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Translating Negation: Induction, Search and Model Errors

Federico Fancellu & Bonnie Webber
School of Informatics
University of Edinburgh
f.fancellu@sms.ed.ac.uk, bonnie@inf.ed.ac.uk

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Why bother? - Examples

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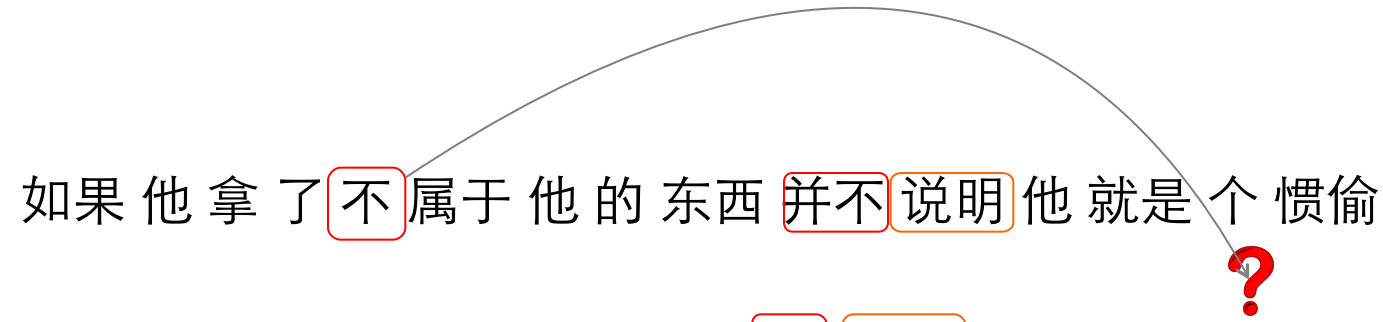

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	Source → Target	Pos	Neg
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- Similar trend for:
  - German → English
  - Czech → English

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What's exactly wrong with negation?

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Potential problem

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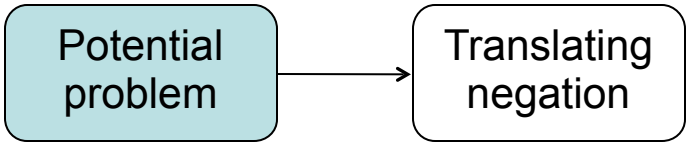

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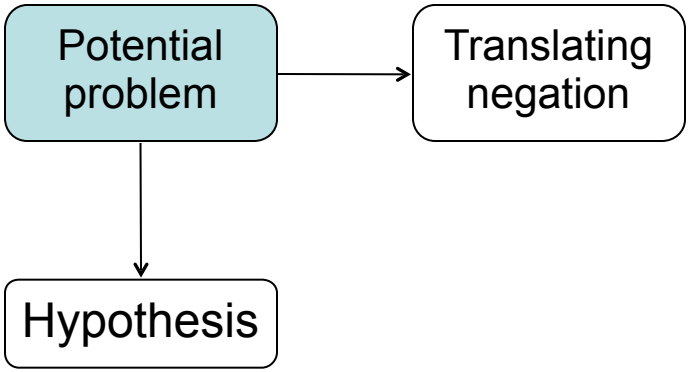

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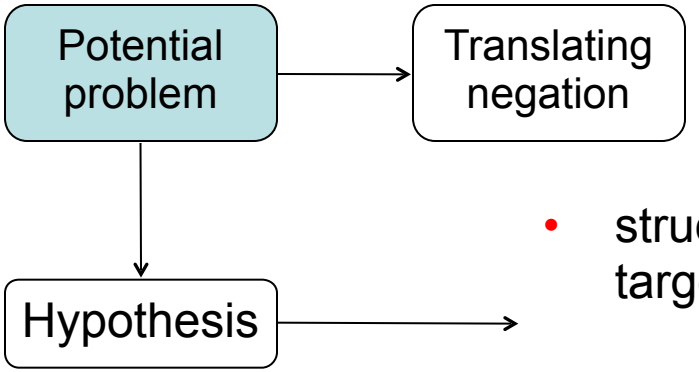

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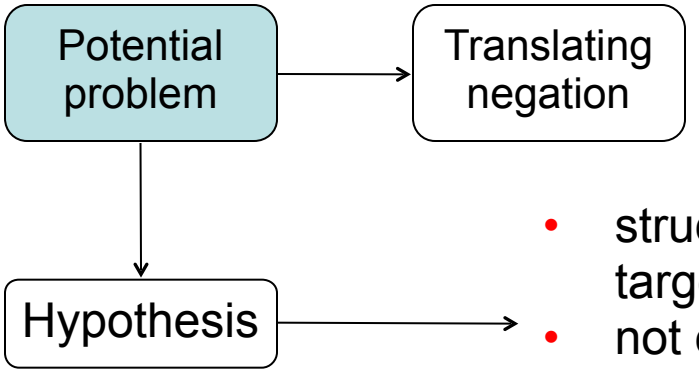

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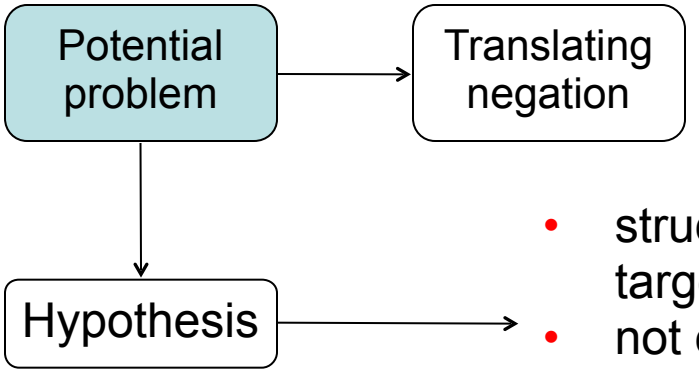

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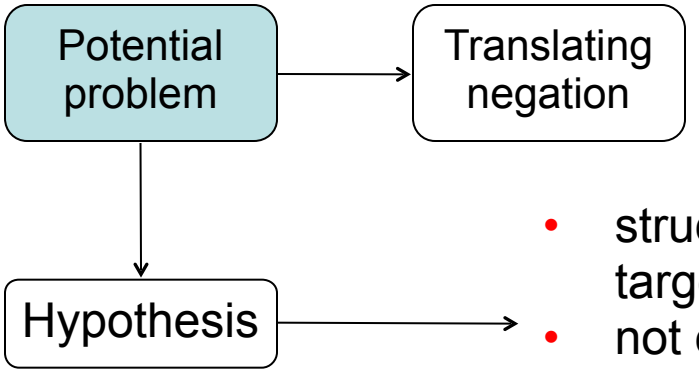

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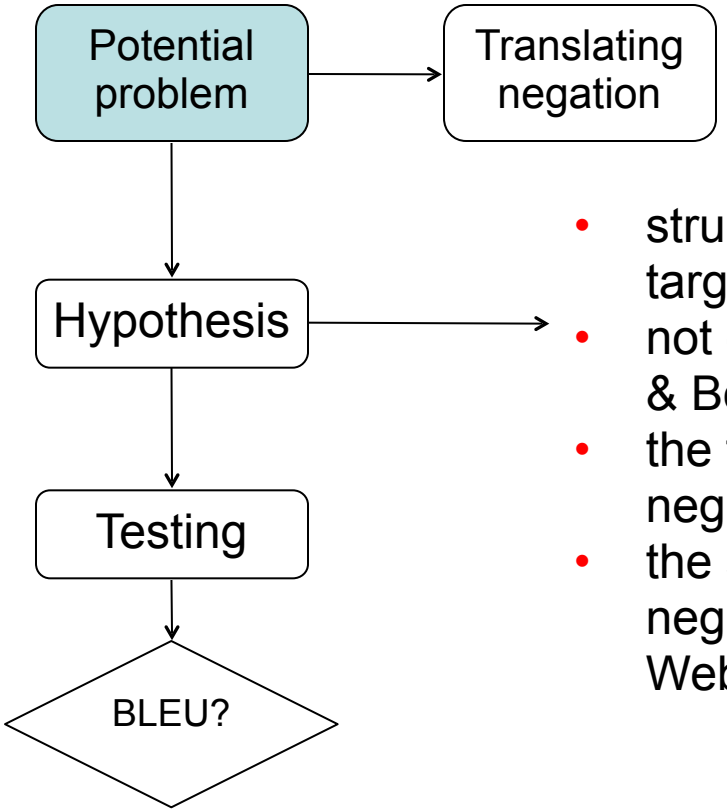

