Semantic Theory

Week 4: Lexical Semantics

Noortje Venhuizen & Harm Brouwer — Universität des Saarlandes — Summer 2022

Building blocks for Semantic Theory

Q: What is the meaning of life?

A: life’

- Lexemes (e.g., *dog, bark*) are “linguistic expressions whose forms are conventionally associated with non-compositional meaning” (Murphy, 2010).
- Grammatical categories (e.g., *-ing, -ed*) are function morphemes with abstract and nonreferential meanings (closed class)
- A grammatical word is “an expression that cannot be interrupted, moves as a unit, and has a part of speech identifiable by its morphological inflections and its distribution in phrases” (Murphy, 2010).

Lexical Semantics

- Lexical semantics focuses on the relations between words:
  - Inflections (morphology-semantics interface)
  - Polysemy; word senses (syntax-semantics interface)
  - Metonymy, Metaphor, Inferences (semantics-pragmatics interface)
- Different approaches to lexical semantics:
  - Meaning-to-form: meaning determines relations between words
  - Form-to-meaning: relations between words determine meaning

A closer look at plural NPs

Entailment pattern

(1) *Bill and Mary work* ⊨ *Bill works*

$$work'(b) \wedge work'(m) \vDash work(b)$$

(2) *Bill and Mary work* ⊨ *Mary works*

$$work'(b) \wedge work'(m) \vDash work(m)$$

(3) *All students work, John is a student* ⊨ *John works*

$$\forall x(student(x) \rightarrow work'(x)), student'(j) \vDash work(j)$$

This property of predicates is called distributivity

A closer look at plural NPs

Distributivity does not hold for all predicates…

(1) *Bill and Mary met* $\nvDash$ *Bill met*

(2) *The students met, John is a student* $\nvDash$ *John met*

(3) *The committee will dissolve. John is member of the committee*

$\nvDash$ *John will dissolve.*

“meet”, “dissolve” are collective predicates

Distributive vs. Collective predicates

Distributive predicates

- Applicable to singular and plural NPs;
- Predication with a plural NP "distributes" over the individual objects covered by the NP;
- Examples: *work, sleep, eat, tall, …*

Collective predicates

- Only applicable to plural or group NPs;
- Semantics cannot be reduced to atomic statements about single standard individuals;
- Examples: *meet, gather, unite, agree, be similar, compete, disperse, dissolve, disagree, be numerous, ...*

Mixed predicates (*carry a piano, solve the exercise*): predicates that are ambiguous between the distributive and collective reading

Modeling plural terms

Desiderata for a model with plurality

- A representation of plural terms that is not (only) defined in terms of atomic entities (to account for collective predicates)

  We extend the universe of our model structures with “groups” (or: “sums”)

