Semantic Theory
Lecture 1: Introduction

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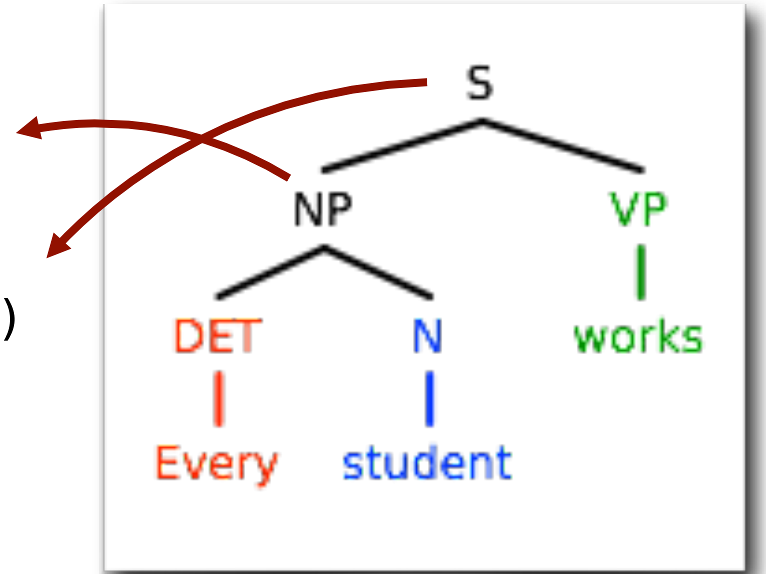
Truth-Conditional Semantics

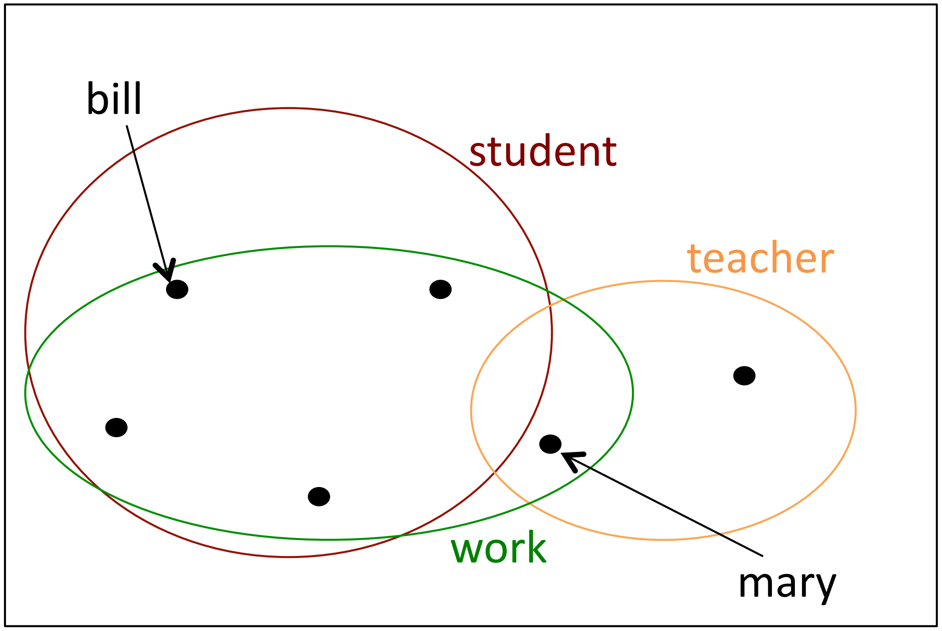
- **Truth-conditional semantics:** to know the meaning of a (declarative) sentence is to know what the world would have to be like for the sentence to be true.
- **Sentence meaning = truth-conditions**
  - ⟦*Every student works*⟧ = 1 iff. student ⊆ work
- **Indirect interpretation**: Translate sentences into logical formulas; then compute truth conditions for logical formulas
  - *Every student works* ⇒ $\forall x(\text{student}'(x) \rightarrow \text{work}'(x))$
  - $[\![\forall x(\text{stud}'(x) \rightarrow \text{work}'(x))]\!]^{M,g} = 1$ iff $V_M(\text{stud}') \subseteq V_M(\text{work}')$

Translating Sentences to FOL Formulas: Semantics Construction

- **Lexical entries:**
  - every ↤ $\lambda P \lambda Q \forall x(P(x) \rightarrow Q(x))$
  - student ↤ student'
  - works ↤ work'
- **Construction Steps:**
  - $\lambda P \lambda Q \forall x(P(x) \rightarrow Q(x))(student')$
    $\Rightarrow_\beta \lambda Q \forall x(student'(x) \rightarrow Q(x))$
  - $\lambda Q \forall x(student'(x) \rightarrow Q(x))(work')$
    $\Rightarrow_\beta \forall x(student'(x) \rightarrow work'(x))$



Computing truth conditions for logical formulas: Model structure



Computing truth conditions for logical formulas: Interpretation

- *"Every student works"* $\Rightarrow \forall x(\text{student}(x) \rightarrow \text{work}(x))$

