Semantic Theory

Lecture 11 – Lexical Semantics II

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Verbs and Events

- Modeling verb semantics using events provides a natural solution to several problems of logic-based semantics.
- **However …**
  Not all verbs can be appropriately interpreted through implicit event arguments.

Verbs Expressing States *vs.* Events

(1) *Mary kicked John*

“there is a kicking event, in which Mary and John are involved”

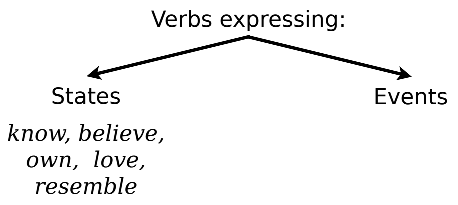
(2) *John knew the answer*

“there is a knowing event, in which John and the answer are involved” **(?)**

Verbs Expressing States *vs.* Events

- There are verbs expressing states and verbs expressing events (which we call non-stative for the time being)
  - **Statives:** *know, believe, have, desire, love*
  - **Non-statives:** *run, walk, kick, kill, build a house*
- Only non-stative verbs come with an event argument:
  - kick'(e, x, y)
  - know'(x, y)

Aspectual Verb Classes - 1



Linguistic Evidence for State-Event Distinction

Progressive form

(1) *John is running*

(2) *John is building a house*

(3) **John is knowing the answer*

Linguistic Evidence for State-Event Distinction

Simple present

(1) *Mary runs* (has the habit of running)

(2) *John recites poems* (has the habit of reciting poems)

(3) *John knows the answer*

Linguistic Evidence for State-Event Distinction

Manner adverbials

(1) *John ran carefully*

(2) *John carefully built a house*

(3) **John carefully knew the answer*

Verbs and Events

- Modeling verb semantics using events provides a natural solution to several hard problems of logic-based semantics.
- **However …**
  Not all verbs can be appropriately interpreted through implicit event arguments.
- **Moreover …**
  Event-expressing verbs do not form a homogeneous semantic class.

Aspectual Verb Classes - 1

Verbs expressing:

States

know, believe, own, love, resemble

Eventualities

Different distribution of duration adverbials

(1) a. *John painted a picture in an hour*
  b. **John walked in an hour*
  c. **It rained in an hour*

(2) a. *?John painted a picture for an hour*
  b. *John walked for an hour*
  c. *It rained for an hour*

(3) a. *It took John an hour to paint a picture*
  b. **It took John an hour to walk*

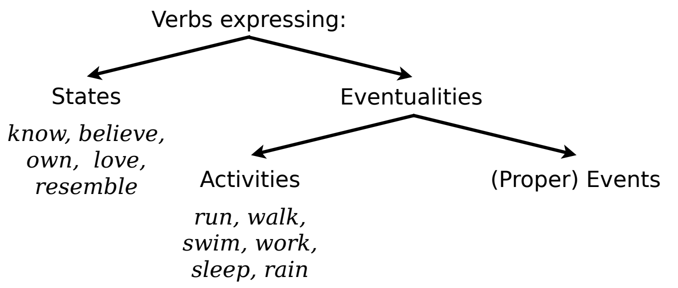
Different inferential properties

- *John walked from 8 a.m. to 11 a.m.*
  ⊨ *John walked from 9 to 10 a.m.*
- *It rained from 8 a.m. to 11 a.m.*
  ⊨ *It rained from 9 to 10 a.m.*
- *John painted a picture from 8 a.m. to 11 a.m.*
  ⊭ *John painted a picture from 9 to 10 a.m.*

Different inferential properties

- *John stopped walking*
  $\models$ *John walked*
- *It stopped raining*
  $\models$ *It rained*
- *John stopped painting a picture*
  $\not\models$ *John painted a picture*

Aspectual Verb Classes - 2



Verbs and Events

- Modeling verb semantics using events provides a natural solution to several hard problems of logic-based semantics.
- **However …**
  Not all verbs can be appropriately interpreted through implicit event arguments.
- **Moreover …**
  Event-expressing verbs (as opposed to statives) do not form a homogeneous semantic class.
- The same holds even for proper event verbs (as opposed to verbs expressing processes or activities).

