Composing Conversational Negation

Razin Shaikh, Lia Yeh, Benjamin Rodatz, Bob Coecke

ACT 2021

Overview

Compositional distributional semantics

Conversational negation

- Words (SemSpace 2021, arXiv:2105.05748)
- Sentences
- Evolving meanings

Overview

Compositional distributional semantics

Conversational negation

Words (SemSpace 2021, arXiv:2105.05748)

Sentences

Evolving meanings

Compositional distributional semantics – DisCoCat

Compositional distributional semantics – DisCoCat

Meaning

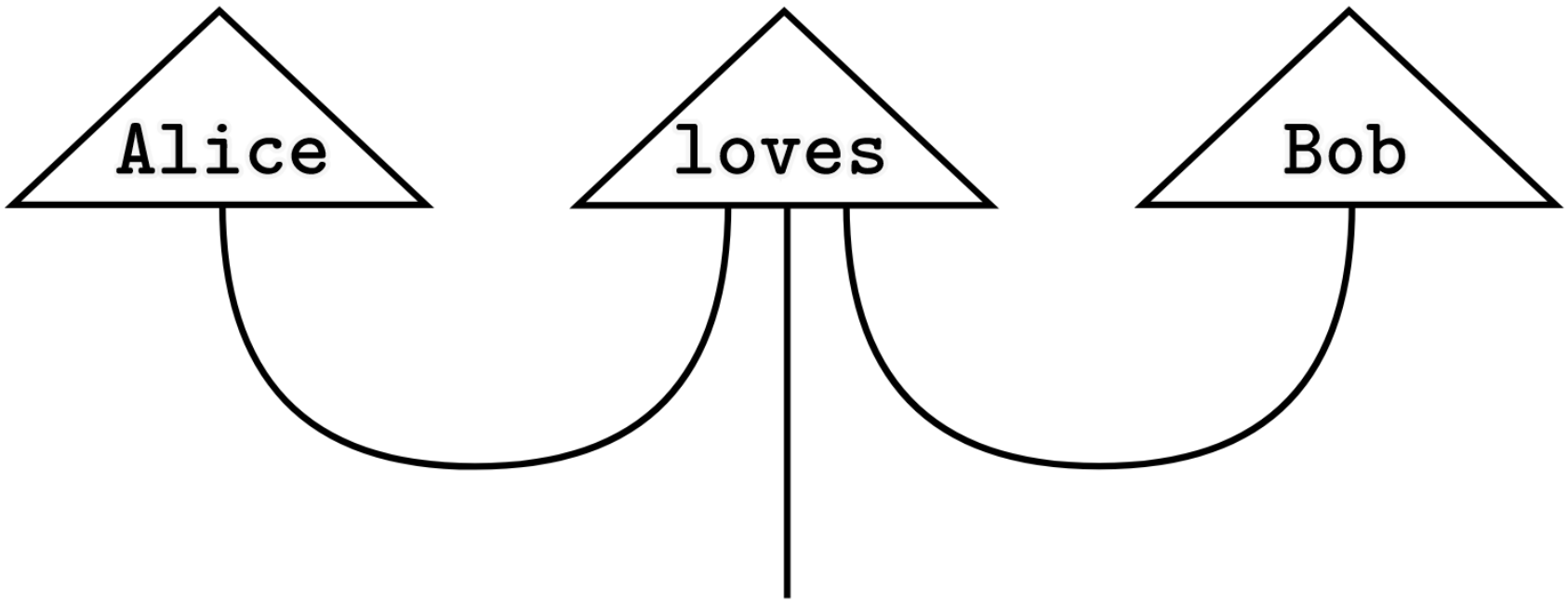
Compositional distributional semantics – DisCoCat

Grammar

Meaning

Compositional distributional semantics – DisCoCat

Meaning of words to meaning of sentence



DisCoCat

words to
sentence

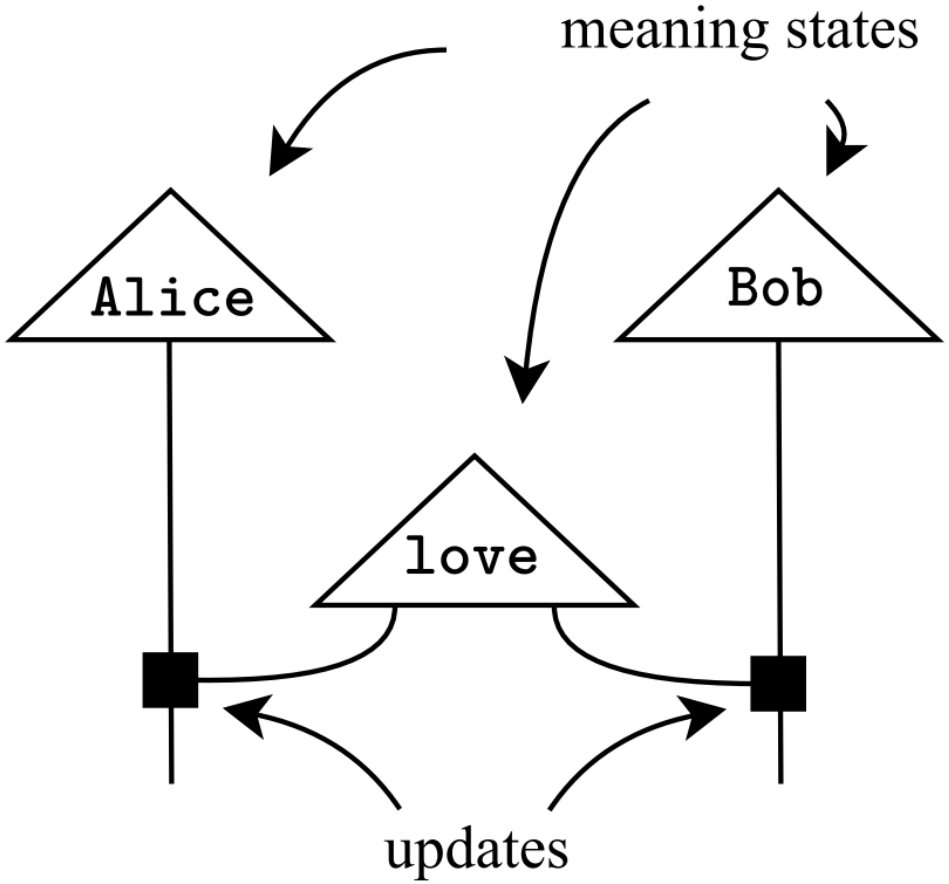
DisCoCat

words to sentence

DisCoCirc

sentences to text

DisCoCirc



Overview

Compositional distributional semantics

Conversational negation

Words (SemSpace 2021, arXiv:2105.05748)