- $[\![\forall x(\text{student}(x) \rightarrow \text{work}(x))]\!]^{M,g} = 1$

  iff $[\![\text{student}(x) \rightarrow \text{work}(x)]\!]^{M,g[x/a]} = 1$ for every $a \in U_M$

  $[\![\text{student}(x)]\!]^{M,g[x/a]} = 0$ or $[\![\text{work}(x)]\!]^{M,g[x/a]} = 1$

  iff $[\![x]\!]^{M,g[x/a]} \notin V_M(\text{student})$ or $[\![x]\!]^{M,g[x/a]} \in V_M(\text{work})$

  iff $g[x/a](x) \notin V_M(\text{student})$ or $g[x/a](x) \in V_M(\text{work})$

  iff $a \notin V_M(\text{student})$ or $a \in V_M(\text{work})$

- $\forall x(\text{student}(x) \rightarrow \text{work}(x))$ is true in M iff for every $a \in U_M$

  $a \notin V_M(\text{student})$ or $a \in V_M(\text{work})$

- which is equivalent to: $V_M(\text{student}) \subseteq V_M(\text{work})$

Determining Model-specific truth values

$[\![\forall x(\text{student}(x) \rightarrow \text{work}(x))]\!]^{M,g} = 1$ iff $V_M(\text{student}) \subseteq V_M(\text{work})$

Let M=M1:

$V_{M1}(\text{student}) \subseteq V_{M1}(\text{work})$,

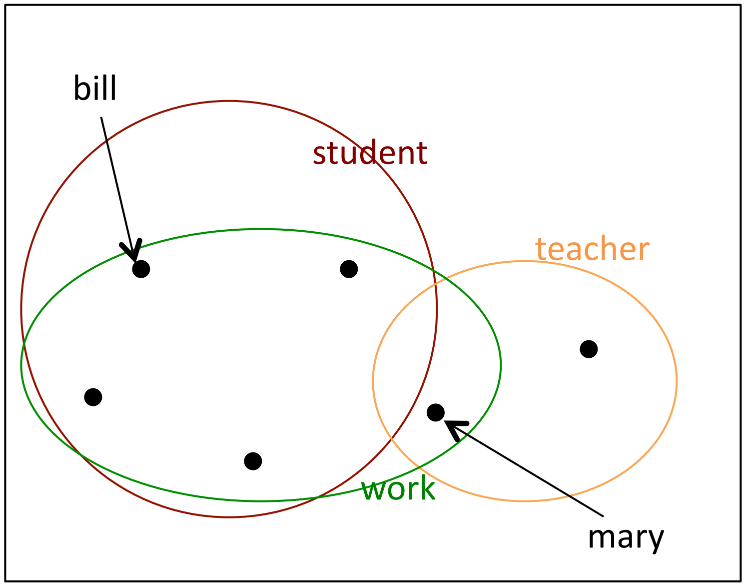
so $[\![\forall x(\text{student}(x)\rightarrow\text{work}(x))]\!]^{M1,g} = 1$

Let M=M2:

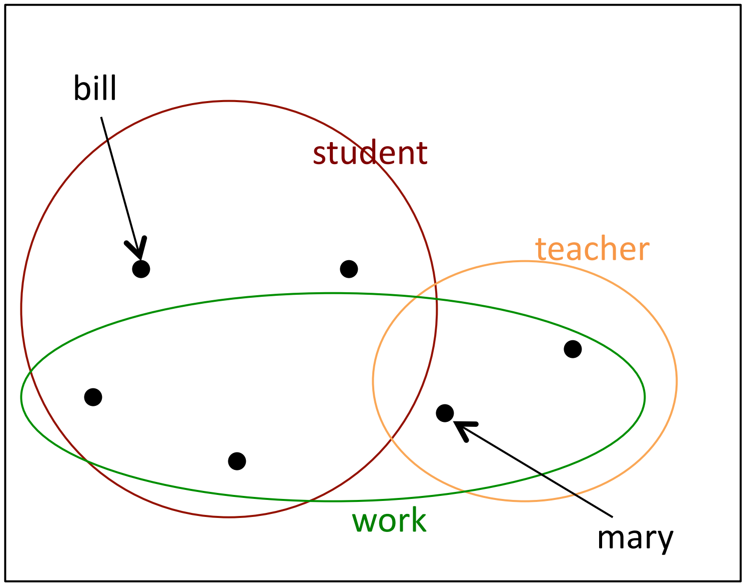
$V_{M2}(\text{student}) \not\subseteq V_{M2}(\text{work})$,

so $[\![\forall x(\text{student}(x)\rightarrow\text{work}(x))]\!]^{M2,g} = 0$

M1



M2



Truth-Conditionally Controlled Inference

- A set of formulas Γ entails formula A ($\Gamma \models A$) iff A is true in in every model structure M in which all A $\in$ Γ are simultaneously true.

