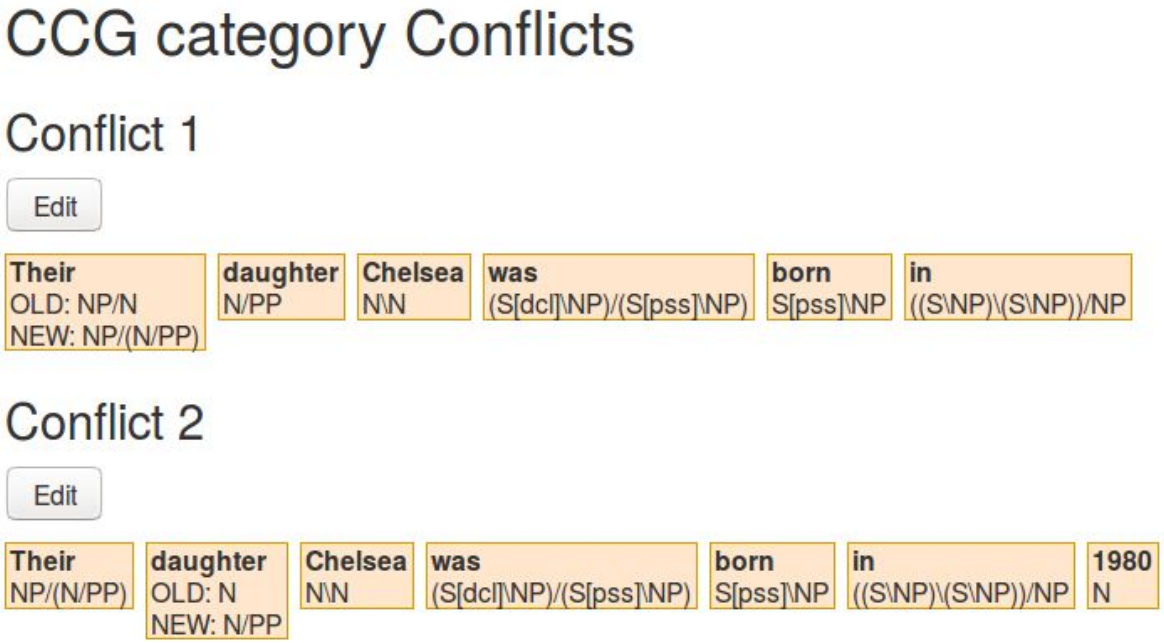
Tom bought a new book in New~York

Retrain tokenizer, which now makes a mistake!

Tom bought a new~book in New~York

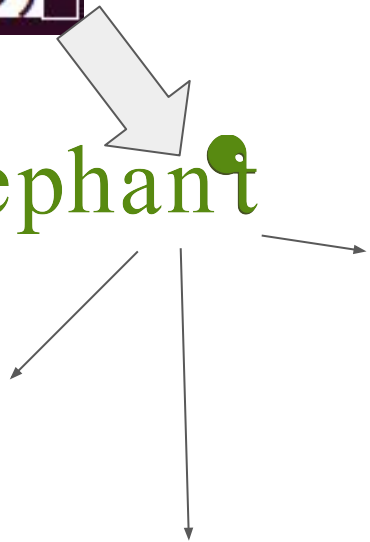
Compare new tokenization to old tokenization: conflict!

Tom bought a new~book in New~York



Segmentation/tokenization

```
His cell phone is off.
raw/p05/d2458/en.raw (END)
```




```
0 3 1001 His
4 14 1002 cell phone
15 17 1003 is
18 21 1004 off
21 22 1005 .
out/p05/d2458/en.tok.off (END)
```

```
His cell~phone is off .
out/p05/d2458/en.tok (END)
```

```
72 S
105 I
115 I
32 O
99 T
101 I
108 I
108 I
32 I
112 I
104 I
111 I
110 I
101 I
32 O
105 T
115 I
32 O
111 T
102 I
102 I
46 T
13 O
10 O
out/p05/d2458/en.tok.iob (END)
```

CCG parsing

```
His cell~phone is off .
out/p05/d2458/en.tok (END)
```

EasyCCG

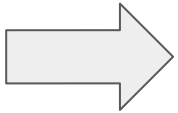
```
ccg(1,
 ba(s:dcl,
  fa(np,
   t(np/(n/pp), 'His', [lemma:'his']),
   t(n/pp, 'cell~phone', [lemma:'cell~phone'])),
  rp(s:dcl\np,
   fa(s:dcl\np,
    t((s:dcl\np)/(s:adj\np), 'is', [lemma:'is']),
    t(s:adj\np, 'off', [lemma:'off'])),
   t(., '.', [lemma:'.'])))).

out/p05/d2458/en.parse (END)
```

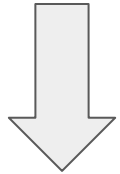
```
NP/(N/PP)
N/PP
(S[dcl]\NP)/(S[adj]\NP)
S[adj]\NP
.
out/p05/d2458/en.cats (END)
```

Symbolization (lemmatization with Morpha + rule based system)

```
0 3 1001 His
4 14 1002 cell phone
15 17 1003 is
18 21 1004 off
21 22 1005 .
out/p05/d2458/en.tok.off (END)
```



```
male
cellphone
be
off
.
out/p05/d2458/en.lemma (END)
```

