Logic Now and Then

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My Brief and Beyond

- My brief: Natural language semantics:

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- Beyond my brief:

  How our understanding of the nature and scope of Logic has
  changed over the past decades.

Logic then

- The old perspective:

  The systems of classical logic – First Order Predicate Logic, Second and Higher Order Logic, the Lambda Calculus – have given us a definitive *Characteristica Universalis*.

  The fundamental problems of logic have been solved:

- We know how to express even highly complex propositions in an exact, logically transparent way.

- The concepts of logical validity and logical deduction have been given a definitive explication for these systems.

Semantics

- Two areas of Semantics in which Johan's contributions have been important and influential:

  1. Quantifiers and Quantification

  2. Temporal Semantics, Logic and Ontology

Semantics

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- Question: Why?

  Don't the symbolic systems of classical logic provide us with most that is needed for the central task?

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- What is Natural Language Semantics?

- Its central task: to describe how the meaning of an NL expression is determined by its form.

- Fact: This proves to be a big and (surprisingly) hard problem.

- Question: Why?

  Don't the symbolic systems of classical logic provide us with most that is needed for the central task?

- Answer: 'Not really'

Semantics

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  1. First reason:

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  (i)   utterance time

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- Two (ubiquitous) contextual factors:

    (i) utterance time

    (ii) discourse context

- Example:

    (1) A: Is Mary at home?

    (2) B: Yes, she is. And Bill is with her.

Semantics

2. Second reason:

- The grammatical architecture of natural languages is fundamentally different from that of the Predicate Calculus.

- This difference is the source of many more specific differences between natural languages and predicate logic, including the modes of expressing quantification..

Quantifiers and Quantification

- Predicate Logic:

  The standard quantifiers operate on single formulas, and bind a single variable.

  (Semantically such a quantifier is a set of sets.)

Quantifiers and Quantification

- Natural Language:

  1. Quantification is expressed by all sorts of words:

  i. Determiners: *every, some, most, few*, ..
  ii. Frequency Adverbs: *always, sometimes, never, often*, ..
  iii. Other particles: *only, each other*, ..

  2. Even the quantifying expressions that are usually taken to be 'closest' to the quantifiers of formal logic (determiners like *every, some, all*) operate on two 'formulas' and not one.

  3. Quantification is often expressed *through the interaction of several* words and morphemes.

Quantifiers and Quantification

- The next examples illustrate this:

  (3) Some critics only admire each other.

  (4) If 0 is among some numbers and if for any number that is
      among them, its successor is among them too, then these
      numbers are all the numbers.

  (N.B. (4) is a natural language formulation of the '2nd Order
  Induction Principle' of Number Theory.)

  Interacting elements: *some*, *only*, *each other*, plural morphology,
  the plural pronouns *they*, *them*, the plural demonstrative *these
  numbers*:

  (5) Every boy saw a different film.

  Interacting elements: *some*, *a*, *different*

Quantifiers and Quantification

- NL quantification raises wo kinds of questions:

  1. What is the semantics and logic of various NL quantifiers?

     What expressive power do different quantifiers add to the language?

     Which (semantically defined) quantifiers are expressible in a given natural language (e.g. English)?

  2. The syntax-semantics interface question:

     How is the meaning of each quantifying construction in NL determined by its form?

Van Benthem's contributions to NL Quantification

- Johan's contributions:

  Answers to the following types of questions:

- What are natural logical properties for a quantifier to have?

- Which quantifiers have those properties?

- Which quantifiers can be defined with the help of which others?

- In particular:

  i. Which quantifiers can be defined with the means of Predicate Logic?

  ii. Which polyadic quantifiers can be defined with the help of unary quantifiers?

Van Benthem's contributions to NL Quantification

- These last questions have a special importance for natural language semantics.

- On their own, the primary vehicles of quantification in natural language, determiners and frequency adverbs, express unary quantifiers.

- Polyadic quantification is typically expressed through interactions of different sentence constituents.

