HG2002 Semantics and Pragmatics

Sentence Relations, Truth and Models

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Lecture 4

https://bond-lab.github.io/Semantics-and-Pragmatics/

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Overview

➤ Revision: Word Meaning

   ➤ Defining *word*
   ➤ Lexical and Derivational Relations
   ➤ Lexical Universals

➤ Logic and Truth

➤ Necessary Truth, A Priori Truth and Analyticity

➤ Entailment

➤ Logical Metalanguage (10.2–3)

➤ Semantics and Models (10.4–5)

➤ Presupposition

➤ Next week: Chapter 5: Situations

Revision: Word Meaning

Word meaning

➢ What is a word? How easy is it to define 'word'?

➢ Lexical and grammatical words

➢ Lexical Relations

➢ Derivational Relations

    ➢ Inchoative, causative, conative, …(**alternations**)
    ➢ Agentive nouns

➢ Meaning: Relative or universal?

Words

word slippery to define: orthographic, phonological, conceptual definitions mainly overlap

lexeme base (uninflected) form of a word (or multi word expression)

vagueness having an underspecified meaning

ambiguous having more than one possible meaning

content word with a denotation (typically open class : **lexical word**)

function word no denotation (typically closed class: **grammatical word**, **structural word**)

Senses and Relations

polysemous having multiple meanings

monosemous having just one meaning

homonyms words unrelated meaning; grammatically equivalent; with identical forms

Lexical Relations

synonymy all meanings identical; in all contexts; descriptive and non-

hyponymy is-a, kind-of: supertype **hypernym**; subtype **hyponym**

meronymy part-whole: part **meronym**; whole **holonym**

antonymy (complementary, gradable, reverse, converse, taxonomic sisters)

member-collection member of a group (*tree-forest*)

portion-mass element of stuff (*grain-rice*)

domain used in a domain (*[software] driver -golf*)

Sentence Relations and Truth

Meanings can be related

(1)   A and B are **synonymous**: A means the same as B

    a.   *My brother is a bachelor*

    b.   *My brother has never married.*

(2)   A **entails** B: if we know A then we know B

    a.   *The child killed the cat.*

    b.   *The cat is dead.*

(3)   A **contradicts** B: A is inconsistent with B

    a.   *Fred has long hair.*

    b.   *Fred is bald.*

(4) A **presupposes** B: B is part of the assumed background of A

    a. *The King of Pop is dead.*

    b. *There was a King of Pop*

    c. *I regret eating your lunch.*

    d. *I ate your lunch.*

(5) A is necessarily true — **tautology**: A is true but not informative

    a. *Smart people are smart.*

(6) A is necessarily false — **contradiction**: A is inconsistent with itself

    a. *?It is entirely made of copper and it is not made of metal.*

    b. *A is not A.*

Logic, Truth and Argument

Logic

➤ Classical logic is an attempt to find valid principles of argument and inference.

a	Humans are mortal	**premise**
b	Socrates is human	**premise**
c	Socrates is mortal	**conclusion**

➤ Can we go from a and b to c?   Yes

➤ Truth is **empirical**: The premises need to correspond with the facts of the world

   ➤ Sentences have **truth values** (true, false or unknown)
   ➤ The state of the world that makes a sentence true or false are its **truth conditions**

Logical Connectives

➤ **and** ($p \wedge q$)

➤ **or** ($p \vee q$: disjunction, inclusive or)

➤ **xor** ($p \oplus q$: exclusive or, either or)

➤ **if** ($p \rightarrow q$: if then, material implication)

➤ **iff** ($p \equiv q$: if and only if) (($p \rightarrow q) \wedge (q \rightarrow p)$)

➤ **not** ($\neg p$: contradiction)

An **argument** is a connected series of statements attempting to establish a proposition.

