Roses and flowers: an informativeness implicature in probabilistic pragmatics

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30 May 2014

The empirical phenomenon

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These examples abound…

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tulips and flowers

These examples abound…

pork and meat

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pork and meat

tulips and flowers

horse and animal

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- **Goals for the talk:**

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- **Goals for the talk:**
  - Briefly investigate the construction's history

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  - Establish what *roses and flowers* means

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  - Show why this construction is a theoretical challenge

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- **Goals for the talk:**
  - Briefly investigate the construction's history
  - Establish what *roses and flowers* means
  - Show why this construction is a theoretical challenge
  - Show how rational speech-act theory meets this challenge

Historical Picture

- Early attestations (COHA reaches back to 1800)

[L]arge clusters…had been…tied to sundry nails and pegs…to form an arch of ***flowers and roses****.*

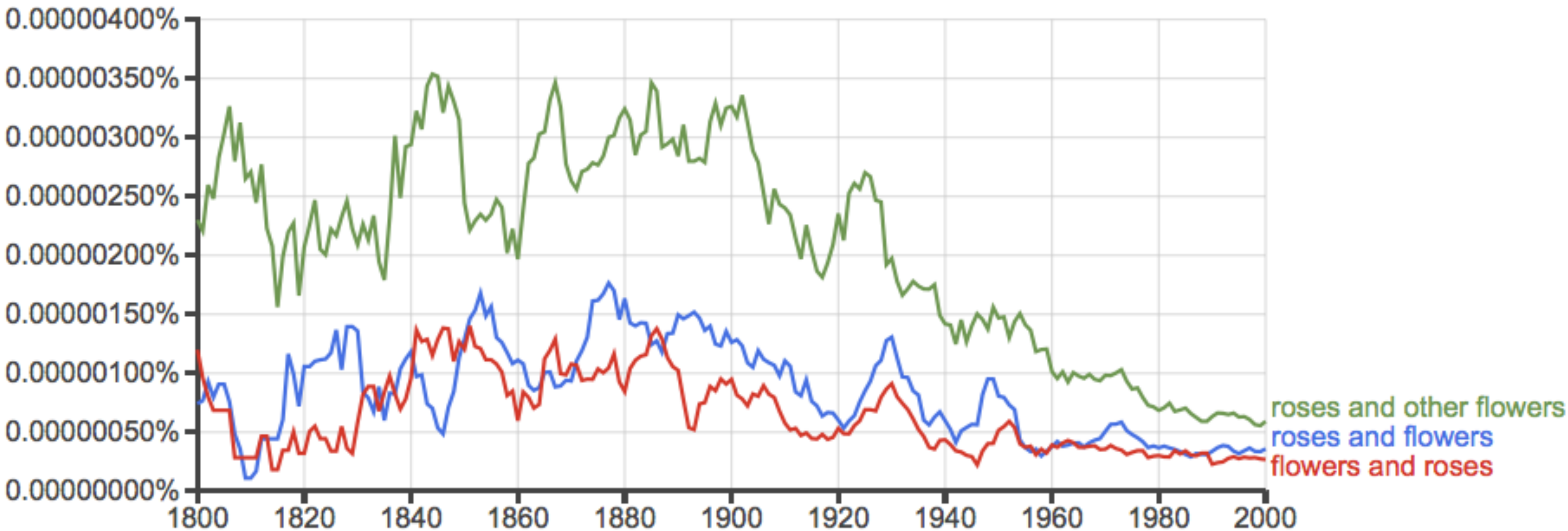
(1856, Harriet Beecher Stowe, *Dred: A Tale of the Great Dismal Swamp)*

It lies north-east and south-west, and its sides adorned with meadows, lofty ***trees and firs****.*

(1812, John Pinkerton, *A General Collection of the Best and Most Interesting Voyages and Travels in All Parts of the World*)

Historical picture

- Are these constructions changing in frequency? **Apparently not!**



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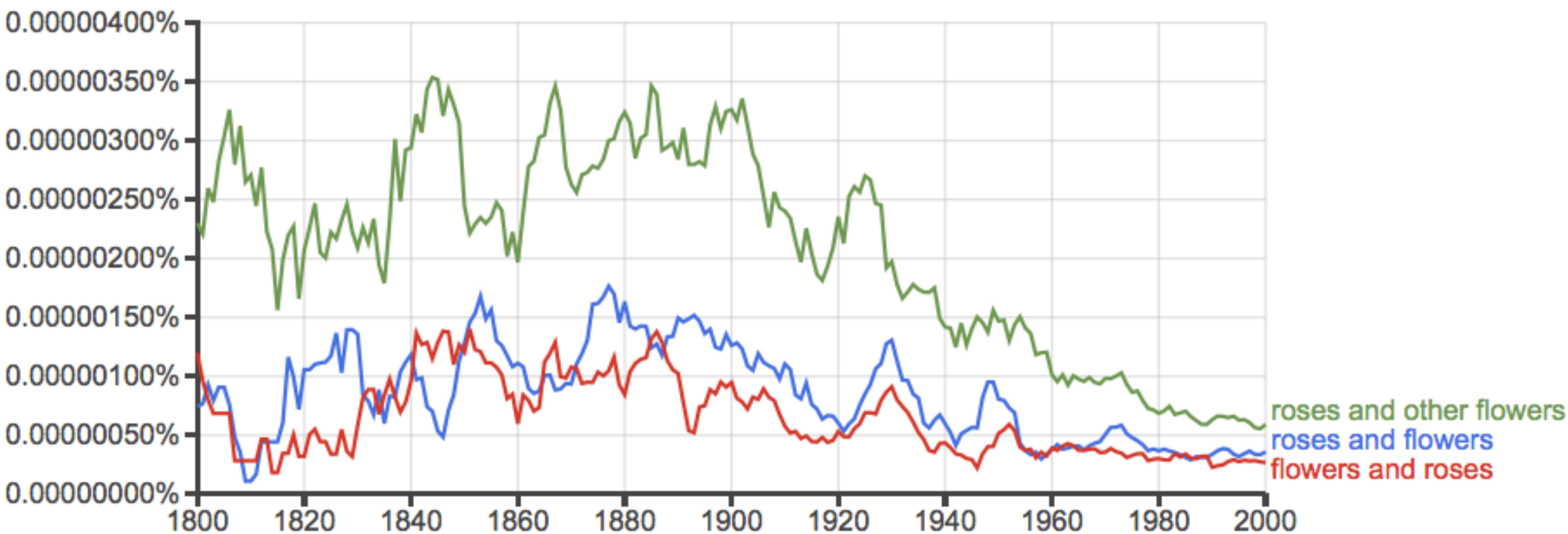

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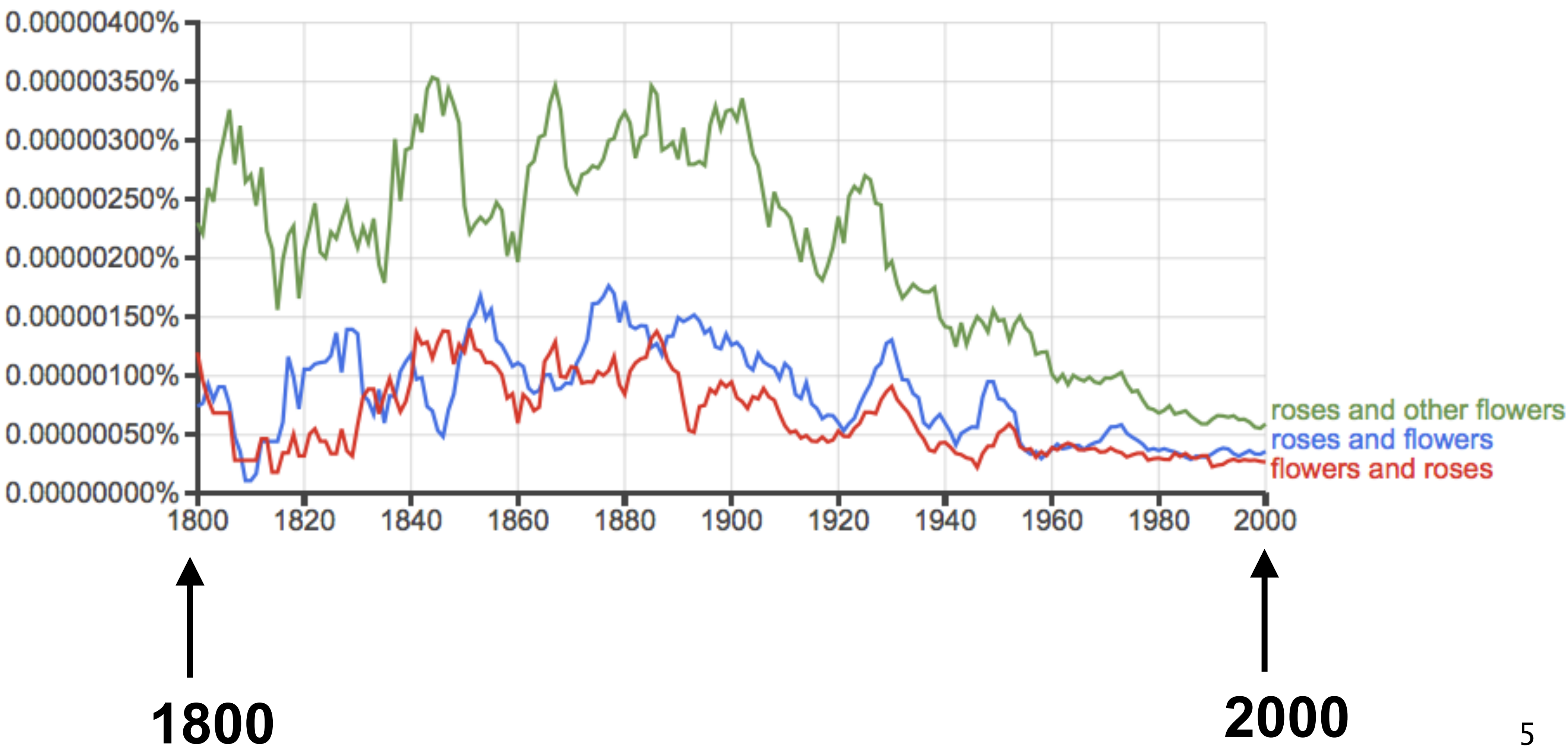

