Semantic Theory

Lexical Semantics II

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Stative and non-stative verbs

- *Mary kicked John* : "there is a kicking event, in which Mary and John are involved"
- *John knew the answer:* "there is a knowing event, in which John and the answer are involved" (?)
- 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 extra argument:
  - kick(e, x, y)
  - know(x, y)

States vs. Events

- Progressive test
  - *John is running*
  - *John is building a house*
  - **John is knowing the answer*
- Manner adverbials
  - *John ran carefully*
  - *John carefully built a house*
  - **John carefully knew the answer*
- Simple present
  - *John runs (has the habit of running)*
  - *John recites poems (has the habit of reciting poems)*
  - *John knows the answer*

Aspectual Verb Classes – 1

Verbs expressing:

States
know, believe, own,
love, resemble

Events

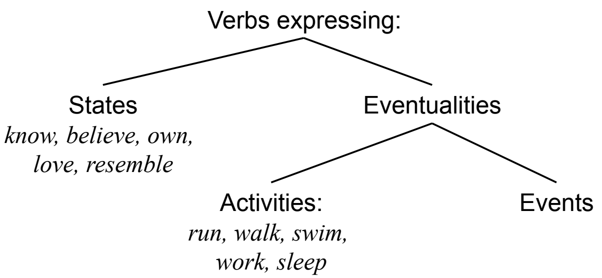
Activities vs. (Proper) Events

- Combination with temporal adjuncts
  - *John painted a picture in an hour*
  - **John walked in an hour*
  - *It took John an hour to paint a picture*
  - **It took John an hour to walk*
  - *John walked for an hour*
  - *?John painted a picture for an hour*

Activities vs. (Proper) Events

- *Inferential Properties*
  - *John walked from 8 a.m. to 11 a.m.* $\models$ *John walked from 9 to 10 a.m.*
  - *John painted a picture from 8 a.m. to 11 a.m.* $\not\models$ *John painted a picture from 9 to 10 a.m.*
  - *John is working in Saarbrücken* $\models$ *John has worked in Saarbrücken*
  - *John is painting a picture* $\not\models$ *John has painted a picture*
  - *John stopped walking* $\models$ *John did walk*
  - *John stopped painting a picture* $\not\models$ *John painted a picture*

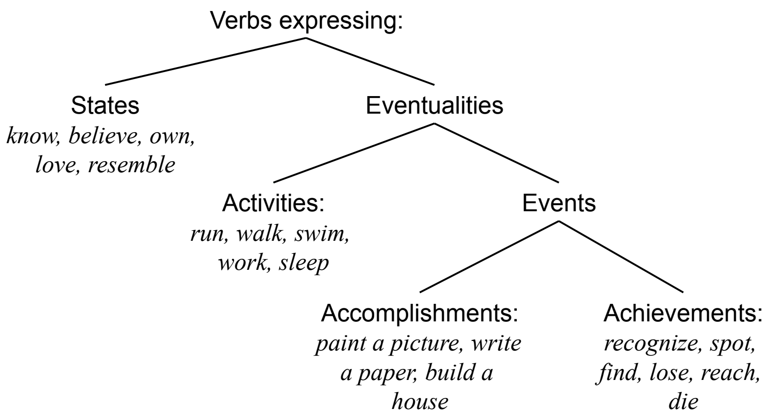
Aspectual Verb Classes – 2



Accomplishments vs. Achievements

- **John is noticing a stranger in the room.*
- **John noticed the painting from 9 to 11 a.m.*
- **John stopped noticing the painting.*
- *John noticed the painting in a few minutes.*
- *John is painting a picture* $\not\models$ *John has painted a picture*
- *John stopped walking* $\models$ *John did walk*
- *John stopped painting a picture* $\not\models$ *John painted a picture*

Aspectual Verb Classes – 3



Vendler's Verb Classification

The taxonomy of aspectual classes was introduced by the linguist Zeno Vendler in the seventies.

Intuitively appealing, but some open questions:

- Vendler considered verbs expressing actions. Extension to events in general? - More or less straightforward
- Vendler calls his classification a verb classification, but (as he observes himself) it is verb phrases rather than verbs that bear aspectual properties.
- Event semantics can distinguish between states and event(ualitie)s: How can we model the difference between activities and proper events?
- We take a detour to answer the last two questions.

Plural Noun Phrases

Bill and Mary work $\models$ *Bill works*

Bill and Mary work $\models$ *Mary works*

work(b) $\wedge$ work(m) $\models$ work(b)

work(b) $\wedge$ work(m) $\models$ work(m)

The students work , John is a student

$\models$ *John works*

$\forall$x(student(x) $\rightarrow$ work(x)), student(j) $\models$ work(j)

Collective predicates

Bill and Mary met $\not\models$ *Bill met*

The students met , John is a student

$\not\models$ *John met*

The committee met, John is member of the committee

$\not\models$ *John met*

- "meet" is a collective predicate.

