Logic and conversation

- Standard logic deals with reasoning, entailment
- Using standard logic, linguistic semantics deals with phenomena related to entailment
- Information exchange more basic use of language than reasoning
- Try to make cooperative information exchange a basic notion of logic

Linguistic aims

- Explain linguistic phenomena using the new logical notions
- We will give some illustrations
- By-product: a better notion of linguistic answerhood (within a partition semantics of questions)

Overview

- The game of interrogation
- A query language
- Semantics for the language
- Logical notions to arbitrate the game
- Answerhood
- Illustration

Game of Interrogation

- Two players: the interrogator and the witness
- The interrogator may only raise issues by asking the witness non-superfluous questions
- The witness may only make credible (Quality), non-redundant (Quantity) statements which exclusively address the issues raised by the interrogator (Relation)

Logic of interrogation

- Define logical notions that arbitrate whether an interrogation proceeds in accordance with the rules
- Like standard logic defines the notion of entailment to arbitrate whether an argumentation is in accordance with the rules of valid reasoning
Query Language

- Let PL be a language of predicate logic.
- If φ is a sentence of PL, then ?φ is a sentence of QL.
- If φ is a formula of PL, then ?φ is a sentence of QL.
- The query operator binds all free variables in φ.

Examples

- Interrogatives ask for the specification of the denotation of an n-place relation (n≥0):
  - ?∃x Px
  - ?Px
  - ?x=a
  - ?Rxy

Proceedings of an interrogation

- Given the strict division of roles, the proceedings of an interrogation can be presented by a sequence of sentences φ₁;...;φₙ from QL.
- We don’t have to indicate who said what.

Denotational semantics

- Standard truth definition for PL:
  \[ \llbracket φ \rrbracket_w = \{1,0\} \]
- Interpretation for QL:
  \[ \llbracket φ \rrbracket_w = \llbracket \llbracket φ \rrbracket_w \rrbracket \]
  \[ \llbracket ?φ \rrbracket_w = \{ v \in W \mid \forall g : \llbracket ?φ \rrbracket_w = \llbracket ?φ \rrbracket_{v,g} \} \]
- Partition semantics for interrogatives

Proposition - Question

Example

- \[ \llbracket ?Px \rrbracket_w \] is the set of worlds where the denotation of \( P \) is the same as in \( w \).
- \[ \llbracket ?Px \rrbracket_w \] is a proposition which exhaustively specifies which objects have the property \( P \).
- So, what you get is the true and complete answer in \( w \).
Update semantics

- In terms of the denotational semantics we define an update semantics for QL.
- We define the notion $C[!\psi]$, the effect of updating a context $C$ with an indicative or an interrogative sentence $\psi$.
- A context will consist of data (provided by the witness) and issues (raised by the interrogator).

Data and Issues

- If we would only consider data, a context could be a subset of the set of possible worlds.
- $C[!\psi] \subseteq C$.
- Interrogatives provide no data, they may only raise issues.
- We model issues by structuring the context.

Structured contexts

- A context $C$ is a symmetric and transitive relation on the set of possible worlds $W$.
- A context $C$ is an equivalence relation on a subset of $W$.
- If two worlds $w$ and $v$ are related in $C$, $<w,v> \in C$, the difference between $w$ and $v$ is not an issue.
- Notation: by $w \in C$ we mean $<w,w> \in C$.

Updating contexts

- $C[!\psi] = \{<w,v> \in C | ![\psi]_w = ![\psi]_v = 1 \}$.
- $C[?!\psi] = \{<w,v> \in C | ![\psi]_w = ![?\psi]_v \}$.
- For $\tau = \psi_1; \ldots; \psi_n$, $C[\tau] = C[\psi_1] \ldots [\psi_n]$.
Adding an issue

Consistency
- $\varphi$ is consistent with $\tau$ iff $\exists C : C[\tau][\varphi] \neq \emptyset$
- Only indicatives can be inconsistent with the context
- Consistency is the logical notion used to arbitrate credibility of the witness
- The witness is judged credible as long as he doesn’t contradict himself

Informativeness
- $\tau$ entails $\varphi$ iff $\forall C : C[\tau] = C[\tau][\varphi]$
- $\varphi$ informative after $\tau$ iff $\tau$ does not entail $\varphi$
- Both indicatives and interrogatives can be uninformative
- Informativeness is the logical notion used to arbitrate whether statements are non-redundant, and questions are not superfluous

Examples entailment
- $?x \text{ entails } ?p_x$ and $\exists x ?p_x$
- $\forall x (P_x \leftrightarrow x = a) \text{ entails } ?P_x$
- Corresponds to 'complete answerhood' in partition semantics
- Note: allows for over-informative answers
- $?x \text{ entails } \forall x ?p_x \text{ is a tautology (or a presupposition of } ?p_x)$

Licensing
- $\tau$ licenses $\varphi$ iff $\forall C, w, v : <w, v> \in C[\tau] \& w \in C[\tau][\varphi] \Rightarrow v \in C[\tau][\varphi]$
- If $\varphi$ eliminates a world from the context, it should eliminate the whole alternative to which that world belongs
- Licensing is the logical notion used to arbitrate whether the witness exclusively addresses the issues raised by the interrogator
Remarks on Licensing

- Licensing is the crucial new logical notion.
- It is typically the formulation of the semantics in update format that gives rise to it.
- The way the notion is defined here is inherently linked to the partition view.
- With overlapping alternatives it does not work anymore.