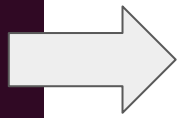


Word Sense Disambiguation (rule based system)

```
male.n.02
cellphone.n.01
0
off.a.01
0
out/p05/d2458/en.wordnet (END)
```

Semantic Roles

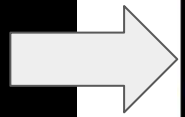
```
0 3 1001 His
4 14 1002 cell phone
15 17 1003 is
18 21 1004 off
21 22 1005 .
out/p05/d2458/en.tok.off (END)
```



```
HAS
CON
NOW
IST
NIL
out/p05/d2458/en.semtag (END)
```

Semantic Role Labeling

```
0 3 1001 His
4 14 1002 cell phone
15 17 1003 is
18 21 1004 off
21 22 1005 .
out/p05/d2458/en.tok.off (END)
```

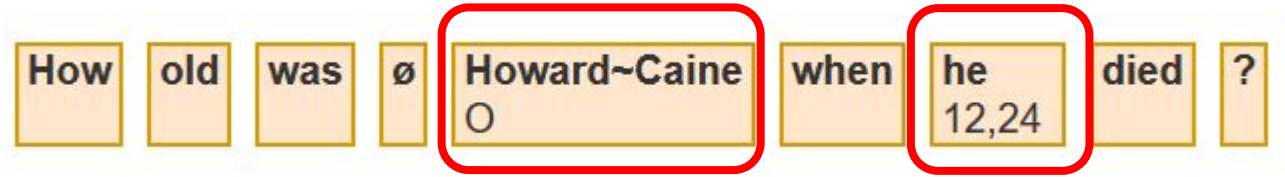


```
[User]

[Attribute]

out/p05/d2458/en.roles (END)
```

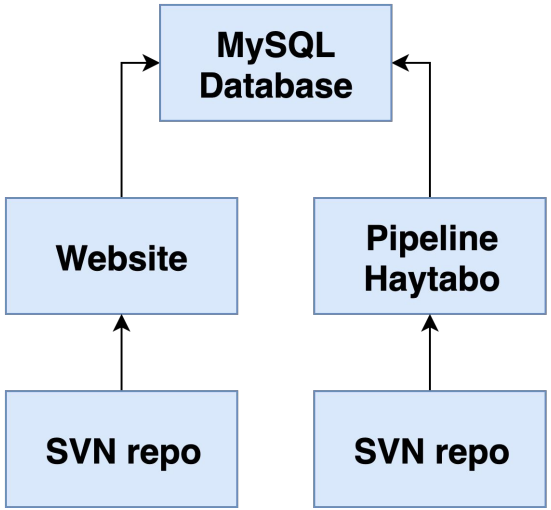
References




```
0 3 1001 How
4 7 1002 old
8 11 1003 was
12 24 1004 Howard Caine
25 29 1005 when
30 32 1006 he
33 37 1007 died
37 38 1008 ?
out/p71/d1390/en.tok.off (END)
```

```
12,24
out/p71/d1390/en.antecedent (END)
```

Organization & maintenance



MySQL

mantis BUG TRACKER

View Issue Details

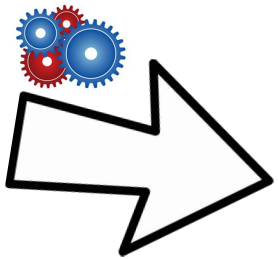
Send a Reminder | Jump to Notes | Jump to History

ID	Project	Category	View Status	Date Submitted	Last Update
0008454	GMB & PMB	PMB: PMBD	public	2017-11-04 08:20	2018-08-02 12:34
Reporter	Johan Bos	Assigned To	Lasha Abzianidze		
Priority	high	Severity	crash	Reproducibility	have not tried
Status	resolved	Resolution	fixed		
Summary	0008454: PMBD crash?				
Description	It seems the last document that has been processed was last night.				
Tags	No tags attached.				
Attach Tags	(Separate by ",")		Existing tags	Attach	

Edit | Assign To: [Myself] | Change Status To: closed | Monitor | Stick | Clone | Reopen | Close | Move | Delete

DRS parsing

End-to-end parsing & shared task



x1	x2	e1	t1
male.n.02(x1)			
Name(x1, alfred~nobel)			
invent.v.01(e1)			
Time(e1, t1)			
Result(e1, x2)			
Agent(e1, x1)			
time.n.08(t1)			
YearOfCentury(t1, 1866)			
t1 ≺ now			
dynamite.n.01(x2)			

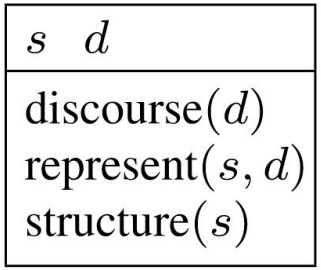
Alfred Nobel invented dynamite in 1866.