Sentences

Evolving meaning

This is **not** a hamster ; this is a …

This is **not** a hamster ; this is a …

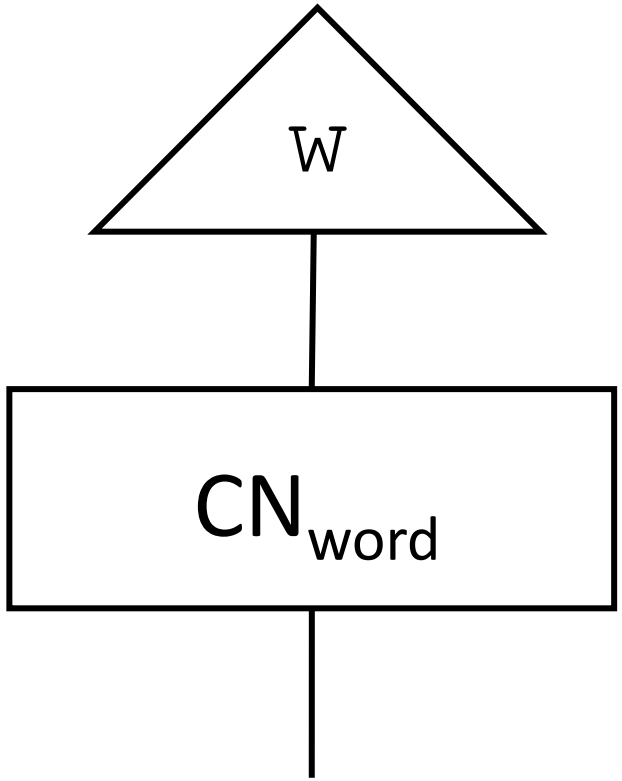
Planet

This is **not** a hamster ; this is a …

Planet

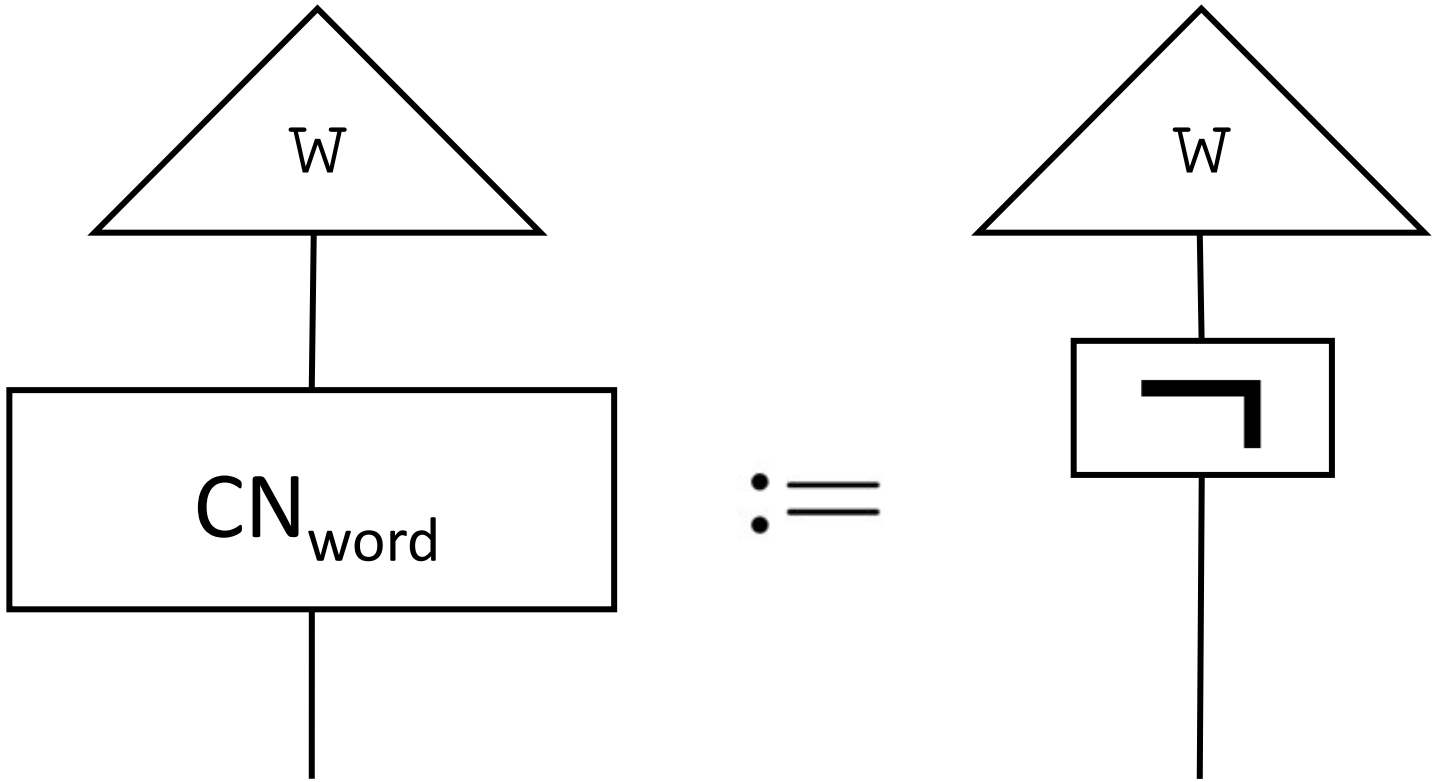
Guinea pig

Conversational negation of words



Benjamin Rodatz, Razin A. Shaikh, and Lia Yeh. "Conversational Negation using Worldly Context in Compositional Distributional Semantics" *SemSpace* 2021

Conversational negation of words



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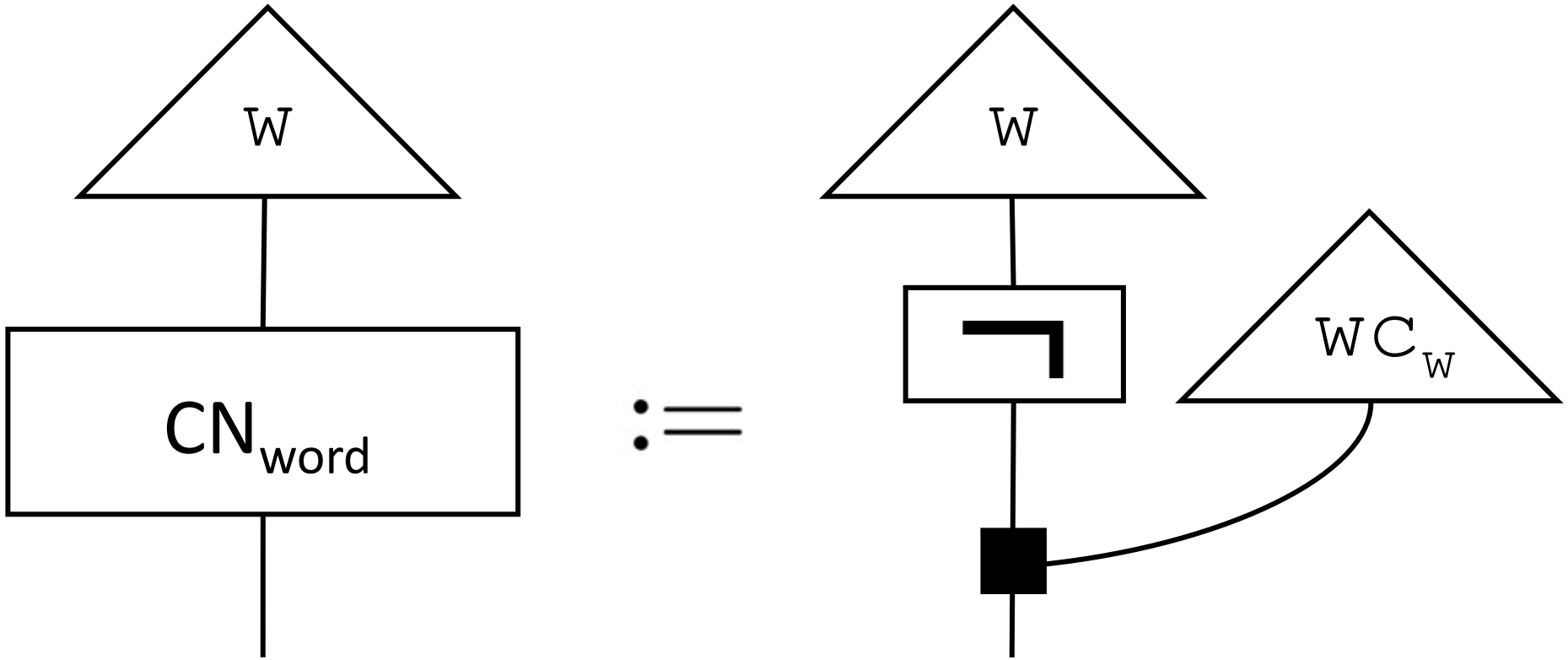
Conversational negation of words



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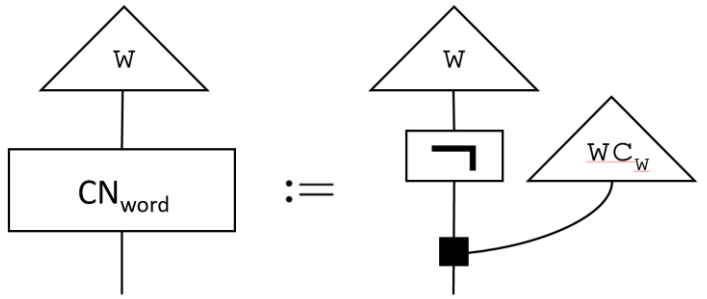
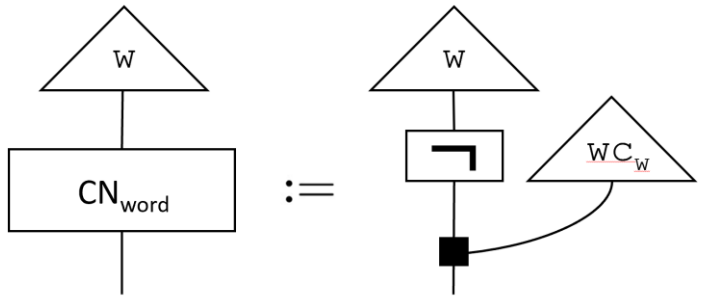
Worldly context for negation of words