Truth Tables

p	q	$p \rightarrow q$	$p \wedge q$	$p \vee q$	$p \oplus q$	$p \equiv q$	$\neg p$
		if	and	or	XOR	iff	not
T	T	T	T	T	F	T	F
T	F	F	F	T	T	F	F
F	T	T	F	T	T	F	T
F	F	T	F	F	F	T	T

➤ Words themselves often carry more implications
I did A and B often implies *I did A first*

➤ There are many ways of saying the operations

Modus ponens

a	All humans are mortal	$p \rightarrow q$	if someone is human they are mortal
b	Socrates is human	p	
c	Therefore, Socrates is mortal	q	

p	q	$p \rightarrow q$
T	T	**T**
T	F	F
F	T	**T**
F	F	**T**

➤ The way that affirms by affirming (Latin)

➤ $p \rightarrow q, p \vdash q$

➤ **material implication** (Not quite the same as English *if*)

Modus tollens

a	If something is human then it is mortal	$p \to q$
b	Zeus is not mortal	$\neg q$
c	Zeus is not human	$\neg p$

p	q	$p \to q$
T	T	**T**
T	**F**	F
F	T	**T**
F	**F**	**T**

➤ The way that negates by negating (Latin)

➤ $p \to q, \neg q \vdash \neg p$

Other types of syllogisms

(deductive reasoning)

➤ **Hypothetical syllogism**

a	If something is human then it is mortal	$p \rightarrow q$
b	If something is mortal then it dies	$q \rightarrow r$
c	If something is human then it dies	$p \rightarrow r$

$p \rightarrow q, q \rightarrow r \vdash p \rightarrow r$

➤ **Disjunctive syllogism**
(modus tollendo ponens: affirm by denying)

a	Either a human is immortal or a human is mortal	$p \oplus q$
b	A human is not immortal	$\neg p$
c	A human is mortal	q

$p \oplus q, \neg p \vdash q$

Bad Arguments

➤ Formal

    ➤ **Affirming the consequent**: $p \rightarrow q, q \vdash p$
professors talk too much, *you talk too much*
$\vdash$ *you are a professor*

➤ Informal

    ➤ **Equivocation**: The sign said "fine for parking here", and since it was fine, I parked there.

    ➤ **No True Scotsman**: X doesn't do Y; a is an X and does Y; a is not a true X

    ➤ **Slippery Slope**: We mustn't allow text abbreviations or students will not be able to write normal text.

    ➤ **False Dilemma**: You are with us or against us

    ➤ **Guilt by Association**: Hitler was a vegetarian $\vdash$ vegetarianism is bad

Bad Arguments, Fake News, Conspiracy Theories

These are important topics, but somewhat out of the scope of this course. If you are interested, here are some good links.

➤ A history of FLICC: Fake experts, Logical fallacies, Impossible expectations, Cherry picking, and Conspiracy theories.

➤ Denialism: what is it and how should scientists respond?

➤ The Conspiracy Theory Handbook

Necessary Truth, A Priori Truth and Analyticity

Other sorts of truth

(7) *My sister is my sister.*

(8) ?*She was murdered but she is still alive.*

Can a statement be known to be true without checking the facts of the world?

➤ Arguments from the speaker's knowledge

  ➤ **A priori** truth is truth that is known without experience.
  ➤ **A posteri** truth is truth known from empirical testing.

➤ Arguments from the facts of the world

  ➤ **Necessary truth** is truth that cannot be denied without forcing a contradiction.
  ➤ **Contingent truth** can be contradicted depending on the facts.

Is Elizabeth the queen of England? Is the queen a woman?

➤ Arguments from our model of the world

➤ **Analytic truth** Truth follows from meaning relations within the sentence.
need to know word meaning
➤ **Synthetic truth** Agrees with facts of the world.

➤ Normally these give the same results, but not always. Why?

If we include our model of word meaning in our reasoning, then *an apple is a fruit* is **analytic**. So it is important to have an explicit model: these models are typically called **ontologies**.

