

LEXICAL SEMANTICS

Word meanings:

Verbs-

- predicate argument structure
- number of arguments
- position and syntactic types
- names for arguments

Nouns-

- not much- meaningless? no truth value but.....no reference?
(extensional semantics)

Terminology:

- lexeme: pairing of orthographic/phonological form with a sense
(symbolic meaning representation)

- lexicon list of lexemes

Dictionaries

- are circular

- where can they ground out?

- Longman's Dictionary of Contemporary English

- procedural semantics

- semantic primitives?

Look at:

- external relations among words

- internal structure of words

RELATIONS AMONG LEXEMES AND THEIR SENSES

Homonymy: same form, different meaning
homonyms

(16.1) Instead, a *bank* can hold the investments in a custodial account in the client's name.

(16.2) But as agriculture burgeons on the east *bank*, the river will shrink even more.

bat

homophones: same phonology, different orthographic form, meanings
wood, would
be, bee

homographs: same orthographic forms, different pron

(16.3) The expert angler from Dora, Mo., was fly-casting for bass rather than the traditional trout.

(16.4) The curtain rises to the sound of angry dogs baying and ominous bass chords sounding.

different parts of speech:
wood, would
be, bee

same part of speech - different / overlapping morphologies

(16.5) He has looked at 14 baseball and football stadiums and found that only one – private Dodger Stadium – brought more money into a city than it took out.

(16.6) Culturally speaking, this city has increasingly displayed its determination to found the sort of institutions that attract the esteem of Eastern urbanites.

problems?

spelling correction: homophones (weather whether)

overlapping morphologies (find found - founded)

speech recognition: homophoneds (to, two, too)

perfect homonyms (bank) mess up N-gram probabilities

text to speech: homographs (bass) (POS tagging for - conduct, content)

IR: *bat care*

translation

Polysemy

multiple related meanings within single lexeme

(16.7) While some *banks* furnish sperm only to married women, others are.....

blood, sperm, egg banks are related

criteria:

etymology
introspection, conception of native speakers

coincidence?

managing senses:

what distinct senses does a lexeme have?
how are they related
how can they be distinguished - Word Sense Disambiguation

(16.8) They rarely *serve* red meat, preferring to prepare seafood, poultry or game birds.

(16.9) He *served* as U.S. ambassador to Norway in 1976 and 1977.

(16.10) He might have *served* his time, come out and led an upstanding life.

connection to food preparation
syntax of *as U.S. ambassador*
connection to incarceration

(16.11) Which of those flights *serve* breakfast?

(16.12) Does Midwest express *serve* Philadelphia?

conjunction?

Synonymy

different lexemes with the same meaning ??

substitutability

(16.14) How big is that plane?

(16.15) Would I be flying on a large or small plane?

substitution in *some* environments because....

polysemy

shades of meaning

collocation constraints

register

(16.16) Miss Nelson, for instance, became a kind of big sister to Mrs. Van Tassel's son, Benjamin.

(16.17) ?Miss Nelson, for instance, became a kind of large sister to Mrs. Van Tassel's son, Benjamin.

shades of meaning

(16.18) What is the cheapest first class fare?

(16.19) ?What is the cheapest first class price?

collocation constraints

(16.20) We frustrate 'em and frustrate 'em, and pretty soon they make a big mistake.

(16.21) ?We frustrate 'em and frustrate 'em, and pretty soon they make a large mistake.

Hyponymy

hyponym more specific

hypernym more general

That is a x. => That is a y.

That is a car. => That is a vehicle.

ontology

taxonomy

object hierarchy

Quillian 1967

inheritance

complex structured objects

WORDNET: A DATABASE OF LEXICAL RELATIONS

(an online resource)

Three databases V, N, Adj&Adv

Category	Unique Forms	Number of Senses
Noun	94474	116317
Verb	10319	22066
Adjective	20170	29881
Adverb	4546	5677