Worldly context for negation of words

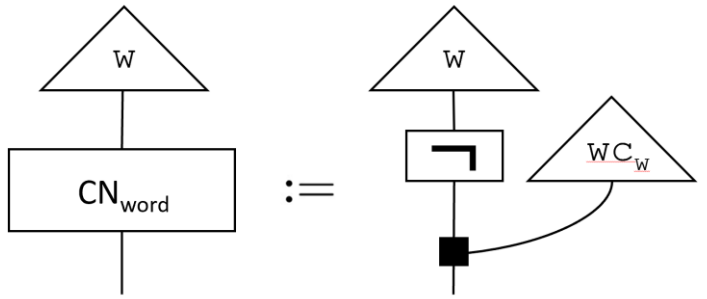
Rodent



Worldly context for negation of words

Animal

Rodent

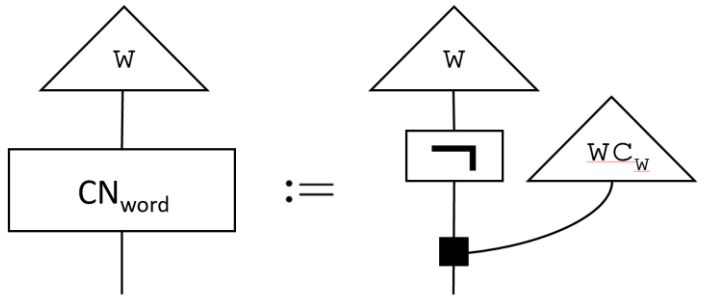


Worldly context for negation of words

Entity

Animal

Rodent

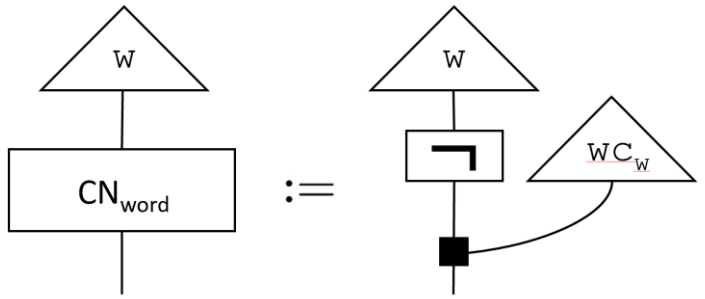


Worldly context for negation of words

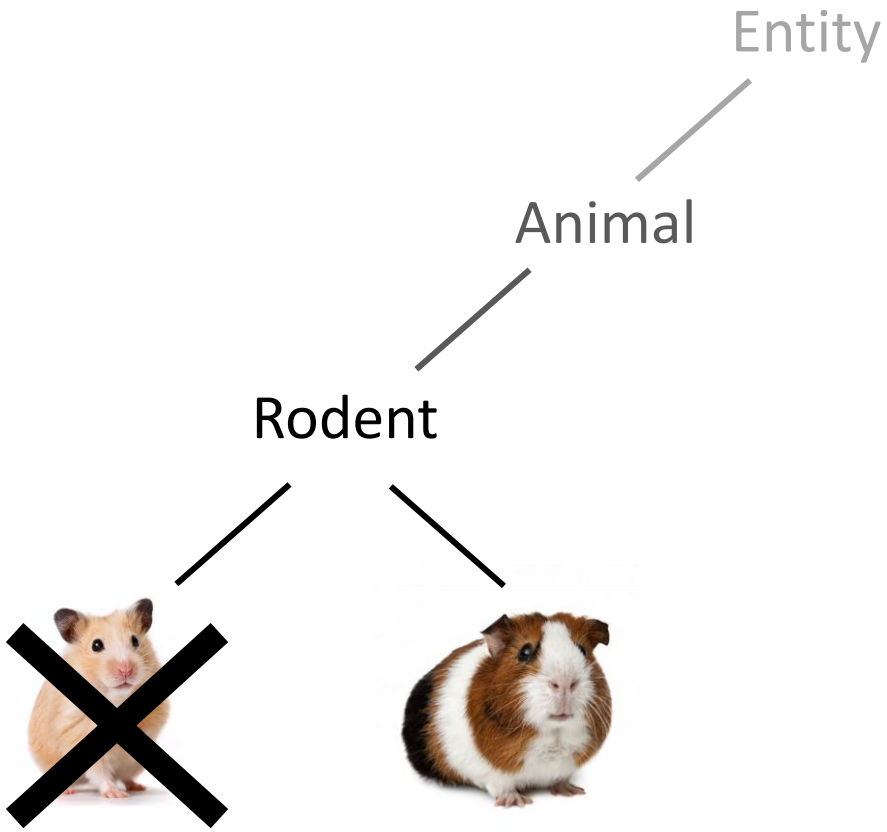
Entity

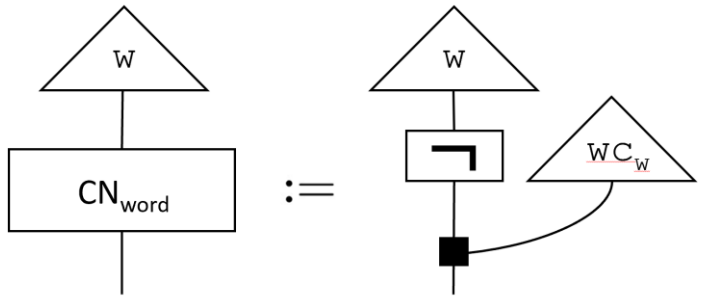
Animal

Rodent



Worldly context for negation of words





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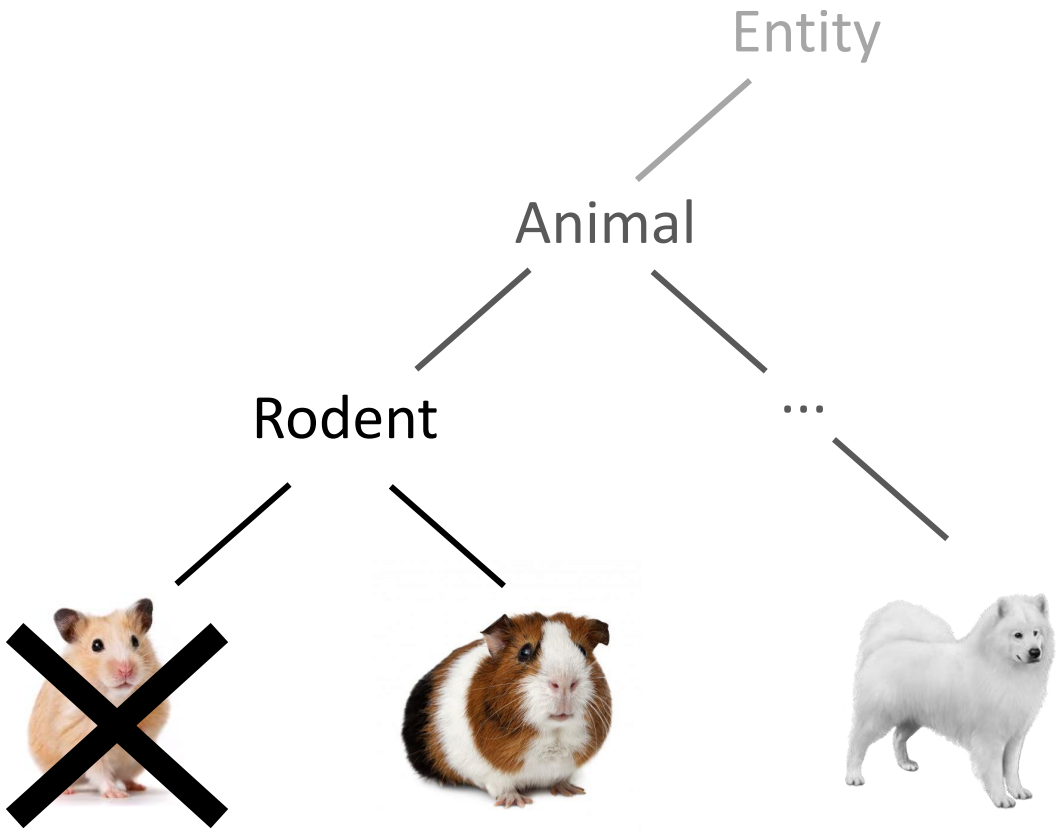