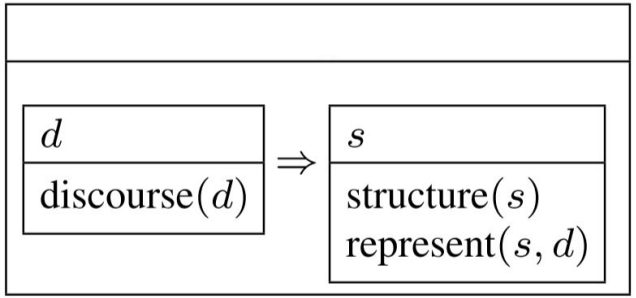
Discourse representation structure (DRS)

Meaning repr. from Discourse Representation Theory (DRT)

DRT characteristics:

- Anaphora
- Tense
- Presupposition
- Discourse
- Attitudes
- Formal semantics
- Compositional

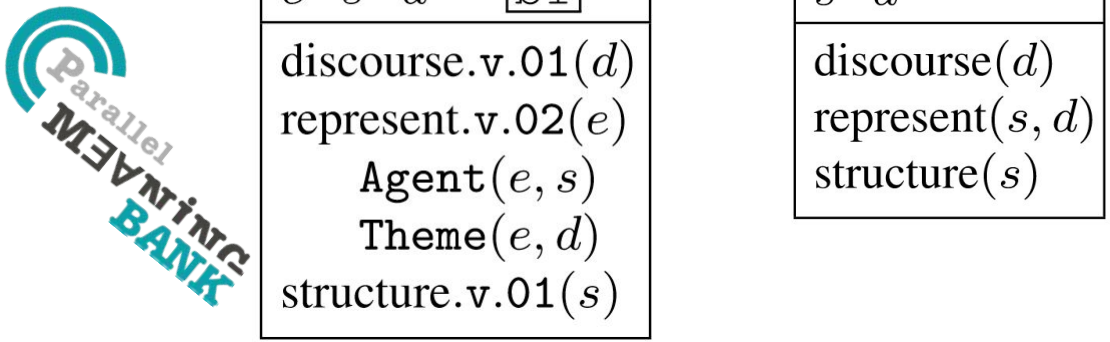




DRSs *à la* the PMB

Extensions to DRSs in the PMB:

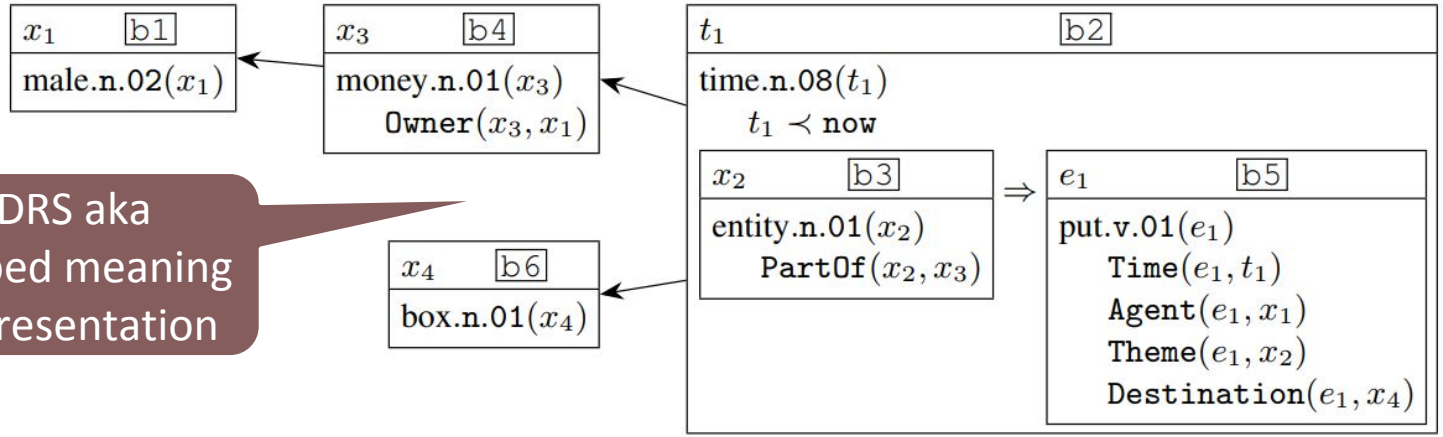
- Lexical (i.e. non-logical) symbols ↦ WordNet senses (Miller, 1995)
- Event semantics with VerbNet roles (Bonial et al., 2011)
- Explicit presuppositions with Porjective DRT (Venhuizen et al., 2018)
- Discourse analysis with Segmented DRT (Asher and Lascarides, 2003)



http://pmb.let.rug.nl

Clausal form (CLF)

01/2312: He put all his money in the box.



