

Topics for Today

Semantic Interpretation

1. Logical form
2. Representing words
3. Functional form / semantic roles

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Semantic Interpretation

The process of mapping a sentence into its **logical form**.
logical form: the representation of context-independent, literal meaning

1. Do you know what time it is?
2. Tax returns are due on April 15th.
3. I walked to the bank.
4. American cars. American food. American people.
5. I'm getting cold.

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Advantages of Computing Logical Form

Modularity

“...can study sentence meaning in detail without all the complications of sentence usage. In particular, if sentences have no context-independent meaning, then we may not be able to separate the study of language from the study of general human reasoning and context.” - *James Allen, his NLP textbook*

I walked to the bank.

I swam to the river bank.

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Components of a Meaning Representation

Compositional semantics: we can derive the meaning of the whole sentence from the meanings of the parts. Need to specify the following:

1. the meaning of individual words
2. how the meanings of individual words combine to form the meaning of groups of words
3. how it all fits in with syntactic analysis

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Meaning of Individual Words

word sense: basic semantic unit

Organize the word senses into a set of broad classes of objects by which we classify the world: physical objects, quantity, quality, relation, place, time, position, *states*, *events*, ideas, concepts, plans, *actions*.

Represent senses of a word by providing a pointer to places in the taxonomy. **check** →

check1 : hockey sense

check2 : check mark sense

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Semantic Ambiguity

lexical ambiguity Dexter *ran* last year.

structural ambiguity tied to syntactic ambiguity

WalMart's plans to open a new store in Ithaca were initially thwarted by *fiesty* Yankees and lawyers.

structural ambiguity tied to semantic scoping ambiguity

Every boy loves a dog.

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Noun Phrases

...in first-order logic

Marsha is a child. : (child1 Marsha1)

Marsha is a child. : (child1 (name **m1** Marsha1))

She is a child. : (child1 (pro **s1** she1))

the dog : (the **x**: (dog1 **x**)), (the dog1)

the mangy dog : (the **x**: (& (dog1 **x**) (mangy1 **x**))), (mangy1 (dog1 def)), (the mangy dog1)

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Verbs

Romeo loves Juliet. (loves1 (name **r1** Romeo1) (name **j1** Juliet1))

Max broke the window with the hammer. (<past break1> (name **m1** Max1) (the window1) (the hammer1))

The hammer broke the window. (<past break1> (the hammer1) (the window1))

The window broke. (<past break1> (the window1))

Not quite right...

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Features of the Semantic Representation

- *words*: word senses
- *noun phrases*:
 - structure representing meaning of whole phrase
 - note the difference between class of objects and particular object (e.g., definite vs. indefinite reference)
- *clauses and sentences*: denote functional structure — who did what to whom.

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Uncovering the Functional Structure

Small set of abstract semantic relationships/roles that hold between a verb and its arguments: *thematic roles*, *predicate-argument structure*

Max broke the window with the hammer. (<past break1> (agent Max1) (theme (the window1)) (instr (the hammer1)))

The hammer broke the window. (<past break1> (instr (the hammer1)) (theme (the window1)))

The window broke. (<past break1> (theme (the window1)))

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The window was broken by Max. (<past break1> (agent Max1) (theme (the window1)))

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Role	Definition	Example	Realization
agent	instigator of the action	<i>John</i> broke the window.	S, <i>by-pp</i>
instr	force/tool causing event	<i>The hammer</i> broke the window.	with-pp, S
patient/ theme	thing affected	John broke <i>the window</i> .	DO, S
experiencer	person involved in perception/ state	<i>John</i> saw the clouds.	S

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Role	Definition	Example	Realization
destination	final location	I walked <i>to Upson</i> .	<i>to-pp, into-pp</i>
from-loc	original location	I walked <i>from Bard</i> to Upson.	<i>from-pp, out of</i>
path	path over which something travels	I walked <i>along the ridge</i> .	<i>along-pp, across-pp</i>
recipient	final possessor	I gave <i>John</i> the book.	<i>IO, to-pp</i>

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Difficulties in Determining Functional Form

I paid Mildred \$20 for the sweater.
I bought the sweater from Mildred for \$20.

Lynn became sick.

I ate the spaghetti with a fork.
I ate the spaghetti with John.
I ate the spaghetti with sauce.
I ate the spaghetti with glee.

The man killed the cat.
The man killed in the car accident was drunk.

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Putting It All Together

weak interaction from time to time the syntactic processor may allow the semantic component to decide whether to abandon or continue with a given analysis.

strong interaction semantics and context actually influence *which* syntactic entities get proposed in the first place

Psycholinguistic evidence: both directions

- The teachers taught by the Berlitz method passed the test.
- The children taught by the Berlitz method passed the test.

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Semantic Interpretation

Most methods make the assumption that semantic interpretation is a **compositional** process.

- Syntax-driven rule-by-rule approach.

Other options:

- **Throw out syntax altogether.** Produce semantic representation directly from sentence. Pretty extreme...
- **Somewhere in between.** Partial syntactic analysis; use as input for subsequent semantic interpretation.

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