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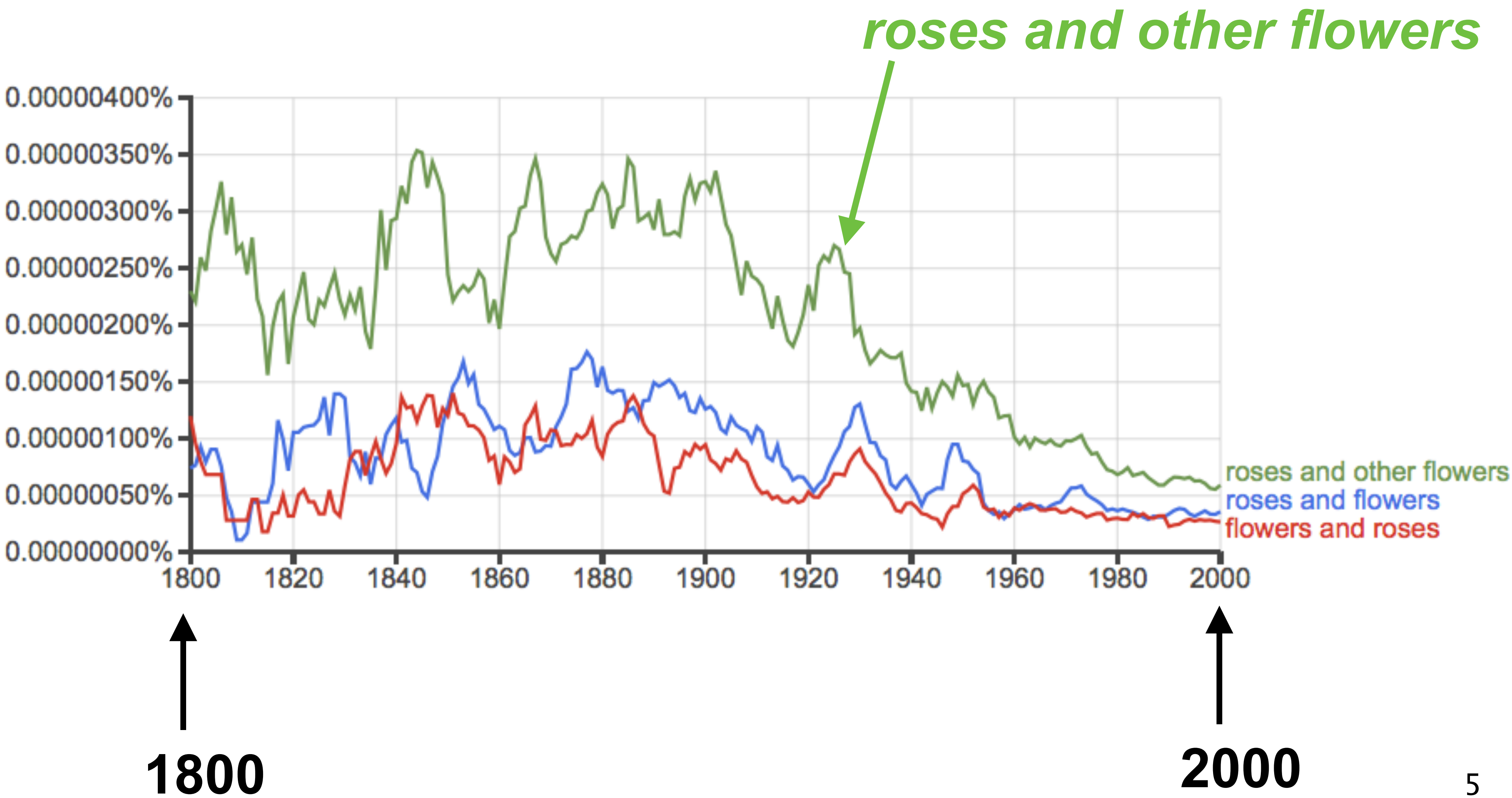

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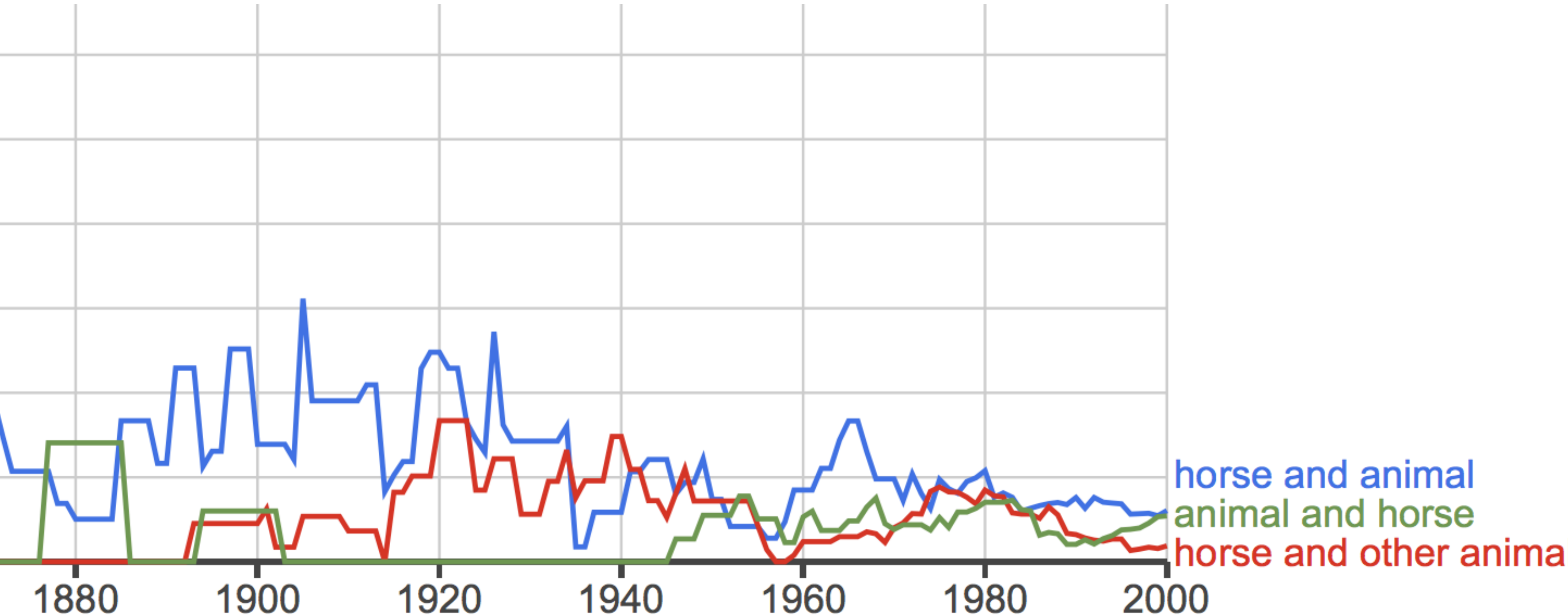

What does *roses and flowers* mean?

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- The intuition: a speaker's commitment with the utterance

roses and flowers

What does *roses and flowers* mean?

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  roses and flowers

  is the same as their commitment with the utterance

  roses and other flowers

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  The road to the airport was lined with roses and flowers.

  Q: *How many types of flowers do you think there were lining the road to the airport?*

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- Critical measurement: does a respondent answer with a number greater than one?

A simple experiment

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- Mechanical Turk study, five conditions:

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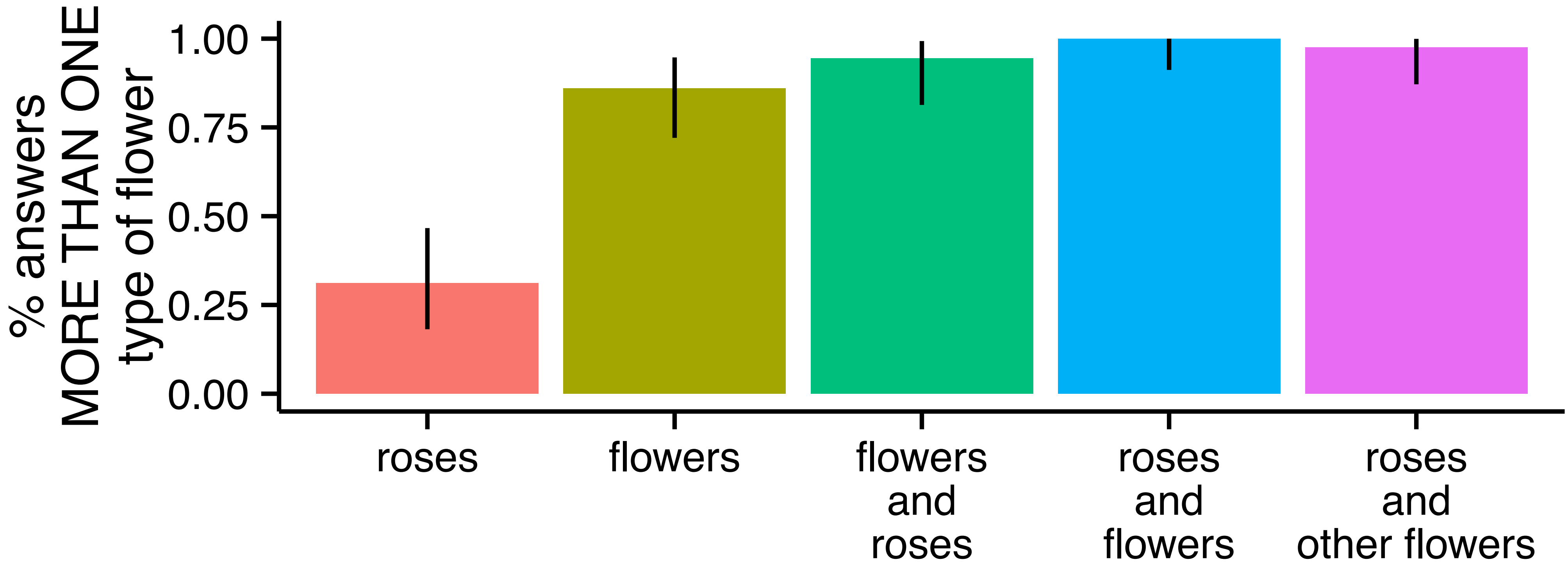
- 250 participants (50 per condition)

Experiment results (with 95% CIs)