DRS aka scoped meaning representation

```
b1 REF x1                b2 IMP b3 b5
b1 male "n.02" x1        b3 REF x2
b2 REF t1                b3 PartOf x2 x3
b2 TPR t1 "now"          b3 entity "n.01" x2
b2 time "n.08" t1        b4 REF x3
b5 REF e1                b4 Owner x3 x1
b5 Agent e1 x1           b4 money "n.01" x3
b5 Theme e1 x2           b5 Destination e1 x4
b5 Time e1 t1            b6 REF x4
b5 put "v.01" e1         b6 box "n.01" x4
```

DRSs parsing

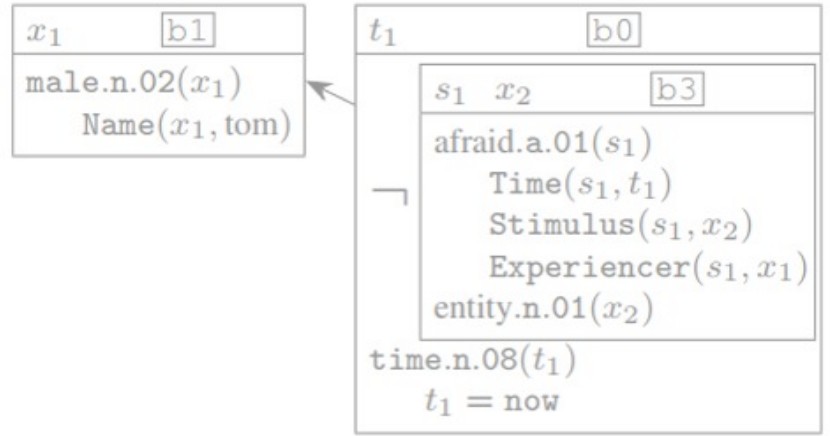
SYSTEM INPUT:

Tom isn't afraid of anything.

SYSTEM OUTPUT:

```
b1 REF x1
b1 male "n.02" x1
b1 Name x1 "tom"
b2 REF t1
b2 EQU t1 "now"
b2 time "n.08" t1
b2 NOT b3
b3 REF s1
b3 Time s1 t1
b3 Experiencer s1 x1
b3 afraid "a.01" s1
b3 Stimulus s1 x2
b3 REF x2
b3 entity "n.01" x2
```

BOX FORMAT:



CLF Referee (van Noord et al., 2019)

Input: CLF

Output: <(True|False), DRS>

Procedure:

- Detect types of variables in cl
- Find binder referent
- Make the relation g
- Find loops in the rel

00/3008: He played the piano and she sang.

```
b6 DRS b1                    b6 DRS b4
b2 REF x1                    b5 REF x3
b2 male "n.02" x1            b5 female "n.02" x3
b1 REF e1                    b4 REF e2
b1 play "v.03" e1            b4 sing "v.01" e2
b1 Agent e1 x1               b4 Agent e2 x3
b1 Theme e1 x2               b4 Time e2 t2
b3 REF x2                    b4 REF t2
b3 piano "n.01" x2           b4 TPR t2 "now"
b1 REF t1                    b4 time "n.08" t2
b1 time "n.08" t1            b6 CONTINUATION b1 b4
b1 TPR t1 "now"              b1 Time e1 t1
```

```
b0 DRS b1                    b0 DRS b5
b2 REF x1                    b6 REF x3
b2 male "n.02" x1            b6 female "n.02" x3
b1 REF e1                    b5 REF e2
b1 play "v.03" e1            b5 sing "v.01" e2
b1 Agent e1 x1               b5 Agent e2 x3
b1 Theme e1 x2               b5 Time e2 t2
b3 REF x2                    b7 REF t2
b3 piano "n.01" x2           b7 TPR t2 "now"
b4 REF t1                    b7 time "n.08" t2
b4 time "n.08" t1            b0 CONTINUATION b1 b5
b4 TPR t1 "now"              b1 Time e1 t1
```

Variable

DRS operator

WordNet sense

Semantic role

Constant

Comparison operator

Discourse relation

Counter (van Noord et al., 2018)