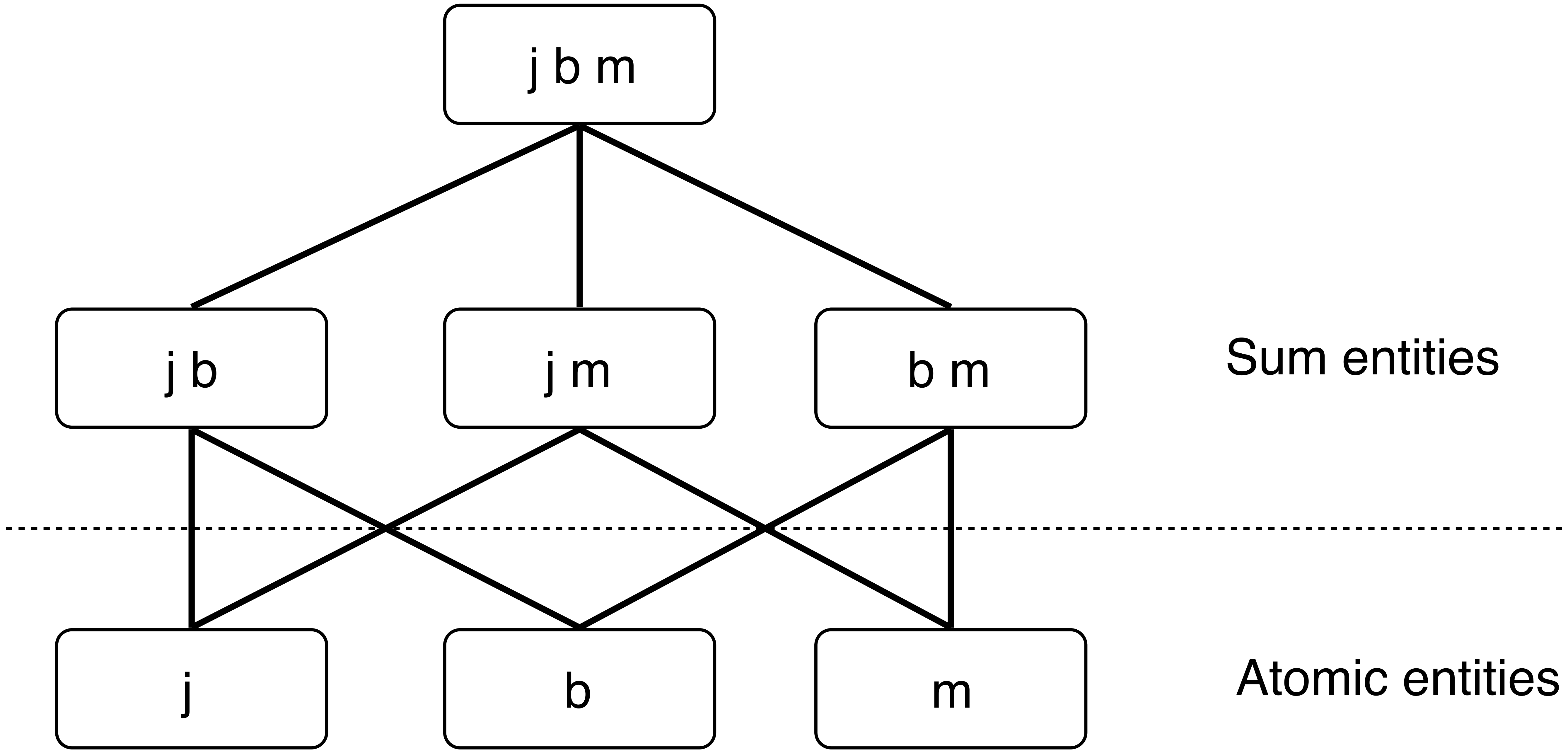
- A relation between atomic and plural entities (to account for the entailment pattern of distributive predicates)

  We add a membership (or: “individual part”) relation to the model structure

- Denotations of types of predicates are restricted to particular parts of universe

Structured Universe

Entities and groups of entities



Lattices and Semi-lattices

- A **partial order** is a structure $\langle A, \leq \rangle$ where $\leq$ is a reflexive, transitive, and antisymmetric relation over A.
  - The **join** ($a \sqcup b$) of $a, b \in A$ is the lowest upper bound for a and b.
  - The **meet** ($a \sqcap b$) of $a, b \in A$ is the highest lower bound for a and b.
- A **lattice** is a partial order $\langle A, \leq \rangle$ that is closed under meet and join.
  - A **join semi-lattice** is a partial order $\langle A, \leq \rangle$ that is closed under join.
- A **bounded lattice** has a maximal element (1) and a minimal element (0).
- 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 is **atomic**, if for every $a \neq 0$ there is an atom b such that $b \leq a$.

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 ≤.
- V is an interpretation function.

In addition, we define:

