

# Negation Detection with Discourse Representation Structures

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# Negation

- Nothing is more home to semantics than negation!
- Modelling negation important in semantic interpretation
- We present and evaluate an off-the-shelf semantic parser:

**BOXER**

# C&C tools and Boxer

- State-of-the-art NLP pipeline
- Used in constructing the GMB
- Build upon syntactic parser for CCG
- Boxer produces DRT representations (“boxes”)

CCG = Combinatory Categorical Grammar

DRT = Discourse Representation Theory

# Example DRS

**saw nothing suspicious**

S[dcI]\NP

$\lambda v0. \lambda v1. (v0 @ \lambda v2. \quad )$

$\neg ( \quad ; (v1 @ e4) )$

thing(x3)  
suspicious(x3)  
see(e4)  
agent(e4, v2)  
patient(e4, x3)

# Shared task: basic idea

1. Run C&C and Boxer to output DRSs for the shared task data
2. Traverse all produced DRSs
3. Every time a negation operator is found, output tokens associated with its scope (and the token triggering it)

# Cue Detection

- Adding new negation triggers (“never”, ...)
- Decomposition of negated words
  - negation prefixes or suffixes
  - nouns, adjectives and adverbs (WordNet)
- Redefine lexical semantics that are not considered triggers (“all”)

# Cue Detection: tokens

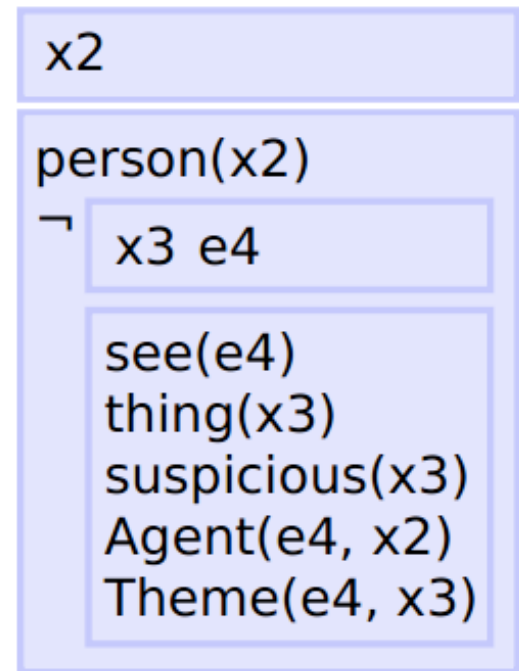
- Use graph structure of DRS to output tokens
- DRG: set of tuples linked to tokens
- All DRSs and conditions are labelled internally
- A negated DRS k1 with condition c1:

...	...	...	...
k1	subordinates:neg	k6	no
k6	concept	c1:problem	
c1:problem	instance	k6:x1	problem
...	...	...	...



# Scope Detection

- Tokens in scope are detected on the basis of the detected negation cue
- Includes tokens directly associated with conditions in the scope of the negation



# Negated Event/Property Detection

- heuristic algorithm that takes a scope and its syntax tree
- first largest VP constituent matching scope
- first verb dominated by this constituent is taken as negated event, except when:
  - modals
  - to be

# Two runs

- Run 1: C&C + Boxer
- Run 2: C&C + Boxer + postprocessing
  - gap filling in scope detection
  - interjections
  - “no doubt” etc.

# First run results

Table 1: Results of the first run (without postprocessing)

Task	gold	system	tp	fp	fn	precision (%)	recall (%)	F1 (%)
Cues:	264	261	219	33	45	86.90	82.95	84.88
Scopes(cue match):	249	261	32	37	217	46.38	12.85	20.12
Scopes(no cue match):	249	261	32	37	217	46.38	12.85	20.12
Scope tokens(no cue match):	1805	1821	1269	552	536	<b>69.69</b>	<b>70.30</b>	<b>69.99</b>
Negated(no cue match):	173	169	89	76	82	53.94	52.05	52.98
Full negation:	264	261	20	33	244	37.74	7.58	12.62
Cues B:	264	261	219	33	45	<b>83.91</b>	<b>82.95</b>	<b>83.43</b>
Scopes B (cue match):	249	261	32	37	217	12.26	12.85	12.55
Scopes B (no cue match):	249	261	32	37	217	12.26	12.85	12.55
Negated B (no cue match):	173	169	89	76	82	52.66	52.05	52.35
Full negation B:	264	261	20	33	244	7.66	7.58	7.62

# Second run results

Table 2: Results of the second run (with postprocessing)

Task	gold	system	tp	fp	fn	precision (%)	recall (%)	F1 (%)
Cues:	264	261	224	28	40	88.89	84.85	86.82
Scopes(cue match):	249	256	102	32	147	76.12	40.96	53.26
Scopes(no cue match):	249	256	102	32	147	76.12	40.96	53.26
Scope tokens(no cue match):	1805	2146	1485	661	320	<b>69.20</b>	<b>82.27</b>	<b>75.17</b>
Negated(no cue match):	173	201	111	85	59	56.63	65.29	60.65
Full negation:	264	261	72	28	192	72.00	27.27	39.56
Cues B:	264	261	224	28	40	<b>85.82</b>	<b>84.85</b>	<b>85.33</b>
Scopes B (cue match):	249	256	102	32	147	39.84	40.96	40.39
Scopes B (no cue match):	249	256	102	32	147	39.84	40.96	40.39
Negated B (no cue match):	173	201	111	85	59	55.22	65.29	59.83
Full negation B:	264	261	72	28	192	27.59	27.27	27.43

# Event/property detection

Table 3: Results of negated event/property detection on gold standard cue and scope annotation

Task	prec.(%)	rec.(%)	F1(%)
Negated (no cue match):	64.06	76.88	69.89
Negated B (no cue match):	59.71	76.88	67.22

# Conclusion

- Off-the-shelf semantic tools (Boxer) works well on previously unseen data for analysing negation
- Most of the engineering time went into matching the formal semantic representation (DRS) into a surface-oriented representation of negation

# Evaluation – focus and scope

- Use just one metric to evaluate negation detection
- Focus on focus
  - Focus should be part of the detected scope
  - Score =  $\frac{\text{\#focus tokens}}{\text{\#scope tokens}}$



# Example

- Gold:  
John did not buy a **red** car.
- System 1: Score =  $1/4 = 0.25$   
John did not [buy a red car].
- System 2: Score =  $1/1 = 1.00$   
John did not buy a [red] car.
- System 3: Score =  $0/3 = 0.00$   
John [did not buy] a red car.

# Meaning Bank – the demo

*A free semantically annotated corpus that anyone can edit!*

- Demo: at 15:30 during the coffee break
- Or go to: [gmb.let.rug.nl](http://gmb.let.rug.nl)