➤ What about *the apple of my eye*?

Building an **inference engine** is actually very, very hard, … But very useful for question answering

Entailment

A truth based approach to entailment

➢ **Entailment**

a	The evil overlord assassinated the man in the red shirt.
b	The man in the red shirt died.

A sentence a entails a sentence b when the truth of the first (a) guarantees the truth of the second (b), and the falsity of the second (a) guarantees the falsity of the first (b).

a		b	
T	$\rightarrow$	T	
F	$\rightarrow$	F,T	don't care
F	$\leftarrow$	F	
T, F	$\leftarrow$	T	don't care

Sources of Entailment

➤ Hyponyms

     (9)   *I rescued a dog today.*

  (10)   *I rescued an animal today.*

Paraphrases: Mutual entailment

➢ (11) *My mom baked a cake.*

     (12) *A cake was baked by my mom.*

p		q
T	$\rightarrow$	T
F	$\rightarrow$	F
F	$\leftarrow$	F
T	$\leftarrow$	T

➢ This is synonymy

➢ What about contradiction?

The Argument Clinic

➤ A sketch from episode 29 of Monty Python's Flying Circus

➤ *An argument is a connected series of statements intended to establish a proposition*

Formal Semantics

Language meets Logic (again)

➢ **formal semantics** is also known as

    ➢ **truth-conditional semantics**
    ➢ **model-theoretic semantics**
    ➢ **Montague Grammar**
    ➢ **logical semantics**

➢ A general attempt to link the meaning of sentences to the circumstances of the world: **correspondence theory**

    ➢ If the meaning of the sentence and the state of the world correspond then the sentence is **true**

Model-Theoretical Semantics

1. Translate from a natural language into a logical language with explicitly defined syntax and semantics

   Fran is alive $\rightarrow$

   alive(Francis) or **A(f)** or **alive(e, x), Francis(x)**

2. Establish a mathematical model of the situations that the language describes

   Hard to do in general

3. Establish procedures for checking the mapping between the expressions in the logical language and the modeled situations.

   Works for small closed worlds

1: Translating English into a Logical Metalanguage

Empirical truths and connectives

➤ **not** ($\neg p$: contradiction: *it is not the case that p*)

➤ **and** ($p \wedge q$)

➤ **or** ($p \vee q$: disjunction, inclusive or)

➤ **xor** ($p \oplus q$: exclusive or, either or $\vee_e$)

➤ **if** ($p \rightarrow q$: if then, material implication)

➤ **iff** ($p \equiv q$: if and only if) ($(p \rightarrow q) \wedge (q \rightarrow p)$)

Simple Statements in Predicate Logic

➤ Consider simple sentences

  ➤ Represent the **predicates** by a capital letter
     these can be n-ary
  ➤ Represent the **individual constants** by lower case letters
  ➤ Represent **variables** by lower case letters (x,y,z)

  (13) *Bobbie is asleep*: A(b)
  (14) *Freddie drinks*: D(f)
  (15) *Freddie drinks beer*: D(f,b)
  (16) *Freddie prefers beer to whiskey*: P(f,b,w)
  (17) *Someone is asleep*: A(x)   (A(x) ∧ P(x))

Ignore tense for the moment

Complex Statements in Predicate Logic

➢ Join simple sentences with logical connectives
   treat relative clauses as **and**

   (18)   *Bobbie who is asleep writhes*: A(b) ∧ W(b)

   (19)   *Bobbie is asleep and Freddie drinks*: A(b) ∧ D(f)

   (20)   *Freddie drinks and sleeps*: D(f) ∧ S(f)

   (21)   *Freddie doesn't drink beer*: ¬ D(f,b)

   (22)   *If Freddie drinks whiskey Bobbie sleeps*: D(f,w) → S(b)

➢ If you run out of letters, use two, keep them unique in the world
   you are modeling