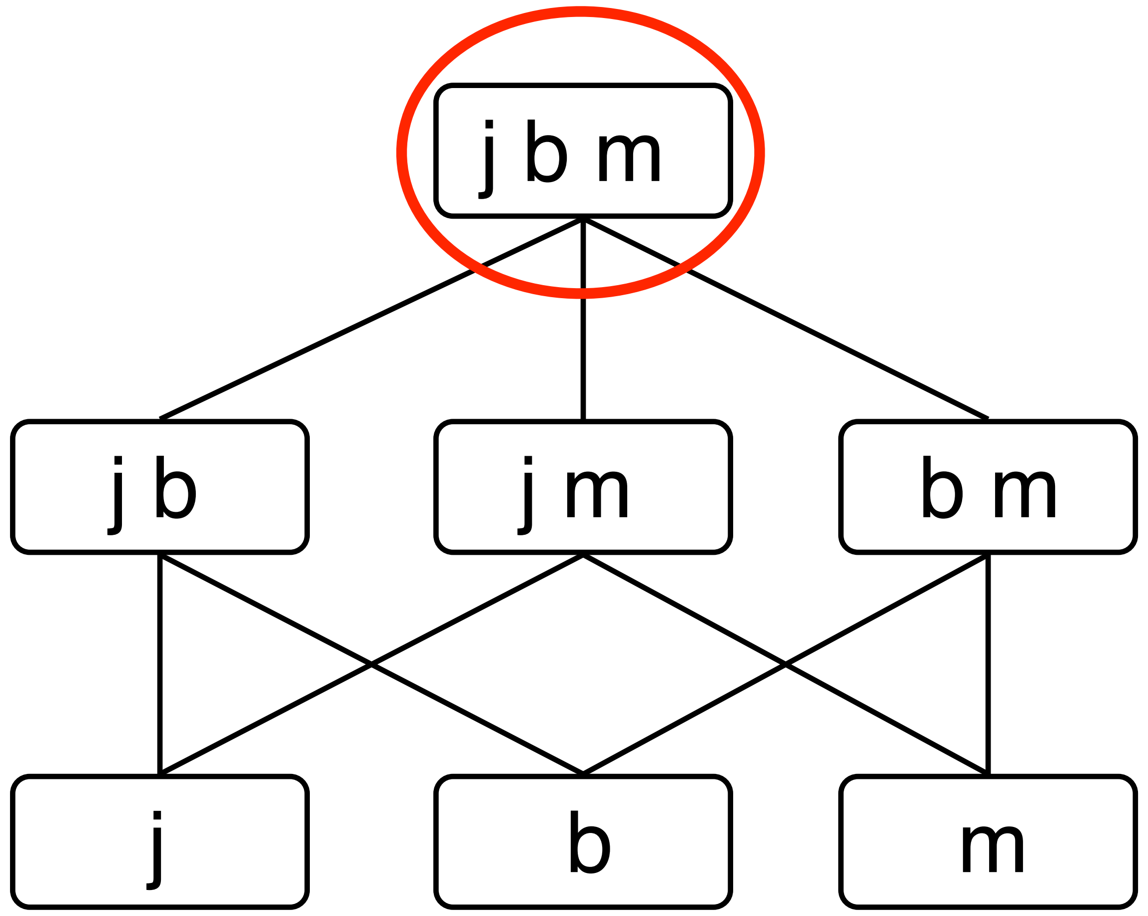
- $A \subseteq U$ is the set of atoms in $\langle U, \leq\rangle$.
- $U \setminus A$ is the set of non-atomic elements, i.e., the set of proper sums or groups in U.