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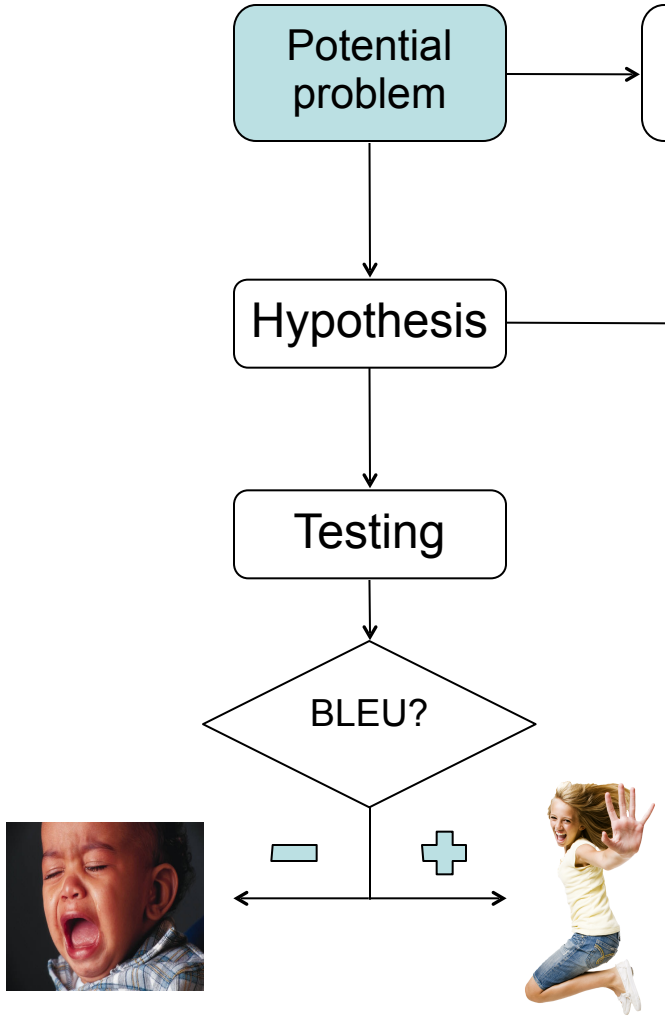

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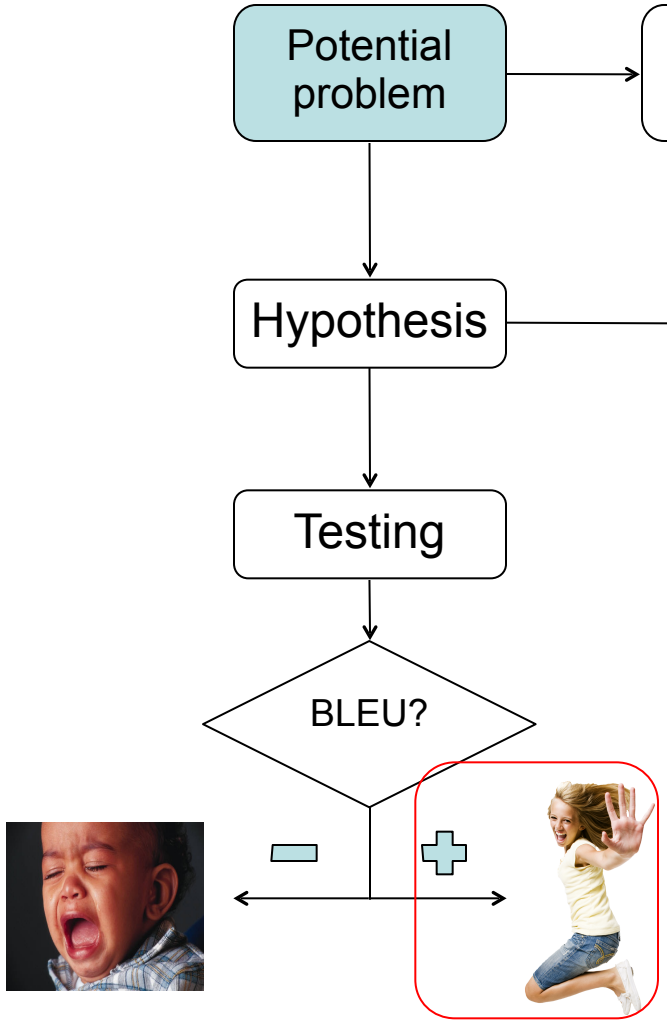

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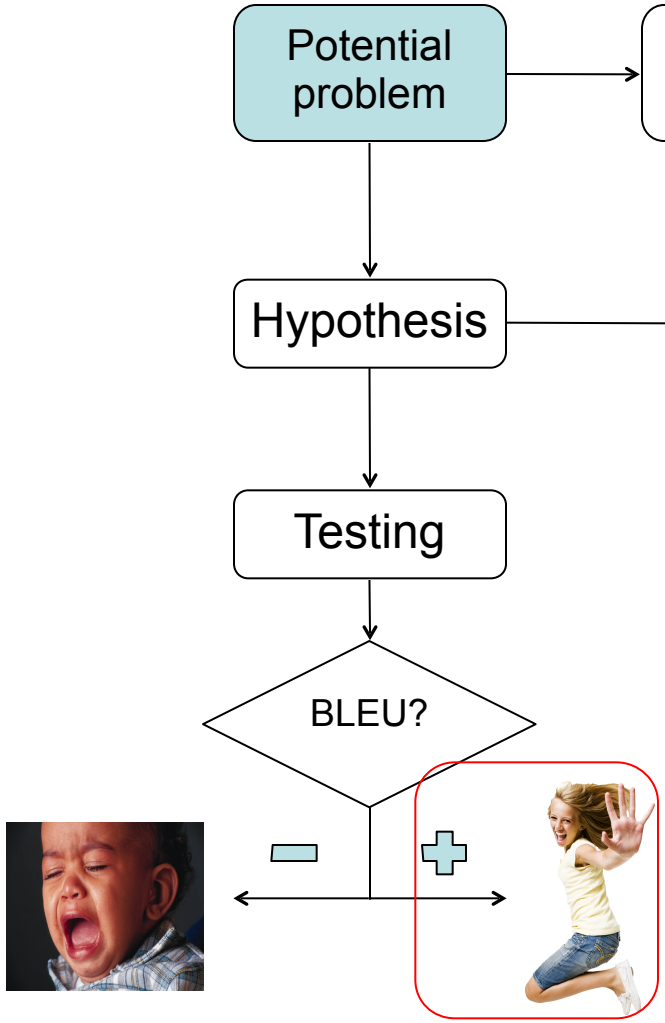

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NO ERROR ANALYSIS

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Rationale

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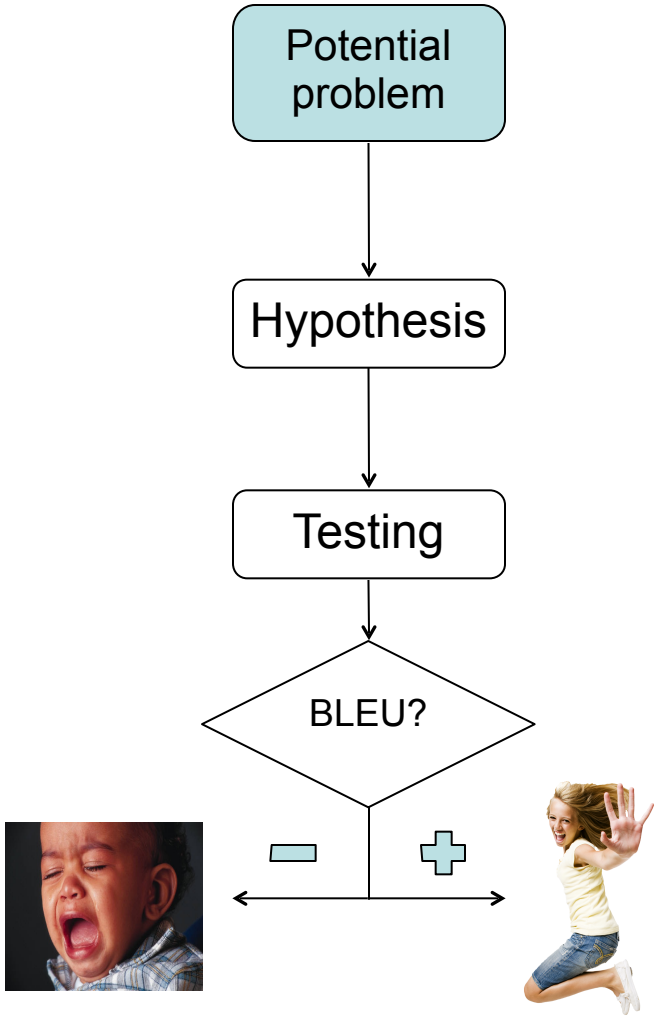