Adaptation of Smatch (Cai & Knight, 2013) to 3-variable clauses

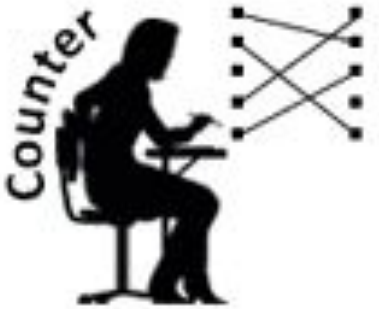
Input: 2 x CLFs

Output: $0 \leq$ F-score ≤ 1

Pre-processing: remove redundant REF-clauses

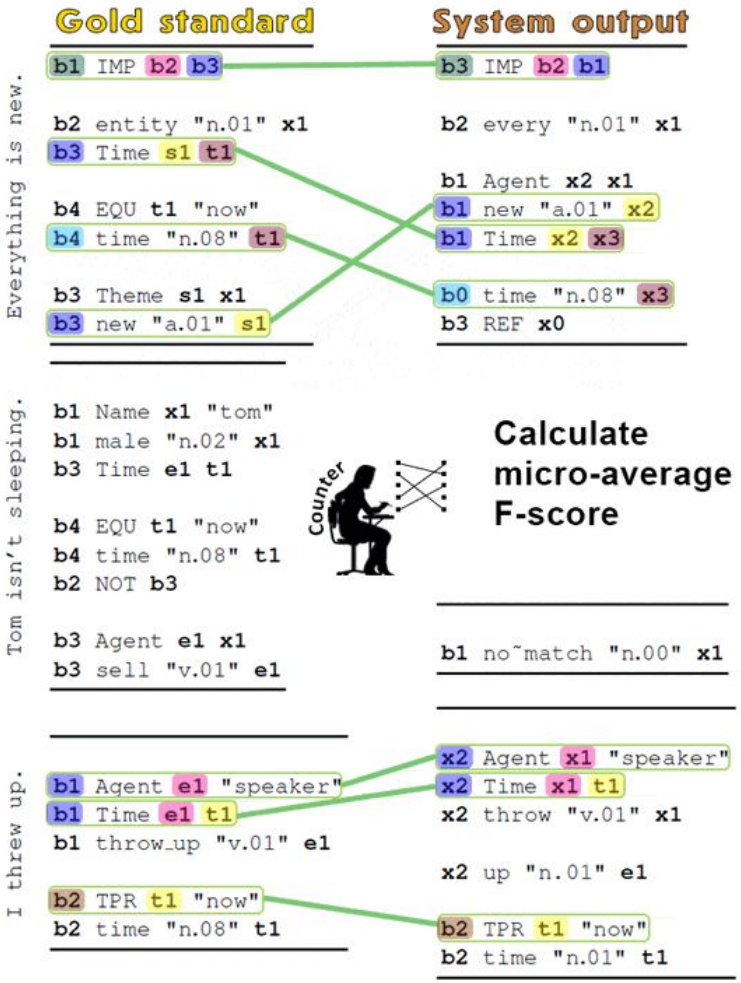
Procedure:

- Hill-climbing search: next optimal variable matching
- Several restarts
- Smart initial matches



https://github.com/RikVN/DRS_parsing

CLF comparison



$$F_{\text{micro-avg}} = \frac{2PR}{P+R} = \frac{2 \times 7/14 \times 7/20}{7/14 + 7/20} \approx 0.4118$$

Data format

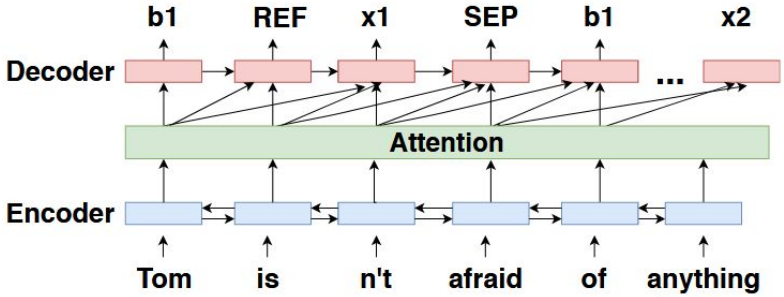
```
Nick Leeson was arrested for collapse of Barings Bank PLC.
```

8 tokens

```
b1 REF x1                          % Nick~Leeson [0...11]
b1 Name x1 "nick~leeson"           % Nick~Leeson [0...11]
b1 male "n.02" x1                  % Nick~Leeson [0...11]
b2 REF t1                          % was [12...15]
b2 TPR t1 "now"                    % was [12...15]
b2 Time e1 t1                      % was [12...15]
b2 time "n.08" t1                  % was [12...15]
b2 REF e1                          % arrested [16...24]
b2 Patient e1 x1                   % arrested [16...24]
b2 arrest "v.01" e1                % arrested [16...24]
b2 Theme e1 x2                     % for [25...28]
b2 REF x2                          % collapse [29...37]
b2 collapse "n.04" x2              % collapse [29...37]
b2 Patient x2 x3                   % of [38...40]
b3 REF x3                          %
b3 Name x3 "barings~bank~plc"      % Barings~Bank~PLC [41...57]
b3 company "n.01" x3               % Barings~Bank~PLC [41...57]
                                   % . [57...58]
```

Neural boxer (strong baseline)

Sequence to sequence: two BiLSTM layers (300 nodes)



	Sentences	Tokens	Avg tok/sent
Gold train	3,998	24,917	6.2
Gold test	557	3,180	5.7
Silver	73,778	638,610	8.7

Parameter	Value	Parameter	Value
RNN-type	LSTM	dropout	0.2
encoder-type	brnn	dropout type	naive
optimizer	sgd	bridge	copy
layers	2	learning rate	0.7
nodes	300	learning rate decay	0.7
min freq source	3	max grad norm	5
min freq target	3	beam size	10
vector size	300	length normalization	0.9

van Noord, Abzianidze, Toral, Bos (2018): Exploring Neural Methods for Parsing Discourse Representation Structures (TACL)

Characters vs words-based seq2seq

Word-based: GloVe embeddings

Character-based: Semantic roles, DRS operator as supercharacters

Model	Prec	Rec	F-score	% ill
Char	78.1	69.7	73.7	6.2
Word	73.2	65.9	69.4	5.8
Char + Word	78.9	69.7	74.0	7.5

BPE encoding didn't improve over characters

van Noord, Abzianidze, Toral, Bos (2018): Exploring Neural Methods for Parsing Discourse Representation Structures (TACL)

Representing variables

De Bruijn index:

λz. (λy. y (λx. x)) (λx. z x) := λ (λ 1 (λ 1)) (λ 2 1)

```
b1 REF x1
b1 male "n.02" x1
b1 Name x1 "tom"
b2 REF t1
b2 EQU t1 "now"
b2 time "n.08" t1
b0 NOT b3
b3 REF s1
b3 Time s1 t1
b3 Experiencer s1 x1
b3 afraid "a.01" s1
b3 Stimulus s1 x2
b3 REF x2
b3 entity "n.01" x2
```