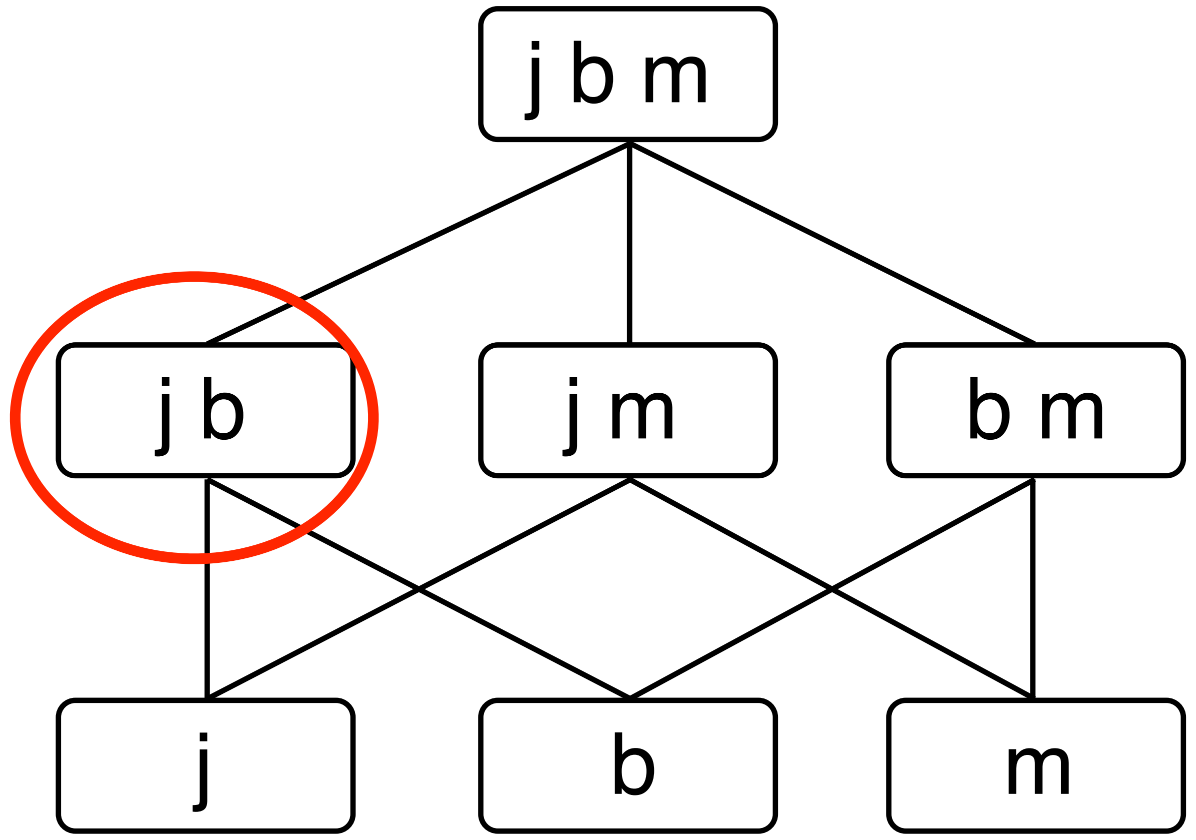
Domain restrictions

Collective predicates

Let P_c be the set of collective predicates (*meet, collaborate, …*)

- The domain of P_c is restricted to non-atomic elements: $V_M(P_c) \subseteq U \setminus A$