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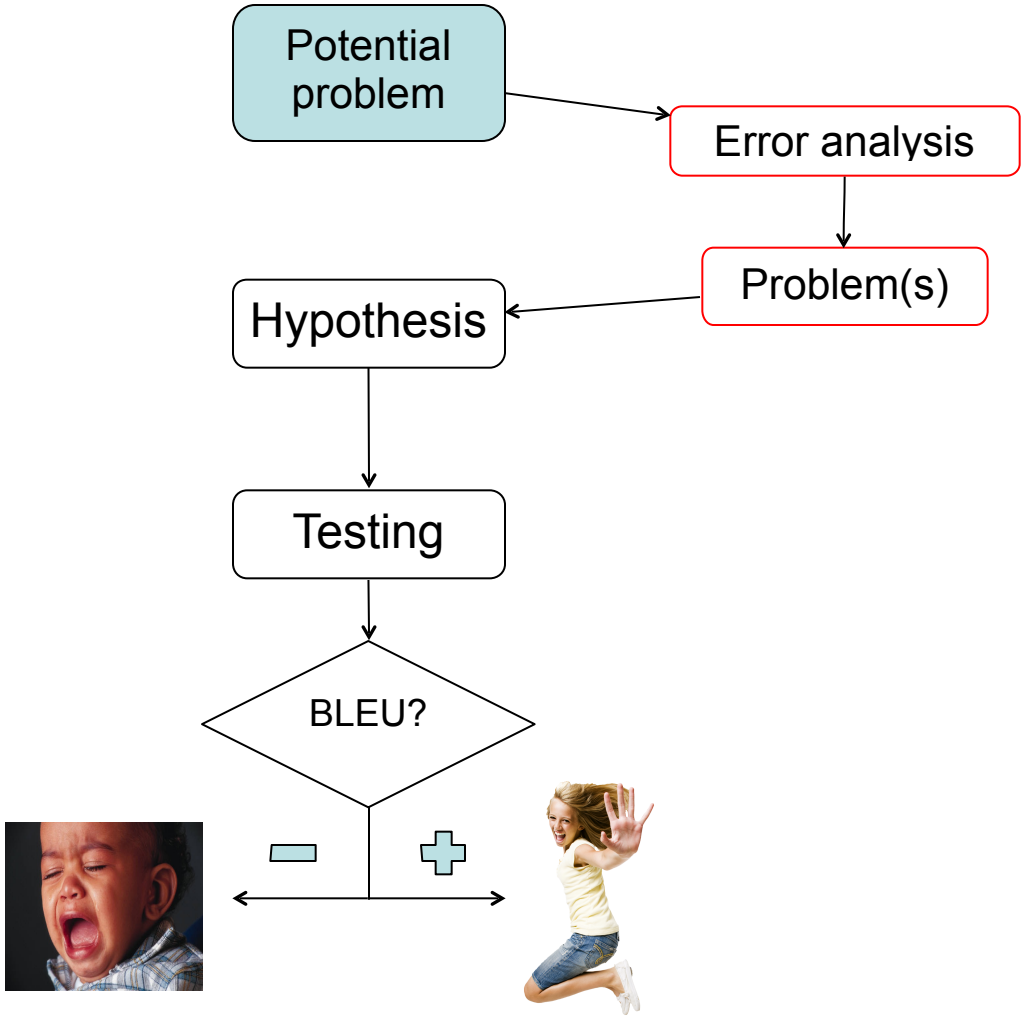
Potential problem
Error analysis
Problem(s)
Hypothesis
Testing
BLEU?

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Contributions

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  - Finding the *causes* of negation-related error during decoding
  - Highlighting the shortcomings of previous techniques
    - Constrained decoding
  - Develop an informative way to analyze the translation of negation at each step during decoding
    - **Chart analysis**

Sub-constituents of negation

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- Scope: all the elements whose falsity would prove negation to be false.
  - The event is included in the scope

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- **Rule/phrase Table**: the best translation cannot be generated because its necessary phrases/rules are absent from the search space → **induction** errors
- **Search space**: the most probable output is absent from the search space → **search** errors
- **Model**: the model scores a sub-optimal translation higher than an optimal one → **model** errors

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- Implemented as a feature in Moses:
  - 1 if the hypothesis is a sub-string of the reference
  - - inf if the hypothesis is not a sub-string of the reference

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the parents of the family are somewhat shameless

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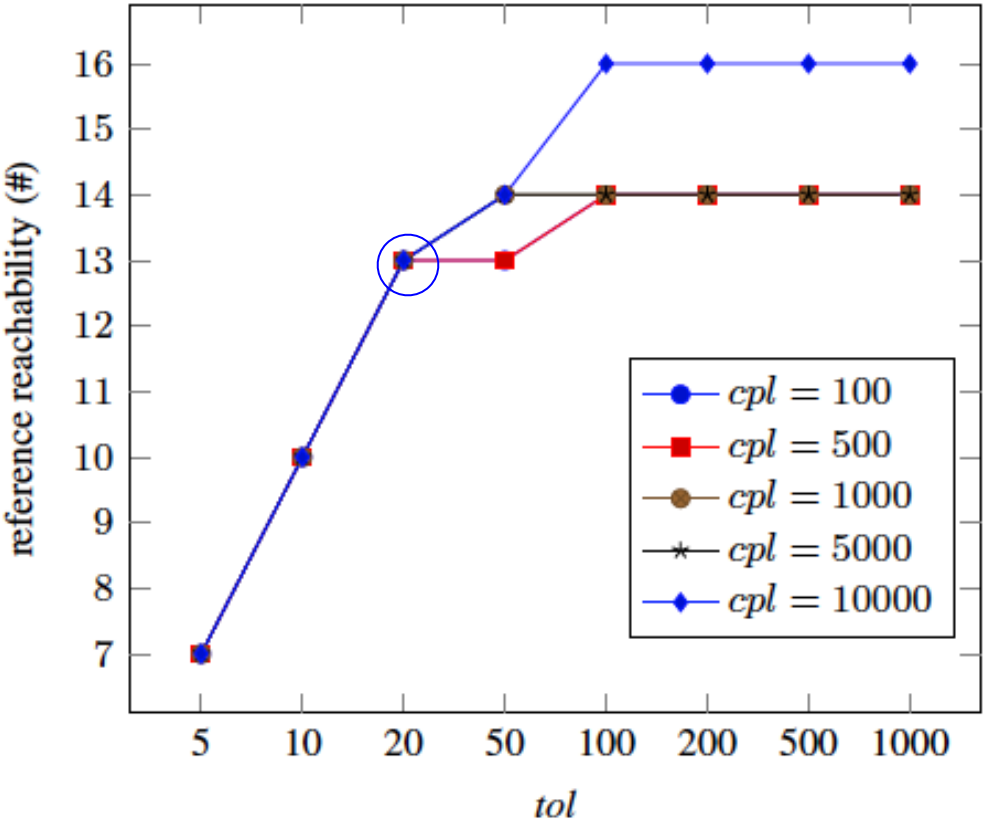
Results


reference reachability (#)
16
15
14
13
12
11
10
9
8
7
5
10
20
50
100
200
500
1000
tol
cpl = 100
cpl = 500
cpl = 1000
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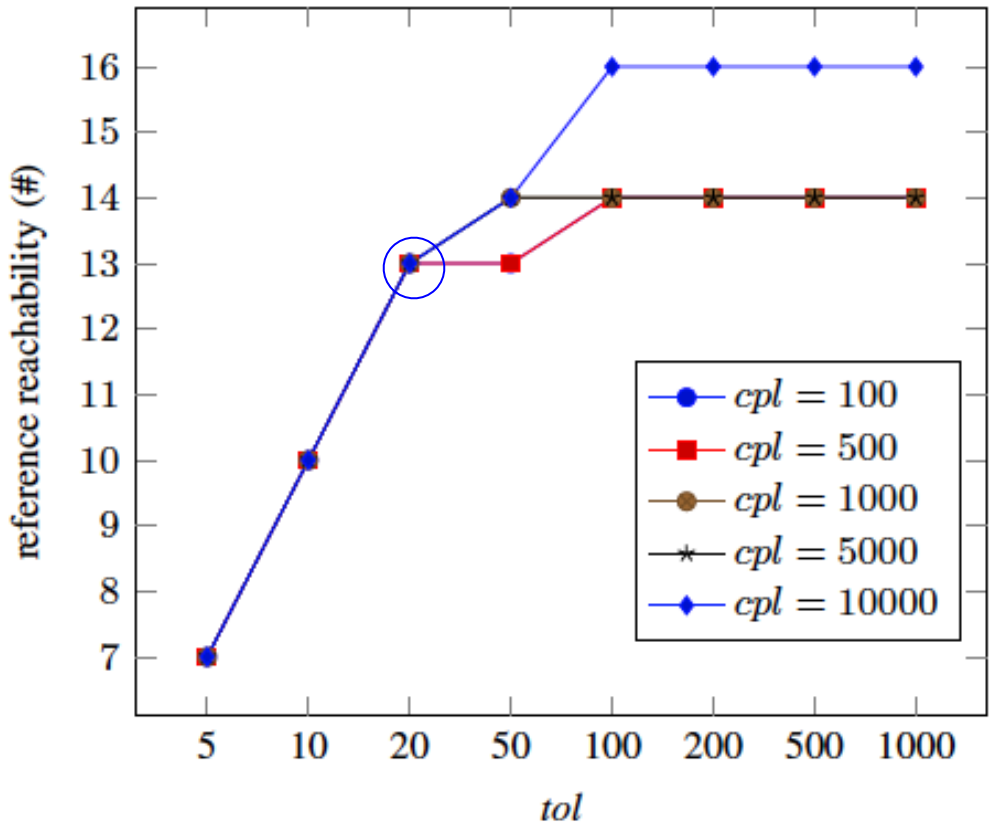