(a) Standard naming

```
$1 REF @1
$1 male "n.02" @1
$1 Name @1 "tom"
$2 REF @2
$2 EQU @2 "now"
$2 time "n.08" @2
$0 NOT $3
$3 REF @3
$3 Time @3 @2
$3 Experiencer @3 @1
$3 afraid "a.01" @3
$3 Stimulus @3 @4
$3 REF @4
$3 entity "n.01" @4
```

(b) Absolute naming

```
[NEW] REF ⟨NEW⟩
[0] male "n.02" ⟨0⟩
[0] Name ⟨0⟩ "tom"
[NEW] REF ⟨NEW⟩
[0] EQU ⟨0⟩ "now"
[0] time "n.08" ⟨0⟩
[NEW] NOT [NEW]
[0] REF ⟨NEW⟩
[0] Time ⟨0⟩ ⟨-1⟩
[0] Experiencer ⟨0⟩ ⟨-2⟩
[0] afraid "a.01" ⟨0⟩
[0] Stimulus ⟨0⟩ ⟨1⟩
[0] REF ⟨NEW⟩
[0] entity "n.01" ⟨0⟩
```

(c) Relative naming

Experiments

Tokenization: None vs Elephant vs Moses

Variable representation: absolute vs relative

Casing: lower vs true vs feature

	Char parser		Word parser	
	F1	**% ill**	**F1**	**% ill**
Baseline (bs)	73.7	6.2	69.4	5.8
Moses (mos)	74.1	4.8	71.8	5.8
Elephant (ele)	74.0	5.4	71.1	7.5
bs/mos + absolute (abs)	75.3	3.5	73.5	2.0
bs/mos + relative (rel)	76.3	4.2	74.2	3.1
bs/mos + rel + lowercase	75.8	3.6	74.9	3.1
bs/mos + rel + truecase	76.2	4.0	73.3	3.3
bs/mos + rel + feature	76.9	3.7	74.9	2.9

Experiments

Tokenization: None vs Elephant vs Moses

Variable representation: absolute vs relative

Casing: lower vs true vs feature

	Char parser		Word parser	
	F1	**% ill**	**F1**	**% ill**
Baseline (bs)	73.7	6.2	69.4	5.8
Moses (mos)	74.1	4.8	71.8	5.8
Elephant (ele)	74.0	5.4	71.1	7.5
bs/mos + absolute (abs)	75.3	3.5	73.5	2.0
bs/mos + relative (rel)	76.3	4.2	74.2	3.1
bs/mos + rel + lowercase	75.8	3.6	74.9	3.1
bs/mos + rel + truecase	76.2	4.0	73.3	3.3
bs/mos + rel + feature	76.9	3.7	74.9	2.9

Experiments with silver data

Silver data: the PMB vs self-produced

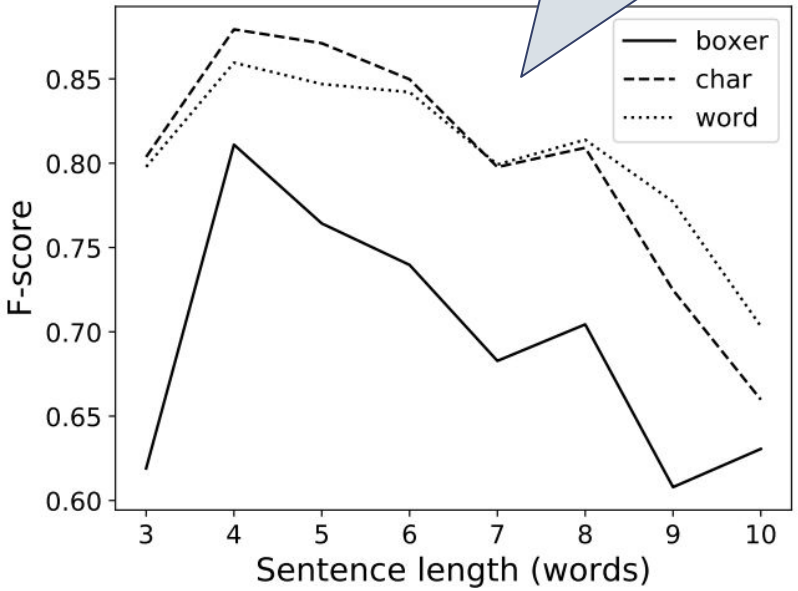
	Char parser		Word parser	
Data	**F1**	**% ill**	**F1**	**% ill**
Best gold-only	75.9	2.9	72.8	2.0
+ ensemble	77.9	1.8	75.1	0.9
Gold + silver	82.9	1.8	82.7	1.1
+ ensemble	83.6	1.3	83.1	0.7

	Char parser		Word parser	
Data	**F1**	**% ill**	**F1**	**% ill**
Silver (Boxer-generated)	83.6	1.3	83.1	0.7
Bronze (Boxer-generated)	83.8	1.1	82.4	0.9
Bronze (NN-generated)	77.9	2.7	74.5	2.2
without ill-formed DRSs	78.6	1.6	74.9	0.9

