Lecture 10: Negation

L98: Introduction to Computational Semantics

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Lecture 10: Negation

1. Negation in different languages
2. Negation scope
3. Beyond truth-conditions
4. Negation and LLMs (Homework 3)

Negation in Different Languages

Every language has a way to express negation

- Negation appears in all human languages, highlighting its essential role in communication.
- *Not* is the thirteenth most frequently used word in the English language. If we look at the combined frequency of *not* and *no*, negation is in the top ten list.
- While every language has a way to express negation, the specific structures and rules vary.

Double negative

(1) a. You cannot not do this.

b. You must/should do it

Negative concord

In some langugages, what looks like double negation is in fact a circumflex morpheme for single negation.

(2) Je ne regrette rien (French)

Variants of negative markers

Negative affixes

(3) Czech (Indo-European, Slavic)
ne-vol-al
NEG-call-PST.3SG
'He was not calling / did not call."

(4) Lezgian (Nakh-Dagestanian, Lezgic)
xürünwi-jri ada-waj meslät-ar q̃aču-zwa-č
villager-PL(ERG) he-ADEL advice-PL take-IMPF-NEG
'The villagers do not take advice from him.'

(5) Chukchi (Chukotko-Kamchatkan)
a-nto-ka (itə-rkən)
NEG-go.out-NEG be-DUR
'(S)he does not go out.'

(6) Dolakha Newar (Tibeto-Burman)
yārkhār- yār-mā-khā-u
hang hang-NEG-
'hang' and 'not hang'

Variants of negative markers

Negative particles

(7) Indonesian (Austronesian, Sundic)
mereka tidak menolong kami
they NEG help us.EXCL
'They didn't help us.'

(8) Taba (Austronesian, S Halmahera-W New Guinea)
n-han ak-la te
3SG-go ALL-sea NEG
'She's not going seawards.'

(9) French (Indo-European, Romance)
le chanteur ne chante pas
DEF singer NEG sing.3SG NEG
'The singer is not singing.'

Variants of negative markers

Negative verbs

(10) Forest Enets (Uralic, Samoyedic)

a. mud' Dudinka-xan d'iri-đ
1SG Dudinka-LOC.SG live-1SG
'I live in Dudinka.'

b. mud' Dudinka-xan ńi-đʔ d'iri-ʔ
1SG Dudinka-LOC.SG NEG-1SG live-CNG
'I do not live in Dudinka.'

(11) Tongan (Austronesian, Oceanic)

a. na'e 'alu 'a siale
PST go ABS Siale
'Siale went.'

b. na'e 'ikai ke 'alu 'a siale
PST NEG SBJN go ABS Siale
'Siale did not go.'

Negation Scope

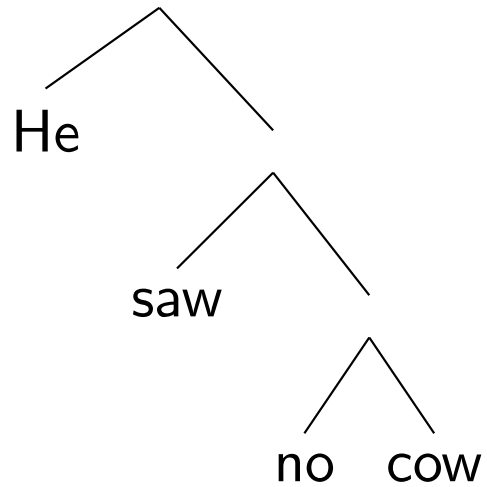
Negative scope

Truth-conditional concern: Negation reverses the truth value of a proposition, but which one?

(12) a. He didn't see the cow

b. He saw no cow

c. $\nexists y(\text{cow'} \wedge \text{see'}(x, y))$



- Semantically, the word *no* has a impact on the whole sentence.
- Syntactically, *no* governs a much smaller area.

(13) a. We needs actions and not thoughts.

b. He failed to catch the first train.

c. This is an unclean desk.

Cross-lingual differences

Problems with negation and modal scope

English:

(14) a. you mustn't cry
must (not (cry))

b. you needn't cry
not (must (cry))

German:

(15) a. du musst nicht weinen
not (must (cry))

b. du darfst nicht weinen
must (not (cry))

First and second language learner

(16) a. 换言说，没有宗教生活与日常生活差距。second Mandarin learner

b. 换言说，宗教生活与日常生活之间没有距离。

Negation Scope Resolution: an old-fashion NLP task

Sub-tasks

- **Negation cue**: linguistic unit that expresses negation.
- **Negation event**: the event related to a cue.
- **Negation scope**: the maximum part(s) of the sentence that are influenced or negated by negation cue.

(17) a. We needs actions and not thoughts.

b. He failed to catch the first train.

c. This is an unclean desk.

d. 换言说，没有宗教生活与日常生活差距。

e. 换言说，宗教生活与日常生活之间没有距离。

- Simple solution: BIO-based sequence labeling

Presupposition

(18) a. Sue stopped drinking.

b. The king of France is bald.

c. John drinks too.

d. Even JOHN drinks.

e. It was Fred who ate the beans.