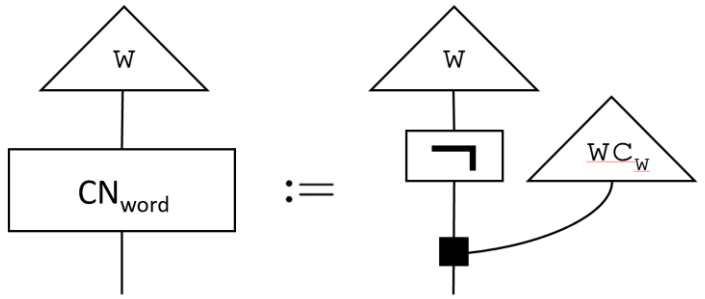

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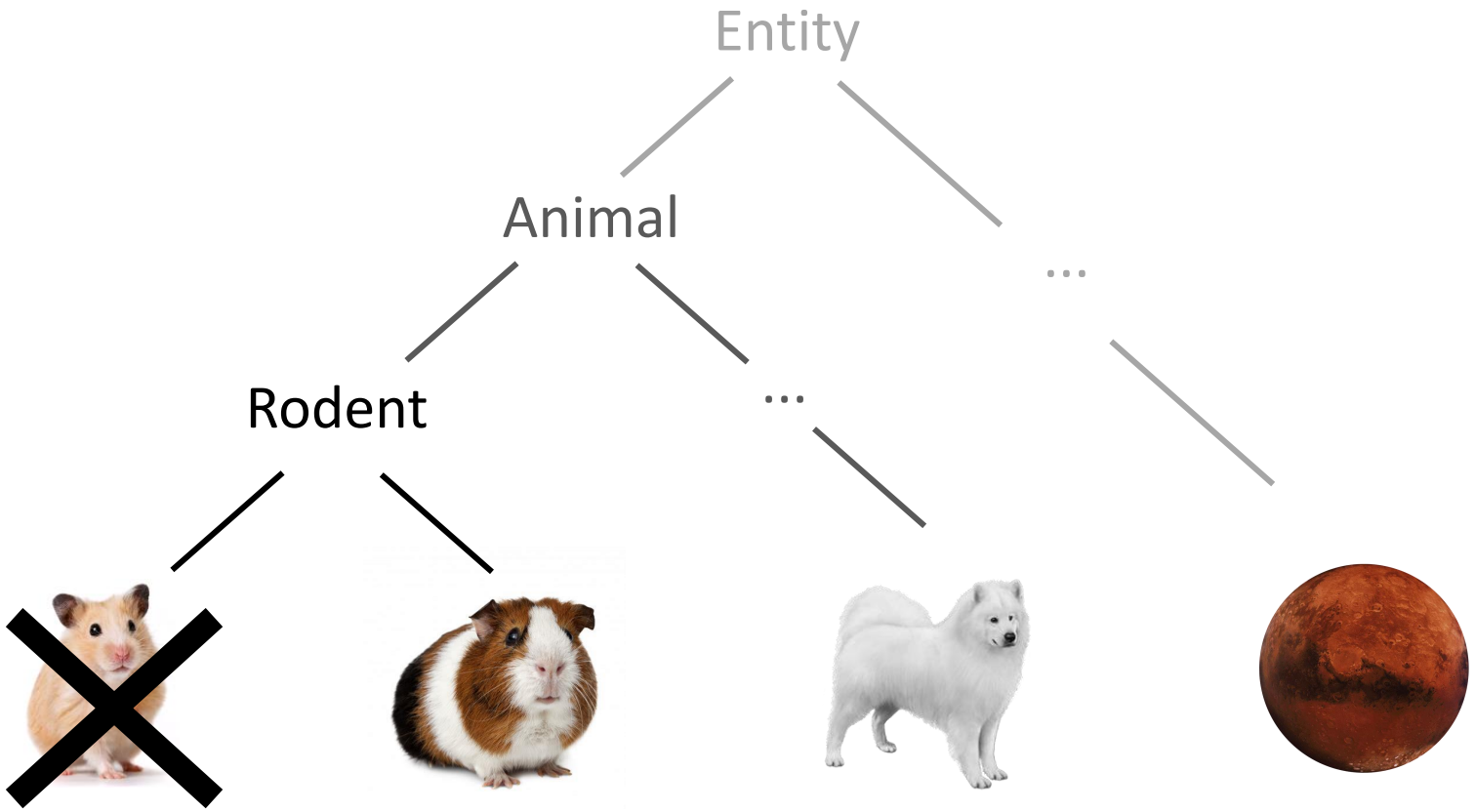
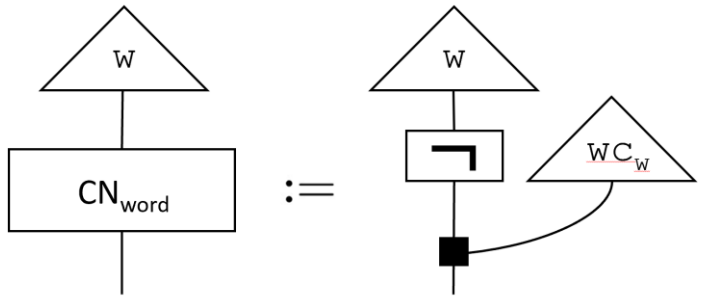
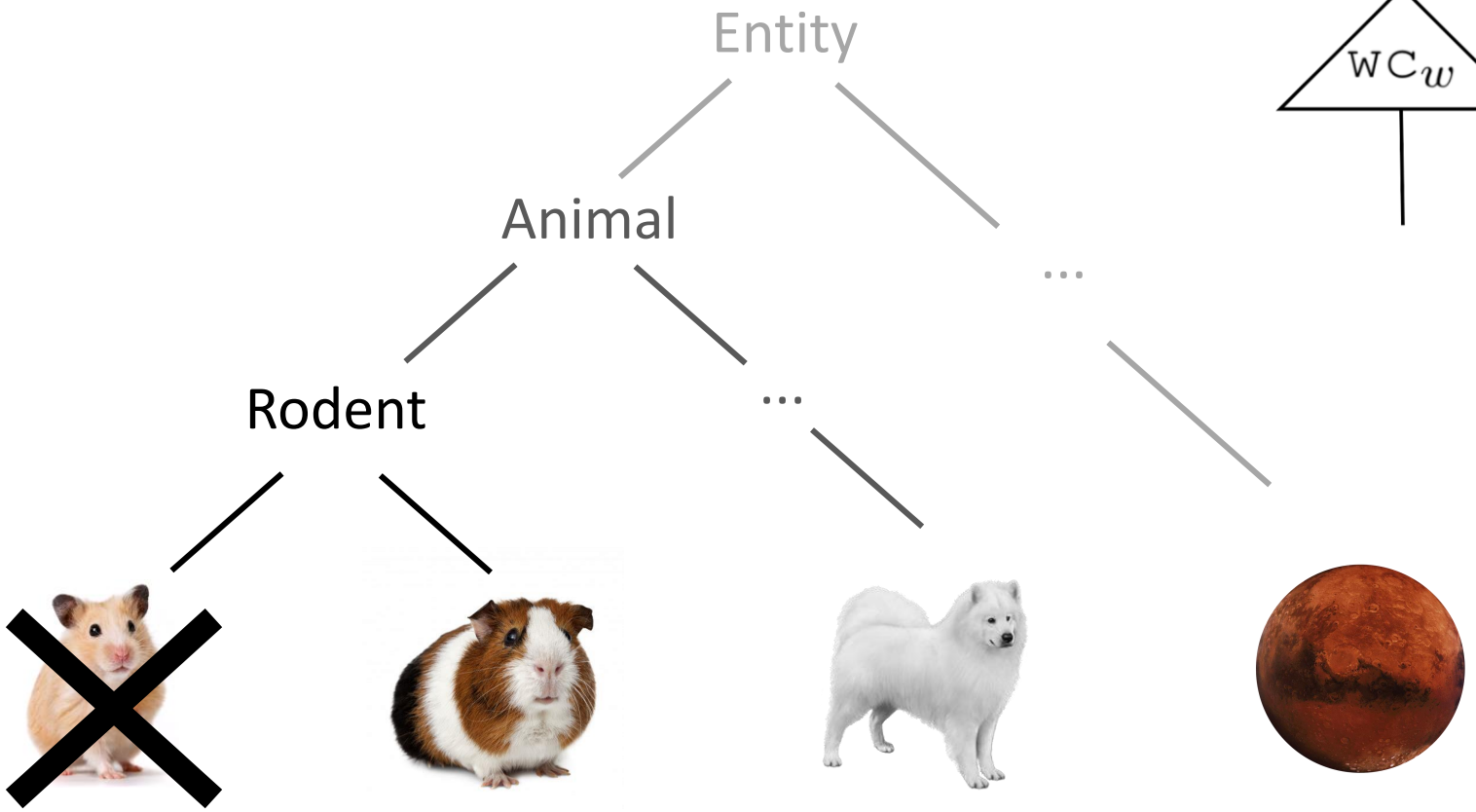
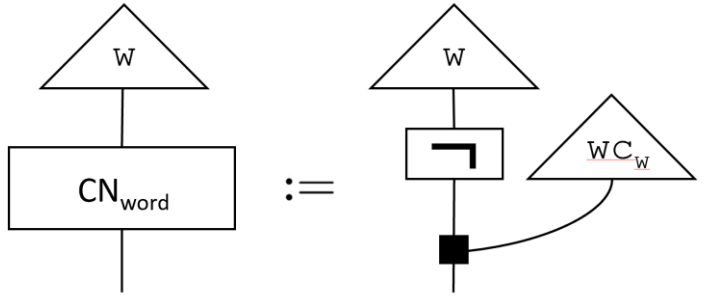




Worldly context for negation of words



$$\mathrm{WC}_w := \sum_i p_i \, h_i$$



Overview

Compositional distributional semantics

Conversational negation

Words (SemSpace 2021, arXiv:2105.05748)

Sentences

Evolving meaning

Conversational Negation – sentence

DisCoCat

From words to sentences

How to do the same for conversational negation?