   (23)   *Bobbie who is asleep snores*: A(b) ∧ Sn(b)

Ignore tense for the moment

Quantifiers in Predicate Logic

➤ Quantifiers bind variables and scope over predications

   ➤ **Universal Quantifier** ($\forall$: *each, every, all*)
   ➤ **Existential Quantifier** ($\exists$: *some, a*)

     (24)   *All students learn logic*: $\forall x\ (S(x) \rightarrow L(x,l))$

     (25)   *A student learns logic*: $\exists x\ (S(x) \wedge L(x,l))$

     (26)   *Some students learn logic*: $\exists x\ (S(x) \wedge L(x,l))$

     (27)   *No students learn logic*: $\neg\exists x\ (S(x) \wedge L(x,l))$

     (28)   *All students don't learn logic*: $\forall x\ (S(x) \rightarrow \neg L(x,l))$
              logically equivalent to (27)

   ➤ $\forall$ must check each one (so $\rightarrow$)
   ➤ $\exists$ is falsified by one counter example (so $\wedge$)

➤ All variables must be bound
   If there is an x, y, z it must have a $\forall$ or $\exists$

Some Advantages in Translating to Predicate Logic

➤ Explicit representation of scope ambiguity

(29) *Everyone loves someone*

    a. *Everyone has someone they love*:
$$\forall x \, (P(x) \rightarrow \exists y \, (P(y) \land L(x,y))) \quad \approx \quad \forall x \exists y \, (L(x,y))$$

    b. *There is some person who is loved by everyone*:
$$\exists y \, (P(y) \land \forall x \, (P(x) \rightarrow L(x,y))) \quad \approx \quad \exists y \forall x \, (L(x,y))$$

(30) *Everyone didn't enjoy the exam*

    a. *All the people hated "didn't enjoy" the exam*:
$$\forall x \, (P(x) \rightarrow \neg E(x,e)) \quad \approx \quad \forall x \neg \, E(x,e)$$

    b. *Not all people enjoyed the exam*:
$$\neg \forall x \, (P(x) \rightarrow E(x,e)) \quad \approx \quad \neg \forall x \, E(x,e)$$

➤ But the big advantage is in reasoning with the real world
denotational semantic analysis

Often people omit the P(x), P(y)

2: The Semantics of the Logical Metalanguage (the model of the situations)

Creating a Model

1. a **semantic interpretation** of the symbols of the predicate logic

2. a **domain**: the model of a situation which identifies the linguistically relevant entities, properties and relations

3. a **denotation assignment function**: this is a procedure which matches the linguistic elements with the items in the model that they denote (a **naming function**)

Semantic Interpretation of Symbols

➤ Is the denotation correct (does it match the real world)?

  ➤ **Sentence** p is true in situation v if it corresponds with the real world:
    $[\![\text{p}]\!]^v$ = T: the denotatum of p in v is **true**
    $[\![\text{p}]\!]^v$ = F: the sentence p is **false** in situation v
  ➤ **Constant** denotation of a constant is the individual entity in question
  ➤ **Predicate constants** are sets of individuals for which the predicate holds
    $\{< x, y, z >: x \text{ hands } y \text{ to } z\}$
    the set of all individuals x, y, z such that x hands y to z

The Domain

➤ The domain represents the individuals and representations in a situation v

➤ Consider Joy Division in Manchester, April 1980

➤ Band Members: Ian Curtis, Bernard Sumner, Peter Hook and Stephen Morris
➤ Manager: Tony Wilson
➤ Producer: Martin Hannet

➤ U = {Ian, Bernard, Peter, Stephen, Tony, Martin}

➤ Combine this with an assignment function F to form a model $M_1 = <U_1, F_1>$ (or set of models: $M_2 = <U_1, F_2>$, ...)

Extension

➢ The **extension** of a concept or expression is the set of things it denotes.