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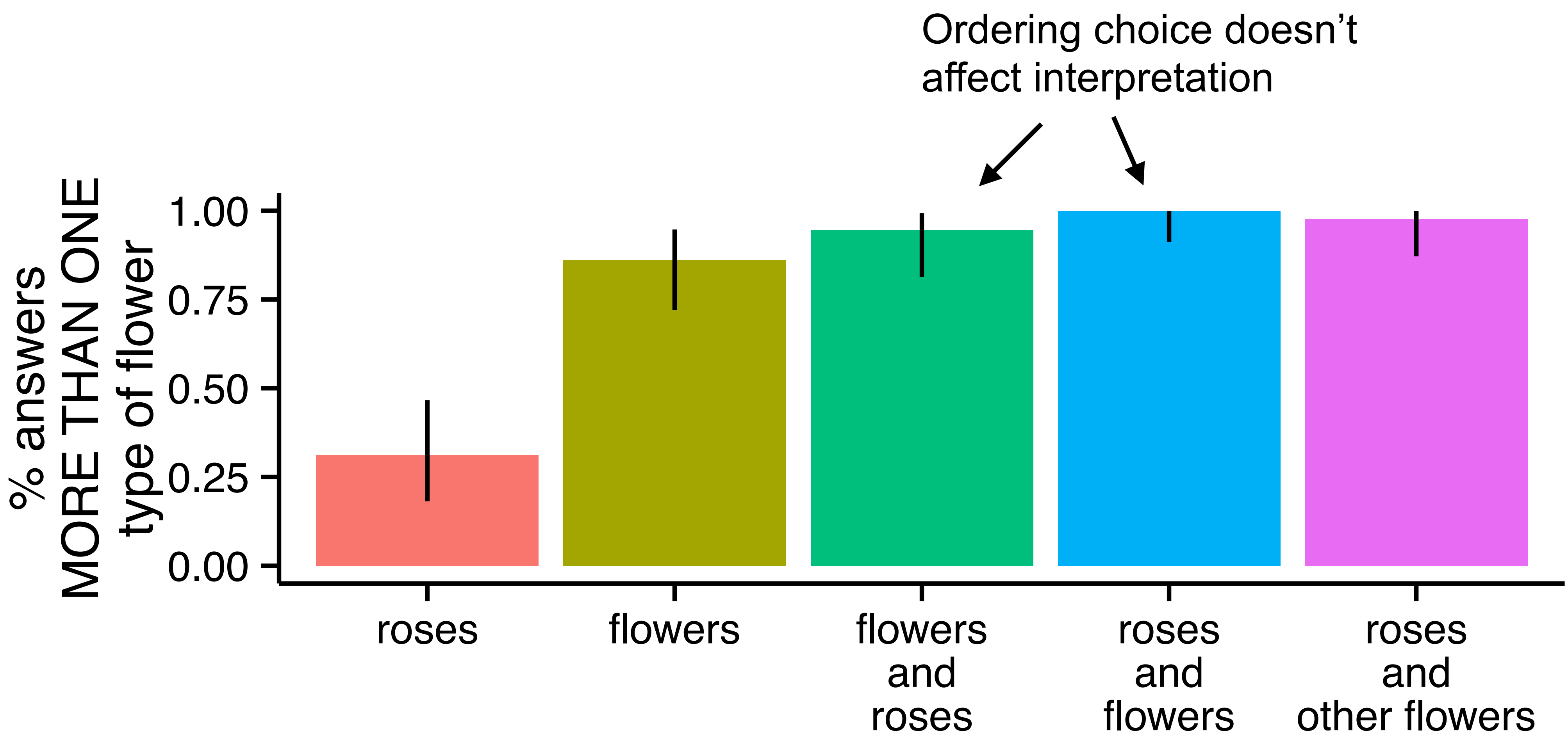

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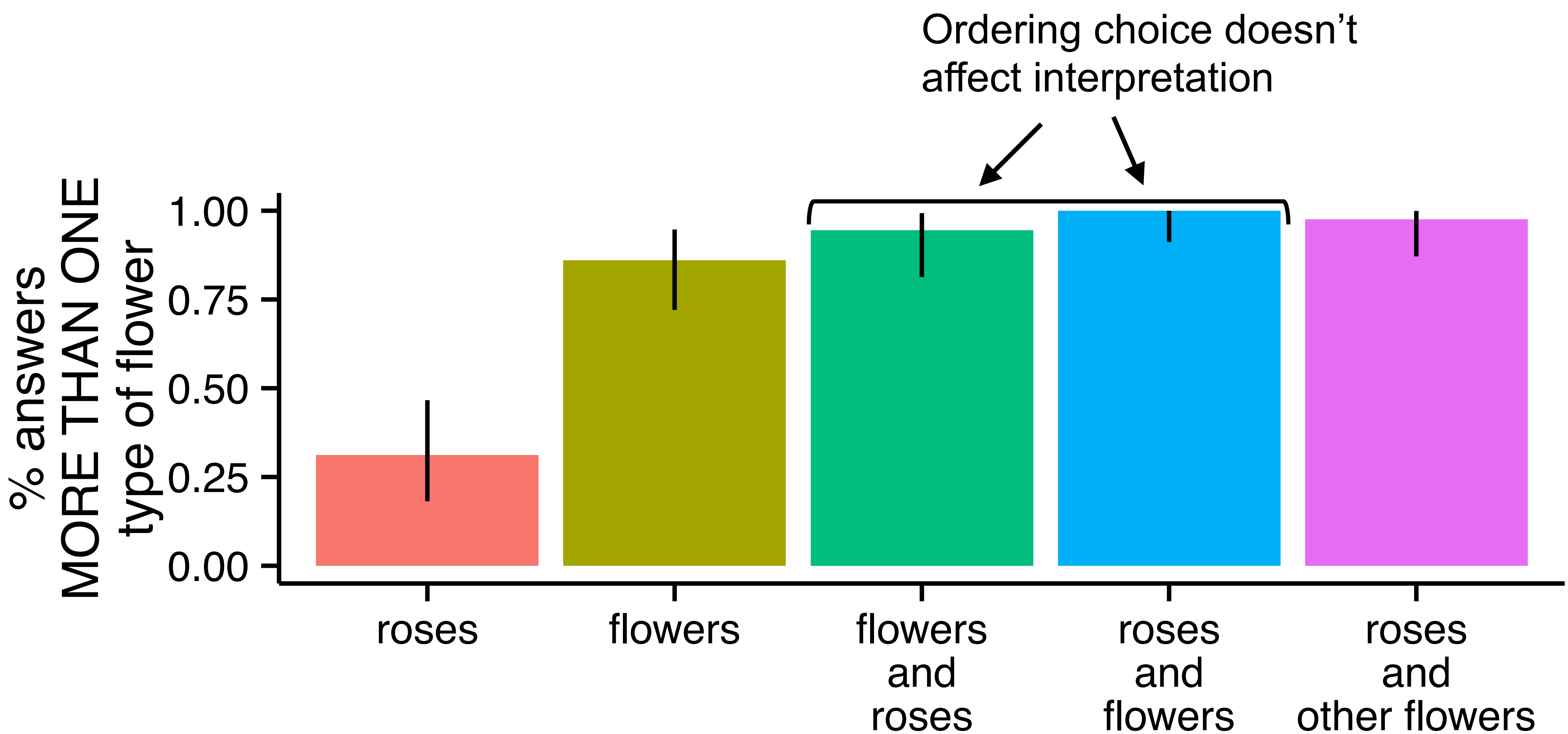

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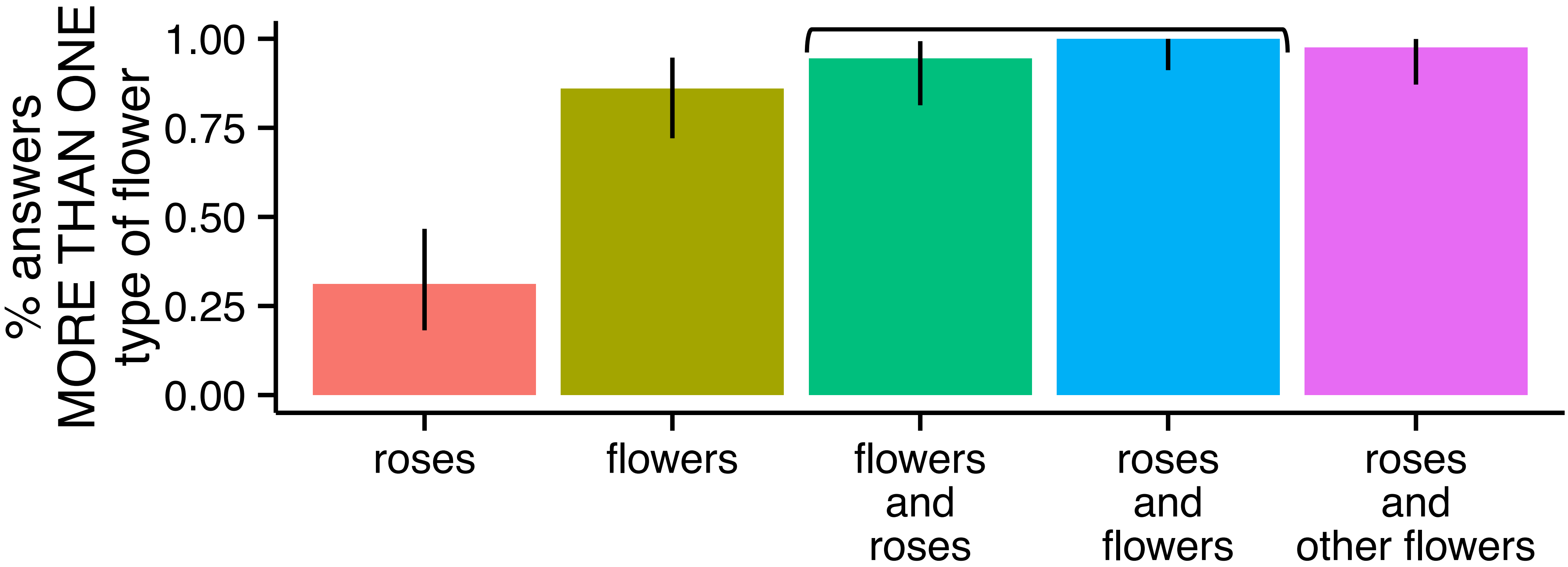
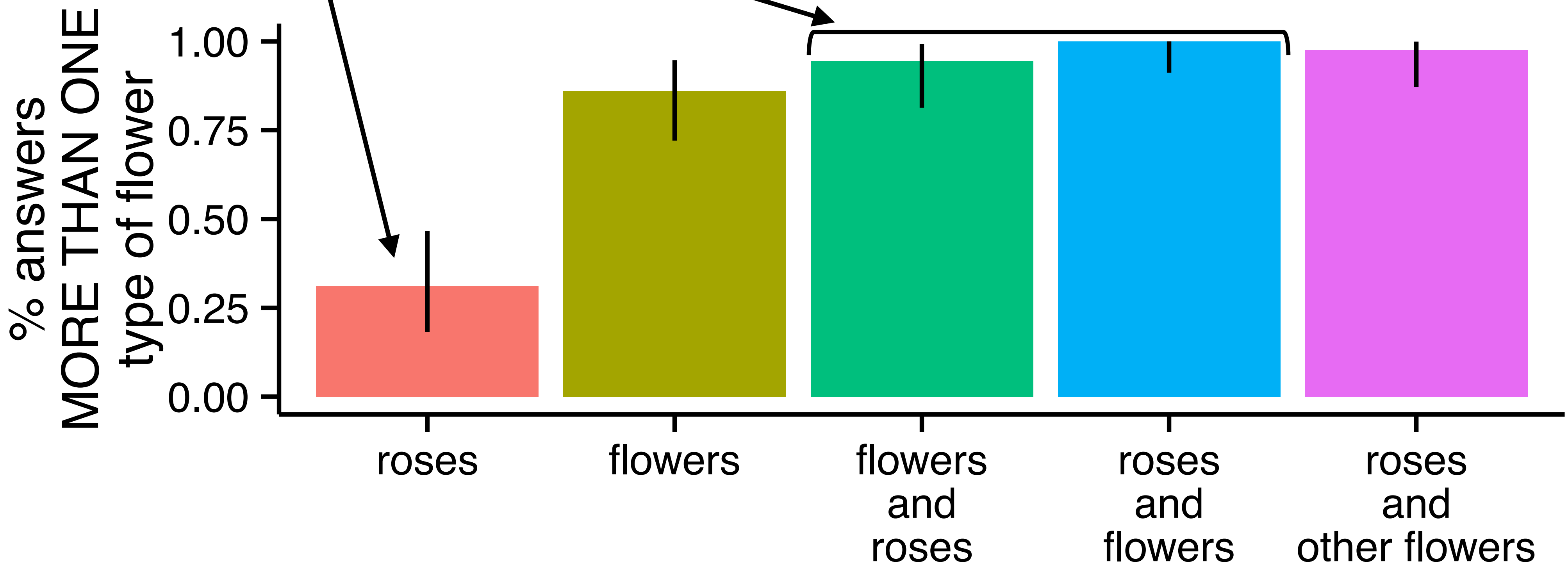


