Multidimensional Semantics

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Why this course

- Increasing number of accounts in Semantics, Pragmatics, Discourse and Dialogue feature a multidimensional aspect
- Not related *prima facie* but share a multidimensional flavor
- Determine whether all these 'multidimensionalities' are related to each other
- Focus on 3 phenomena:
  - quotation
  - supplements and discourse structure
  - meta-linguistic level and communication management
- Compare, Assess multidimensionality
  - Does it help reducing the distance between the approaches?
  - For any good?

Semantics

Meaning

- truth conditions : relation between sentences and models
- context change potential: relations between models of the context

What is in the context?

- Linguistic left context
  - Including speech events?
  - Including 'performance' related aspect (timing, turn-taking,...)?
- Restricted world description
  - Including discourse participants?

Two approaches (ideally converging [Ginzburg, 2012]):

- looking for a grammar
- model language-based interaction (e.g applications in Dialogue systems)

Models

Most of the work in formal semantics relies on the translation of NL sentences into logic formulas that are interpreted into model theory
Which models?

- Originally, represent the actual content of the linguistic message (or how the world should be like for the proposition to be true)
- Looking at more phenomena (Anaphora, Presuppositions,...), context took a bigger part through the discourse referents introduced by the linguistic expressions and that are present in this context
- Simultaneously, the notion *common ground (also game board)* common to all discourse participants

Common ground

A standard view, [Stalnaker, 1978] in [Portner, 2007]

Definition

- The Common Ground is the set of propositions which the participants in the conversation mutually agree to treat as true for purposes of the exchange.
- They are the pragmatically presupposed propositions.
- Assertion is the addition of a proposition to the Common Ground

But a proposition can be shared without being treated as true. (structure in the Common Ground)

Subsection 1

What is a multidimensional semantics?

A definition from modal logic

Multidimensional modal logic
[Marx and Venema, 1997, Venema and Marx, 1999]
Standardly A frame $\mathcal{F} = \langle U, R \rangle$ is composed of a set and of a relation
In a multidimensional modal logic:

- States (possibles worlds) are not simply abstract elements (propositions) but have inner structures
- Accessibility relations are determined with this inner structure
- states are tuples over a base set U
- U can be replaced by set of sets
- Homogeneous frame if the values of the elements of a state are drawn from the same set *(e.g Interval logic)*
- Heterogeneous frame if not *(e.g space + time coordinates)*

Issue: Expressivity and Natural Language Semantics

- Tense, Modality in MG [Montague, 1973] require indexes (w, t)
- Most of the work in natural language semantics is multidimensional
- Related to the discussion on the expressivity of the natural language

Insights from multidimensional modal logic are inspiring but too strict for us

Intuitive ideas about multidimensional semantics

A multidimensional approach

- Introduce a new structure (layers, levels, dimensions) into the semantics (models)
- How to provide such a structure:
  1. Enrich the interpretation mechanism
     - adding parameters multiplies the way a formula can be evaluated (time, speaker, place,...)
  2. Create "areas" in the model for different types of meaning
  3. Structure the domain with explicit constraints
     - extending the type inventory over e, t by splitting e into subtypes

Multidimensional analysis vs. Multidimensional semantics

- Most approaches recognize the necessity of a multidimensional approach
  - Different ways of communicating information: assert, imply (many different ways)
  - Multi-modality
  - Cognitive, Linguistic, Social constraints

This does not necessarily require a multidimensional semantics

- Careful organization of the common ground

Case for multidimensional semantics:

- Independence of the dimensions $\rightsquigarrow$ necessity of a multidimensional approach
- Modeling convenience $\rightsquigarrow$ usefulness of a multidimensional approach

Interim conclusion

- Different tools for creating multidimensionality lead to different kind of multidimensionality
- Drastically complicates the modeling apparatus
- Why do we need it?

Subsection 2

Why a multidimensional semantics?

Different origins

- **Dialogue/Discourse Processing**, Dealing with "real" data requires to deal with several "dimensions" at a time [Bunt, 2009]
- **Formal Semantics / Pragmatics**, Progress in various aspects of semantics/pragmatics has triggered the desire (and the capacity?) with a broader range of phenomena involving different aspects of meaning

Different origins

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Example

(1) A: Could you tell me what departure times there are for flights to Frankfurt on Saturday?
B: Yes, let me have a look. OK, There's a Lufthansa flight leaving at 07:45, [Bunt, 2011b]

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Example

(1) a. Lance, a great champion, has been questioned about his use of doping products.
b. John said that this damn Lance is a great champion.