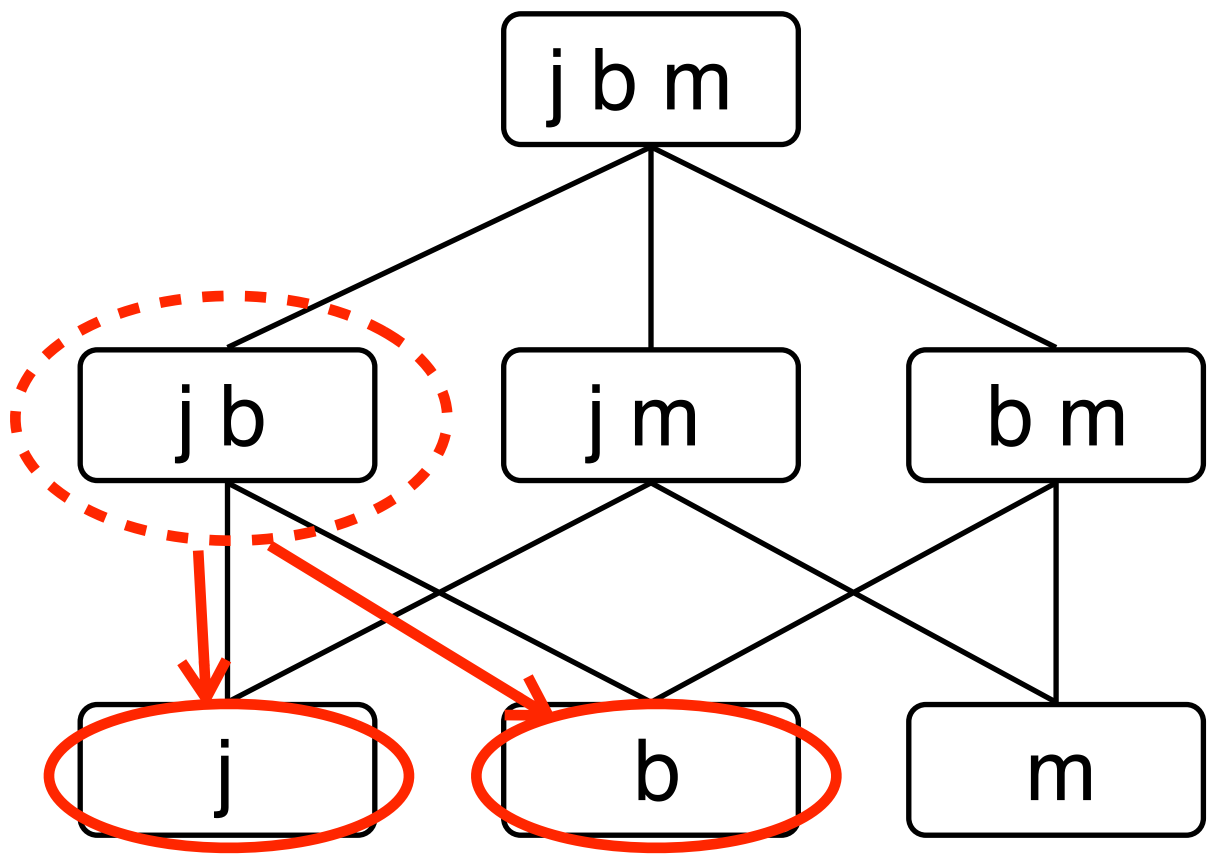


Domain restrictions

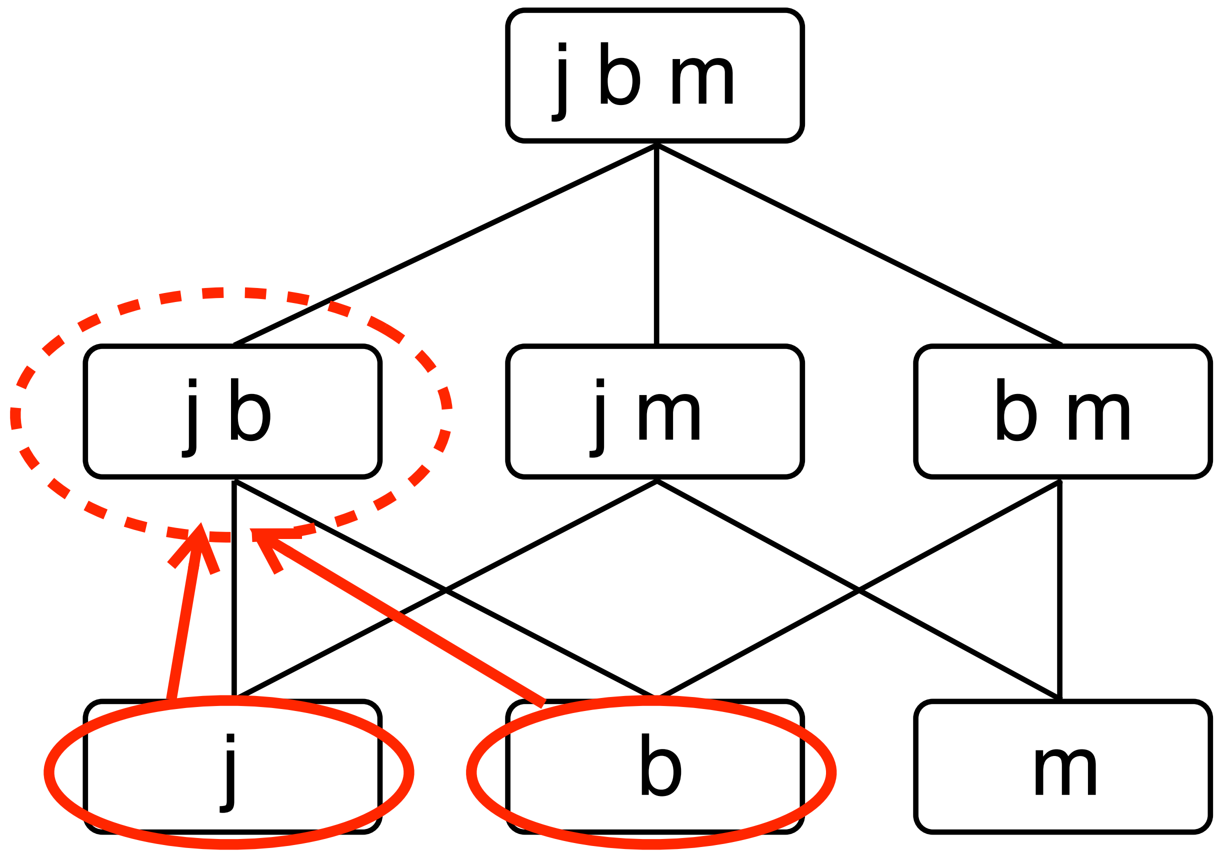
Distributive predicates

Let P_d be the set of distributive predicates (*work, tall, student, …*)