`M(`*`roses and flowers`*`) = M(`*`flowers and roses`*`)`

Experiment results (with 95% CIs)

Conjoining ***flowers*** onto ***roses*** massively changes interpretation ($p \ll 0.001$)



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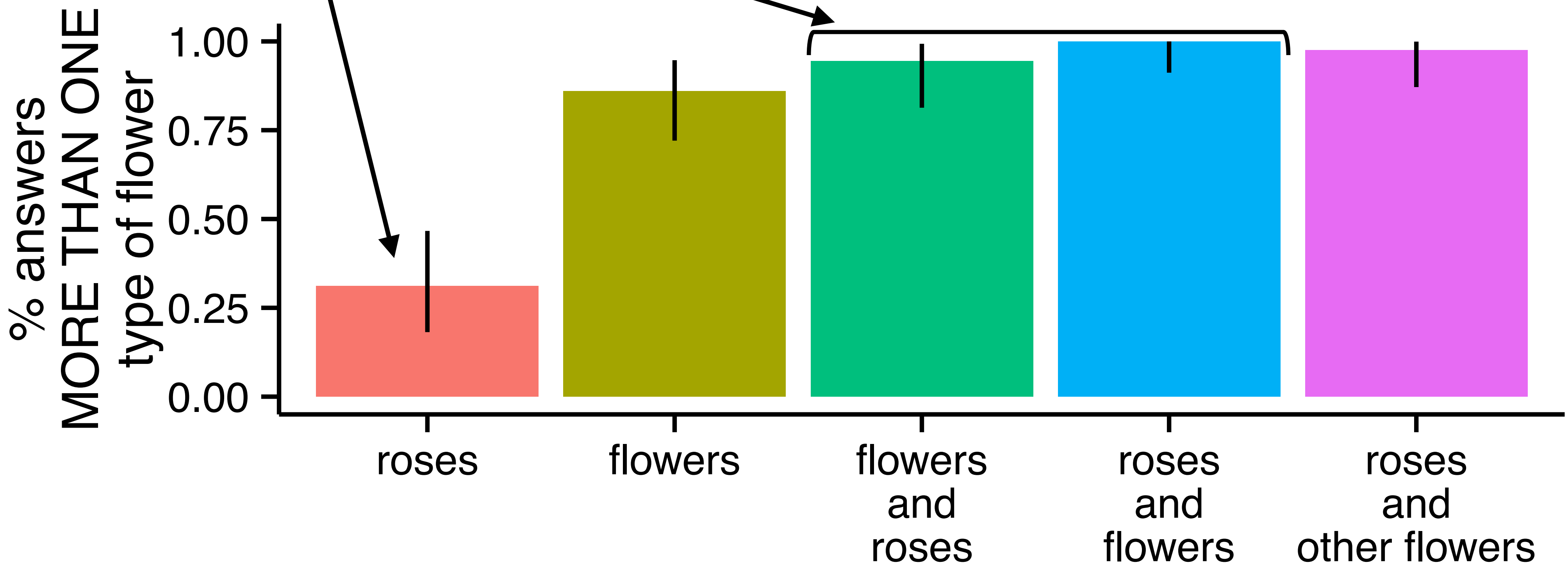
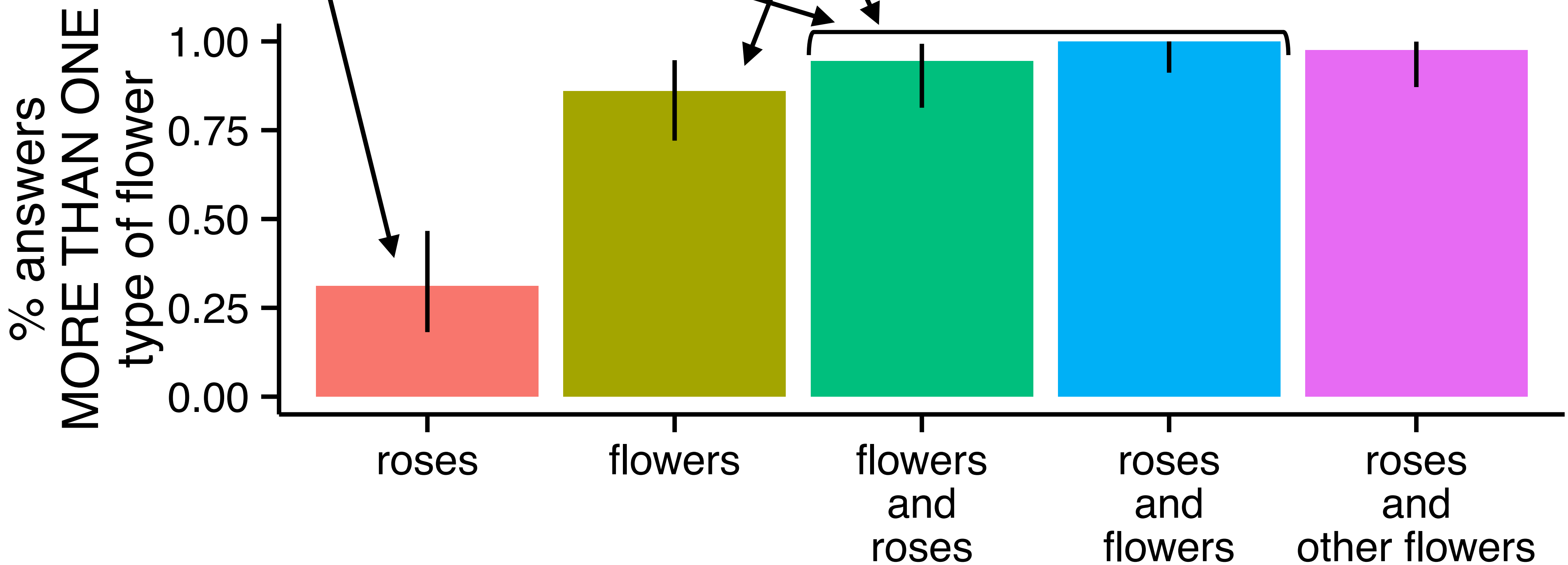


M(*roses and flowers*) = M(*flowers and roses*)
M(*roses and flowers*) ≠ M(*roses*)

Experiment results (with 95% CIs)

Conjoining ***flowers*** onto ***roses*** massively changes interpretation ($p \ll 0.001$)

Conjoining ***roses*** onto ***flowers*** changes interpretation too! ($p<0.025$)



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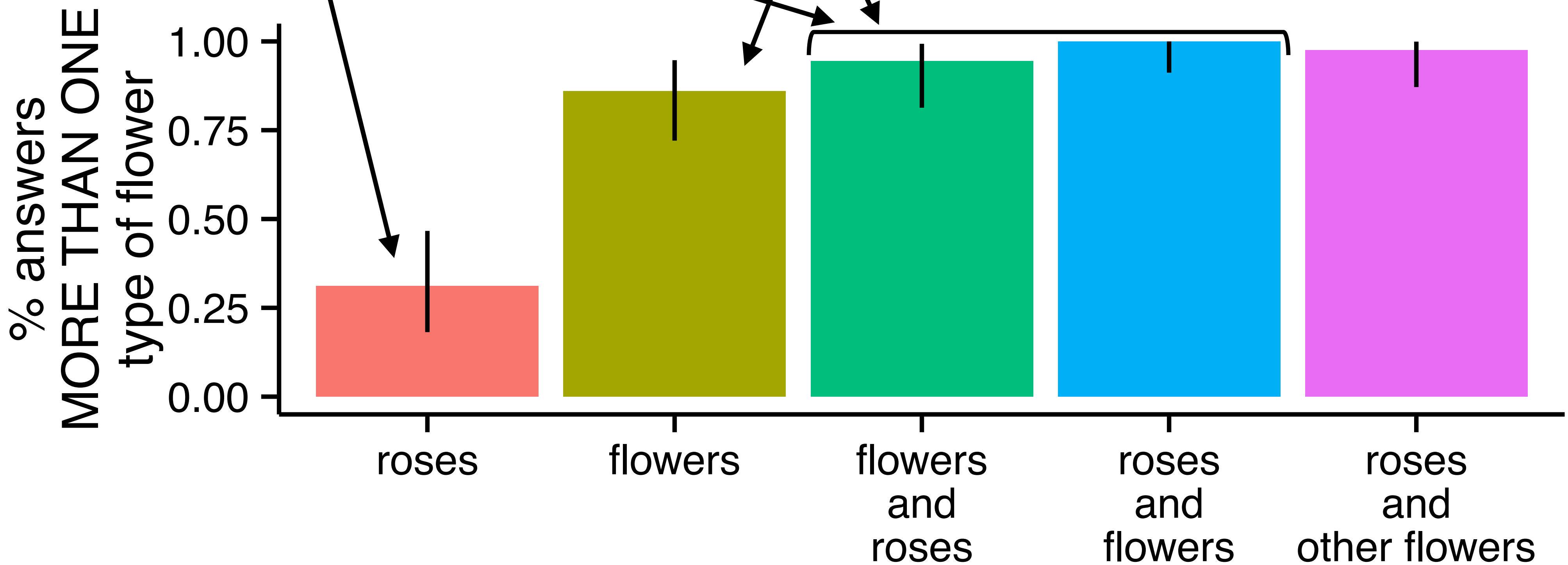

