Competence in lexical semantics

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Problem statement

Characterizing what it means for a speaker to be competent in lexical semantics remains perhaps the most significant stumbling block in reconciling the two main threads of semantics, Chomsky's cognitivism and Montague's formalism. In the paper, three broad families of semantic theories are compared and contrasted from the competence standpoint:

MG Montague Grammar and its lineal descendants, including Discourse Representation Theory (DRT), dynamic predicate logic, etc.

ACR Algebraic Conceptual Representations starting with [Quillian1969], and KL-ONE [Brachman and Schmolze1985, Woods and Schmolze1992], today best represented by Natural Semantic Metalanguage [Wierzbicka1972, Goddard2002], Abstract Meaning Representation [Banarescu et al.2013], Hobbs' system [Gordon et al.2011] and 4lang [Kornai2010, Kornai2012, Recski and Ács2015]

CVS Continuous Vector Semantics [Osgood et al.1975, Schütze1993, Bengio et al.2003, Turian et al.2010, Mikolov et al.2013, Pennington et al.2014]

The standard view [Partee1979, Partee2013] is that psychological reality requires compositionality, otherwise an infinite amount of information would need to be memorized. MG assumes that words are characterized by intensions, formal objects that require an infinite amount of information to specify.

Main questions of competence

- Learnability
- Replicating traditional notions of lexical relatedness such as synonymy, antonymy, ambiguity, polysemy, etc.
- Interface to compositional semantics
- Language-specificity and universality

Basic vocabularies

Two main approaches: [Thorndike1921] based on term and document frequency, and [Ogden1944] based on the ability to define other words. We have inspected the directed graph that can be obtained from any dictionary by taking the words as nodes and adding edges from a to b if a appears in the definition of b. The minimal set required for defining all words is called a Feedback Vertex Set (FVS). Finding the FVS is NP-complete, we used heuristics (dropping rare words first).

Properties of four different dictionaries

Dictionary	#words	FVS
4lang (all senses)	31,192	1,008
4lang (first senses)	3,127	361
LDOCE (all senses)	79,414	1,061
LDOCE (first senses)	34,284	376
CED (all senses)	154,061	6,490
CED (first senses)	80,495	3,435
`en.wiktionary` (all senses)	369,281	2,504
`en.wiktionary` (first senses)	304,029	1,845
formal	2,754	129

MG Learnability of intension/extension – infinite task, huge problem.

ACR Vocabulary learning reduces to learnability of basic vocabulary. The dominant portion of the vocabulary is not connected to direct sensory signals but is learned from context [McKeown and Curtis1987].

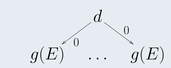
CVS Embeddings are already learned from corpora, but data requirements are currently unrealistically large.

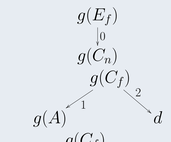
4lang syntax

$D \to E(,E)^*$

$E \to E_n \mid E_f$

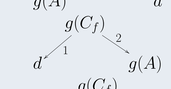
$E \to C_n(E_f)$



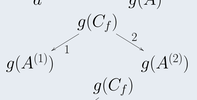


$E_f \to AC_f$

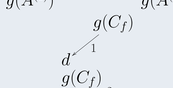
$E_f \to C_f A$



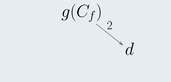
$E_f \to A^{(1)}C_f A^{(2)}$



$E_f \to C_f$'



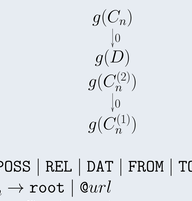
$E_f \to$ 'C_f



$E_f \to E_n$

$E_n \to C_n$

$E_n \to C_n[D]$



$E_n \to C_n^{(1)}(C_n^{(2)})$

$A \to E_n \mid$ `[D]`

$C_n \to$ `AGT` | `PAT` | `POSS` | `REL` | `DAT` | `FROM` | `TO` | `AT`

$C_n \to$ `root` | `@`url

$E \to$ <C>, $A \to$ <A>

$C_n \to$ `[a-z-]+(/[0-9]+)`

$C_f \to$ `[A-Z_]+(/[0-9]+)`

4lang, AMR, and other ACR systems be formulated in terms of hyperedge replacement grammars [Chiang et al.2013].

Lexical relatedness

MG Word similarity =? similarity of meaning postulates. Only a handful of meaning postulates exist, generally restricted to temporals, intensionals, quantifiers i.e. for those words where the underlying logic has the resources [Zimmermann1999].

ACR Similarity of words = similarity of graphs. Used in a competitive SemEval 2015 system [Recski and Ács2015].

CVS Widely used, best results so far.

Interface with compositional semantics

MG Smooth interface except for issues of contextuality, which force as many derivation trees at the disambiguation stage as there are distinct word meanings. With the average English word 3-ways ambiguous, this requires 3^{15} trees for a sentence of length 15.

ACR Built from content words by spreading activation, early disambiguation, good handling of fragmentary input [Nemeskey et al.2013].

CVS Approaches to compositionality broadly investigated, several competing methods, currently with Context Vector Grammars [Socher et al.2013] in the lead.

Deep cases in 4lang

freq	abbr	comment
487	`AGT`	agent
388	`PAT`	patient
34	`DAT`	dative
82	`REL`	root or adpositional object
70	`POSS`	default for relational nouns
20	`TO`	target of action
15	`FROM`	source of action
3	`AT`	location of action

Universality, language-specificity

MG No discussion of deeper universals e.g. in case linking

ACR Universal deep cases, surface realization separated out

CVS Universals may be present in embeddings, but we cannot recover them for now.

Conclusions

MG Hopeless as a theory of lexical competence

ACR Fits well with Pāṇini, generative semantics, and several versions of post-TG syntax such as LFG, RG, RRG, Berkeley Construction Grammar [Goldberg1995]

CVS Farther from direct linguistic/psycholinguistic concerns

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