Determining Entailment

- student(bill), ∀x(student(x) → work(x)) $\overset{?}{\models}$ work(bill)
- For every M :
  student(bill) is true in M iff V_M (bill) ∈ V_M(student)
  ∀x(student(x) → work(x)) is true in M iff V_M (student) ⊆ V_M (work)
- From V_M (bill) ∈ V_M(student) and V_M (student) ⊆ V_M (work), it follows that
  V_M (bill) ∈ V_M(work) (basic set-theoretic inference)
- Now, V_M (bill) ∈ V_M(work) is just the truth condition for work(bill).
- Therefore: In every model structure M satisfying student(bill) and ∀x(student(x)→work(x)), the formula work(bill) is true:
  Valid entailment.

The Most Certain Principle of Semantics

- "For two sentences A *and B, if in some possible situation A is true and B is false, A and B must have different meanings*." (M. Cresswell, 1975)

Applied to logical representations of NL sentences:

- For a logical formula α and a sentence A: If in some possible situation corresponding to a model structure M A is true, and α is not, or vice versa, then α is not an appropriate meaning representation for A.

Semantic Theory: Structure of the Course

- Sentence Semantics
- Discourse Semantics
- Aspects of Word Semantics

Sentence Semantics: Problems

(1) a. *John is a blond piano player*

b. *John is blond*

(2) a. *John is a poor piano player*

b. *John is poor*

(3) *John finds a lump of gold*

(4) *John seeks a lump of gold*

(5) *John seeks a unicorn*

Quantifier Scope

(1) A gardener watered every flower bed

(2) An American flag was hanging in front of every building

(3) A representative of every company saw most samples

Monotonicity and Generalized Quantifiers

(1)A master student passed a mid-term exam

(2)A master student passed an exam

(3)A student passed a mid-term exam

(4)No master student passed a mid-term exam

(5)No master student passed an exam

(6)No student passed a mid-term exam

(7)Every master student passed a mid-term exam

(8)Every master student passed an exam

(9)Every student passed a mid-term exam

Sentence Semantics: Schedule

- First-order Logic
- Type Theory and Lambda Calculus
- Quantifier Scope and Quantifier Storage
- Generalized Quantifiers

Discourse Semantics: Problems

- **Anaphora**

  (1) *Bill likes his dog. He often walks him.*

  (2) *Bill likes his dog, although he sometimes bites him.*

  (3) *Bill likes his dog, although she sometimes bites him.*

- **Ellipsis**

  (4) *John loves Mary, and so does Bill.*

  (5) *John loves his wife, and so does Bill.*

Presupposition

(1) a. *Bill regrets that his cat has died*

b. Bill doesn't regret that his cat has died

(2) a. *Bill's cat has died*

b. Bill's cat hasn't died

(3) a. *Bill owns a cat*

b. Bill doesn't own a cat

Information Structure

(1) a. Who ate the cake?

b. Bill ate the cake.

(2) a. What did Bill eat?

b. Bill ate the cake.

(3) Only the master students were invited to the celebration.

Discourse Semantics: Schedule

- Discourse Representation Theory (DRT)
- Presupposition and Implicature
- DRT-Based Model of Presupposition Projection

Word Semantics: Problems

Event-denoting expressions

(1) a. Bill saw an elephant

b. Bill saw an accident

c. Bill saw the children play

(2) a. Bill buttered a toast

b. Bill buttered a toast at midnight

c. Bill buttered a toast at midnight in the kitchen

Aspect and Aspectual Classes

(1) a. John solved the exercise in an hour

*b. * John solved the exercise for an hour*

*c. * John slept in an hour*

d. John slept for an hour

*(2) a. * John solved exercises in an hour*

b. John solved exercises for an hour

(3) a. John is writing a book, but will never finish it.

Plurals and Collective Predicates

(1) a. The students worked

b. Every student worked

(2) a. The students met

b. Every student met

(3) Two students presented a paper

(4) Five students carried three pianos upstairs

Verb Alternations and Semantic Roles

(1) a. *John sold the book for 19.95€*

b. *The book sells for 19.95€*

(2) a. *The window broke*

b. *A rock broke the window*

c. *John broke the window with a rock*

(3) a. *Mary likes John*

b. *John pleases Mary*

(4) a. *John sold the car to Bill*

b. *Bill bought the car from John*

Word Semantics: Schedule

- Event Semantics and Tense
- Aspect and Aspectual Classes
- Plurals, Collectives, Mass Terms
- Role and Frame Semantics

Exercises and Exam

- **Final exam** takes place on Thursday, July 24th
  - (date to be confirmed)
- **You have to register**
  - until Monday, July 7th
- **Exercise sheets:**
  - You have to submit solutions to all but one of the exercise sheets, and you have to get at least 50% of the points, to be admitted to the final exam
  - Exercise sheets can be done in groups (up to 3 students)
- For more details, see
  - www.coli.uni-saarland.de/courses/semantics-14

Literature

- Gamut, Logic, Language, and Meaning, Vol. 2, University of Chicago Press, 1991
- Kamp and Reyle, From Discourse to Logic, Kluwer, 1993