Van Benthem's contributions to NL Quantification

- References:

  Essays in Logical Semantics. Reidel, 1983

  Determiners and Logic, Linguistics and Philosophy, 1983

  Questions about Quantifiers, Journal of Symbolic Logic, 1984

  Polyadic Quantifiers. Linguistics and Philosophy, 1989

Temporal Semantics and Logic

- As noted: the utterance time is almost always relevant.

  (1)   A: Is Mary at home?

  (2)   B: Yes, she is. And Bill is with her.

  Compare this with:

  (2') B: Mary was here when I arrived.

  (2") B: Mary was here half an hour ago, but she left after ten
            minutes.

  (2') and (2") talk about time in the past of the utterance time.

  The reference of *half an hour ago* must be computed from the
  utterance time.

Temporal Semantics and Logic

- Also compare:
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Temporal Semantics and Logic

- Also compare:
  - (6) Mary will be here next week.
  - (7) Next week will be a tough one.

- Time enters into the meaning of what we say:
  - (i) As utterance time
  - (ii) As topic of discussion

  These two roles interact and cannot be fully separated.

Temporal Semantics and Logic

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- Example:

  (8) Bill on Sept. 10: Mary was in Paris yesterday.

  (9) Fred on Sept. 12: Mary was in Paris three days ago.

  Uttterance (9) is a valid inference from utterance (8).

Temporal Semantics and Logic

- Van Benthem's *The Logic of Time* (Reidel, 1983) is an early contribution to the semantics and logic of temporal discourse, but it does just what is needed:

  Part I deals with the structure of time, drawing from the natural sciences and from cognition and philosophy

  Part II addresses the problem of semantic dependence on utterance time, for languages with varying temporal resources.

  N.B. The languages considered in Part II are 'Tense Logics' (or 'Temporal Logics'), mostly of the kind proposed by Prior.

  Tense Logics are rather far removed from natural languages. But they are a useful laboratory for studying the impact of temporal context-dependence on meaning and logic.

Logic Now

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- With that, a new conception of the nature and scope of Logic:

Logic as the Science of Representation,

Manipulation and Transmission of Information

Logic Now

- The new dynamic logics are 'dynamic' in that they are
  - (i) about the *changes* in and *transfer* of information, and
  - (ii) about the changes in the epistemic states, plans and 'action spaces' of agents that are produced by information change and information transfer.

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- The new dynamic logics are 'dynamic' in that they are

  (i)   about the *changes* in and *transfer* of information, and

  (ii) about the changes in the epistemic states, plans and 'action spaces' of agents that are produced by information change and information transfer.

- Question: What relation (if any) is there between 'dynamic' in this sense and 'dynamic' in 'Dynamic Semantics'?

Logic Now

- The central idea of Dynamic Semantics:

  Linguistic meaning is 'meaning change potential':

  The meaning of an expression is its capacity to transform a given information state into an new state, which incorporates the information contributed by this expression.

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  Linguistic meaning is 'meaning change potential':

  The meaning of an expression is its capacity to transform a given information state into an new state, which incorporates the information contributed by this expression.

- But information states are abstract semantic objects.

  The relations between information states and the epistemic states of agents are not articulated.

Logic Now

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- But DRT treats information updating in terms of explicit **representations**:

  DRT attributes to these representations a certain cognitive reality.

Logic Now

- The plausibility of DRT's claims about cognitive reality of the particular representations it postulates is a point of debate.

  But some account of the representational form of linguistically conveyed information is urgently needed.

  Otherwise there can be no hope for an account of how agents exploit information in reasoning:

Logic Now

- Like other versions of dynamic semantics, DRT has had little to say about the epistemic status of the representations it posits.

  An integration of DRT into a system of dynamic logic for knowledge and action may be one way to fill this gap.

  And there may be benefits to both sides.

  One thing a theory like DRT could contribute to such an integrated logic:

  semantic representations that can fill the positions of the sentence letters of propositional dynamic logics, thus endowing those logics with a new 'fine structure'.

Logic Now

- At this point this is just 'toekomstmuziek'

  But at least it is now possible to start thinking about such tunes.

  And for that, thanks to all who have taken an active part in the logical revolution that has made such thinking possible.

  And, in particular:

Thank you,

Johan!