Accomplishments vs. Achievements

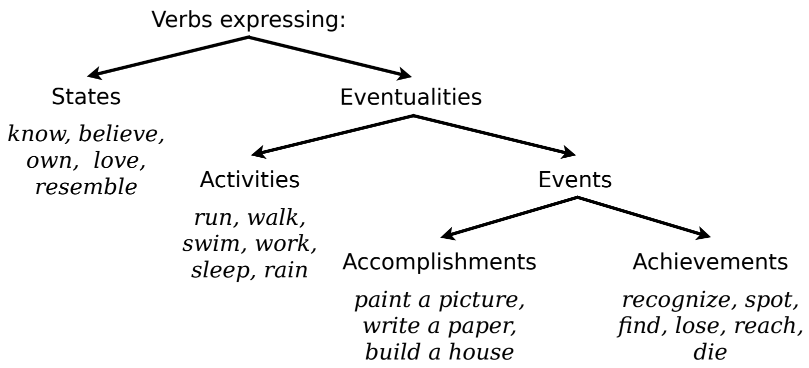
(1) a. *John painted a picture*
 b. *John noticed the picture*

(2) a. *John is painting a picture*
 b. **John is noticing a picture*

(3) a. *John painted a picture from 9 to 11 a.m.*
 b. **John noticed the picture from 9 to 11 a.m.*
 c. **John reached the top of the hill from 9 to 11 a.m.*

(4) a. *John stopped painting a picture*
 b. **John stopped noticing the picture*
 c. **John stopped reaching the top of the hill*

Aspectual Verb Classes - 3



Vendler’s Verb Classification

- The taxonomy of aspectual classes was introduced by the linguist Zeno Vendler in the seventies. It is intuitively appealing, but some issues remain open:
  - What is the essential ontological difference between the different aspectual classes, and how can it be modeled in a logical framework?
  - Vendler talks about “verb classification,” but – as he observes himself – it is verb phrases (*paint a picture, walk to the station*) rather than just the verbs (*paint, walk*) that bear aspectual properties. Compositional treatment?
- To find an answer to these questions, we take a detour through the semantics of common nouns.

Plural NPs

- *Bill and Mary work* ⊨ *Bill works*
- *Bill and Mary work* ⊨ *Mary works*
  - work’(b) ∧ work’(m) ⊨ work(b)
  - work’(b) ∧ work’(m) ⊨ work(m)
- *The students work , John is a student* ⊨ *John works*
  - ∀x(student(x) → work’(x)), student’(j) ⊨ work(j)

Collective predicates

- *Bill and Mary met*
  ⊭ *Bill met*
- *The students met , John is a student*
  ⊭ *John met*
- *The committee will dissove. John is member of the committee*
  ⊭ *John will dissolve.*
- **“meet” is a collective predicate.**

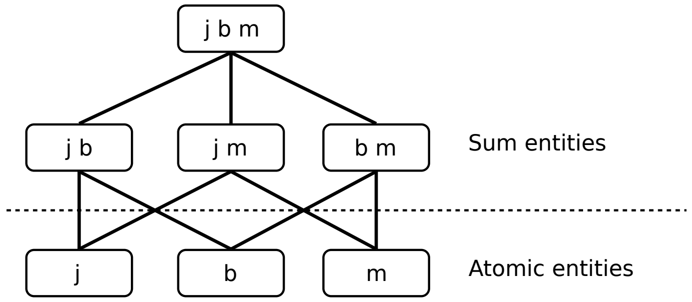
Collective predicates

- **Distributive predicates** like *work, sleep, eat, tall* apply to singular and plural nouns. A predication with a plural NP “distributes” over the individual objects covered by the NP.
- **Collective predicates** are only applicable with plural or group NPs. Their semantics cannot be reduced to atomic statements about single standard individuals.
  - Examples: *meet, gather, unite, agree, be similar, compete, disperse, dissolve, disagree, be numerous, ...*

Modeling Plural Terms

- In the face of collective predicates, we cannot model the semantics of plural terms using “atomic” entities of standard FOL.
- In addition to standard individuals, we add another sort of entities to the model structure universe: “groups” or “sums.”
- Singular expressions denote standard “atomic” entities, plural and group expressions denote sums.
- To represent the semantic relations between the group and its members, e.g., in the context of distributive predicates, we add a new relation, the membership or “individual part” relation to the model structure.

Structured Universe - Example



Lattices and Semi-lattices

- A **partial ordered set** is a structure ⟨A, ≤⟩ where ≤ is a reflexive, transitive, and antisymmetric relation over A.
- Let ⟨A, ≤⟩ be a partial order:
  - The **join** of a and b ∈ A (Notation: **a ⊔ b**) is the lowest upper bound for a and b.
  - The **meet** of a and b ∈ A (Notation: **a ⊓ b**) is the highest lower bound for a and b.
- A lattice is a partial order ⟨A, ≤⟩ which is closed under meet and join.