  ➢ The extension of the word *cat* (written ⟦cat⟧) is the set of all (past, present and future) cats in the world: the set includes Tom, Grumpy Cat, Tama, and so on.

  ➢ ⟦Wikipedia reader⟧ is every person who has ever read Wikipedia.

  ➢ The extension of a predicate is all the things for which that predicate holds: ⟦sing⟧ is everyone who has ever or will ever sing.

  ➢ The extension of a whole statement, as opposed to a word or phrase, is defined as its truth value. So the extension of *Wikipedia is useful* is the logical value 'true'.
  ⟦Wikipedia is useful⟧ = T

The Denotation Assignment Function

➢ Match individual constants and predicate constants with the domain

F(x) returns the **extension** of x

F(i) = Ian; F(b) = Bernard; F(p) = Peter; F(s) = Stephen;

F(t) = Tony; F(m) = Martin

F(J)	=	in Joy Division	=	{Ian, Bernard, Peter, Stephen}
F(S)	=	sings	=	{Ian, Peter}
F(G)	=	plays guitar	=	{Bernard, Ian}
F(B)	=	plays bass	=	{Peter}
F(D)	=	plays drums	=	{Stephen}
F(M)	=	is a manager	=	{Tony}
F(P)	=	is a producer	=	{Martin}
F(F)	=	fires at	=	{<Martin, Tony>}
F(O)	=	(over) produces	=	{<Martin, Ian>, <Martin, Bernard>, <Martin, Peter>, <Martin, Stephan>}

This describes completely a very small world

3: Checking the Truth-Value of Sentences

Evaluating a simple statement

➤ How can we check if *Ian sings*, S(i), is true?

➤ $[\![S(i)]\!]^{M_1}$ = T iff $[\![i]\!]^{M_1} \in [\![S]\!]^{M_1}$
The sentence is true if and only if the extension of *Ian* is part of the set defined by *sings* in the model M_1

➤ $F_1(i) =$ Ian

➤ $F_1(S) = \{$Ian, Peter$\}$

➤ Ian $\in \{$Ian, Peter$\}$

⇒ $[\![S(i)]\!]^{M_1}$ = T

➤ What about *Martin sings*: S(m)

➤ $F_1(m) =$ Martin

➤ $F_1(S) = \{$Ian, Peter$\}$

➤ Martin $\notin \{$Ian, Peter$\}$

⇒ $[\![S(m)]\!]^{M_1}$ = F

Evaluating a complex statement

➤ Is *Ian or Peter plays bass* true?

  ➤ B(i) ∨ B(p)
  ➤ F_1(i) = Ian
  ➤ F_1(p) = Peter
  ➤ F_1(B) = {Peter}
  ➤ Ian ∈ {Peter} = F
  ➤ Peter ∈ {Peter} = T
  ➤ F ∨ T = T
  ⇒ ⟦B(i) ∨ B(p)⟧^{M_1} = T   Yes

  The sentence *Ian or Peter plays bass* is true if and only if either the extension of *plays Bass* contains *Peter* or the extension of *plays Bass* contains *Ian*

Quantifiers

➢ *Did Martin produce everyone in Joy Division?*

➢ $\forall x\ (J(x) \rightarrow O(m,x))$
  * $i \rightarrow O(m,i) = ?$
  * $b \rightarrow O(m,b) = ?$
  * $p \rightarrow O(m,p) = ?$
  * $s \rightarrow O(m,s) = ?$

➢ T,T,T,T = ?

$\Rightarrow$ $[\![\forall x(J(x) \rightarrow O(m,x))]\!] = T$ Yes

What are the advantages?