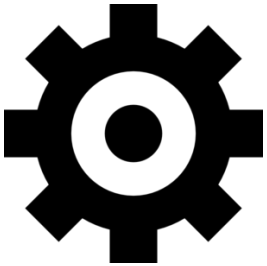
Final results

	Prec	Rec	F-score
SPAR	48.0	33.9	39.7
SIM-SPAR	55.6	57.9	56.8
AMR2DRS	43.3	43.0	43.2
Boxer	75.7	72.9	74.3
Neural Char	79.7	76.2	77.9
Neural Word	77.1	73.3	75.1
Neural Char + silver	84.7	82.4	83.6
Neural Word + silver	84.0	82.3	83.1

Results degrade for longer sentences



Shared task set-up



Competition platform CodaLab

Discussion group slack

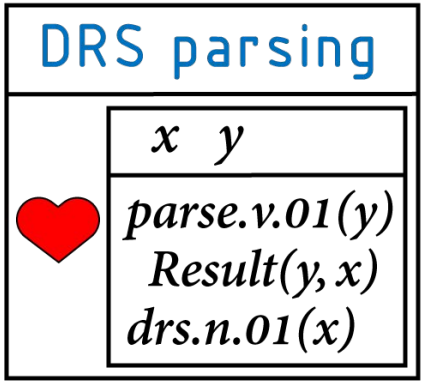
Released data:

- Pre-release in October
- Final release (incl. Silver and Bronze data) in December

Tools:

- Counter – CLF comparison
- Referee – CLF validation

Competition phase: 2 weeks



Participants

32 registered users

4 submissions:

- 3 system description papers
- 1 didn't submit due to the ACL submission policy

	Model	Input	Embeddings	Silver	Bronze
LIU ET AL.	Transformer	char	✖	✔	✔
NOORD ET AL.19	seq2seq	char	✖	✔	✖
NOORD ET AL.18	seq2seq	char	✖	✔	✖
EVANG	stack-LSTMs	word	✔	✖	✖
FANCELLU ET AL.	bi-LSTM	word	✔	✖	✖

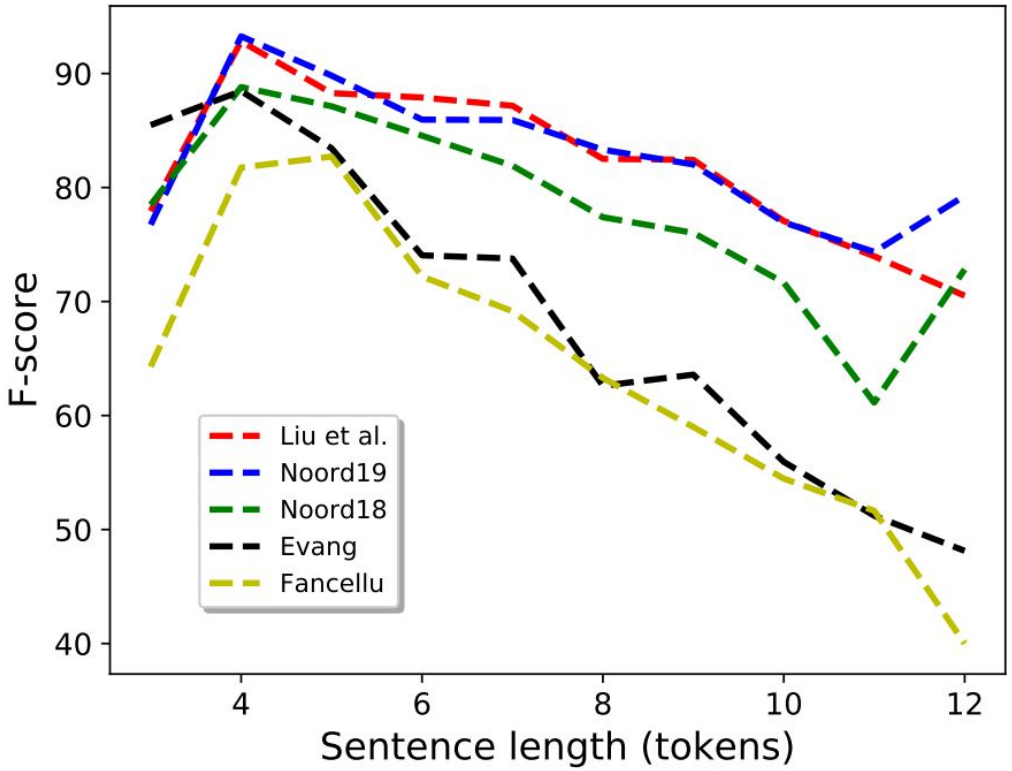
System evaluation

	PMB 2.2.0 (F%)			Evaluation set (%)		
	Train	Dev	Test	Prec.	Rec.	F
AMR2DRS	NA	39.7	40.1	36.7	42.2	38.8
SPAR	NA	40.0	40.8	44.3	35.4	39.4
SIM-SPAR	NA	53.3	57.7	55.7	53.0	54.3
FANCELLU ET AL.	91.1	69.9	73.3	71.9	64.1	67.8
EVANG	84.2	74.4	74.4	71.9	69.9	70.9
NOORD ET AL.18	88.5	81.2	83.3	80.8	78.6	79.7
NOORD ET AL.19	94.9	86.5	86.8	85.5	83.6	84.5
LIU ET AL.	96.9	85.5	87.1	84.8	84.8	84.8