- The domain of P_d is the universe of M: $V_M(P_d) \subseteq U_M$, such that $a \in V_M(F)$ and $b \in V_M(F)$ iff $a \sqcup b \in V_M(F)$



Distributivity



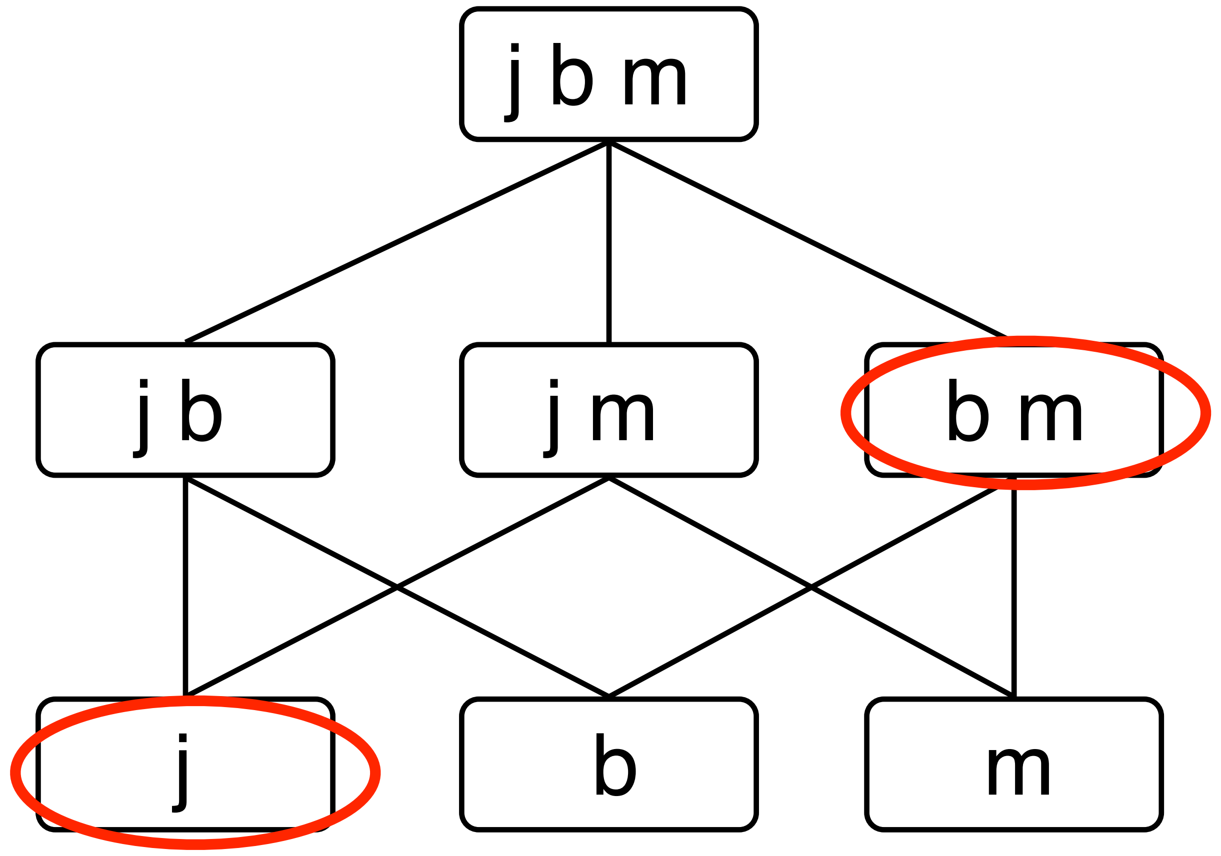
Closure under summation

Domain restrictions

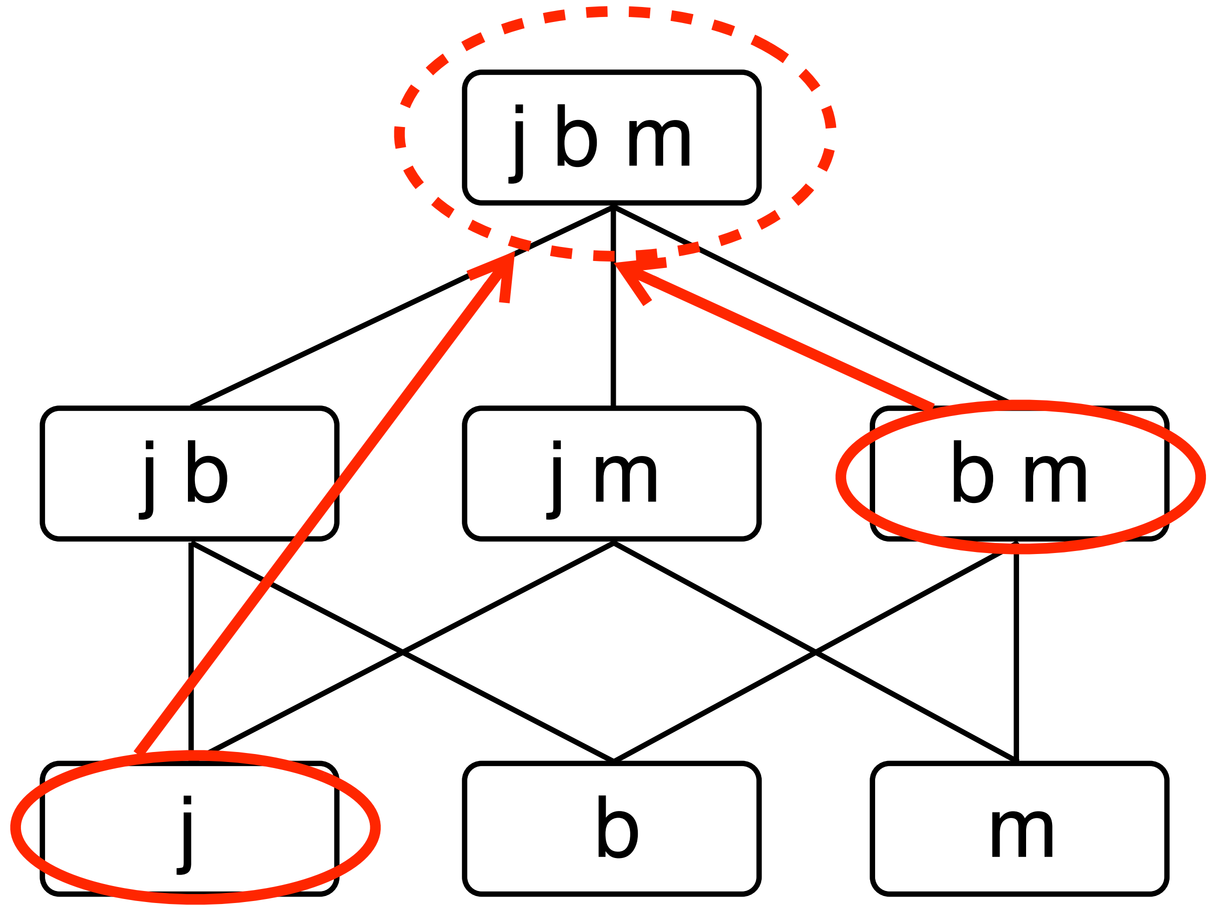
Mixed predicates

Let P_m be the set of mixed predicates *(carry a piano, solve the exercise, …)*

- The domain of P_m is the universe of M: $V_M(P_m) \subseteq U$



Non-distributive



Closure under summation

Language for plural terms

We extend our logical language with a summation operator $\oplus$, a one-place predicate At for "atom", and a two-place relation $\lhd$ for "(proper) individual part"

$j \oplus b$	"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"

In addition, we introduce:

- Variables ranging over proper sums: X, Y, Z, …
- Number-specific constants: "student-sg", "student-pl"

Interpretation of plural terms

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

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

$[\![At(a)]\!]^{M,g} \quad = 1 \ \text{ iff } \ [\![a]\!]^{M,g} \in A$

Individual constants denote either atoms ($\in$ A) or sums ($\in$ U \ A)

Predicate expressions satisfy specific constraints:

- V_M(student-sg) $\subseteq$ A
- V_M(student-pl) $\subseteq$ U \ A

Interpretation of distributive predicates

Meaning Postulate for plural model structure

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

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

$$\forall x[P_d(x) \leftrightarrow \forall y[At(y) \wedge y \lhd x \rightarrow P_d(y)]]$$

Interpretation of mixed predicates

Examples of ambiguous interpretation

(1) *Every student presented a paper*

(2) *John and Mary presented a paper*

(3) *Two students presented a paper*

(4) *Two students presented three papers*