Illustration

(2) A: Paul did it again.
B: ah...right... uh... John said that this damn Paul is a "weirdo"

- again $\rightsquigarrow$ Paul did the same thing before
- ah $\rightsquigarrow$ B is surprised
- right $\rightsquigarrow$ B acknowledges what has been said
- uh $\rightsquigarrow$ B wants to keep the turn to say something
- damn $\rightsquigarrow$ B does not like Paul / John does not like Paul
- "weirdo' $\rightsquigarrow$ John is using slang, John is impolite / John is cool
- "John said that this damn Paul is a "weirdo"" $\rightsquigarrow$ say(J,strange(P))

All "meaning"? $\rightsquigarrow$ all semantics?

Pleas for multidimensionality

the question is not whether a multidimensional theory is motivated – it seems inevitable – but rather how best to formalize this notion [Potts, 2005]

Pleas for multidimensionality

Expressive content contributes a dimension of meaning that is separate from the regular descriptive content. [Potts, 2007b]

Pleas for multidimensionality

The goal of this paper is to lay out, discuss and defend a multi-dimensional architecture for the interpretation and use of quantifying expressions in natural language [Dekker, 2008]

Pleas for multidimensionality

So that is what this paper is about: a general framework for rep- resenting and integrating all and sundry kinds of information that can be conveyed by linguistic means. [Geurts and Maier, 2003]

Pleas for multidimensionality

We show how the multifunctionality of discourse markers can be described systematically by using a multidimensional model of the interpretation of communicative behaviour in dialogue
[Petukhova and Bunt, 2009]

Subsection 3

Which dimensions?

What is multidimensionality in the frameworks

In translating each English phrase to an ordered pair of formulas, ⟨extension expression;implicature expression⟩, we arrive at a system which is very similar in concept to H. Herzberger (1973) 'two dimensional logic'. [Karttunen and Peters, 1979]:p16

What is multidimensionality in the frameworks

The first is the speech-report contribution. The second gets us to the content: it is what we would give as a semantics for Lisa says Homer is bald (no quotation marks). This is the sense in which quotative utterances are multidimensional. [Potts, 2007a]

What is multidimensionality in the frameworks

The theory is multidimensional, but in a deeper sense than that of Potts 2005, because the descriptive and expressive realms are, in the present paper, distinguished not only syntactically (in the semantic types), but also model-theoretically. [Potts, 2007b]

What is multidimensionality in the frameworks

Multi-dimensional dynamic semantics expands on standard dynamic semantics by treating multiple information types such as assertion, conversational implicatures and world-knowledge based inferences in one unified formalism. We will argue that apparent differences are merely a consequence of other basic principles constraining permissible semantic operations on discourse content depending on the information type. Information types behave differently in monologue or text than in dialogue because of these basic principles. [Spenader and Maier, 2009]:p1708

What is multidimensionality in the frameworks

The idea underlying our semantics for the LDRS language is simply that, instead of specifying what is the truth-conditional content of an LDRS ϕ, we have to define what is the truth-conditional content of a selection L of layers in ϕ. [Geurts and Maier, 2003]

What is multidimensionality in the frameworks

The DIT framework supports a multidimensional semantics by relating context update operators to different compartments of structured context models which include, besides information states of the usual kind (beliefs and goals related to a task domain), also a dialogue history, information about the agents processing state, beliefs about dialogue partners process- ing states, information and goals concerning the allocation of turns [Petukhova and Bunt, 2009]

Multidimensionality in Dialogue Processing

- NLP task: provide the communicative function of a speech production
- Communivative functions : Generalization of illocutionary forces
- Various schemes (MAPTASK, TRAINS, DAMSL, SWBD-DAMSL,...)
- one-dimensional vs. multidimensional schemes
- DAMSL, DIT++ : multidimensional schemes

Why multi-dimensional tagsets?