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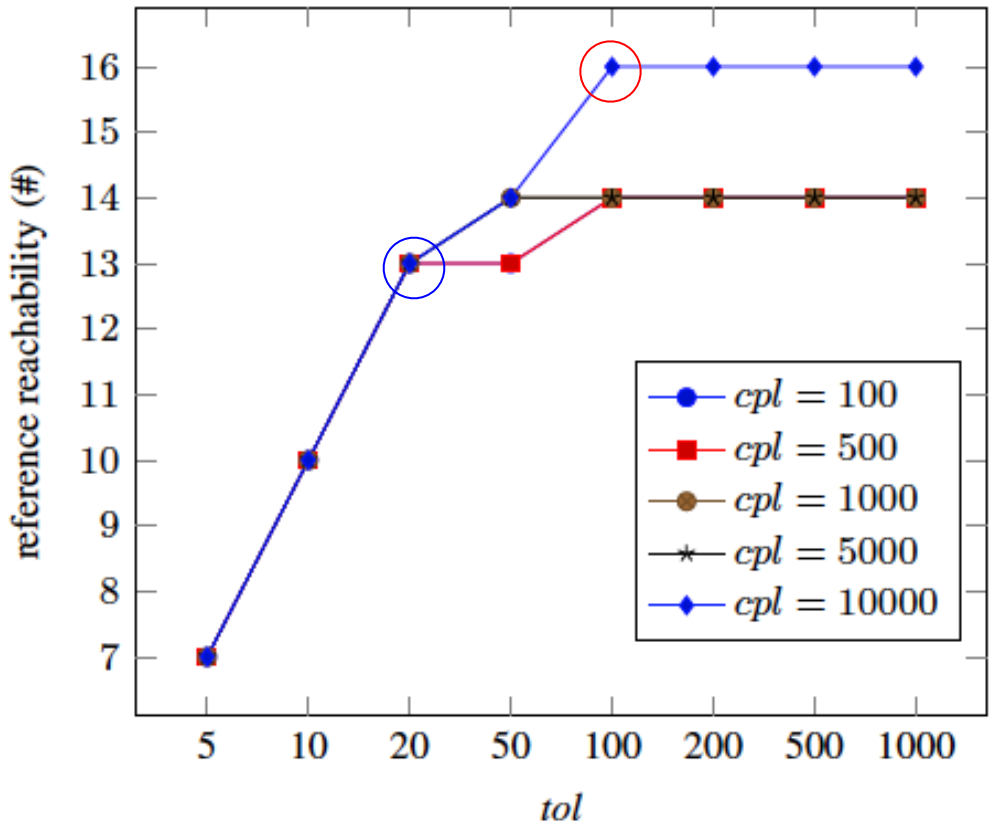

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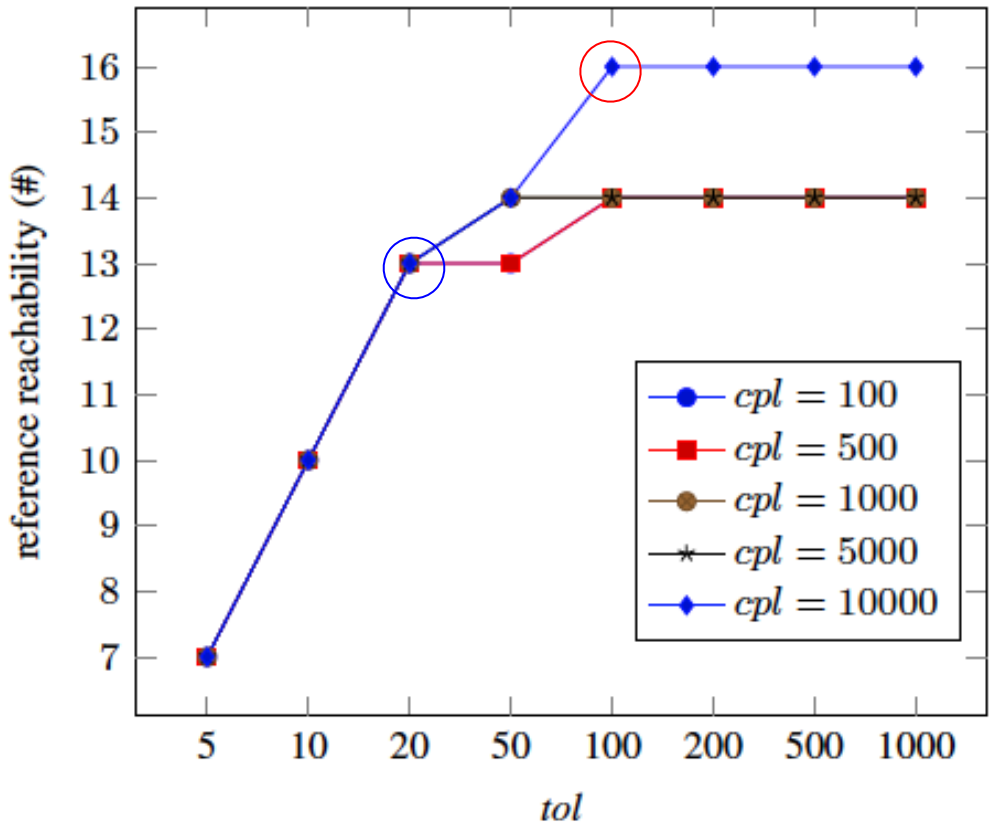

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  - **model** errors

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    - ! CD is based only one or a few references vs. virtually infinite ways of translating a sentence
  - If **model** errors, which score component is the most responsible?
  - CD treats decoding as a “black box”
  - It is hard to connect CD with **deletion** and **reordering** errors

Chart analysis

- Analysis of each step during decoding
- Access to hypothesis stacks and sub-scores
  - In-depth analysis of **model** errors
- We can understand the causes of **deletion** and **reordering** errors
- We can analyze the translation of cue, event and scope separately
- We can analyze patterns of translation amongst these elements

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How does it work?

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- Input → decoding chart trace

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- A good translation of negation needs to meet four conditions:
    1. The cue has to be translated
    2. The event has to be translated
    3. The cue has to refer to the right event
    4. The scope elements should be placed in the correct negation scope

How does it work?

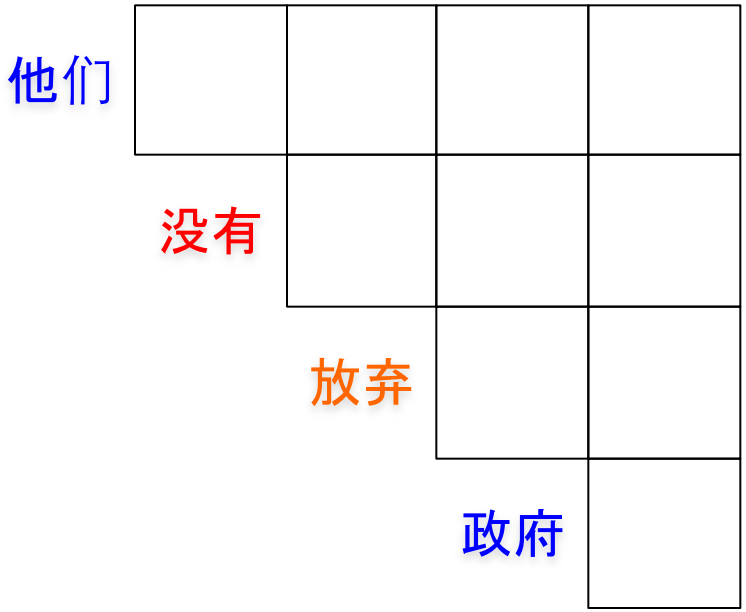
- Input → decoding chart trace
- A good translation of negation needs to meet four conditions:

deletion
1. The cue has to be translated
2. The event has to be translated

reordering
3. The cue has to refer to the right event
4. The scope elements should be placed in the correct negation scope

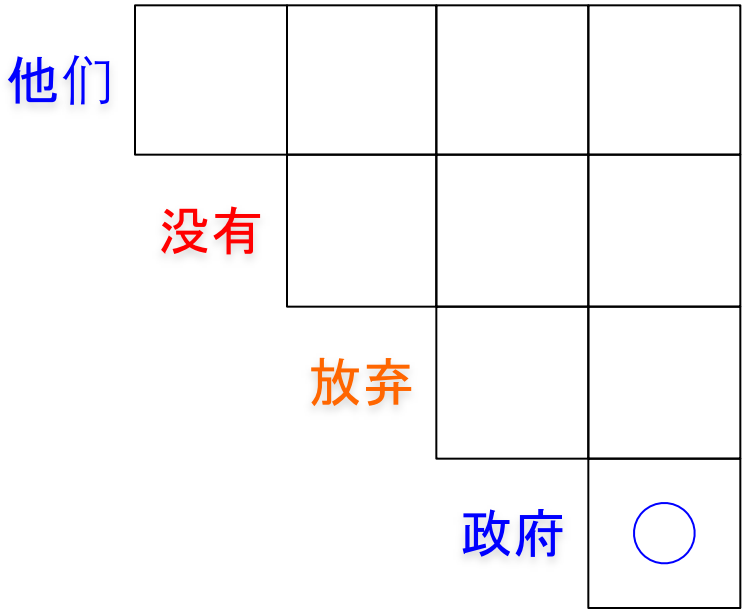
How does it work? – Cont'd

- Assuming we know the elements of negation on the source, the cell has to satisfy a given condition if it cover one or more of those elements