Conversational Negation – sentence

Bob did not drive to Oxford by car

Conversational Negation – sentence

Bob did not drive to Oxford by car

Bob did not drive to Oxford by car – Alice did

Conversational Negation – sentence

Bob did not drive to Oxford by car

Bob did not drive to Oxford by car – Alice did

Bob did not drive to Oxford by car – He drove a van

Conversational Negation – sentence

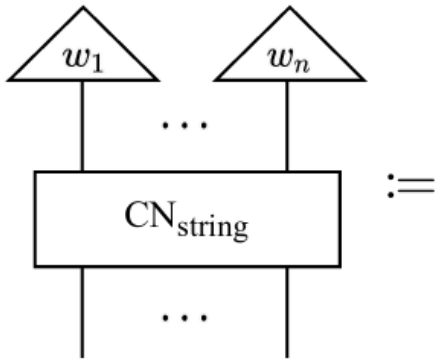
Bob did not drive to Oxford by car

Bob did not drive to Oxford by car – Alice did

Bob did not drive to Oxford by car – He drove a van

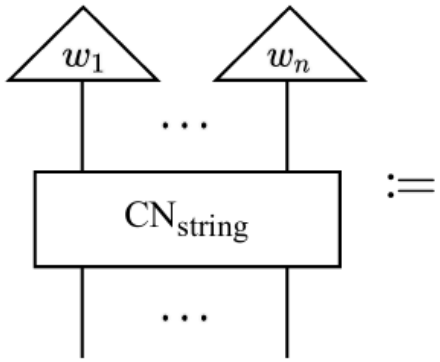
Bob did not drive to Oxford by car – Alice drove to Oxford by van

Conversational Negation – sentence



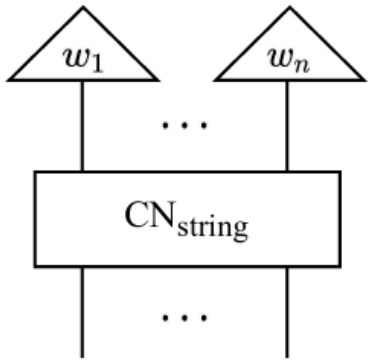
$:=$

Conversational Negation – sentence



$$:= \sum_{i=1}^{n} p_{\{w_i\}} \left(w_1 \otimes \cdots \otimes \mathrm{CN}_{\mathrm{word}}(w_i) \otimes \cdots \otimes w_n \right) \; +$$

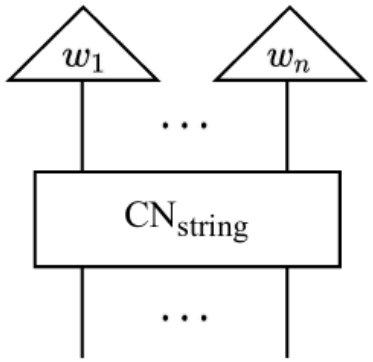
Conversational Negation – sentence



$$:= \sum_{i=1}^{n} p_{\{w_i\}} \left(w_1 \otimes \cdots \otimes \mathrm{CN}_{\mathrm{word}}(w_i) \otimes \cdots \otimes w_n\right) \; +$$

$$\sum_{i=1}^{n} \sum_{j=i+1}^{n} p_{\{w_i, w_j\}} \left(w_1 \otimes \cdots \otimes \mathrm{CN}_{\mathrm{word}}(w_i) \otimes \cdots \otimes \mathrm{CN}_{\mathrm{word}}(w_j) \otimes \cdots \otimes w_n\right)$$

Conversational Negation – sentence



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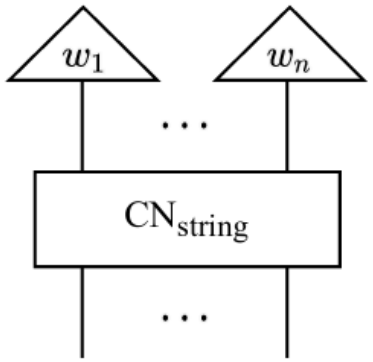
$$+ \quad \cdots$$

Conversational Negation – sentence

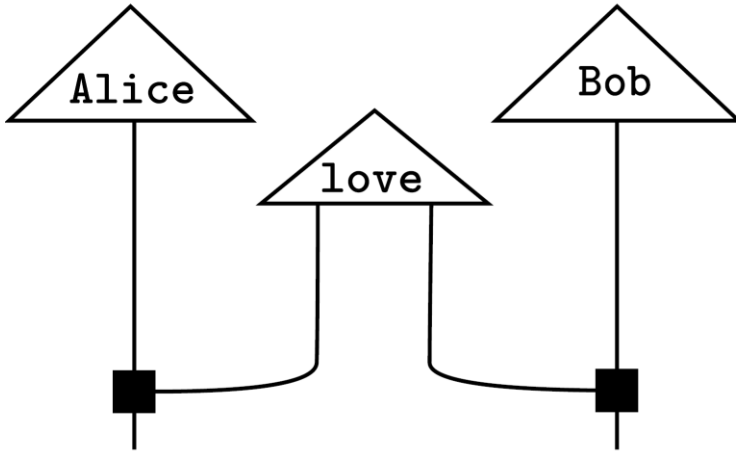


$$:= \sum_{i=1}^{n} p_{\{w_i\}} \left(w_1 \otimes \cdots \otimes \mathrm{CN}_{\mathrm{word}}(w_i) \otimes \cdots \otimes w_n\right) \; +$$

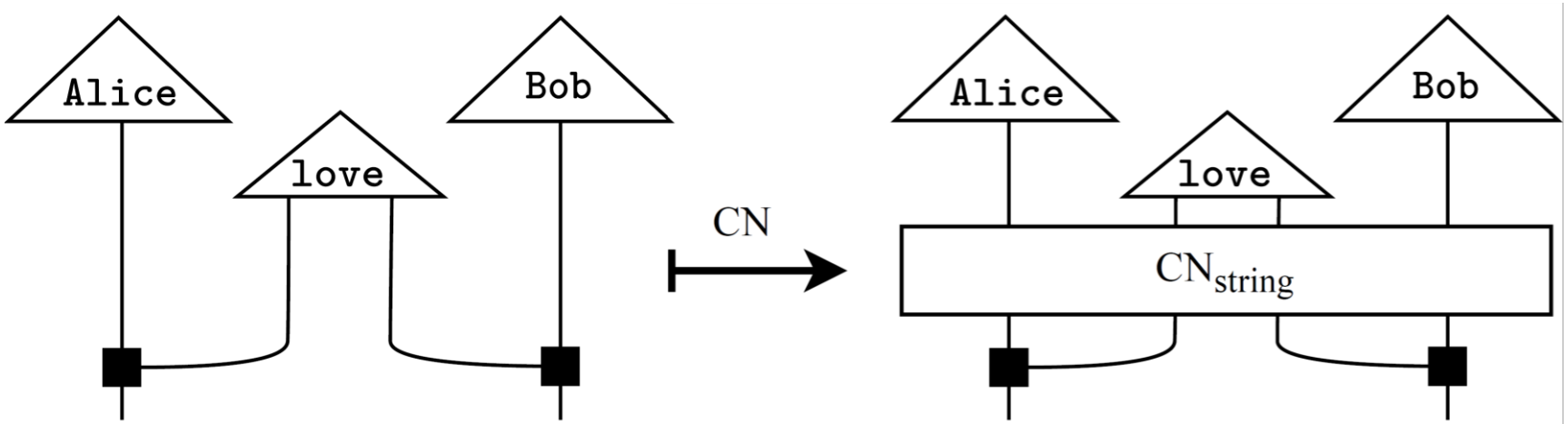
$$\sum_{i=1}^{n} \sum_{j=i+1}^{n} p_{\{w_i, w_j\}} \left(w_1 \otimes \cdots \otimes \mathrm{CN}_{\mathrm{word}}(w_i) \otimes \cdots \otimes \mathrm{CN}_{\mathrm{word}}(w_j) \otimes \cdots \otimes w_n\right)$$

$$+ \quad \cdots$$

$$= \sum_{S' \in \mathcal{P}(S) \setminus \{\emptyset\}} p_{S'} \bigotimes_{i=1}^{n} \begin{cases} w_i & \text{if } w_i \notin S' \\ \mathrm{CN}_{\mathrm{word}}(w_i) & \text{if } w_i \in S' \end{cases}$$