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To understand the above sentences, we need some further information that goes beyond the meaning expressed by the sentence.

Such extra information

- goes beyond linguistic meaning, but it is not implicature,
- is something that the speaker assumes to be the case prior to making an utterance,
- is what we call **presupposition**.

Fregean and Strawsonian view

Examples proposed by Frege

(19) a. Kepler died in misery.

b. Kepler did not die in misery.

c. Kepler did not die in misery, or the name Kepler has no reference.

Presupposition and constancy under negation

A sentence A semantically presupposes another sentence B if:

- in all situations where A is true, B is true,
- in all situations where A is false, B is true,
- in a situation where B is true, A may be either true or false,
- in all situations where B is false, A is neither true nor false.

Beyond Truth Conditions

More than reversing the truth values

(20) a. a door mat saying 'NOT UNWELCOME' is less welcoming than 'WELCOME'

b. 'Not happy' often communicates the opposite of 'happy', that is, 'sad';
'not sad' tend to communicate a medial state between happy and sad

Three common perspectives of negation

- truth-conditional logic
- subjective certainty
- communicative pragmatics
  - Negative utterances have more specific contextual requirements than their positive counterparts. Out-of-context negative sentences warrant more background inferences.
  - Negation interacts with context to produce rich pragmatic effects.

Human language comprehension

Early psycholinguistic research

- Negative sentences are found to be more difficult to process than positive sentences.
- Experiments based on tasks: sentence completion, sentence verication, logical reasoning and inference drawing.
- Finding: longer response times and higher error rates for negated sentences compared to their positive counterparts.

Example: Sentence completion

(21) a. ___ is an even number.

b. ___ is not an even number.

c. ___ is an odd number.

d. ___ is not an odd number.

Human language comprehension

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Example: Sentence verification

- Verifying positive and negative sentences against world knowledge, such as *an elephant is not a mammal*.
- Verifying sentences against pictures, such as the sentence *the dots are not red* against an image of red or black dots.

Human language comprehension (cont)

Positive argument in negation processing

- In the early processing stage, negation seems to be ignored and negative sentences seem to be processed as if they were positive.

Example

- Shortly after reading a negative sentence, participants simulate the situation consistent with the sentence's positive argument.
- 250 milliseconds (ms) after reading *the door isn't open*, participants were faster to respond to an image of an open door than a closed door.
- This effect was reversed later on (at 1,500ms latency).

Asymmetry

- Negative statements are generally less informative than affirmatives.
- Negative are morphosyntactically more marked (all languages have negative markers while few have affirmative markers)

Example

Standalone negative sentences are often more ambiguous than their positive counterparts.

(21) Blinken and Biden Are Right: Afghanistan Is Not Saigon. It is far worse.

Paradox of negative judgment

If a positive statement refers or corresponds to a positive fact, to what state of affairs does a negative statement refer or correspond? What in fact is a negative fact?

Negation is not difficult with context

- The majority of above-mentioned studies tested negation processing without context.
- More recent studies show that, with appropriate contextual support, negative sentences are not difficult to process.

Example

(22) Blinken and Biden Are Right: Afghanistan Is Not Saigon. It is far worse.

Some behavioural studies demonstrate that

- with non-supporting context, negative sentences took signicantly longer to read than positives;
- with supporting context, there was no dierence between negatives and positives.

Negation and Large Language Models

Evaluating Large Language Models

- Recent experiments demonstrate that LLMs fail at interpreting contexts in which understanding negation is required.
- The reasons still remain largely unclear.
- So far, such evaluation research doesn't consider many facets beyond truth-conditions.

Homework 3

Old plan

- ~~Take-home test 3 is given in Lecture 11; the due is Lecture 13 – students will have one week to do this test.~~
- ~~All students are assigned with a paper on modeling common ground in dialogue system. Students will recieve related but different papers. Each student will write a review of their assigned paper, including a comprehensive summary and their own thoughts.~~
- Word limit: 500 words.
- Assessment criteria: 15 points on whether a student understands the paper correctly; 5 points on whether a student is able to think critically.

Homework 3

New plan

- Take-home test 3 is given in Lecture 10; the due is Lecture 13 – students will have two weeks to do this test.
- Each student selects a paper from a given set of papers on evaluating negative expressions in large language models. Each student will write a review of their assigned paper, including a comprehensive summary and their own thoughts.
- Word limit: 500 words.
- Assessment criteria: 15 points on whether a student understands the paper correctly; 5 points on whether a student is able to think critically.

Homework 3: Papers

Students can freely choose any paper from the below list:

- https://aclanthology.org/2023.emnlp-main.531/
- https://aclanthology.org/2023.starsem-1.10.pdf
- https://aclanthology.org/2024.naacl-long.284/
- https://aclanthology.org/2023.findings-acl.472.pdf
- https://aclanthology.org/2023.acl-long.550/
- https://aclanthology.org/2024.acl-long.33/
- https://aclanthology.org/2023.emnlp-main.912.pdf

Reading

- Ye Tian and Richard Breheny. 2019. Negation. *Oxford Hndbook of Experimental Semantics and Pragmatics*.