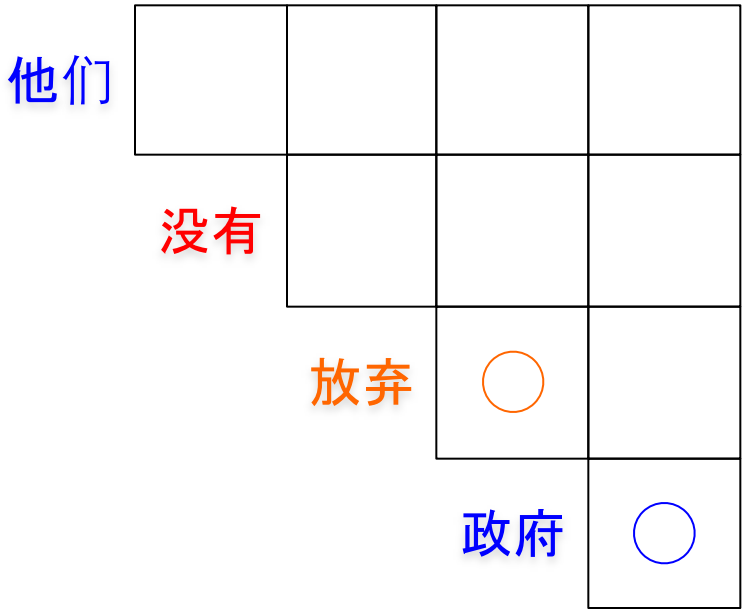
How does it work? – Cont'd

- Assuming we know the elements of negation on the source, the cell has to satisfy a given condition if it cover one or more of those elements



How does it work? – Cont'd

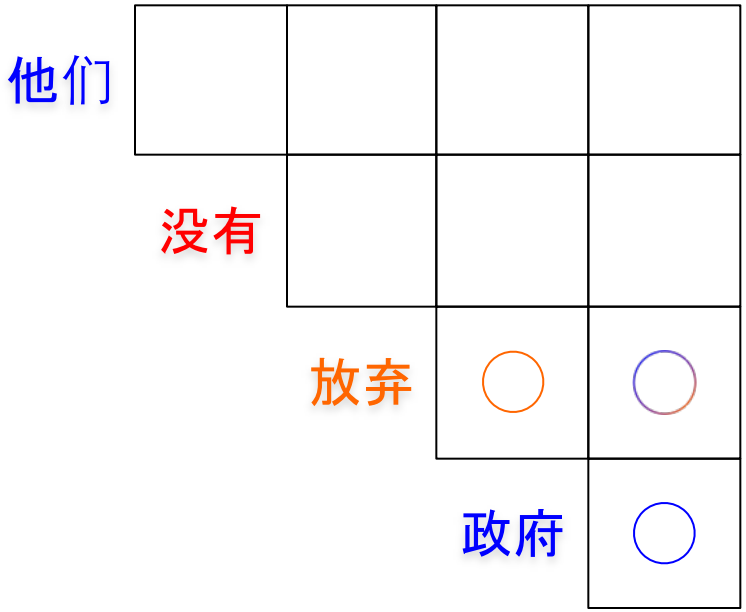
- Assuming we know the elements of negation on the source, the cell has to satisfy a given condition if it cover one or more of those elements



event needs to be translated

How does it work? – Cont'd

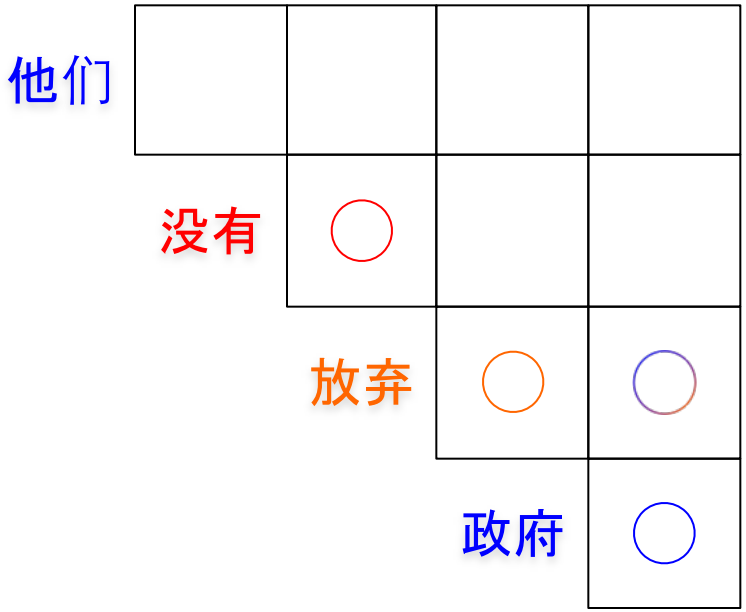
- Assuming we know the elements of negation on the source, the cell has to satisfy a given condition if it cover one or more of those elements



scope element attached to the right
event

How does it work? – Cont'd

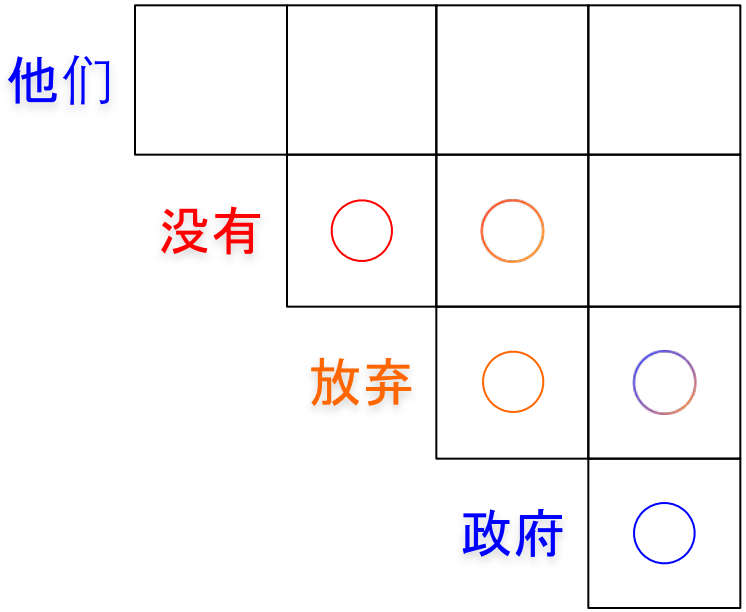
- Assuming we know the elements of negation on the source, the cell has to satisfy a given condition if it cover one or more of those elements



cue needs to be translated

How does it work? – Cont'd

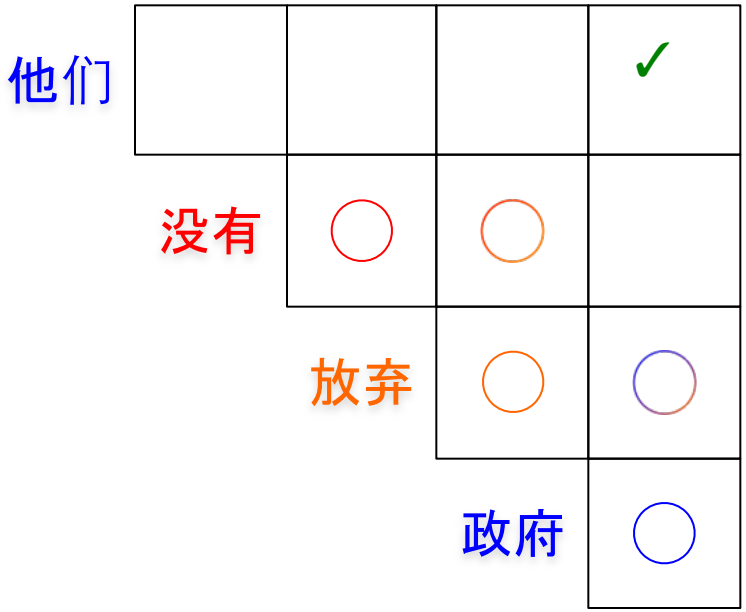
- Assuming we know the elements of negation on the source, the cell has to satisfy a given condition if it cover one or more of those elements



cue should refer to the right event

How does it work? – Cont'd

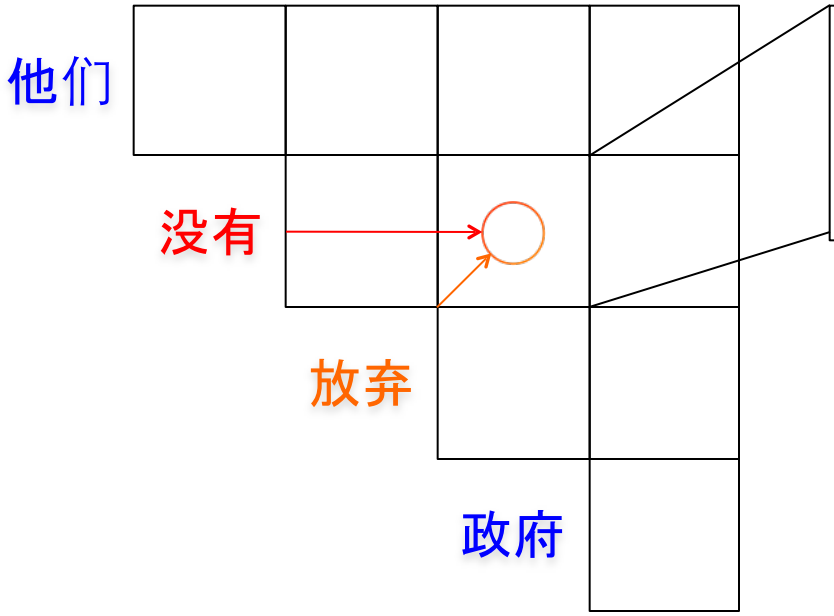
- Assuming we know the elements of negation on the source, the cell has to satisfy a given condition if it cover one or more of those elements