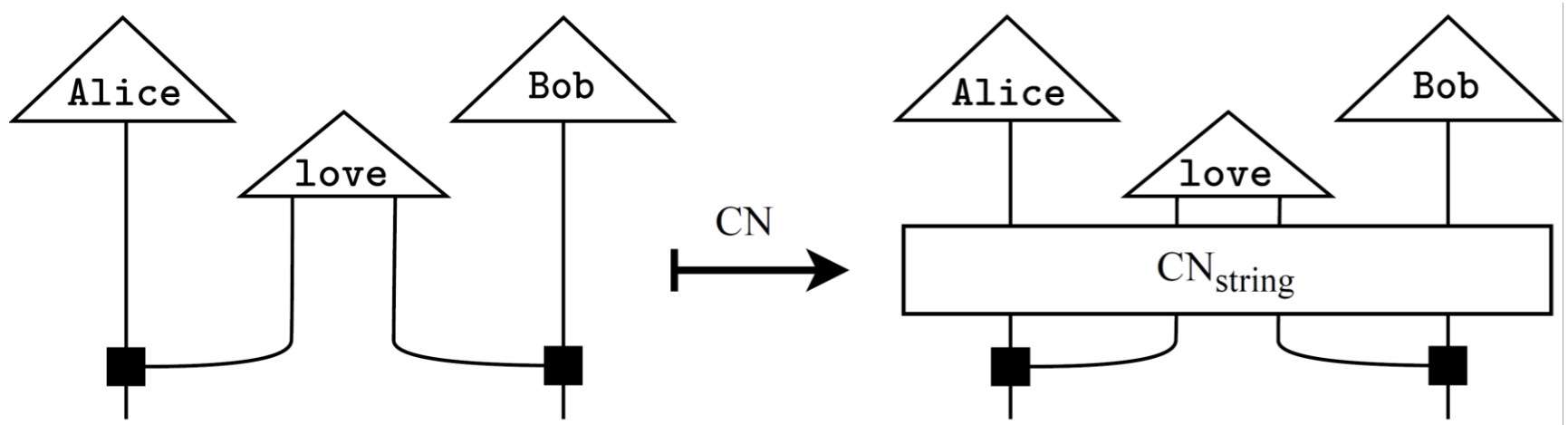


Alice loves Bob.



Alice loves Bob.

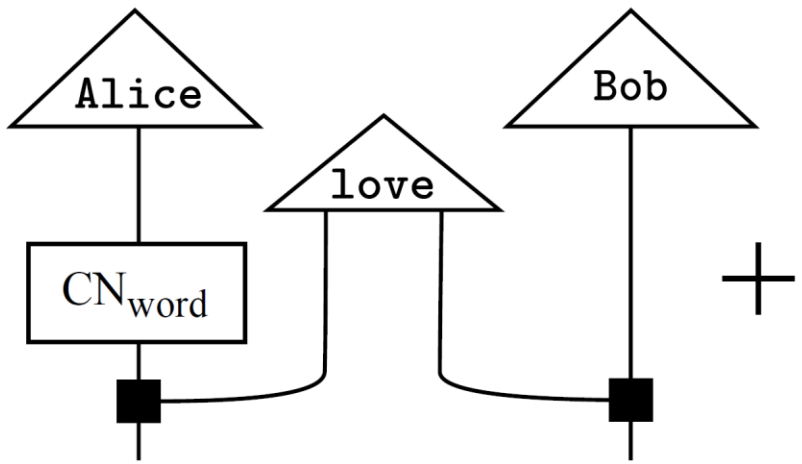
Alice doesn’t love Bob.



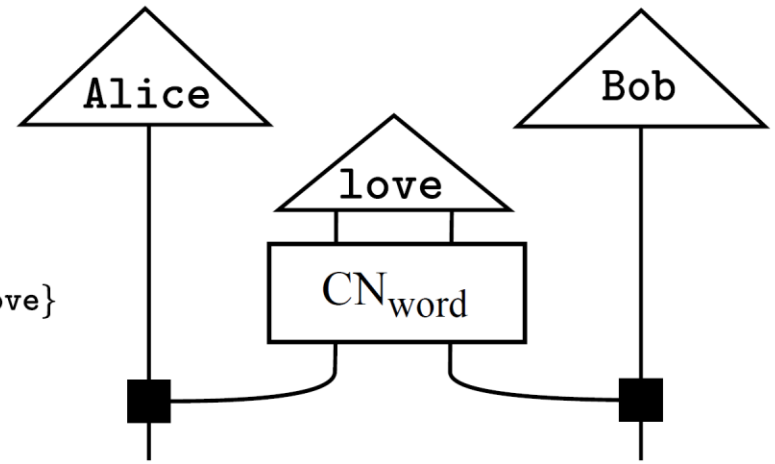
Alice loves Bob.

Alice doesn't love Bob.

$=$ $p_{\{\texttt{Alice}\}}$



$+$ $p_{\{\texttt{love}\}}$



$+ \ \ldots$

Alice doesn't love Bob.

Alice doesn't love Bob.

Calculating the weights

Calculating the weights

- From text
  - Surrounding sentences (e.g. using entailment)

Calculating the weights

- From text
  - Surrounding sentences (e.g. using entailment)
- From speech
  - Intonation

Calculating the weights

From text

- Surrounding sentences (e.g. using entailment)

From speech

- Intonation

From environment

- Physical location of the speaker

Calculating the weights

- From text
  - Surrounding sentences (e.g. using entailment)
- From speech
  - Intonation
- From environment
  - Physical location of the speaker
- From knowledge of the world
  - Sensibility of interpretation

Overview

Compositional distributional semantics

Conversational negation

Words (SemSpace 2021, arXiv:2105.05748)

Sentences

Evolving meaning

Conversational Negation – evolving meaning

Conversational Negation – evolving meaning

Alice is a mathematician.

Conversational Negation – evolving meaning

Alice is a mathematician. Alice lives in Oxford.

Conversational Negation – evolving meaning

Who is “not Alice”?

Alice is a mathematician. Alice lives in Oxford.

Conversational Negation – evolving meaning

Who is “not Alice”?

Alice is a mathematician. Alice lives in Oxford.

Bob is a computer scientist.

Bob lives in Oxford.

Conversational Negation – evolving meaning

Who is “not Alice”?

Alice is a mathematician.

Alice lives in Oxford.

Bob is a computer scientist.

Bob lives in Oxford.

Claire is a pianist.

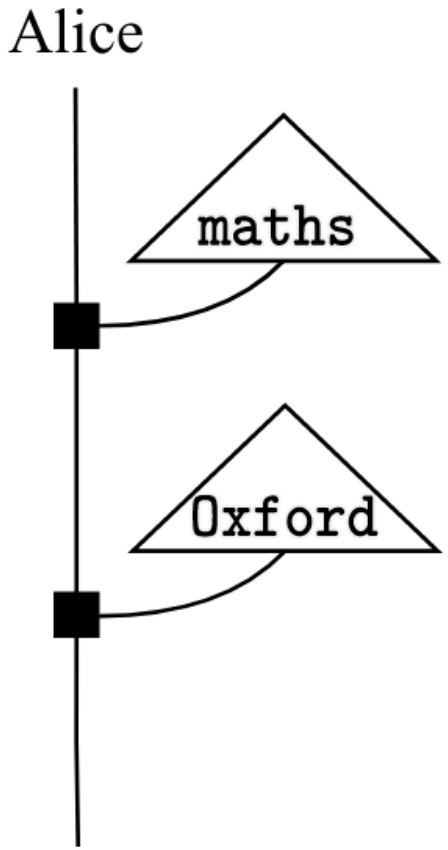
Claire lives in Hong Kong.

Alice is a mathematician.

Alice lives in Oxford.

Alice is a mathematician.

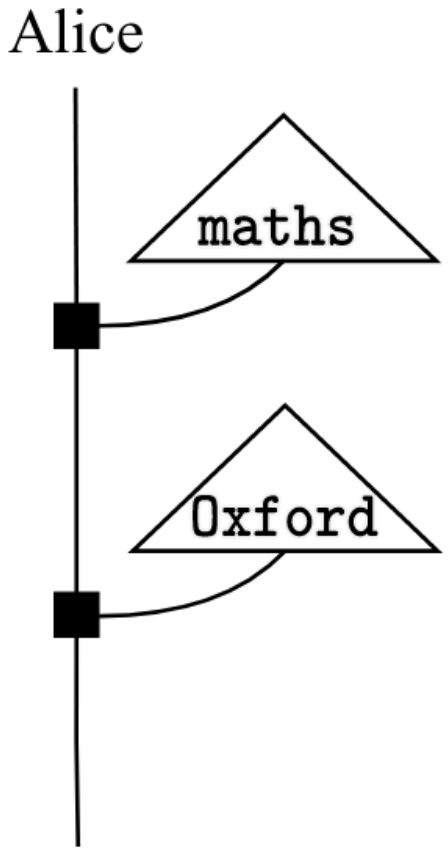
Alice lives in Oxford.



Alice is a mathematician.

Alice lives in Oxford.

Alice who is a mathematician lives in Oxford.



