Ambiguity: Representation and Resolution (ARR)

Introduction to the workshop

Timm Lichte & Christian Wurm

University of Düsseldorf, Germany

ESSLLI, Sofia, 06.08.2018

SFB 991

HEINRICH HEINE
UNIVERSITÄT DÜSSELDORF

Topics of the workshop

- Definition of ambiguity
- Representation of ambiguity
- Resolving/processing of ambiguity
- Recognition of ambiguity

GOALS:

- work towards a unified perspective on ambiguity
- bring together researchers from various backgrounds (linguistics, computational linguistics, computer science, logic, philosophy)

What is ambiguity?

Ambiguity

There are two or more possible readings with exactly one **actual and intended** reading.

(1) a. ***bank*** (‘financial institute’, ‘strip of land along a river’)
b. ***see the man with the telescope*** (‘seeing with a telescope’, ‘seeing someone that has a telescope’)
c. ***every boy loves a movie*** ($\forall > \exists$, $\exists > \forall$)
d. ***She was happy*** (with context: ‘Laura was happy’, ‘Sue was happy’)

⟹ information asymmetry between hearer and speaker

What is **not** ambiguity?

Underspecification

There are two or more possible readings.

(2) a. ***car*** (‘cabriolet’, ‘SUV’, ‘minivan’, ...)
    b. ***Someone was happy*** (‘Kim was happy’, ‘Sue was happy’, ...)

Vagueness

There are two or more possible readings with “fuzzy edges”.

(3) ***red*** (‘light red’, ‘dark red’, ...)

How to represent ambiguity?

Say:

e	is an EXPONENT	(*bank*)
m_1	is one MEANING of e	(‘financial institute’)
m_2	is another MEANING of e	(‘river bank’)
(e, m)	is a SYMBOL	

Syntactic approach

Two separate symbols (e, m_1) and (e, m_2).

Semantic approach

One ambiguous symbol $(e, m_1 \parallel m_2)$.

Question: What does $\parallel$ actually mean?

The denotation of ambiguity

Question: What does $\|$ actually mean?

Quick shot: Disjunction!

$$
\begin{aligned}
& m_1 \parallel m_2 \equiv m_1 \vee m_2 \\
\text{Hence:} \quad & \neg(m_1 \parallel m_2) \equiv \neg(m_1 \vee m_2) \equiv \neg m_1 \wedge \neg m_2 \\
\text{Yet intuitively:} \quad & \neg(m_1 \parallel m_2) \equiv \neg m_1 \parallel \neg m_2
\end{aligned}
\qquad \lightning
$$

(4)#***There is no bank***.

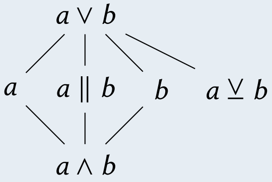
‘There is no financial institute and there is no strip of land along the river.’

(see also Pinkal [1], Poesio [2], and Stallard [3])

The denotation of ambiguity

Question: What does $||$ actually mean?

Between disjunction and conjunction



(5) ***Give me the dough!***

(6) ***Give me the pastry or give me the money!***

(7) ***Give me the pastry and give me the money!***

The semantics of linguistic ambiguity

We have investigated the meaning of $\|$ in the context of **Boolean algebras**.

- This is an important restriction: Boolean algebras correspond (via algebraization) to classical logic – which might not necessarily the right logic for NL-semantics.
- Still, the vast majority of semanticists interpret connectives in classical logic – so for all choices, this seems to be the most natural!
- In the algebraic approach, algebraic $\leq$ (defined by $a \leq b \Leftrightarrow a \wedge b = b$) corresponds to logical $\vdash$ and semantic $\models$

The semantics of linguistic ambiguity

Question: What are the semantic properties of $\|$?

In terms of **denotation**, there is a fundamental difference between disjunction and ambiguity: the meaning of an ambiguous statement depends on the underlying (often unknown) **intention** of the speaker:

Intentionality

$$a \wedge b \leq a \parallel b \leq a \vee b \tag{1}$$

$$a \leq a \vee b \tag{2}$$

$$\textbf{But:} \;\; a \nleq a \parallel b \nleq a \tag{3}$$

I need some money! $\nleq$ *I need some dough!*
I need some pastry or some money! $\neq$ *I need some dough!*

The semantics of linguistic ambiguity

The **combinatorial properties** of ambiguity are different from disjunction: ambiguity has the property of universal distribution:

Universal distribution

$$\sim(a \parallel b) = \sim a \parallel \sim b \quad (4)$$

$$(a \parallel b) \vee c) = (a \vee c) \parallel (b \vee c) \quad (5)$$

$$(a \parallel b) \wedge c) = (a \wedge c) \parallel (b \wedge c) \quad (6)$$

$$(a \parallel b) \longrightarrow c = (a \longrightarrow c) \parallel (b \longrightarrow c) \quad (7)$$

$$a \longrightarrow (b \parallel c) = (a \longrightarrow b) \parallel (a \longrightarrow c) \quad (8)$$

The semantics of linguistic ambiguity

There are some additional properties of $\|$:

Associativity

$$(a \parallel b) \parallel c = a \parallel (b \parallel c) \tag{ass}$$

Idempotence

$$a \parallel a = a \tag{id}$$

Commutativity (arguable)

$$a \parallel b = b \parallel a \tag{com}$$

Uniform Usage

The following hypothesis of uniform usage is necessary for an algebraic treatment of ambiguity:

Uniform usage (UU)

In a given context, an ambiguous statement is used consistently in **only one** sense.