All elements should be translated and should correctly related to each other

Stack analysis – model errors

- Analysis whether a component is more responsible for **model** errors



1. gave up | p(e|f) p(f|e) p(LM) $p_{lex.}$ … ✖
2. not | p(e|f) p(f|e) p(LM) $p_{lex.}$ …

[…] ✓

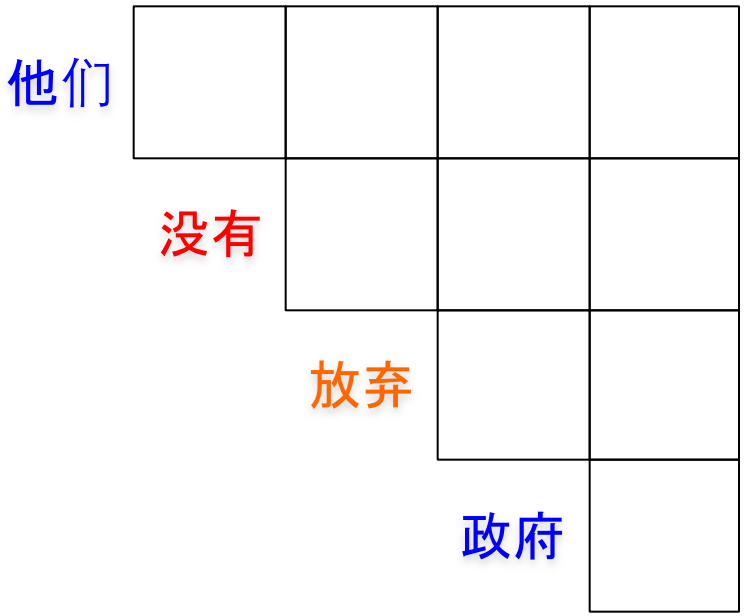
10: did not give up | p(e|f) p(f|e) p(LM) $p_{lex.}$ …

10 meets all conditions, 1 does not

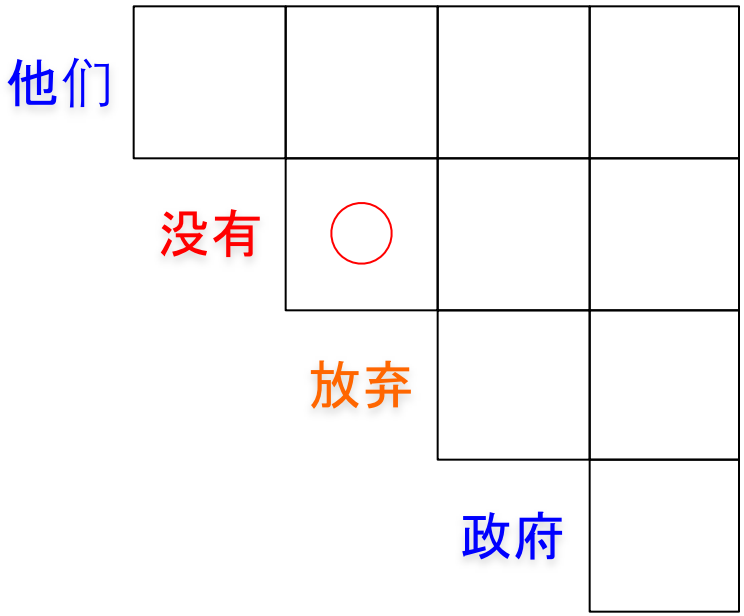
1: p(e|f) p(f|e) p(LM) p_{lex}(e|f) p_{lex}(e|f)

10: p(e|f) p(f|e) p(LM) p_{lex}(e|f) p_{lex}(e|f)

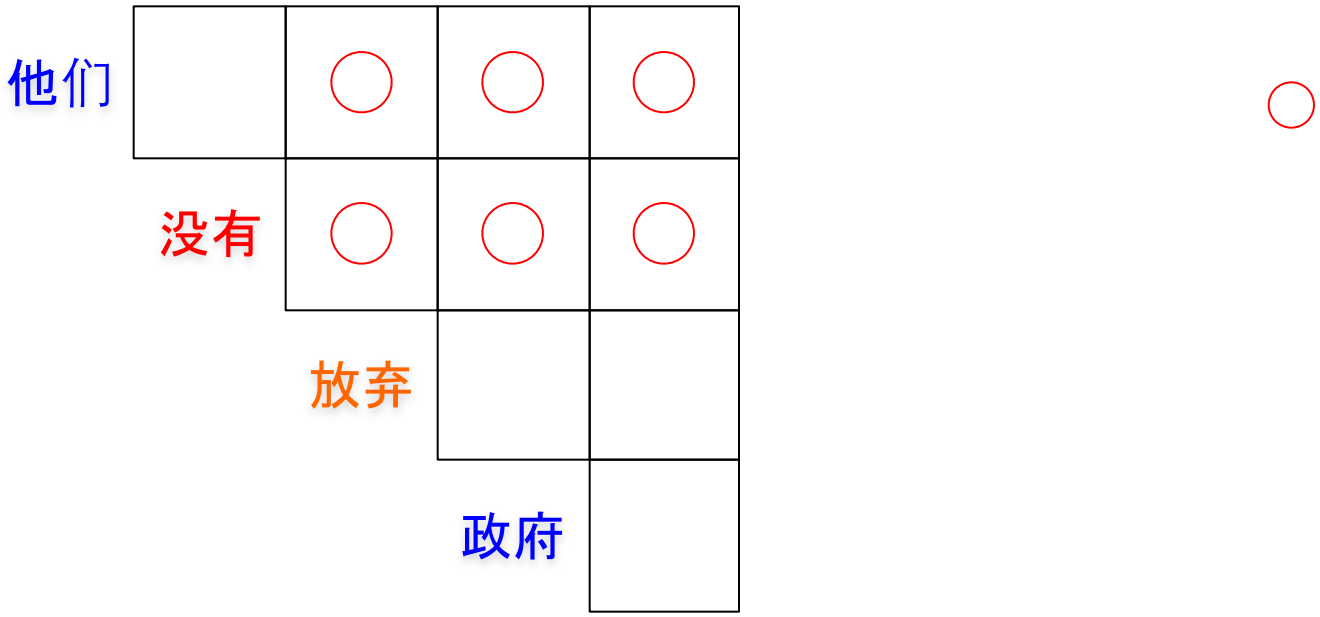
Stack analysis – search/induction errors



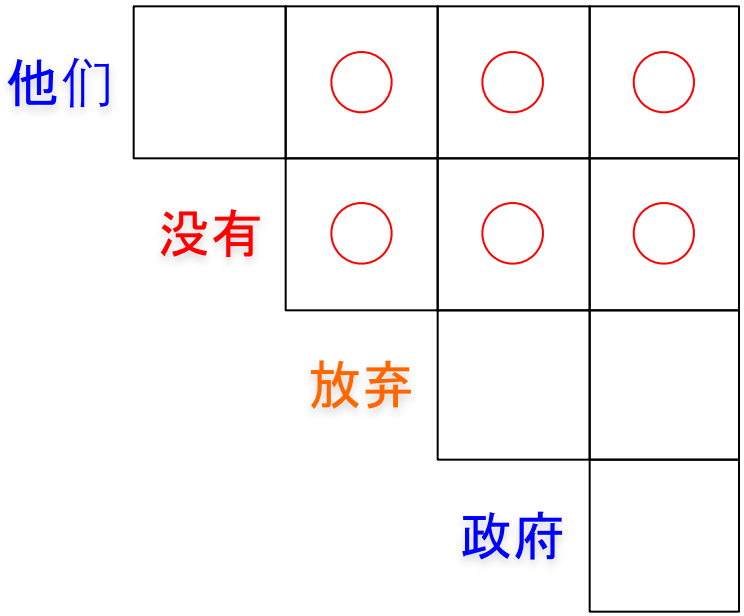
Stack analysis – search/induction errors