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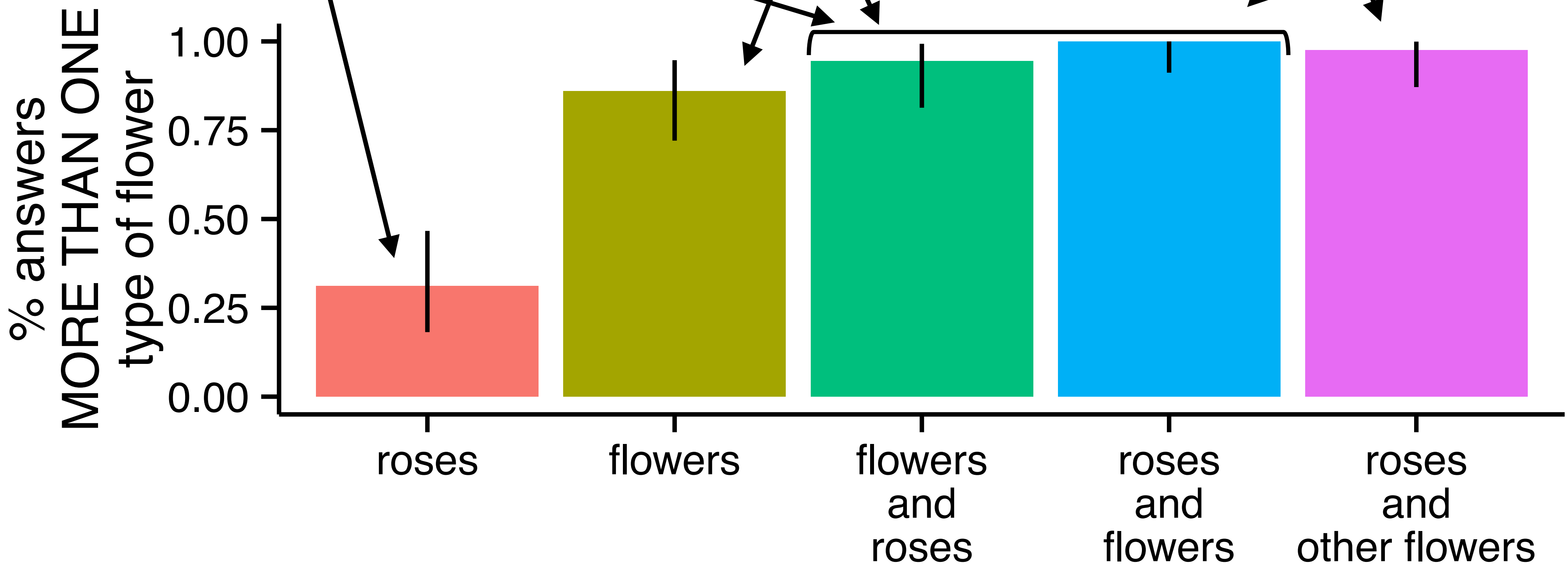
Adding ***other*** has no discernible effect

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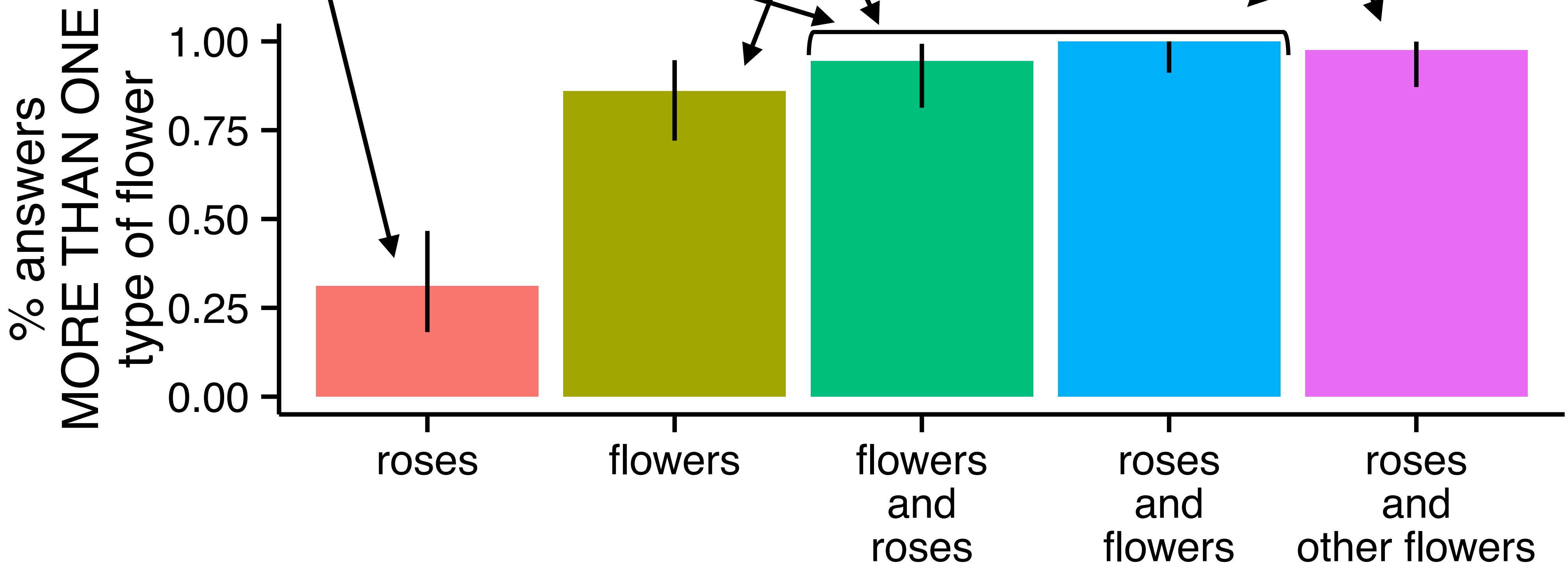

M(*roses and flowers*) = M(*flowers and roses*)

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M(*roses and flowers*) = M(*roses and other flowers*)

The semantic puzzle

We sell roses and flowers for Mother's Day.

We sell roses and other flowers for Mother's Day.

We sell roses for Mother's Day.

The semantic puzzle

We sell roses and flowers for Mother's Day.

We sell roses and other flowers for Mother's Day.

We sell roses for Mother's Day.

The semantic puzzle

We sell roses and flowers for Mother's Day.

- What does this mean?

We sell roses and other flowers for Mother's Day.

We sell roses for Mother's Day.

The semantic puzzle

We sell roses and flowers for Mother's Day.

- What does this mean?
- Empirically, we saw that it means

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The semantic puzzle

We sell roses and flowers for Mother's Day.

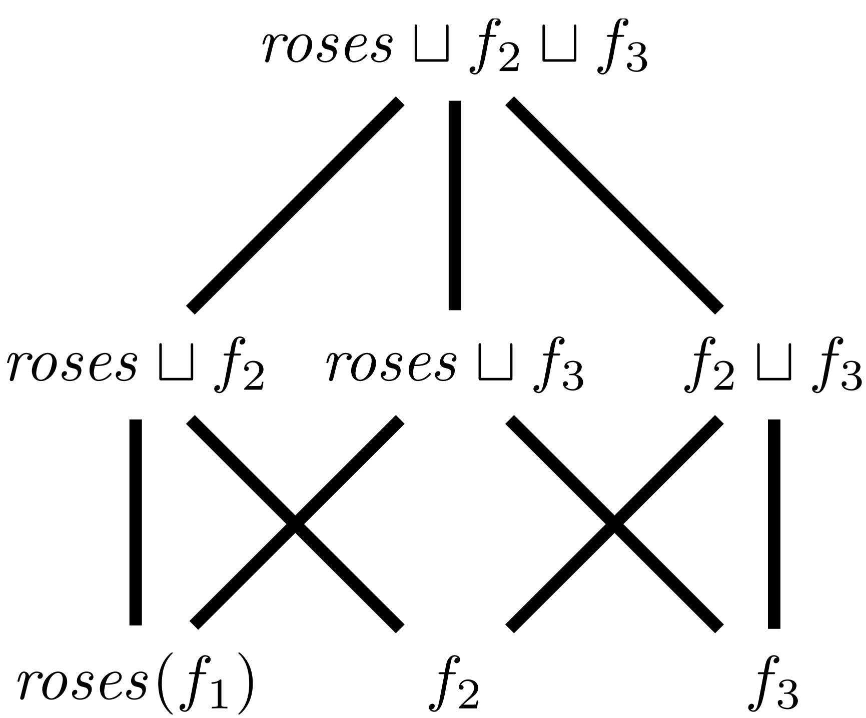
- What does this mean?
- Empirically, we saw that it means

We sell roses and other flowers for Mother's Day.

- But I will show that it should literally mean

We sell roses for Mother's Day.