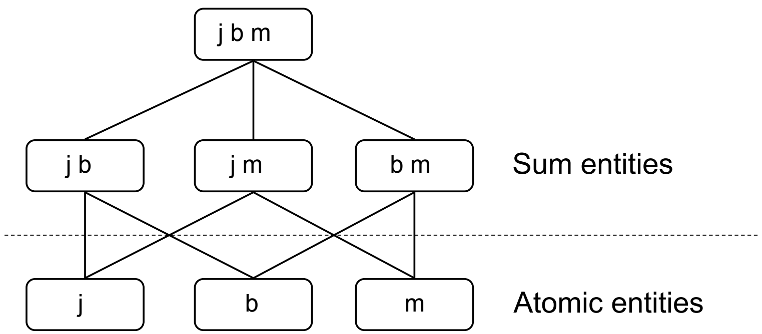
Collective predicates

- Collective predicates are only applicable with plural or group NPs. Their semantics cannot be reduced to atomic statements about single standard individuals.
- Examples for collective predicates:
  - *meet, gather, unite, agree, be similar, compete, disperse, disagree, be numerous, ...*
- Distributive or 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.

Modeling Plural Terms

- In addition to standard individuals, we add "group" or "sum" entities to the model structure universe.
- Singular expressions denote standard "atomic" entities, plural and group expressions denote sums.
- To model the entailment relations between the group and its members, e.g., in the context of distributive predicates, we also add 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, ≤> with reflexive, transitive, and antisymmetric ≤ .
- Let <A, ≤> be a partial order:

  The join of a and b ∈ A: $a \sqcup b$ is the lowest upper bound for a and b.

  The meet of a and b ∈ A: $a \sqcap b$ 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 $a \in A$ is an atom, if $a \neq \mathbf{0}$ and there is no $b \neq \mathbf{0}$ 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 structure 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 $\langle U, \leq \rangle$.
- $U \backslash A$ is the set of non-atomic elements, i.e., the proper sums or groups in U.

Logic for plural terms

- Like standard FOL. We add a summation operator $\oplus$, a one-place predicate At for "atom" and a two-place relation $\triangleleft$ for "(proper) individual part".
- Application examples:
  - $j \oplus b$, translating "John and Bill"
  - $j \oplus b \triangleleft$ the_committee: "John and Bill are individual parts / members of the committee"
- We may use singular and plural forms of common nouns:
  - student_sg, student_pl in addition to student
- We further introduce variables X, Y, Z, ...ranging over proper sums

Interpretation

Like standard FOL interpretation

- with additional clauses for $\oplus$ and $\triangleleft$:

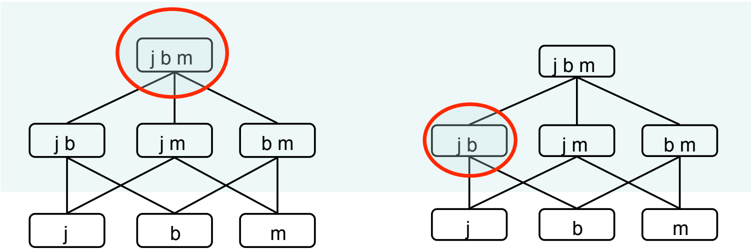
  $[\![a \oplus b]\!]^{M,g} = [\![a]\!]^{M,g} \sqcup [\![b]\!]^{M,g}$

  $[\![a \triangleleft b]\!]^{M,g} = 1$ iff $[\![a]\!]^{M,g} < [\![b]\!]^{M,g}$

  $[\![At(a)]\!]^{M,g} = 1$ iff $[\![a]\!]^{M,g} \in A$
- with individual constants denoting either atoms ($V_M(a) \in A$) or sums ($V_M(a) \in U \backslash A$)
- predicates satisfying specific constraints with respect to their semantics

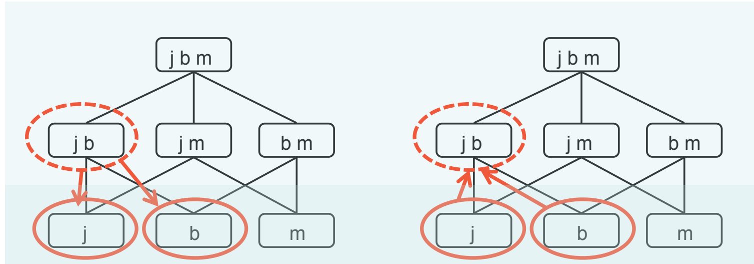
Collective predicates

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



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

Distributive predicates

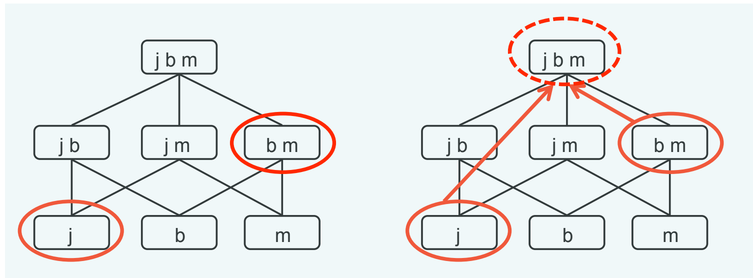
- If a distributive predicate applies to a set $M \subseteq A$, then the full denotation of the predicate is the join semi-lattice generated by M.

- The denotation of distributive predicates is uniquely determined by their atomic members:

  $\forall x(F(x) \leftrightarrow \forall y(At(y) \wedge y \lhd x \rightarrow F(y)))$

Interpretation of predicates

- Mixed predicates F (e.g., *carrying a piano, solving the exercise*):
  $V_M(F) \subseteq U$



Non-distributive, but closed under summation

Examples

- *Every student presented a paper*
- *John and Mary presented a paper*
- *Two students presented a paper*
- *Two students presented three papers*