sense entries

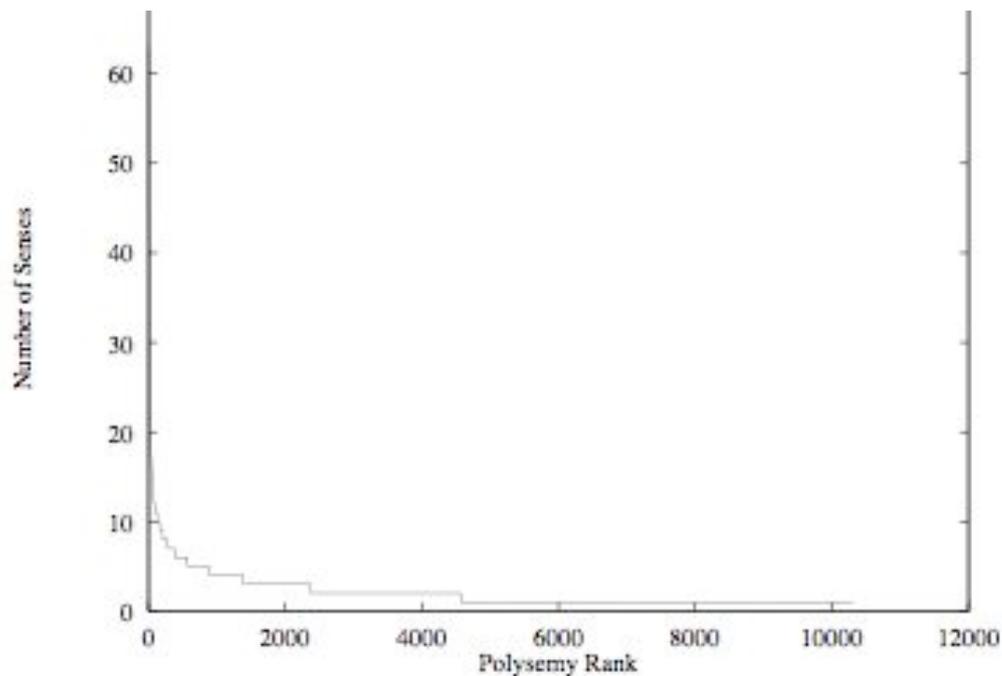
- set of synonyms
- gloss
- examples of use

The noun "bass" has 8 senses in WordNet.

1. bass - (the lowest part of the musical range)
2. bass, bass part - (the lowest part in polyphonic music)
3. bass, basso - (an adult male singer with the lowest voice)
4. sea bass, bass - (flesh of lean-fleshed saltwater fish of the family Serranidae)
5. freshwater bass, bass - (any of various North American lean-fleshed freshwater fishes especially of the genus *Micropterus*)
6. bass, bass voice, basso - (the lowest adult male singing voice)
7. bass - (the member with the lowest range of a family of musical instruments)
8. bass - (nontechnical name for any of numerous edible marine and freshwater spiny-finned fishes)

no phonology

no distinction between homonymy polysemy



Zipf distribution of distribution of polysemy in verb database

domain independent lexical relations:

Relation	Definition	Example
Hypernym	From concepts to superordinates	<i>breakfast</i> : <i>meal</i>
Hyponym	From concepts to subtypes	<i>meal</i> → <i>lunch</i>
Has-Member	From groups to their members	<i>faculty</i> : <i>professor</i>
Member-Of	From members to their groups	<i>copilot</i> → <i>crew</i>
Has-Part	From wholes to parts	<i>table</i> → <i>leg</i>
Part-Of	From parts to wholes	<i>course</i> › <i>meal</i>
Antonym	Opposites	<i>leader</i> ⇄ <i>follower</i>

Relation	Definition	Example
Hypernym	From events to superordinate events	<i>fly</i> → <i>travel</i>
Troponym	From events to their subtypes	<i>walk</i> › <i>stroll</i>
Entails	From events to the events they entail	<i>snore</i> → <i>sleep</i>
Antonym	Opposites	<i>increase</i> . . . <i>decrease</i>

Relation	Definition	Example
Antonym	Opposite	<i>heavy</i> ↔ <i>light</i>
Adverb	Opposite	<i>quickly</i> ↔ <i>slowly</i>

Synonymy:

synset

{chump, fish, fool, gull, mark, patsy, fall guy,
sucker, schlemiel, shlemiel, soft touch, mug}

Hyponymy

hypernym and hyponym relations

```
Sense 3
bass, basso --
(an adult male singer with the lowest voice)
=> singer, vocalist
    => musician, instrumentalist, player
        => performer, performing artist
            => entertainer
                => person, individual, someone...
                    => life form, organism, being...
                        => entity, something
                            => causal agent, cause, causal agency
                                => entity, something

Sense 7
bass --
(the member with the lowest range of a family of
musical instruments)
=> musical instrument
    => instrument
        => device
            => instrumentality, instrumentation
                => artifact, artefact
                    => object, physical object
                        => entity, something
```

THE INTERNAL STRUCTURE OF WORDS

what the meaning components should consist of:

Thematic Roles

(16.22) Houston's Billy Hatcher broke a bat.

(16.23) He opened a drawer.