This leaves of course many things unspecified (as context), but allows us to treat $||$ as an algebraic operator (which is a function!)

Ambiguous algebras

Ambiguous algebra

An AMBIGUOUS ALGEBRA is a structure $\mathbf{A} = (A, \wedge, \vee, \sim, \|, 0, 1)$, where $(A, \wedge, \vee, \sim, 0, 1)$ is a Boolean algebra, and $\|$ is a binary operation for which the following holds:

$$\sim(a \parallel b) = \sim a \parallel \sim b \tag{$\|$ 1}$$

$$a \wedge (b \parallel c) = (a \wedge b) \parallel (a \wedge c) \tag{$\|$ 2}$$

$$\text{At least one of} \quad a \leq a \parallel b \quad \text{or} \quad b \leq a \parallel b \quad \text{holds} \tag{$\|$ 3}$$

Ambiguous algebras: a peculiar axiom

$$\text{At least one of} \quad a \leq a \parallel b \quad \text{or} \quad b \leq a \parallel b \quad \text{holds} \qquad (\parallel 3)$$

Note that ($\parallel$ 3) is a **disjunction**!

- This entails, among other, that there is no *free ambiguous algebra*, a central tool in general algebra.
- Put differently, in *every* ambiguous algebra some equalities hold which do not hold in all ambiguous algebras (this nicely models the epistemic aspect of ambiguity)
- To the best of our knowledge, axioms of this kind have not been considered in general algebra so far. Any algebraist know better?

Questions regarding the axiomatization

1. Do these axioms entail all properties we find intuitively true for ambiguity?
   – As far as we can see, clearly yes.

2. Do they imply some properties we find intuitively incorrect for ambiguity in general?
   – Unfortunately, also clearly yes.

3. Do non-trivial algebras exist which satisfy these axioms? (That is, for example, algebras with more than one element?)
   – Clearly yes, but if we add commutativity for $\|$, then no.

4. Are there ambiguous algebras, where $a \| b \neq a$ and $a \| b \neq b$?
   – No, there are not.

This workshop: Program

Day 1: The nature of ambiguity – part one

- Opening
- Invited talk: Diego Valota: *Towards a Propositional Logical Structure of Ambiguous Words in Weighted Automata*

Day 2: The nature of ambiguity – part two

- Lucia Gomez Alvarez: *Ambiguity: What is it that needs representing and what needs resolving?*
- Paul Dekker: *Readings*
- Henk Zeevat: *Lexical meaning and disambiguation*

This workshop: Program (cont.)

Day 3: Ambiguity between syntax, semantics and usage

- Miki Obata & Chigusa Morita: *Syntactic agreement as a disambiguation Task: Evidence from Japanese adjectives*
- Yoshie Yamamori: *Presupposition and implicature in Chimerical Conditionals*
- Uliana Petrunina: *Ambiguity of Russian participles on word/context levels and use of frequency*

Day 4: Ambiguity and distributional semantics

- Invited talk: Gemma Boleda: *What's in a name? or, what recent results in computational semantics tell us about ambiguity*

This workshop: Program (cont.)

Day 5: Ambiguity, polysemy and underspecification

- Laura Kallmeyer, Rainer Osswald & Christian Retoré: *Levels of ambiguity and underspecification in regular polysemy*
- Kurt Erbach: One reading to rule them all: *Basic readings of plural predicates?*
- Closing discussion

Conclusion

Enjoy ARR!

Conclusion

Enjoy ARR!*

*absolute risk reduction

*average room rate

*average rate of return

*aldosterone-to-renin ratio (low blood pressure!)

...

[1] Pinkal, Manfred. 1999. On semantic underspecification. In Harry Bunt & Reinhard Muskens (eds.), *Computing meaning: volume 1*, 33–55. Dordrecht: Springer.

[2] Poesio, Massimo. 1994. Semantic ambiguity and perceived ambiguity. In Kees van Deemter & Stanley Peters (eds.), *Semantic ambiguity and underspecification*, 159–201. Stanford, CA: CSLI Publications.

[3] Stallard, David. 1987. The logical analysis of lexical ambiguity. In *Proceedings of the 25th annual meeting of the Association for Computational Linguistics (ACL '87)*, 179–185.