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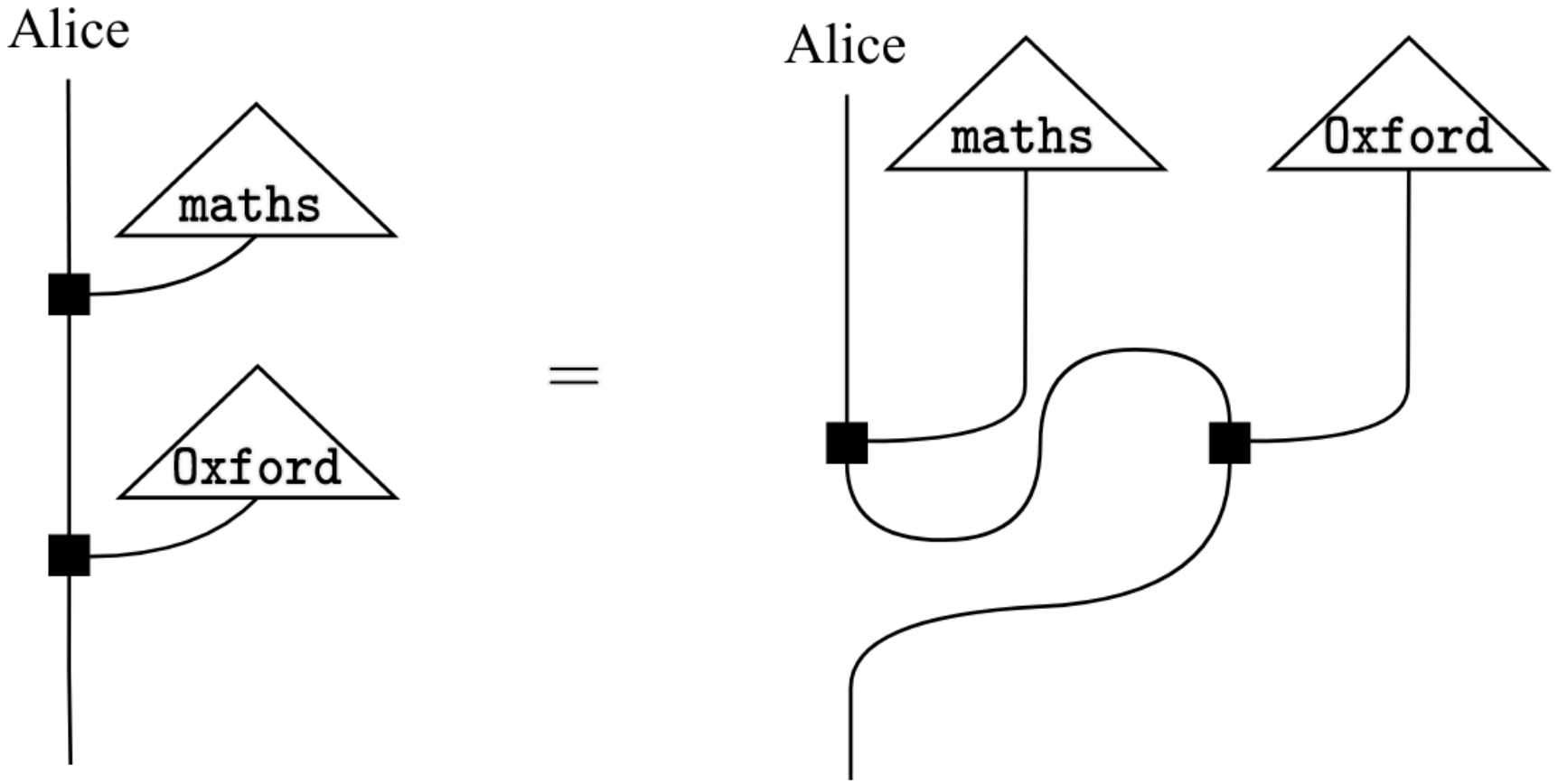

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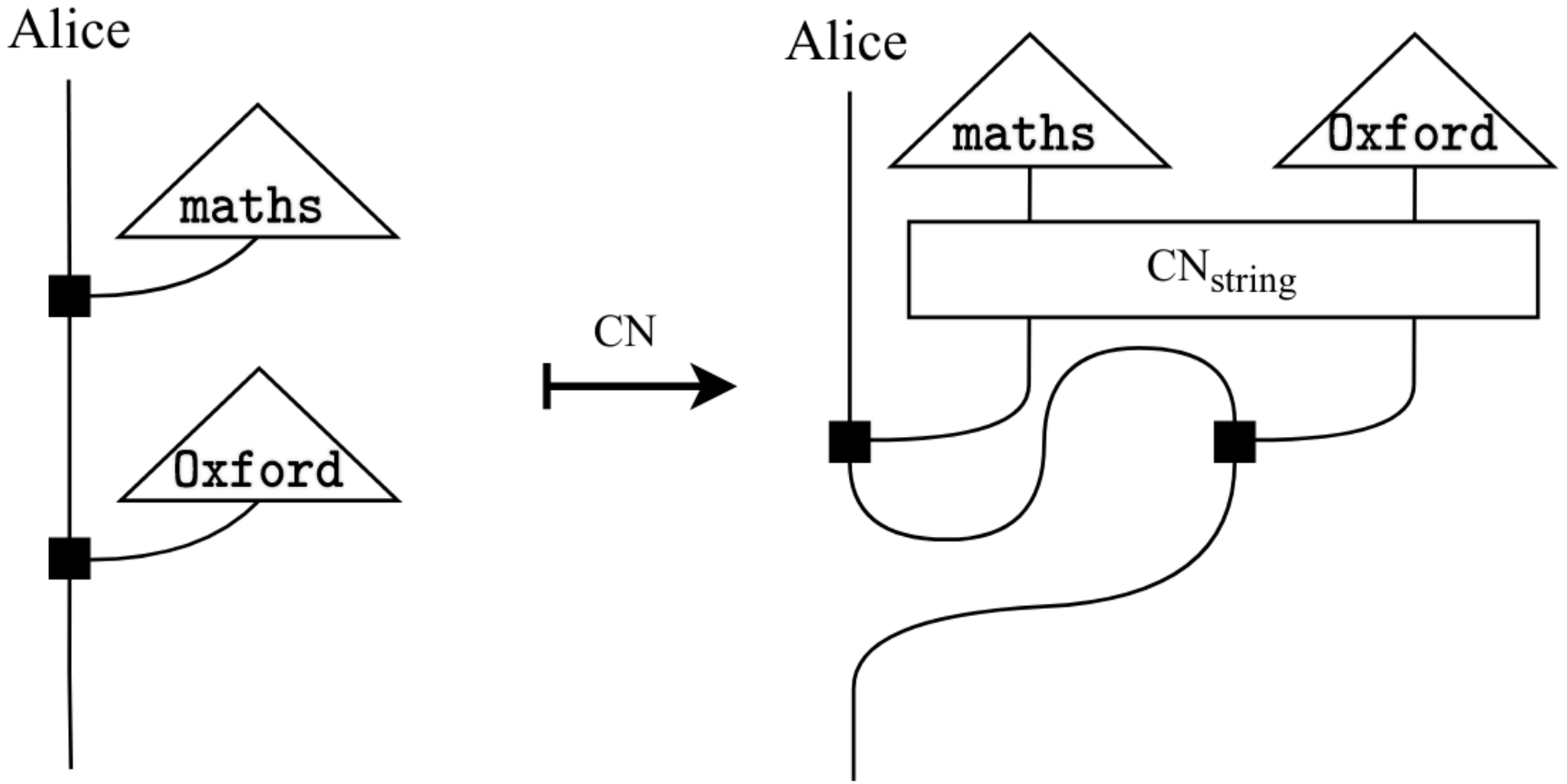
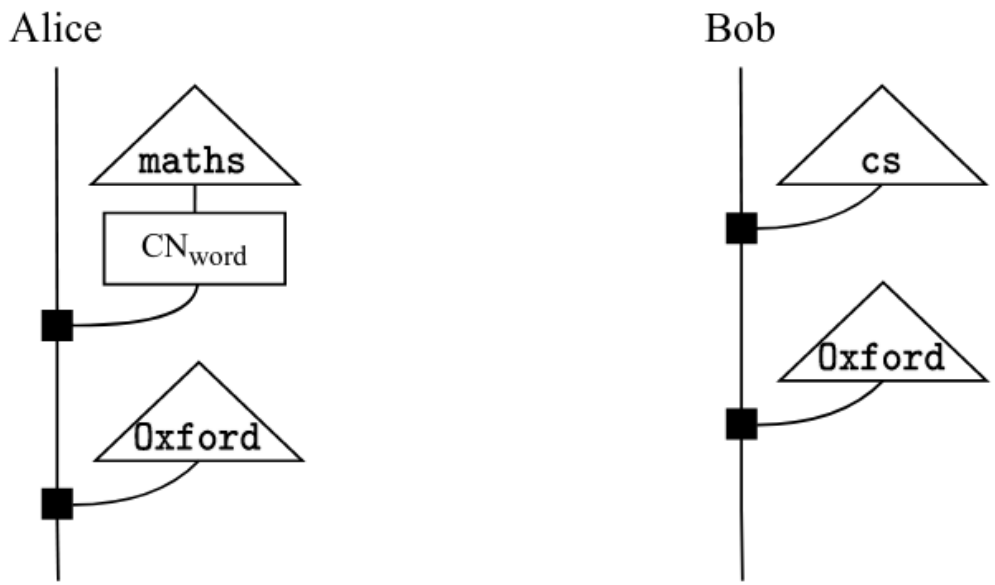
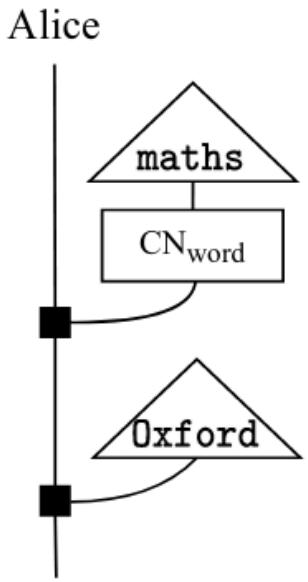
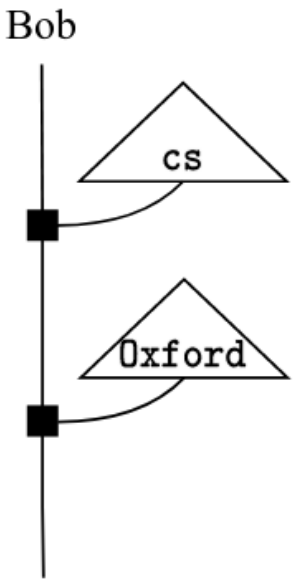
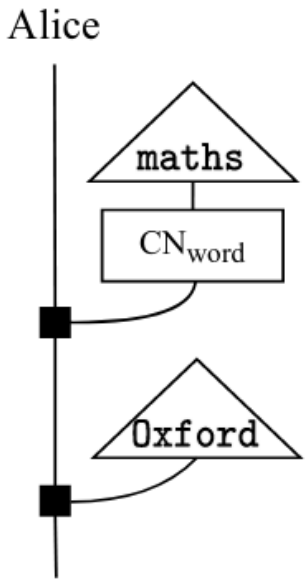