$\square e, x, y$ *Isa* (*e*, *Breaking*) \square *Breaker* (*e*, *BillyHatcher*)
 \square *BrokenThing* (*e*, *y*) \square *Isa* (*y*, *BaseballBat*)

$\square e, x, y$ *Isa* (*e*, *Opening*) \square *Opener* (*e*, *he*)
 \square *OpenedThing* (*e*, *y*) \square *Isa* (*y*, *Door*)

deep roles

thematic role captures generality

agents - volitional causation

theme - affected entity

(16.24) A company soccer game last year got so rough that Mr. Cockwell broke his collarbone and an associate broke an ankle.

experiencer

(16.25) The quake broke glass in several downtown skyscrapers.

force

(16.26) It broke his jaw.

instrument

Thematic Role	Definition
AGENT	The volitional causer of an event
EXPERIENCER	The experiencer of an event
FORCE	The non-volitional causer of the event
THEME	The participant most directly affected by an event
RESULT	The end product of an event
CONTENT	The proposition or content of a propositional event
INSTRUMENT	An instrument used in an event
BENEFICIARY	The beneficiary of an event
SOURCE	The origin of the object of a transfer event
GOAL	The destination of an object of a transfer event

Thematic Role	Example
AGENT	<i>The waiter spilled the soup.</i>
EXPERIENCER	<i>John has a headache.</i>
FORCE	<i>The wind blows debris from the mall into our yards.</i>
THEME	<i>Only after Benjamin Franklin broke the ice...</i>
RESULT	<i>The French government has built a regulation-size baseball diamond...</i>
CONTENT	<i>Mona asked "You met Mary Ann at a supermarket"?</i>
INSTRUMENT	<i>He turned to poaching catfish, stunning them with a shocking device...</i>
BENEFICIARY	<i>Whenever Ann Callahan makes hotel reservations for her boss...</i>
SOURCE	<i>I flew in from Boston.</i>
GOAL	<i>I drove to Portland.</i>

Applications to Linking Theory and Shallow Semantic Interpretation

intermediary between deep semantics and surface realization

AGENT > *INSTRUMENT* > *THEME*

(16.27) *John opened the door.*
AGENT THEME

(16.28) *John opened the door with the key.*
AGENT THEME INSTRUMENT

(16.29) *The key opened the door.*
* AGENT THEME *mistake: should be INSTRUMENT

(16.30) *The door was opened by John.*
THEME AGENT

dative alteration - verb classes

(16.31)

a. *Doris gave/sent/read the book to Cary.*
AGENT THEME GOAL

b. *Doris gave/sent/read Cary the book.*
AGENT GOAL THEME

affect verbs allow THEME as subject, or EXPERIENCER Subj, THEME as prep obj.

(16.32)

a. *That frightens me.*
THEME EXPERIENCER

b. *That interests me.*
THEME EXPERIENCER

(16.33)

a. *I am frightened of that.*
EXPERIENCER THEME

b. *I am interested in that.*
EXPERIENCER THEME

c. *I am surprised at that.*
EXPERIENCER THEME

but some alterations violate any standard verb classification

thematic roles only relevant to NP and PP arguments of verbs

so list all possible thematic frames for verb (with probabilities)

Selection Restrictions

violation:

(16.37) I wanna eat someplace that's close to ICSI.

(16.38) I wanna eat some really cheap Chinese food right now.

on senses, not lexemes

(16.39) Well, there was the time they served green-lipped mussels from New Zealand.

(16.40) Which airlines serve Denver?

(16.41) Which ones serve breakfast?

variety of specificity of selectional restrictions, and open-ended

(16.42) In rehearsal, I often ask the musicians to imagine a tennis game.

(16.43) Others tell of jumping over beds and couches they can't imagine clearing while awake.

(16.44) I cannot even imagine what this lady does all day.

(16.45) Atlantis lifted Galileo from the launch pad at 12:54 p.m. EDT and released the craft from its cargo bay about six hours later.

(16.46) When the battle was over, Mr. Kruger lifted the fish from the water, gently removed the hook from its jaw, admired it, and eased it back into the lake.

(16.47) To diagonalize a matrix, is to find its eigenvalues.

selectional restrictions of non verbal lexeme senses

(16.48) Radon is a naturally occurring odorless, tasteless gas that can' be detected by human senses.

(16.49) What is the lowest fare for United Airlines flight four thirty?

(16.50) Are there any restaurants open after midnight?

Representing Selection Restrictions

sense of verb *eat* using thematic roles, ignoring λ notation

$\lambda e, x, y \text{ Eating}(e) \lambda \text{ Agent}(e, x) \text{ Patient}(e, y)$

adding a selectional restriction

$\lambda e, x, y \text{ Eating}(e) \lambda \text{ Eater}(e, x) \lambda \text{ Patient}(e, y) \lambda \text{ Isa}(y, \text{EdibleThing})$

adding the filler *a hamburger*

$\lambda e, x, y \text{ Eating}(e) \lambda \text{ Eater}(e, x) \lambda \text{ Patient}(e, y) \lambda \text{ Isa}(y, \text{EdibleThing})$
 $\lambda \text{ Isa}(y, \text{Hamburger})$

using WordNet

{food, nutrient}



Primitive Decomposition

(16.51) Jim killed his philodendren.