Stack analysis – search/induction errors

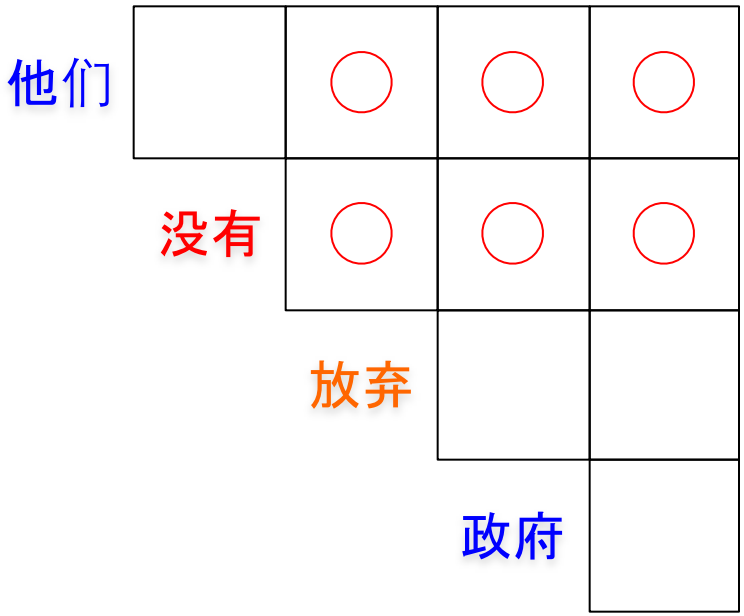


Stack analysis – search/induction errors



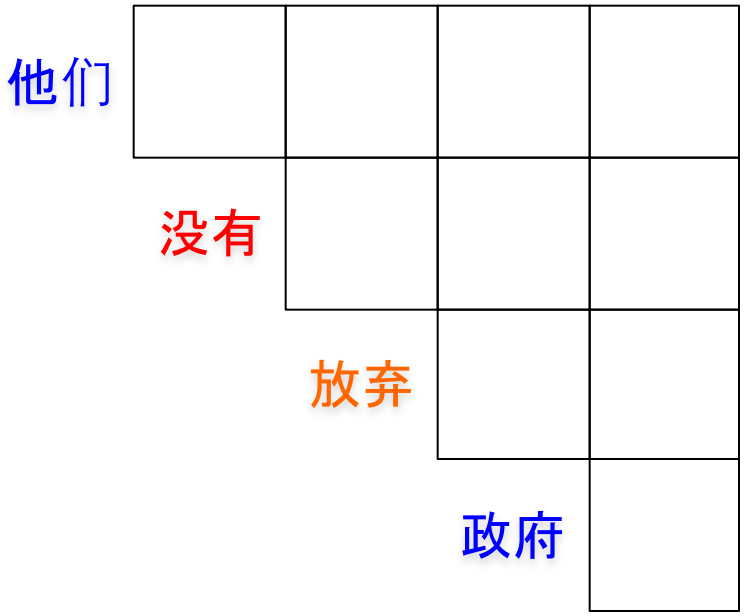
- cue has to be translated in all cells marked with ○

Stack analysis – search/induction errors

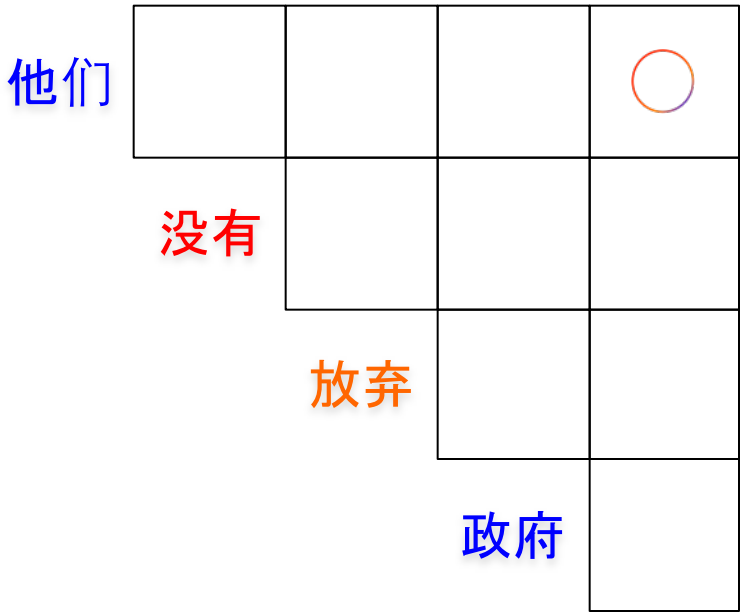


- cue has to be translated in all cells marked with ◯
- If no cue is found in any of these cells:
  - Modify *translation option limit* and *cube pruning pop limit* to assess the presence of **search** and **model** errors
- Same applies to the other two elements

Stack analysis – others/ongoing

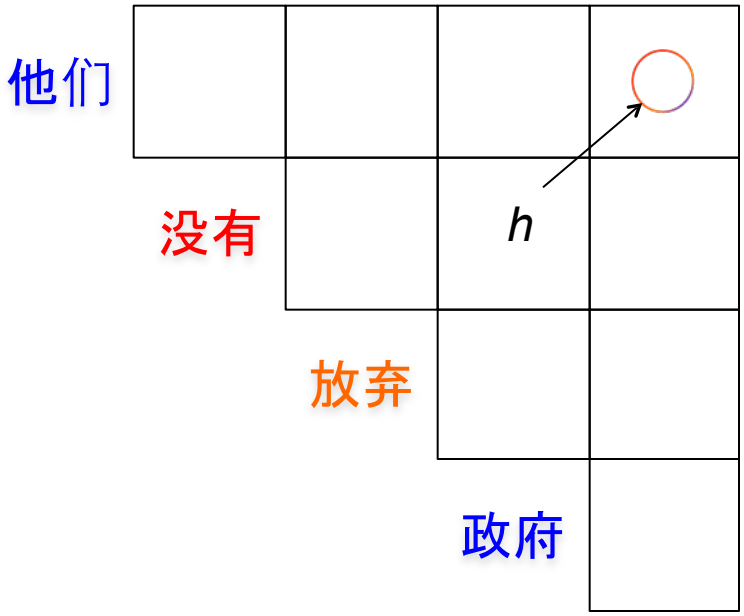


Stack analysis – others/ongoing



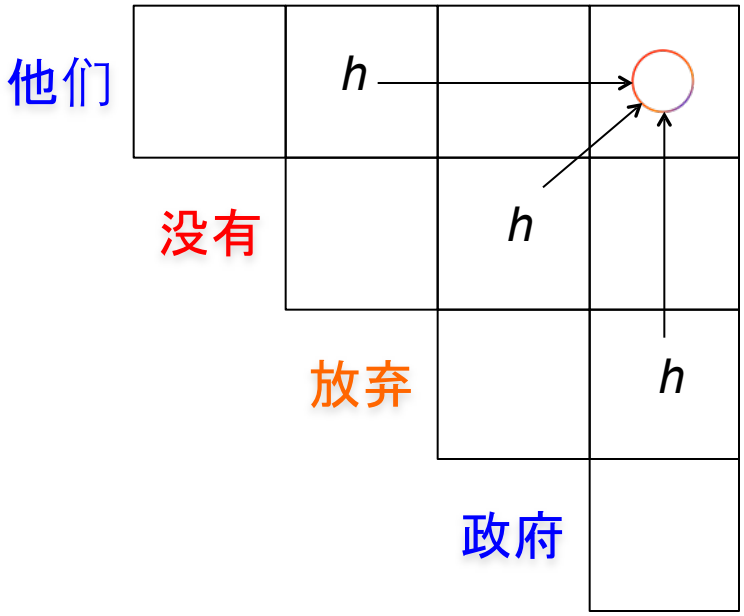
- Rule trace to study negation element combinatory tendencies

Stack analysis – others/ongoing



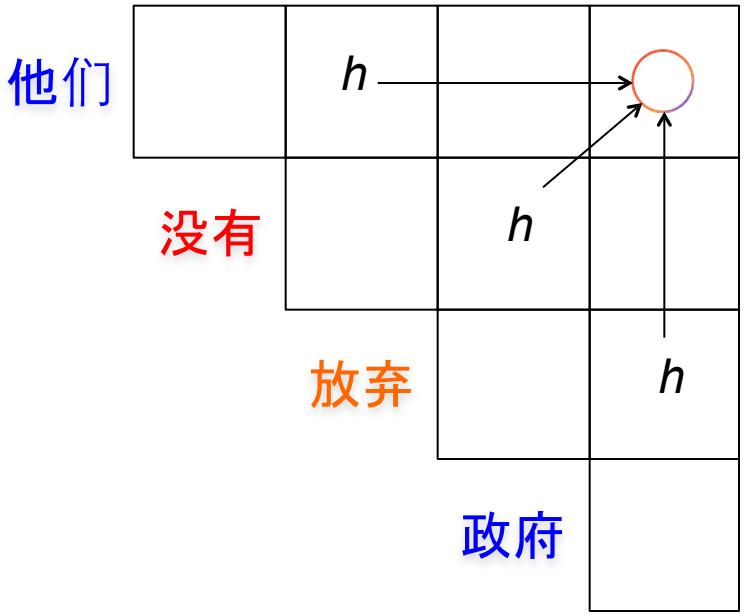
- Rule trace to study negation element combinatory tendencies
- Is cue translated along side the event?

Stack analysis – others/ongoing



- Rule trace to study negation element combinatory tendencies
- Is cue translated along side the event?
- Is cue and event translated separately and combined together via glue rules?

Stack analysis – others/ongoing



- Rule trace to study negation element combinatory tendencies
- Is cue translated along side the event?
- Is cue and event translated separately and combined together via glue rules?
- What about event and scope?

Negation detection

- Source → annotations from manual error analysis
- Target?

1. gave up ||| […]
2. not ||| […]

10: did not give up ||| […]

[…]

25: he did not give up ||| […]

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cue

Not
No
Neither
Impossible
By no means
[…]

*CRF (F1 > 90%)

Negation detection

- Source → annotations from manual error analysis
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1. gave up ||| […]
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No
Neither
Impossible
By no means
[…]

*CRF (F1 > 90%)

Negation detection

- Source → annotations from manual error analysis
- Target?

??