Remarks on Licensing

- Licensing only deals with relatedness of assertions to questions.
- Since questions do not eliminate worlds, questions are always licensed.
- Relatedness of one question to another is rather captured by entailment, which in partition semantics corresponds to the notion of a subquestion.
- Rules of the game prohibit subquestions.
Fact about Licensing

- \( \tau \) licenses \( \psi \) iff \( \tau \) entails \( \psi \)
- An indicative is licensed by the context iff the corresponding polar interrogative is part of the issues raised in the context
- Note that this means that from a logical perspective the notion of licensing is superfluous, entailment can do the job

Fact about pertinence

- \( \phi \) pertinent after \( \tau \) iff \( \neg \phi \) pertinentic after \( \tau \)
- \( \phi \) pertinent after \( \tau \) iff \( \tau \) entails \( \phi \)
- Pertinence of an indicative presupposes the corresponding polar question

Pertinence

- \( \phi \) pertinent after \( \tau \) iff \( \phi \) is consistent with \( \tau \)
- \( \phi \) is informative after \( \tau \) and \( \phi \) is licensed by \( \tau \)
- Quality, Quantity and Relation
- The logical notion of pertinence arbitrates whether an interrogation is in accordance with the rules of the game

Example answers

- Pertinent answers to \( \psi \): \( \neg Pa \)
- \( \neg Pa \)
- \( \neg Pb \)
- \( \forall x Px \)
- \( \forall x (Px \leftrightarrow x = a) \)

Answerhood

- \( \psi \) is a pertinent answer to \( \psi \) iff \( \psi \) is pertinent after \( \psi \)
- Allows for partial answers, but not for over-informative answers
- Let \( \psi \) and \( \chi \) be pertinent answers to \( \psi \). \( \psi \) is a more informative answer to \( \psi \) than \( \chi \) iff \( \psi \) entails \( \chi \) (and not vice versa)
- Comparing answers nice and easy!

Illustration

Alf rescued Bea. And No-one else.
Ambiguous:
Rab; \( \exists x (Rx b \land x \neq a) \)
Rab; \( \exists x (Rx x \neq b) \)
Illustration

(Who rescued Bea?)
Alf rescued Bea. And no-one else
Ambiguity resolved:
\[ \text{Ambiguity resolved:} \]
\[ \text{Explanation:} \]
\[ \text{Not licensed after } ?Rxb; Rab \]

Illustration

(Who rescued Bea?)
Alf rescued Bea. And no-one else
Ambiguity resolved:
\[ \text{Explanation:} \]
\[ \text{Not licensed after } ?Rax; Rab \]

Illustration

(Whom did Alf rescue?)
Alf rescued Bea. And no-one else
Ambiguity resolved:
\[ \text{Explanation:} \]
\[ \text{Not licensed after } ?Rax; Rab \]

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(Whom did Alf rescue?)
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(Whom did Alf rescue?)
Alf rescued Bea. And no-one else
Ambiguity resolved:
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Presupposing an issue

Alf rescued Bea
presupposes
Did Alf rescue Bea?
Who rescued Bea?
preserved under
negation
Alf did not rescue Bea
presupposes
Who rescued Bea?

Only

Who rescued Bea? Only Alf rescued Bea.
\[ ?Rxb; Rab \land \exists x(Rxb \land x \neq a) \]

Who rescued Bea? *Alf rescued only Bea
\[ ?Rxb; Rab \land \exists x(Rax \land x \neq b) \]
Not a pertinent answer

A remaining issue?

Did someone rescue Bea?
Yes. Alf rescued Bea.

Is this equally correct if the ‘Yes’ is missing?
Conclusion

- Enriching the notion of meaning to embody both information and issues opens a new perspective on dealing with pragmatic issues in rather standard logical terms.
- The notion of licensing embodies a very strict logical notion of relatedness to the context, but the illustrations suggest that such a strict notion is linguistically relevant.

Looking ahead

- On all levels, the system is rather restricted.
- The game is very limited and artificial.
- Even as a first order query language the language is poor as compared to natural language.
- The idea that a new perspective on the notion of meaning is at stake does not really play a role.

Data and issues

- In our language providing data and raising issues is divided over two different categories of sentences.
- It might be interesting to look at hybrid cases, where e.g. an indicative sentence (implicitly) raises an issue as well.
  - Someone came to visit me yesterday
  - Who was it?

Language

- Things that could be added:
  - Questions as subformulas
  - Conditional questions
  - Which questions
  - What happens to the partition view?

Game

- Turn the game into a more realistic dialogue game, where really exchange of information plays a role.
- Extend relatedness/licensing to questions as well.
- Allow for critical moves in the game: denial, doubt.