- Cluster the communicative functions, helps keeping a clear tag set
- Cluster induce an organization, helps the decisions for the annotation process
- Within one-dimension choices are generally mutually exclusive, helps for the annotation process (decision tree)

Definition

Dimension [Bunt, 2011a] A dimension is an aspect of participating in dialogue which:

- dialogue participants can address by means of dialogue acts
- can be addressed **independently** of the other aspects of participating in dialogue which are distinguished.

[Popescu-Belis, 2005, Bunt, 2011a]

Some candidates for dimensions, standards

- meta-communication $\rightsquigarrow$ linguistic objects
- participants attitudes $\rightsquigarrow$ beliefs, desires,...
- social constraints $\rightsquigarrow$ commitments,...
- other participant related ingredients $\rightsquigarrow$ opinion, emotions,...
- meta-data
  - of the speaker: register, dialect, cognitive state...
  - of the situation: cooperative vs. strategic, task-oriented
- at-issue / commentary, implicated vs. expressed

Some candidates for dimensions, more

- also the discourse structure vs. discourse content distinction

Example

(3) a. John moved to Warsaw for two reasons. First, his wife left him and second he got an interesting job offer there.

b. John moved to Warsaw. His wife left him and he got an interesting job offer there.

- Social meaning

Some candidates for dimensions, more

- also the discourse structure vs. discourse content distinction
- Social meaning

Example

(3) [Smith et al., 2010]

a. I'd [a:d] like [la:k] to welcome all y'all from my [ma:] home state!

b. I'd [aɪd] like [laɪk] to welcome all y'all from my [maɪ] home state!

(4) Donnez-moi deux chocolatines.
Give me two chocolate-pastries$_{SouthWest\ France}$

Course Schedule

1. Introduction • Linguistica Phenomena (Today)
2. Quotation (triple multidimensionality) (Laure Vieu)
3. Multidimensionality and Discourse Structure (Laure Vieu)
4. Multidimensionality in Dialogue and Dialogue Modeling (Laurent Prvot)
5. Comparison and perspectives (Together)

What the course is not about

Distributional (multi-dimensional) Semantics

- Study the semantic of terms (and potentially of their composition [Baroni and Zamparelli, 2010] by their distribution in context in large corpora
- Highly-dimensional spaces (typically one dimension per context) are used to express this kind semantics
- Reducing these spaces may lead to identifiable dimensions of meaning

Here:

- Acknowledge the existence of different dimensions (from literature review)
- Investigate how to model them (and their) potential interaction

Indexicals

(5) a. Mary: I am female.
b. John: I am female.

(a) is true while (b) is false, same proposition in the same world
Kaplan proposed two kinds of meaning

1. **Content** is what is said, once evaluated (in a given world) provides the extension
2. **Character** is what determines the content in varying contexts, *(e.g 'I' refer to the speaker or writer)*

Need to introduce a new parameter (*index*) in the valuation function, the context.
This double-indexing is a kind of multidimensionality

Quotation

(6) a. Otto said 'I am a fool'
b. Otto said that I am a fool

Conventional implicatures - Presuppositions

In [Karttunen and Peters, 1979] each phrase is associated with 2 expressions of intensional logic

(7) Even Bill likes Mary
expressed: Bill likes Mary
implicated: Other people like mary and Bill is among the least likely to like her

(8) Bart failed to pass the test. [Potts, 2007c]
expressed = Bart did not pass the test
implicated = Bart tried to pass the test

Laid out in Montague Grammar, each semantic rule associate each 2 expressions
Complex semantics of even^i operates at the level of implicated meaning

Presuppositions [Dekker, 2008]

- Dymamic account
- Multidimensional: it has several valuation function, one per dimension
  - Presupposition satisfaction: $\models_p$
  - Assertion satisfaction: $\models_a$
  - Standard satisfaction : intersection

For any expression E, $[\![E]\!]_{M,g,ce}$, the interpretation of E relative to M, g and ce (sequences of individuals e that are the possible referents of terms in E) is the intersection of

- $[\![E]\!]^a_{M,g,ce}$: the assertion or denotation of E
- $[\![E]\!]^p_{M,g,ce}$: the presupposition of E
- $[\![E]\!]^c_{M,g,ce}$: the contribution of E

Parentheticals [Potts, 2003]

Example

(9)
a. Ames, who stole from the FBI, is now behind bars.
b. Sheila believes that Chuck, a psychopath, is fit to watch the kids.
c. Thoughtfully, Jenny picked up her little sister at school.