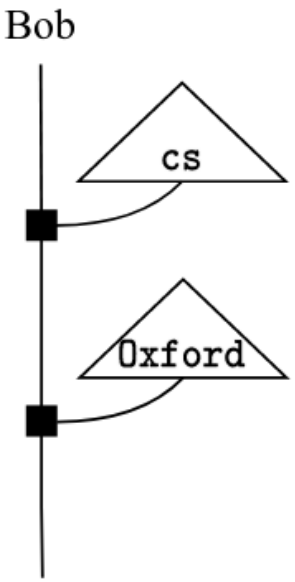

Alice
maths
CN word
Oxford
Bob
cs
Oxford



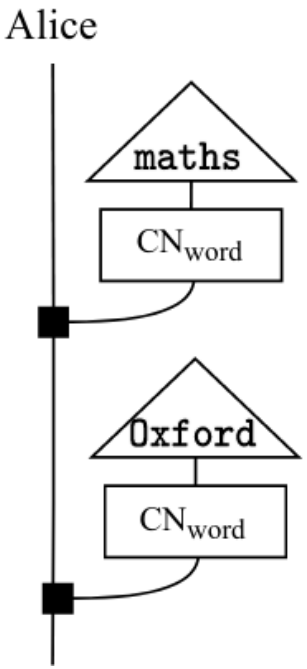


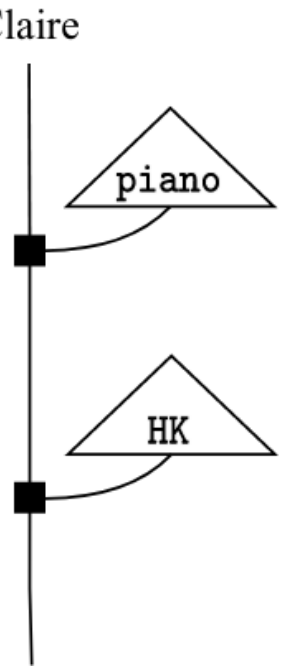
High entailment

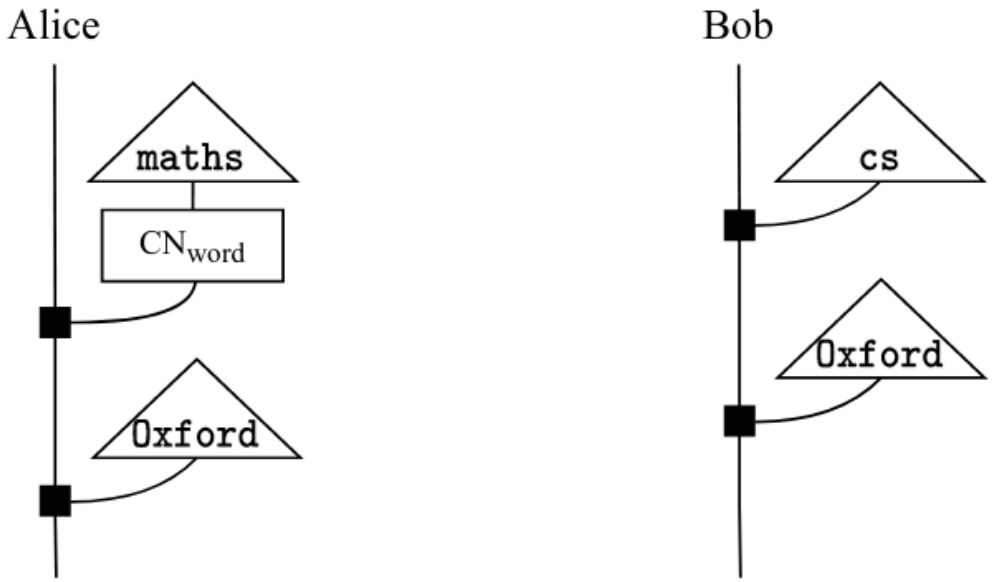




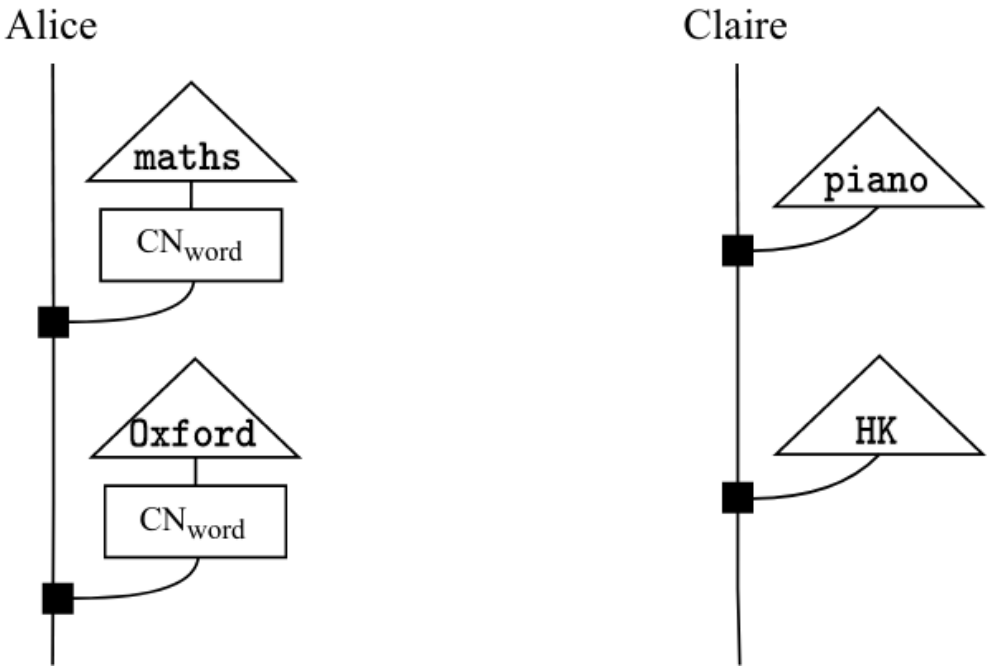
High entailment







High entailment



Low entailment

Future work

Future work

- Calculating weights using different sources

Future work

- Calculating weights using different sources

- Negating phrases in the sentence

This is not the key to the garage. – *This is a toy*

Future work

- Calculating weights using different sources
- Negating phrases in the sentence

  This is not the key to the garage. – *This is a toy*

- Conversational logic

Future work

- Calculating weights using different sources
- Negating phrases in the sentence

  This is not the key to the garage. – *This is a toy*

- Conversational logic
- Experiments beyond negation of single words