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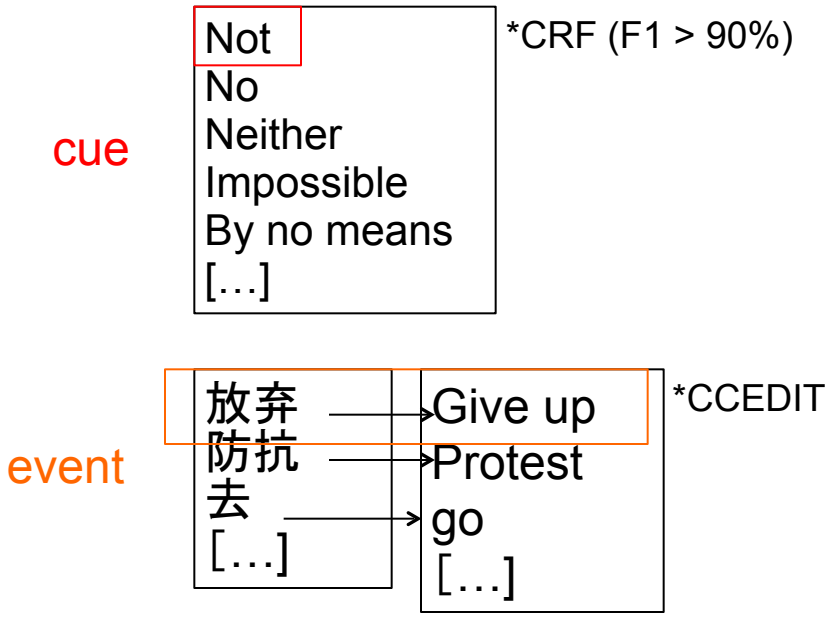
2. not ||| […]

10: did not give up ||| […]

[…]

25: he did not give up ||| […]



Negation detection

- Source → annotations from manual error analysis
- Target?

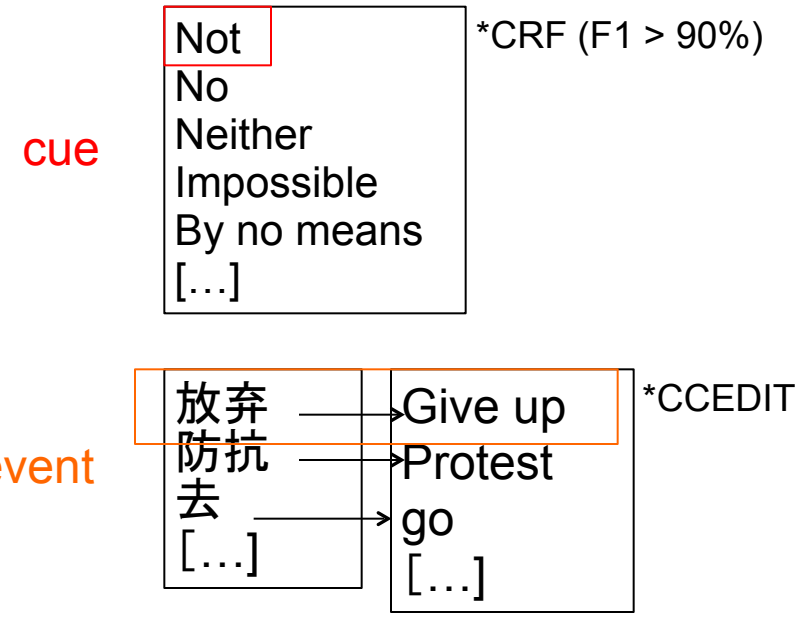
??

1. gave up ||| […]
2. not ||| […]

10: did not give up ||| […]

[…]

25: he did not give up ||| […]



Negation detection

- Source → annotations from manual error analysis
- Target?

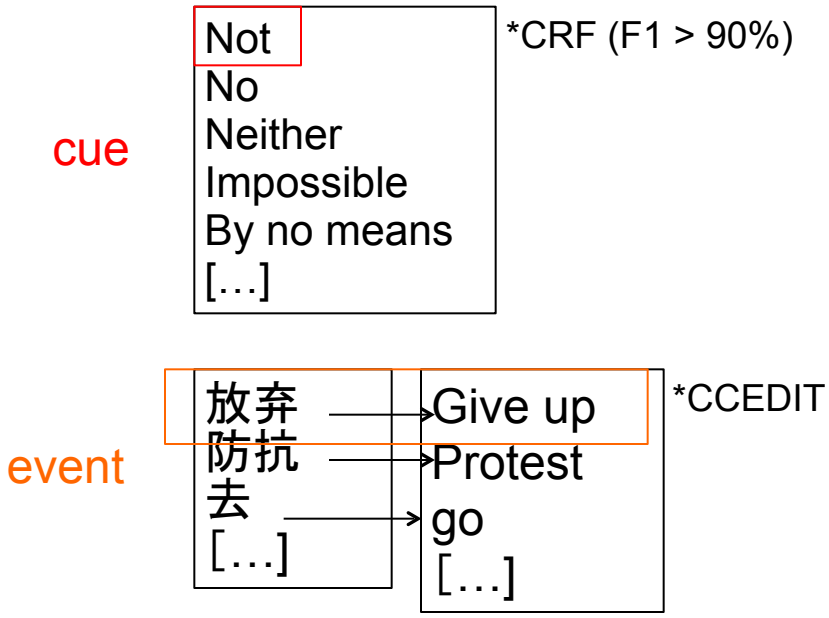
??

1. gave up ||| […]
2. not ||| […]

10: did not give up ||| […]

[…]

25: he did not give up ||| […]



- Better approach: **paraphrase + automatic negation detection** (see Future Work)

System and initial results

- System:
  - Zh → En HIERO; 54 sentences containing negation (from the *manual* error analysis)
- Results:
  - Errors related to the translation of the cue
  - The cue is *never* absent from the chart of *any* sentence
    - no **search** or **induction error**
  - Analysis of the model sub-scores:
    - **Indirect probabilities** (translation and lexical) are responsible for > 60% of bad-ranking
    - **LM** only 25%

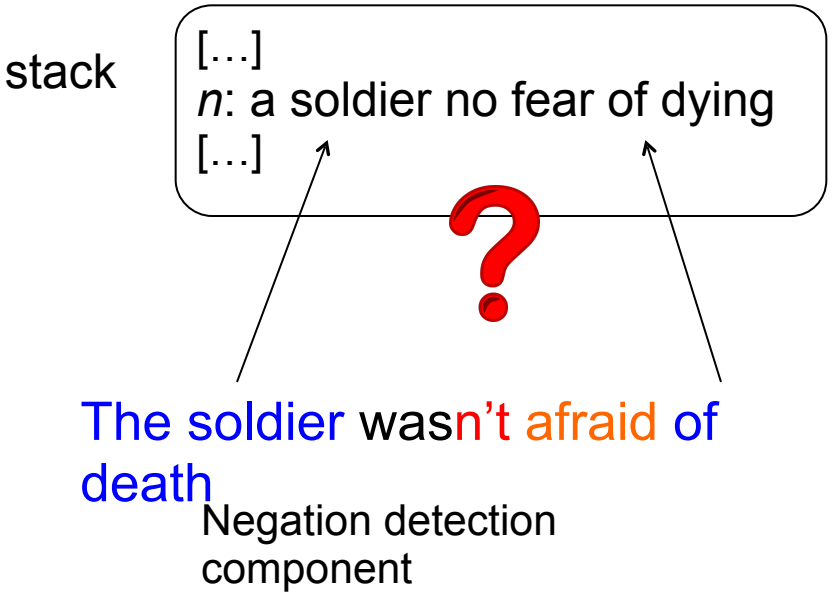
Conclusion

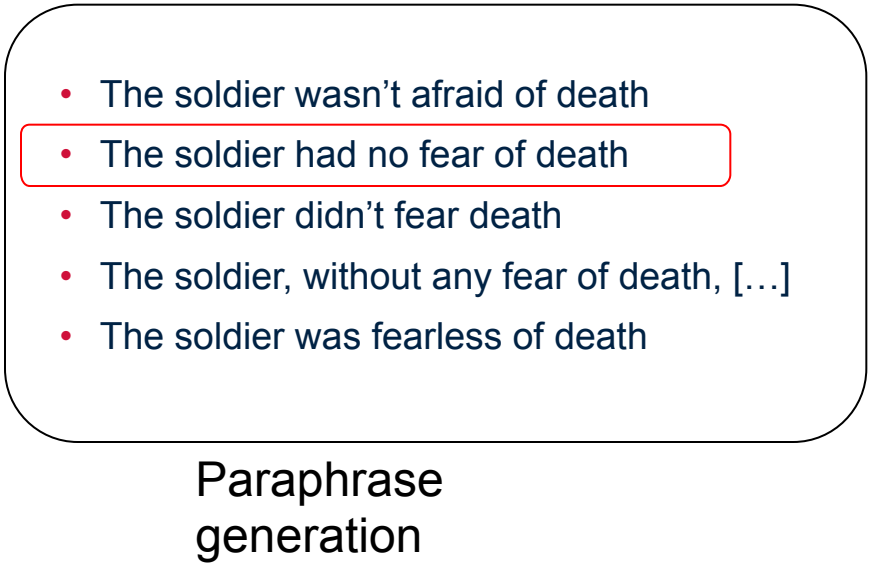
- Translating negation is problematic
- Previous error detection techniques do not offer an in-depth analysis
- A chart analysis offers a better insight in the decoding process

	Model	Search	Induction
Cue	Y	N	N
Event	…	…	…
Scope	…	…	…

Future Work

- Negation detection in the target hypothesis
- No **list!** How to leverage a **reference** translation?





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Thank you!