Other sources

Honorifics [Potts and Kawahara, 2004]

(10) Sam-ga o-warai-ninat-ta.
Sam-nom subj.hon-laugh-subj.hon-past
Descriptive = Sam laughed
Conventional Implicature : The speaker honors Sam

Expressives[Potts, 2005]

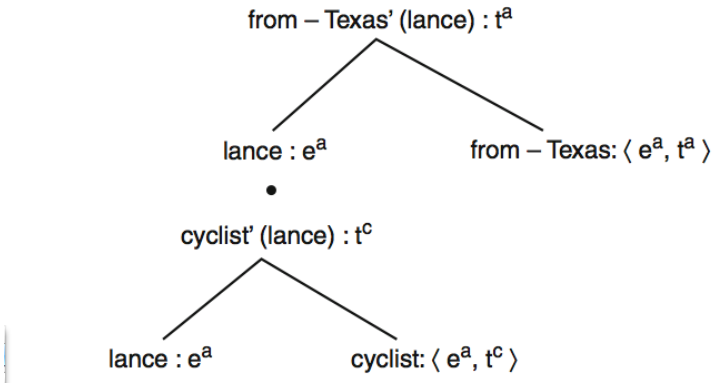
(11) I've just realised Ive got to work out my bloody sales tax.
Descriptive = Ive just realized Ive got to work out my sales tax
Conventional Implicature = I am in a heightened emotional state relating to sales tax

Potts' account, a sketch

Potts proposed an unified account of these phenomena by distinguishing *at-issue* content from conventional implicatures, to do so:

- Introduce an intermediate structure (semantic parse tree) ($\mathcal{L}_{CI}$)
  - Distinguish expressions of different type in $\mathcal{L}_{CI}$ (e^a, t^a) for *at-issue* content and (e^c, t^c) for conventional implicatures in $\mathcal{L}_{CI}$
  - Interpreted using the interpretation function $[\![.]\!]_{\mathcal{M}i,g}$
- Semantic parse trees are associated with participants into another language ($\mathcal{L}_U$)
  - higher-order lambda calculus with types e, t, u
  - Interpreted in discourse structures: $[\![.]\!]_{\mathcal{D},s,a}$
- Also refines the inventory of basic types in $\mathcal{L}_U$

Potts' account, $\mathcal{L}_{CI}$)



As noted in [Amaral et al., 2007],

- Types such as $\langle e_c, t_c \rangle$ or $\langle e_c, t_a \rangle$ are not well-formed in Pottss system.
- CIs are comments on at-issue content (and not, for example, comments on another CI)

Pott's multidimensionality

- interpretation of the *at-issue* term of the root note
- set of interpretations of CI terms (t^c) on any node of the tree

Potts' account, discourse structure:

[Potts, 2003] A discourse structure is a tule $\mathcal{D} = (A, \mathbf{D}, D_u, \mathfrak{M}, \underline{h}, V_{\mathcal{D}})$ where

- $A = a_1, a_2, ...$ is a set of discourse participants.
- $D_u = \{S1, S2, ...\}$ is a set of sentences, the domain of u (a sentence is a pair (syntactic structure, parse tree))
- $\mathbf{D}$ is a set of domains ; $A \subseteq \mathbf{D}$
- $\mathfrak{M} = \{\mathcal{M}_1, \mathcal{M}_2, ...\}$ is a set of intensional models; All $\mathcal{M}_i$ have $\mathbf{D}$ as set of domains. (Common Ground)
- ~~h~~ : Interpretation function from discourse participants (a_i) to intensional models ($\mathcal{M}_i$) (their world views)
- Valuation function: from constants of $\mathcal{L}_U$ to functions formed from objects in $D_e \cup D_u \cup \{0, 1\}$, such that if $\alpha : \sigma$, then $V_D(\alpha)$ $D(\sigma)$

Sum-up

- Strictly speaking, most NL semantics account are multidimensional
- However, current multidimensional accounts vary drastically wrt to what they call dimensions
- Need to get deeper in the accounts

Tomorrow: Focus on quotations

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