Consider the sum semilattice of flower subtypes (Link, 1983):



Its nodes induce a partition over possible worlds:

The sum that *we sell*:

$f_1 \sqcup f_2 \sqcup f_3$
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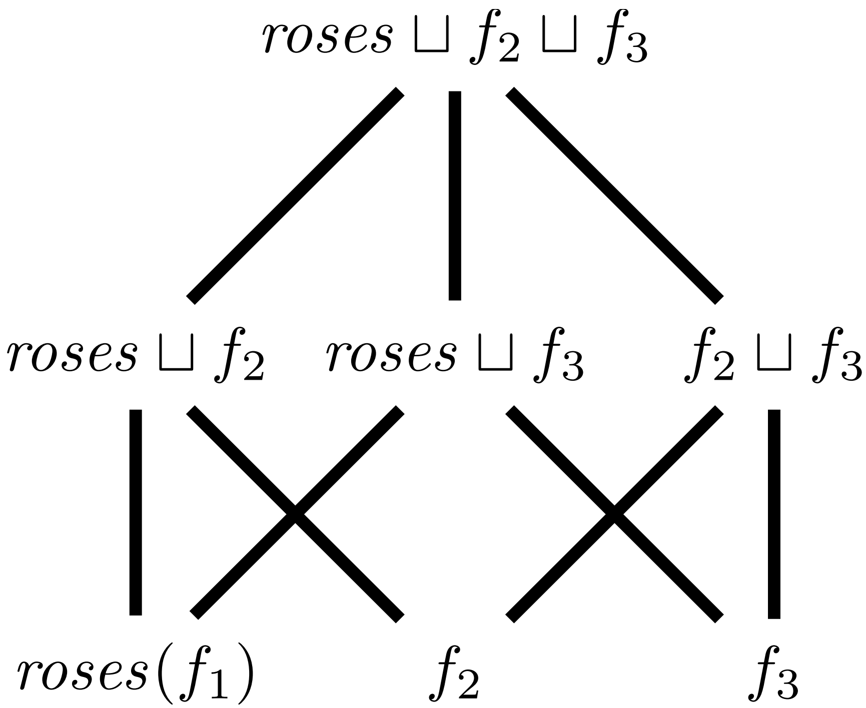

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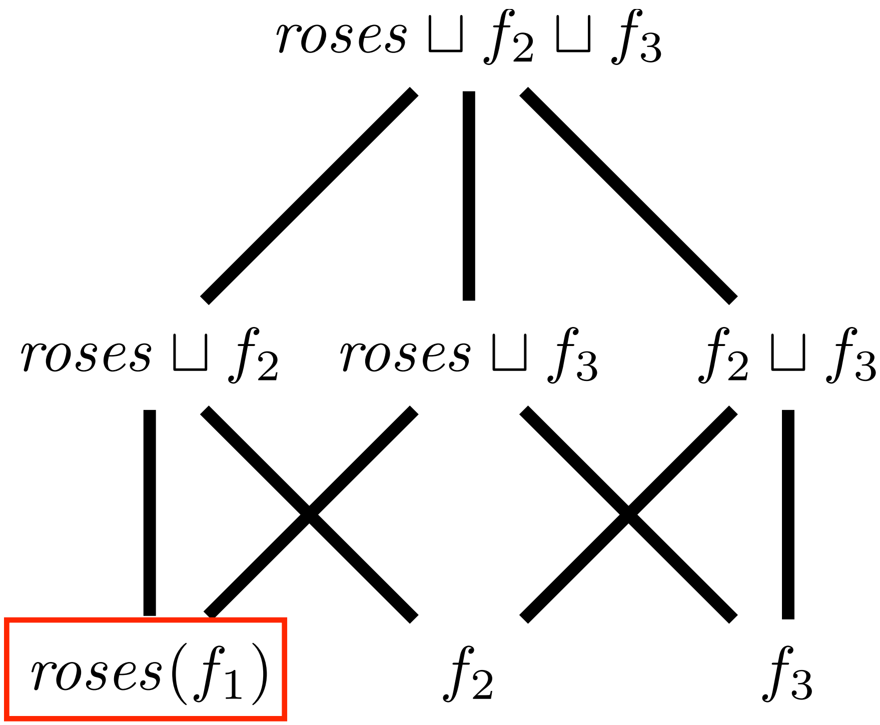

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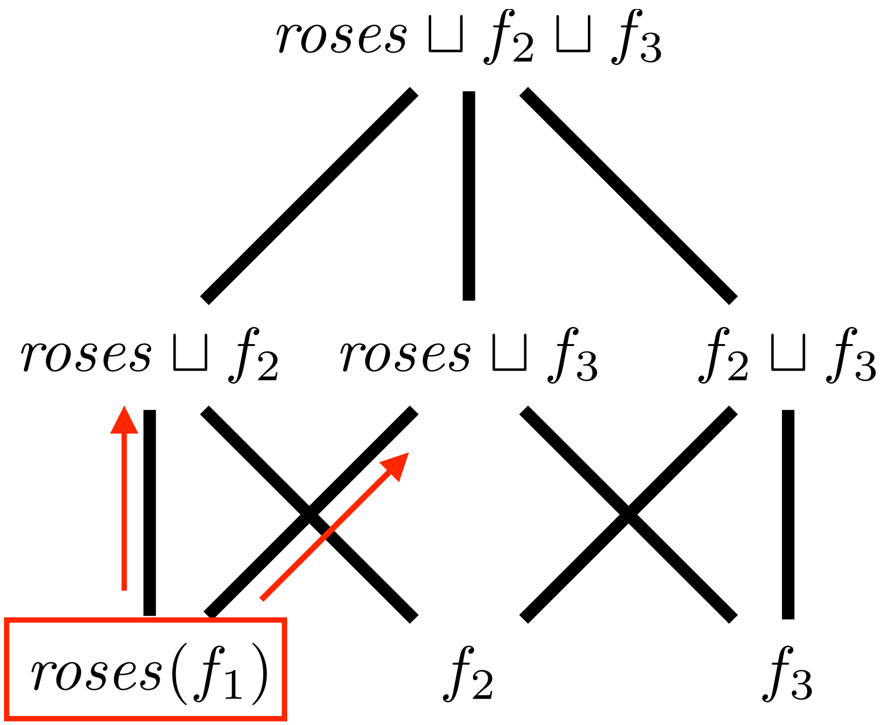

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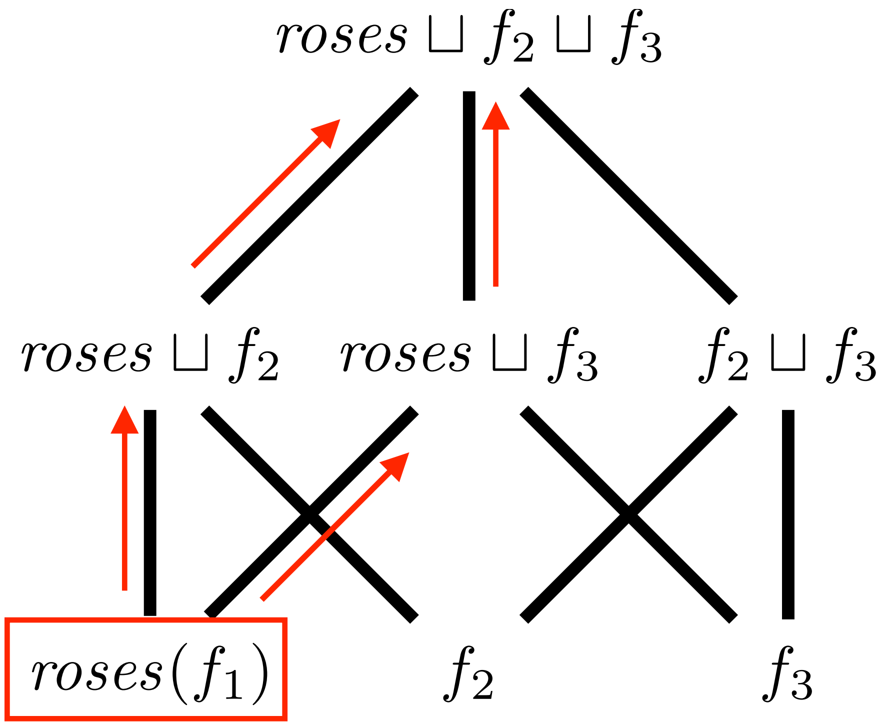

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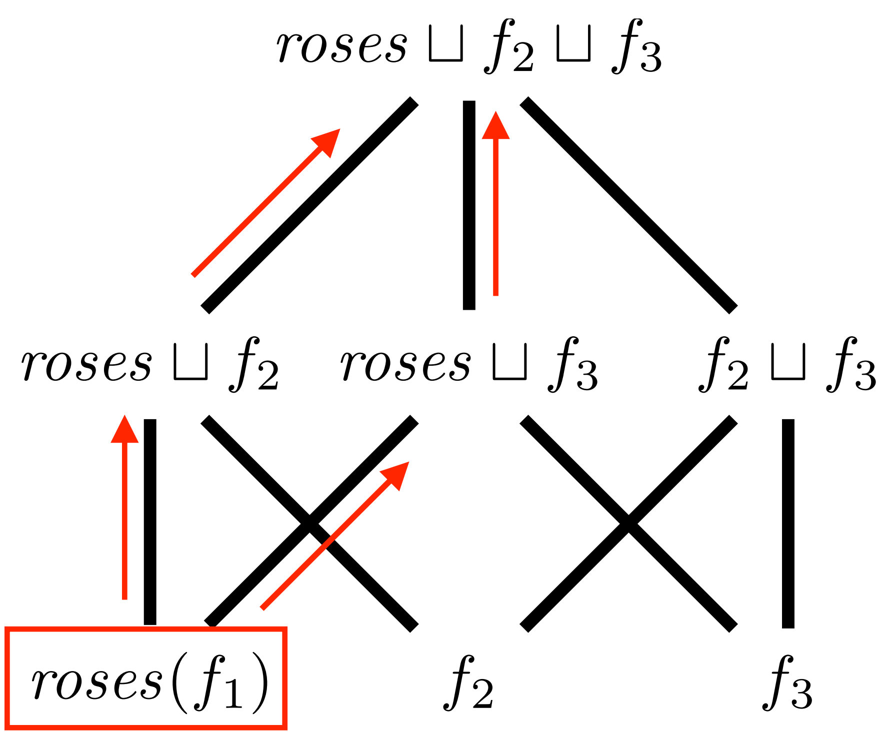

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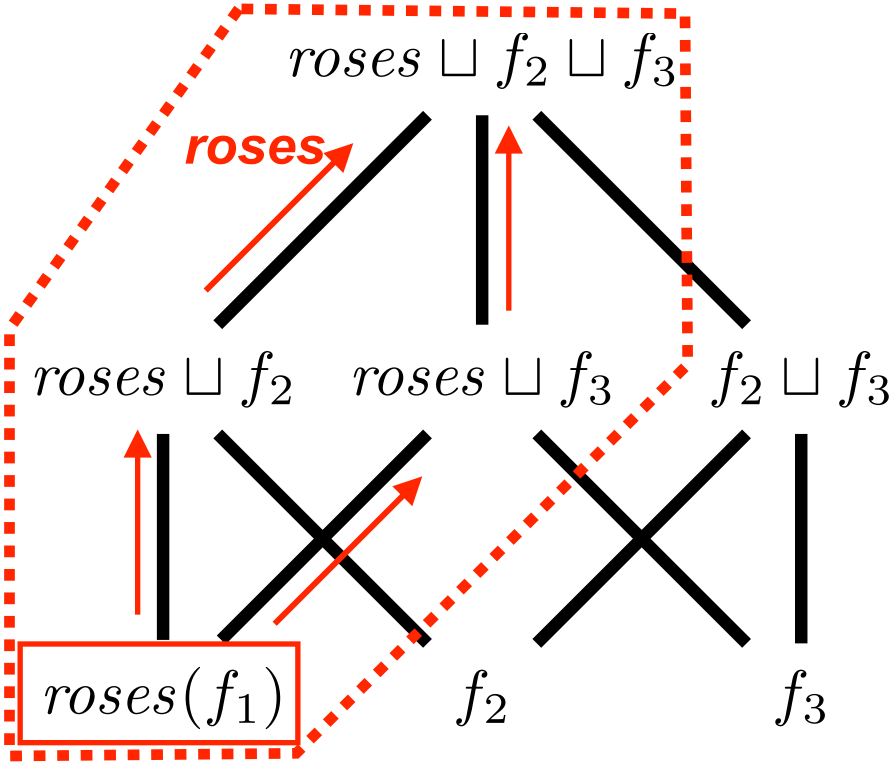