Fine-grained evaluation

	LIU	NOORD19	NOORD18	EVANG	FANCELLU
All clauses	84.8	84.5	79.7	70.9	67.8
DRS Operators	93.9	94.2	91.7	75.2	76.3
VerbNet roles	82.7	83.5	78.1	72.4	66.4
WordNet synsets	83.8	82.3	77.2	67.8	66.5
nouns	89.2	87.5	83.5	75.9	70.3
verbs	69.5	68.9	60.9	44.1	58.3
adjectives	74.8	74.2	66.5	61.5	53.8
adverbs	63.6	45.5	33.3	0.0	31.6
Oracle sense numbers	86.6	87.1	82.6	74.5	69.8
Oracle synsets	90.5	90.7	87.5	80.1	76.5
Oracle roles	88.4	88.5	84.3	74.5	73.7
# of perfect DRSs	214	210	160	95	104
# highest out of 5	383	376	261	171	161
# winner out of 5	100	77	26	18	18
# of ill-formed DRSs	1	0	1	37	5

Performance(text_length)



Hard examples

x1	⇒	x2 e1
cat(x1)		have(e1) Theme(e1, x2) Pivot(e1, x1) ear(x2) Quantity(x2, 2)

Sentence	avg. F	Comment
Thou speakest.	21.4	archaic English
I dinnae ken.	21.8	Scottish
My fault.	24.2	noun phrase
A cat has two ears.	38.1	generic
I look down on liars and cheats.	40.3	coordination, MWE
Get me the number of this young girl.	41.8	imperative
She attends school at night.	44.6	temporal modifier
The union of Scotland and England took place in 1706.	46.4	coordination, MWE
Something I hadn't anticipated happened.	47.0	reduced relative clause
Charles I had his head cut off.	47.2	ordinal, MWE

x1 x2 s1 e1
get(e1) Destination(e1, speaker) Theme(e1, x1) Agent(e1, hearer) number(x1) User(x1, x2) young(s1) girl(x2) Attribute(x2, s1)

Summary

From token-based annotation layers to boxe

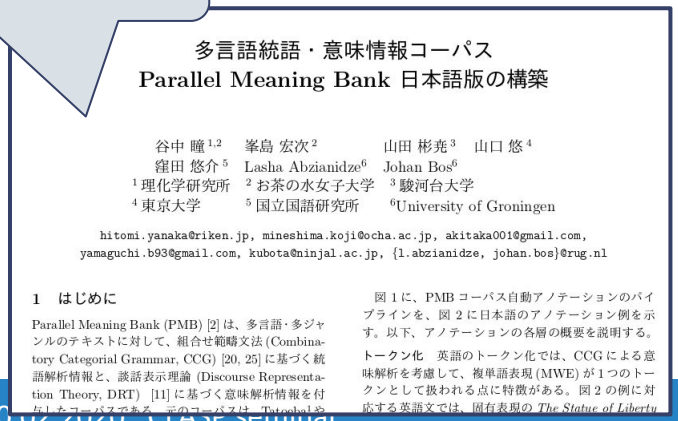
Compositionality & projection are productiv

The PMB explorer: online annotation environment

The PMB pipeline

DRS parsing: end-to-end

Collaboration on FraCaS?



多言語統語・意味情報コーパス
Parallel Meaning Bank 日本語版の構築

谷中 瞳[1,2] 峯島 宏次[2] 山田 彬尭[3] 山口 悠[4]
窪田 悠介[5] Lasha Abzianidze[6] Johan Bos[6]
[1]理化学研究所 [2]お茶の水女子大学 [3]駿河台大学
[4]東京大学 [5]国立国語研究所 [6]University of Groningen

hitomi.yanaka@riken.jp, mineshima.koji@ocha.ac.jp, akitaka001@gmail.com,
yamaguchi.b93@gmail.com, kubota@ninjal.ac.jp, {l.abzianidze, johan.bos}@rug.nl

1 はじめに

Parallel Meaning Bank (PMB) [2] は、多言語・多ジャンルのテキストに対して、組合せ範疇文法 (Combinatory Categorial Grammar, CCG) [20, 25] に基づく統語解析情報と、談話表示理論 (Discourse Representation Theory, DRT) [11] に基づく意味解析情報を付与したコーパスである。元のコーパスは、Tatoeba や

図 1 に、PMB コーパス自動アノテーションのパイプラインを、図 2 に日本語のアノテーション例を示す。以下、アノテーションの各層の概要を説明する。

トークン化 英語のトークン化では、CCG による意味解析を考慮して、複単語表現 (MWE) が 1 つのトークンとして扱われる点に特徴がある。図 2 の例に対応する英語文では、固有表現の *The Statue of Liberty*

PMB release 3.0.0 is coming soon

Lost in Translation - Found in Meaning

NWO
Netherlands Organisation for Scientific Research

VICI project (2016-2020)

`http://pmb.let.rug.nl`