Lattices and Semi-lattices

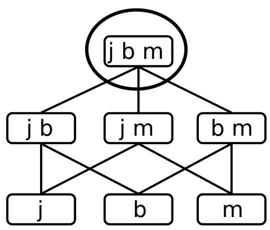
- A lattice may or may not have one maximal and minimal element.
- If it has such elements, they are named 1 and 0, respectively, and the lattice is called bounded.
- An element $a \in A$ **is an atom**, if $a \neq 0$ and there is no $b \neq 0$ in A such that $b<a$.
- A lattice $\langle A, \leq \rangle$ **is atomic**, if for every $a \neq 0$ there is an atom $b \leq a$.
- **A join semi-lattice** is a partial order $\langle A, \leq \rangle$ which is closed under join.

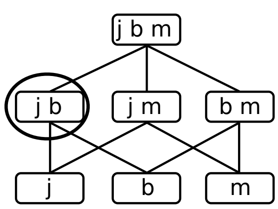
Model structures for plural terms

- A model structure is a pair $M = \langle \langle U, \leq \rangle, V \rangle$, where
  - $\langle U, \leq \rangle$ is an atomic join semi-lattice with universe U and individual part relation $\leq$.
  - V is a value assignment function.
- $A \subseteq U$ is the set of atoms in $\langle U, \leq \rangle$.
- $U \setminus A$ is the set of non-atomic elements, i.e., the proper sums or groups in U.

Collective predicates

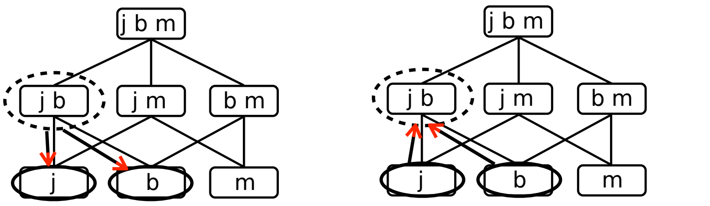
- Collective predicates F (like *meet, collaborate*):
- $V_M(F) \subseteq U \setminus A$





Distributive predicates

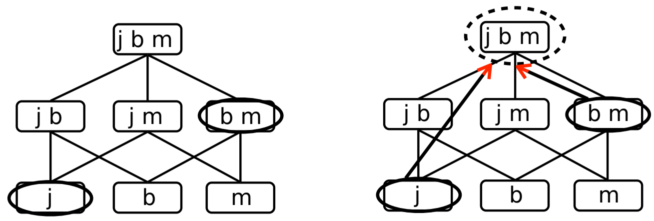
- Distributive predicates F (like *work, tall, student*):
  - $V_M(F) \subseteq U$, such that
  - $a \in V_M(F)$ and $b \in V_M(F)$ iff $a \sqcup b \in V_M(F)$



- →: Distributivity ← : Closure under summation

Mixed Predicates

- Distributive predicates F (like *carry a piano, solve the exercise*):
  - $V_M(F) \subseteq U$



- Non-distributive, but closed under summation

Language for plural terms

- Like standard FOL. We add a summation operator ⊕, a one-place predicate At for "atom" and a two-place relation ⊲ for "(proper) individual part," used as in
  - $j \oplus b$ "the group consisting of John and Bill"
  - $j \lhd j \oplus b$ "John is member of the group consisting of John and Bill"
  - $j \oplus b \lhd c$ "John and Bill are members of the committee"
- We further introduce variables ranging over proper sums, and write them as X, Y, Z, ...
- We may also introduce number-specific individual constants "student-sg", "student-pl" in addition to the general "student"

Interpretation

- Like standard FOL interpretation with additional clauses for ⊕ and ⊲:
  - $[\![a \oplus b]\!]^{M,g} = [\![a]\!]^{M,g} \sqcup [\![b]\!]^{M,g}$
  - $[\![a \lhd b]\!]^{M,g} = 1$ iff $[\![a]\!]^{M,g} < [\![b]\!]^{M,g}$
  - $[\![At(a)]\!]^{M,g} = 1$ iff $[\![a]\!]^{M,g} \in A$
- Individual constants denote either atoms ($V_M(a) \in A$) or sums ($V_M(a) \in U \setminus A$)
- Predicate expressions satisfying specific constraints with respect to their semantics:
  - V_M(student-sg) ⊆ A
  - V_M(student-pl) ⊆ U \ A

Distributive predicates

- If a distributive predicate applies to a set M ⊆ A, then the full denotation of the predicate is the join semi-lattice generated by M.
- The denotation of distributive predicates F is uniquely determined by their atomic members:
  - $\forall x[F(x) \leftrightarrow \forall y[At(y) \wedge y \lhd x \rightarrow F(y)]]$