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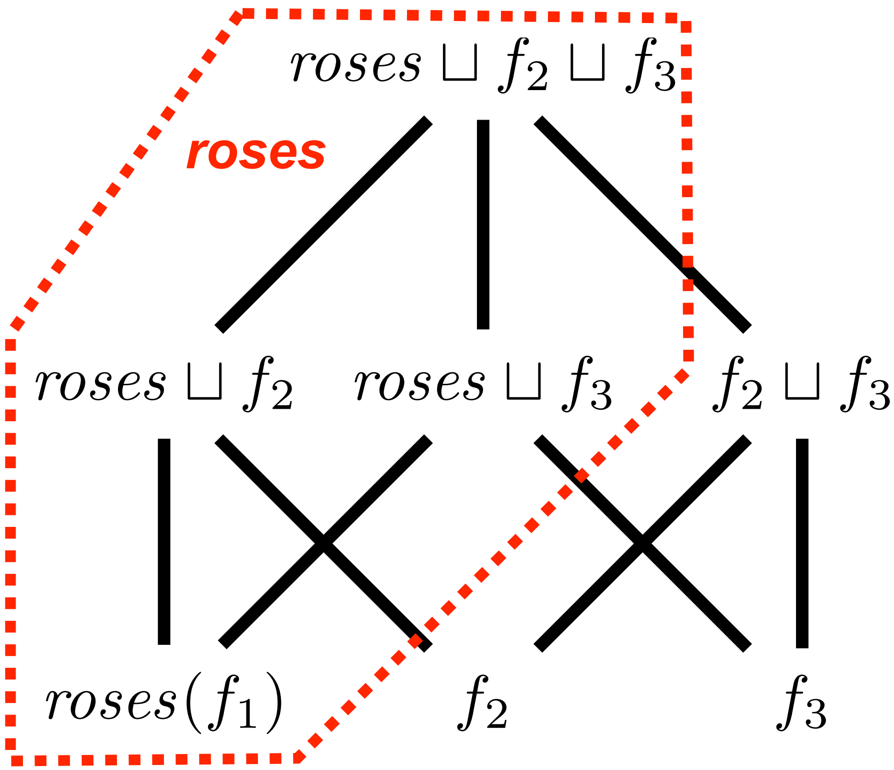

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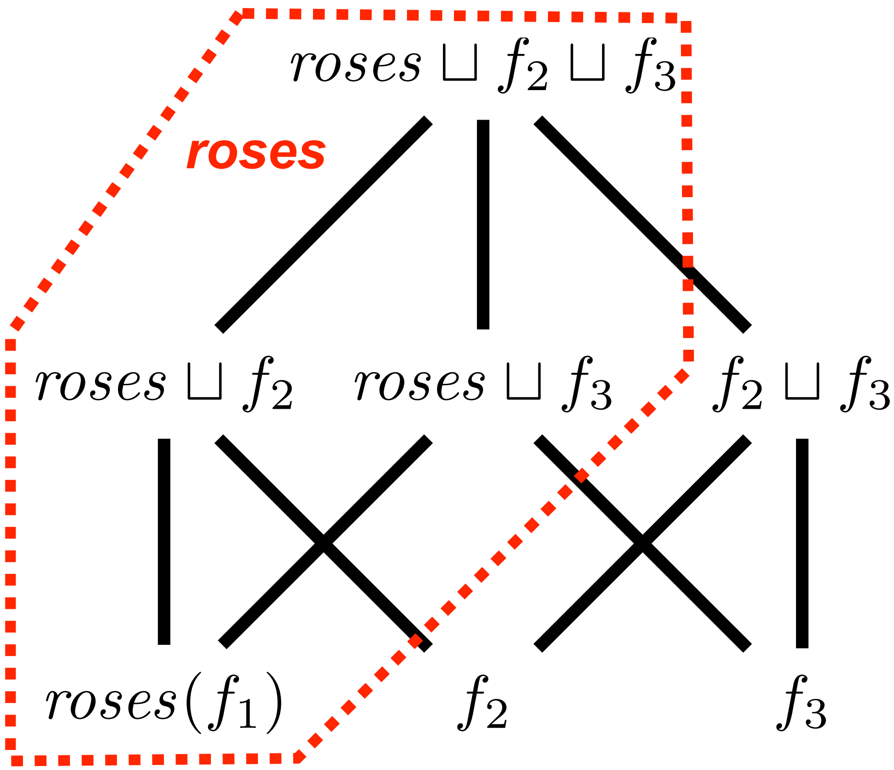

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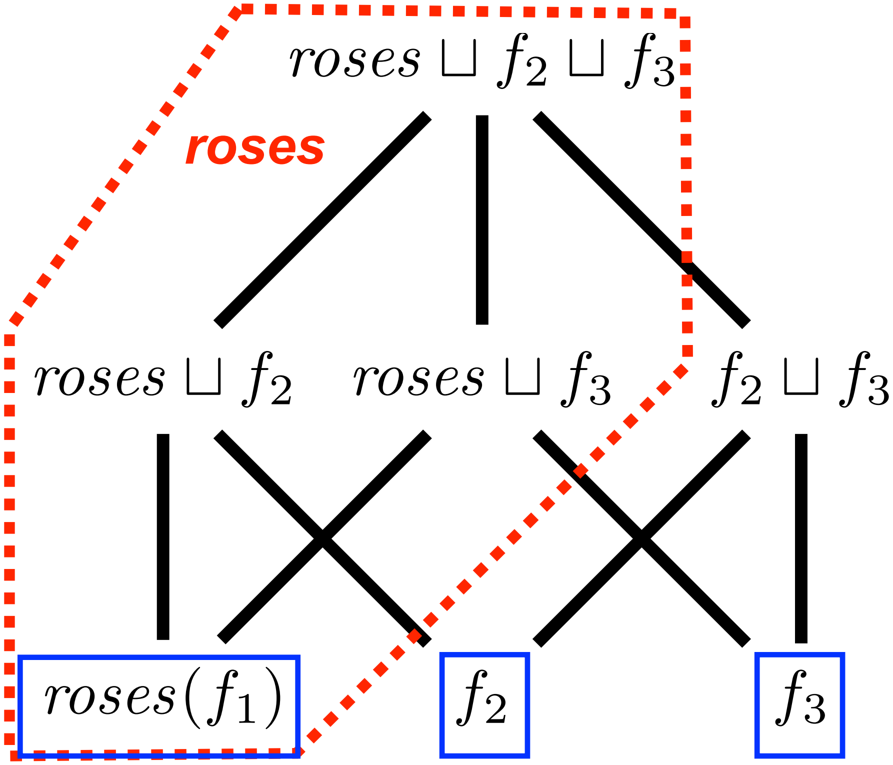

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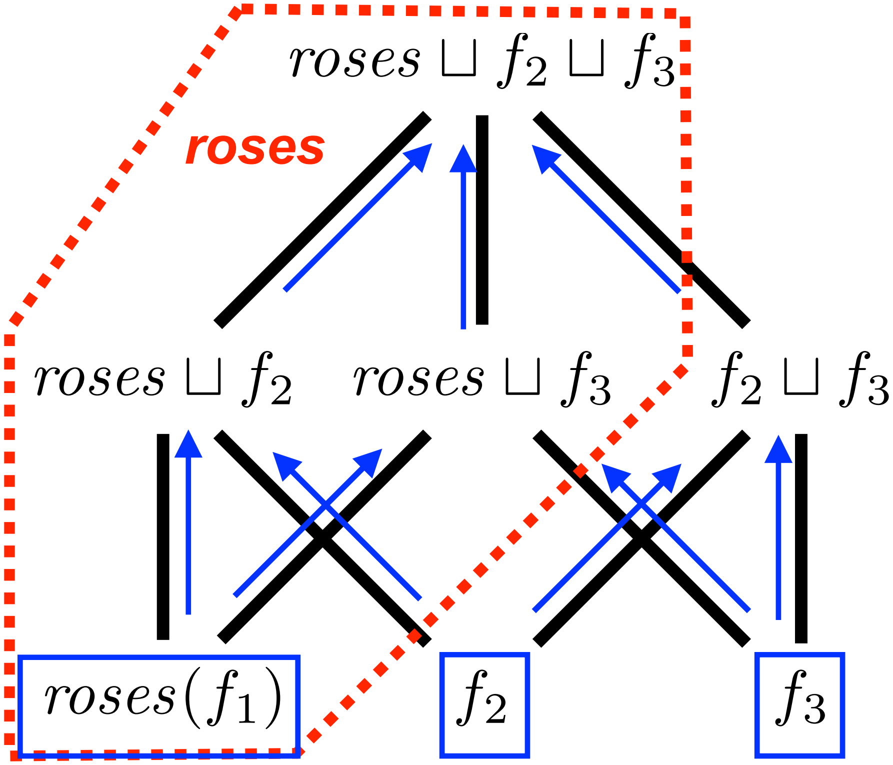