➢ If we can make a translation and define our model

  ➢ we can evaluate truth explicitly
  ➢ we can relate utterances to situations
  ➢ we can deal with quantification and compositionality
  ➢ we can automate the reasoning

➢ More in week 10

Presupposition

Presuppositions

➢ Many statements assume the truth of something else

(31)   a. *Mary's sister bakes the best pies.*
        b. *Mary has a sister.*

➢ Negating the presupposing sentence a doesn't affect the presupposition b

➢ Names presuppose that their referents exist

➢ Triggers

  ➢ Clefts (*it was X that Y*); Time adverbial; Comparative
  ➢ Factive verbs: *realize*; some judgement verbs: *blame*; some change of state: *stop*

Presupposition triggers

➤ **Cleft construction**

(32)   *It was his nonsense that irritated me.*

(33)   *What irritated me was his nonsense.* (pseudo)

(34)   *Something irritated me.*   presupposition

➤ **Time adverbial**

(35)   *I was working five jobs before you went to school*

(36)   *You went to school.*   presupposition

➤ **Comparative**

(37)   *You are even more silly than he is.*

(38)   *He is silly.*   presupposition

Presupposition triggers: Lexical triggers

➤ **Factive verbs** presuppose the truth of their complement clauses.

(39) a. *The students realized that Alex was hungry.*
    b. *The students thought that Alex was hungry.*   no presupposition

(40) a. *Alex regretted not eating lunch.*
    b. *Alex considered not eating lunch.*   no presupposition

➤ **Verbs of judgement**

(41) *Kim blamed me for making a mistake*

➤ **Change of state** (sometimes)

(42) *Alex stopped talking to their imaginary friend.*

Semantic approach

➤ p *Mary's sister bakes the best pies*   presupposing sentence
    q *Mary has a sister*   presupposition

p		q
T	$\rightarrow$	T
F	$\rightarrow$	T
F, T	$\leftarrow$	T

➤ Also true of: $\neg p$ *Mary's sister doesn't bakes the best pies*

➤ Is that different from this?

    a *I gave my dog a bath today.*
    b *I gave an animal a bath today.*

Presupposition versus entailment

➤ Negating the presupposing sentence does not affect the pre-supposition whereas negating an entailing sentence destroys the entailment.

➤ Can you think of other examples that show this difference?

Interactional approach

➢ Presupposition is one aspect of a speaker's strategy of organizing information for maximum clarity for the listener.

(43) *Mary's sister bakes the best pies.*
 a. Assertion 1: *Mary has a sister X.*
 b. Assertion 2: *X bakes the best pies.*

➢ Assertion 1 is in the **background** (old information)

➢ Assertion 2 is in the **foreground** (new information)

Presupposition failure

➤ (44)   *The King of France is bald.*

(45)   *There is a King of France.*   presupposition

➤ The problem with names and definite description is that they presuppose the existence of the named or described entities.

➤ Solution: A speaker's use of a name or definite description to refer usually carries a guarantee that the listener can identify the referent.

Presupposition and context

➤ Presuppositions are context dependent.

   (46)   a. *John ate before going to the movies.*

           b.   *John went to the movies.*   presupposition

   (47)   a. *John died before going to the movies*

           b.   *John went to the movies.*   presupposition

➤ Presuppositions are **defeasible**: they can be canceled given the right context.

Can we really talk about semantics without context?

➤ Some people argue that presupposition is a pragmatic phenomenon. It is supposedly part of the set of assumptions made by participants in a conversation: **common ground**.

➤ What happens if I said *Their child is a teacher.*, and you don't already know that they have children?

➤ Lewis (1979) proposes a principle of **accommodation** where

if at time t something is said that requires presupposition p to be acceptable, and if p is not presupposed just before t then — *ceteris paribus* — presupposition p comes into existence.

➤ Presuppositions are introduced as new information

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ceteris paribus = "all other things being equal or held constant"

Summary

➤ Logic and Truth

➤ Necessary Truth, A Priori Truth and Analyticity

➤ Logical Metalanguage (10.2–3)

➤ Semantics and Models (10.4–5)

➤ Entailment

➤ Presupposition

➤ Next week: Chapter 5: Situations

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References