(16.52) Jim did something to cause his philodendren to become not alive.

(16.53) John opened the door.

(16.54) The door opened.

(16.55) The door is open.

basic primitives such as DO, CAUSE, BECOME + open ended set of predicates

more abitious: Coneptual Dependency

Primitive	Definition
ATRANS	The abstract transfer of possession or control from one entity to another.
PTRANS	The physical transfer of an object from one location to another
MTRANS	The transfer of mental concepts between entities or within an entity.
MBUILD	The creation of new information within an entity.
PROPEL	The application of physical force to move an object.
MOVE	The integral movement of a body part by an animal.
INGEST	The taking in of a substance by an animal.
EXPEL	The expulsion of something from an animal.
SPEAK	The action of producing a sound.
ATTEND	The action of focusing a sense organ.

(16.56) The waiter brought Mary the check.

$\square x. y \text{ Atrans } (x) \text{ Actor } (x, \text{Waiter}) \square \text{ Object } (x, \text{Check}) \square \text{ To } (x, \text{Mary})$
 $\square \text{ Ptrans } (y) \square \text{ Actor } (y, \text{Waiter}) \square \text{ Object } (y, \text{Check}) \square \text{ To } (y, \text{Mary})$

compositional analysis of nouns

□*x* *Isa* (*x*, *Feline*) □ *Isa* (*x*, *Youth*)

□*x* *Isa* (*x*, *Canine*) □ *Isa* (*x*, *Youth*)

□*x* *Isa* (*x*, *Human*) □ *Isa* (*x*, *Youth*)

□*x* *Isa* (*x*, *Feline*) □ *Isa* (*x*, *Adult*)

□*x* *Isa* (*x*, *Canine*) □ *Isa* (*x*, *Adult*)

□*x* *Isa* (*x*, *Human*) □ *Isa* (*x*, *Adult*)

but Bollinger- the Atomization of Meaning 1965 (Language)
in response to Katz & Fodor, 1963

what is the residue after the primitives are extracted?

e.g., how do you express various words regarding walking in CD?

Semantic Fields

reservation, flight, travel, buy, price, cost, fare, rates, meal, plane

frames, scripts, models

CREATIVITY AND THE LEXICON

Metaphor

(16.57) That doesn't scare Digital, which has grown to be the world's second-largest computer maker by poaching customers of IBM's mid-range machines.

corporations as living things

Lakoff & Johnson (1980)

Metonymy

(16.61) GM killed the Fiero because it had dedicated a full-scale factory to...

a more concrete thing to stand for more abstract

product for activity (that produced it)
author for author's work
place for institution

Computational Approaches to Metaphor and Metonymy

convention-based approaches vs. reasoning-based approaches

Abstraction of Thematic roles can help:

He melted her reserve with a husky-voiced paean to her eyes.

If He and reserve as the Melter and Melted, then those labels lose any meaning they might have had literally.

If Agent and Theme then don't have the same problems

SELECTIONAL RESTRICTION-BASED WORD SENSE DISAMBIGUTION

two approaches:

during rule based semantic analysis, side effect of elimination of ill-formed semantic components
stand-alone approach

(17.1) “In our house, everybody has a career and none of them includes washing dishes,” he says.

(17.2) In here tiny kitchen at home. Ms. Chen works efficiently, stir-frying several simple dishes, including braised pig’s ears and chicken livers with green peppers.

selectional restrictions on PATIENT roles of *wash* and *stir-fry*

arguments select verbs-

(17.3) Well, there was the time they served green-lipped mussels from New Zealand.

(17.4) Which airlines serve Denver?

(17.5) Which ones serve breakfast?

arguments and verbs can both have multiple senses:

(17.6) I am looking for a restaurant that serves vegetarian dishes.

additional information needed about arguments:

hierarchical type information	hypernym info re heads of args to predicates
semantic selectional restrictions	attach synsets to args of each predicate-bearing lexical item

Limitations of Selectional Restrictions

still ambiguous:

(17.7) What kind of dishes do you recommend?

obvious violations that are well-formed and interpretable (so can't eliminate)

(17.8) But it fell apart in 1931, perhaps because people realized you can't eat gold for lunch if you're hungry.

negative scope make it OK, but local restrictions would prevent it

(17.9) In his two championship trials, Mr. Kulkarni ate glass on an empty stomach, accompanied only by water and tea.

unusual action, but this is what was intended to be said

(17.10) If you want to kill the Soviet Union, get it to try to eat Afghanistan.

metaphor and metonymy

preferences:

frame based understanding:

eat:

agent: person, animate thing, consuming thing

object: food, fuel, resource, consumable

restriction: agent is capable of consuming object

restruction: object is resource for agent

I eat apples

my car eats gasoline

I eat gasoline

My car eats apples