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	$\emptyset$

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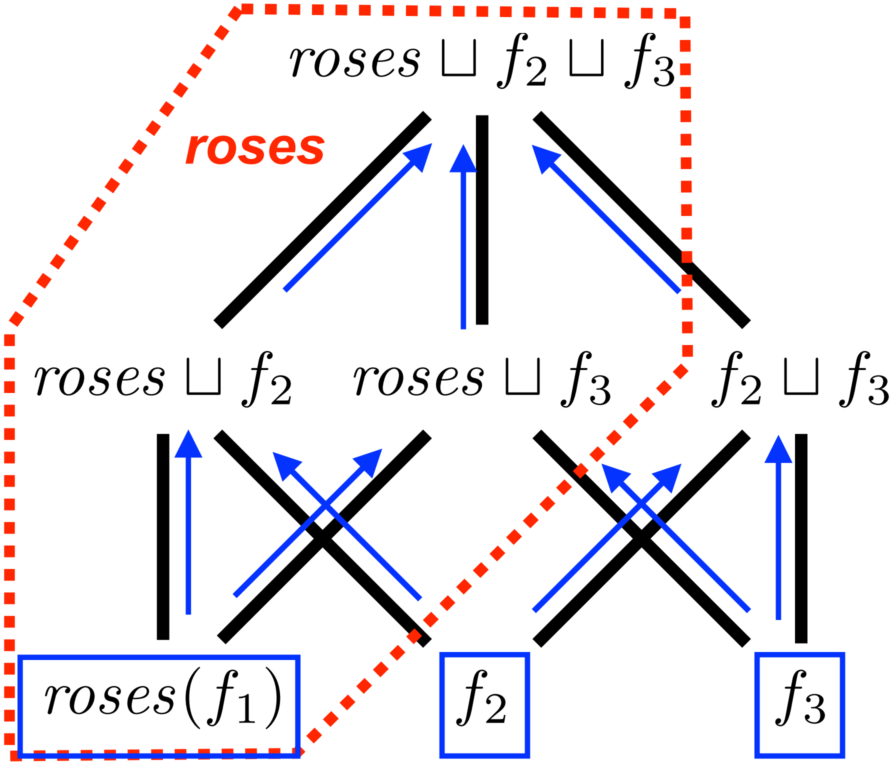

*We sell **roses**.*

*We sell **flowers**.*

Its nodes induce a partition over possible worlds:

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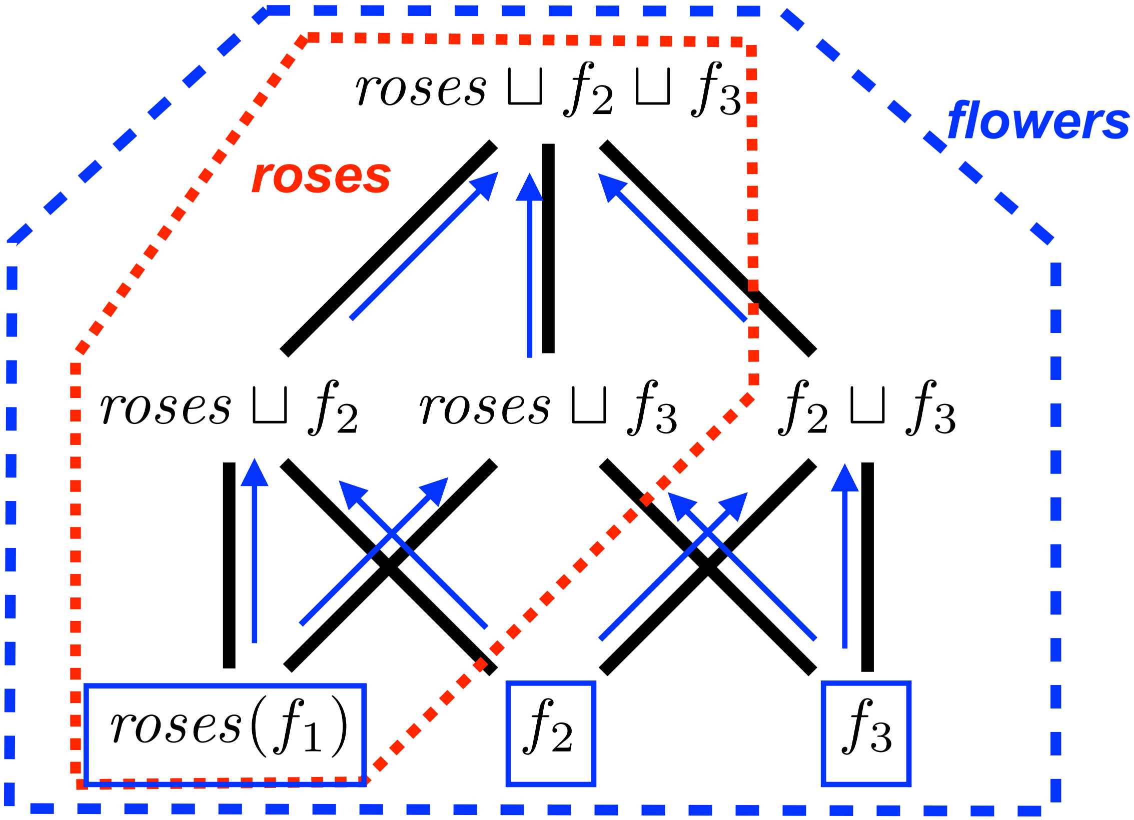

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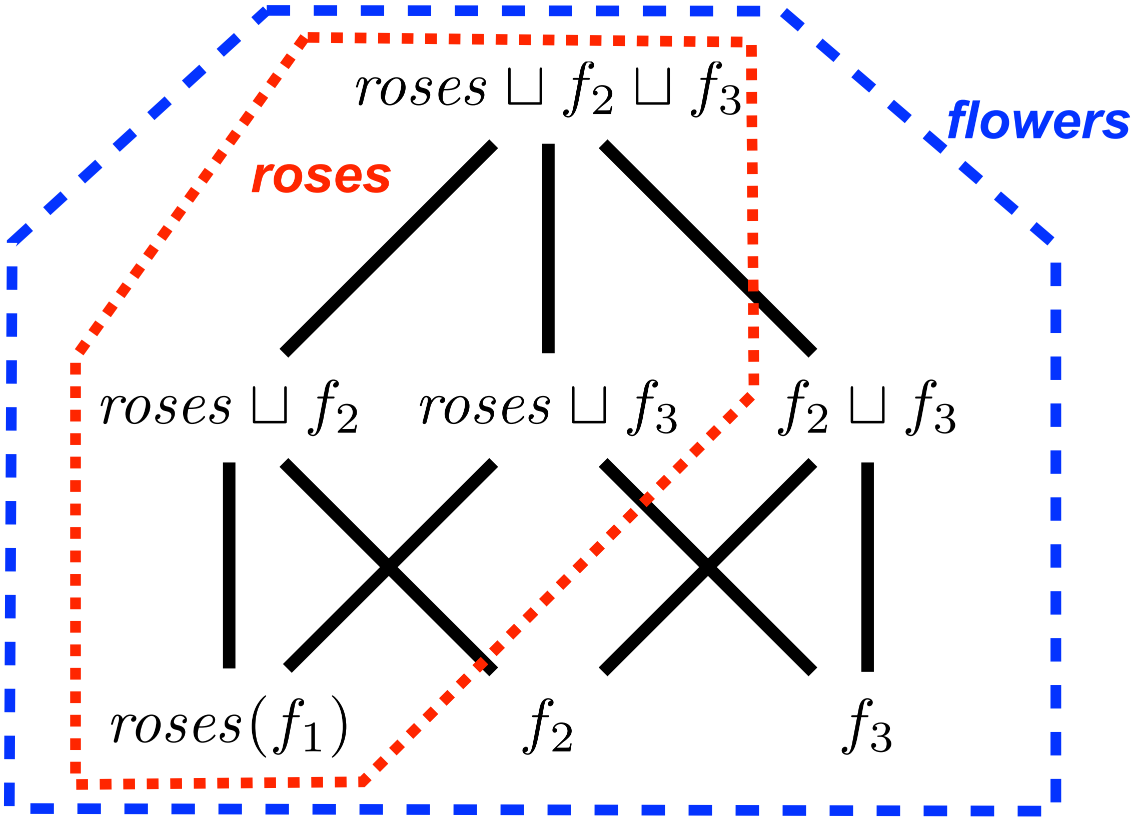

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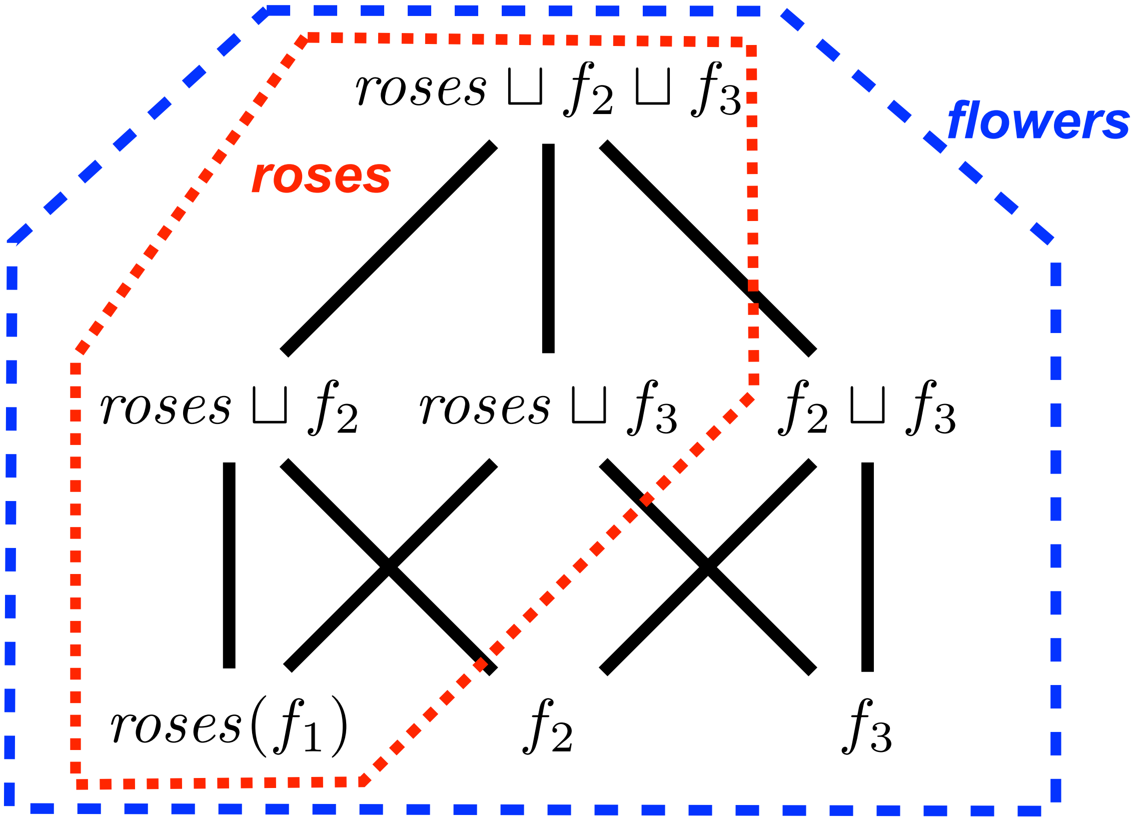

We sell **roses**.

We sell **flowers**.

We sell **roses and flowers**.

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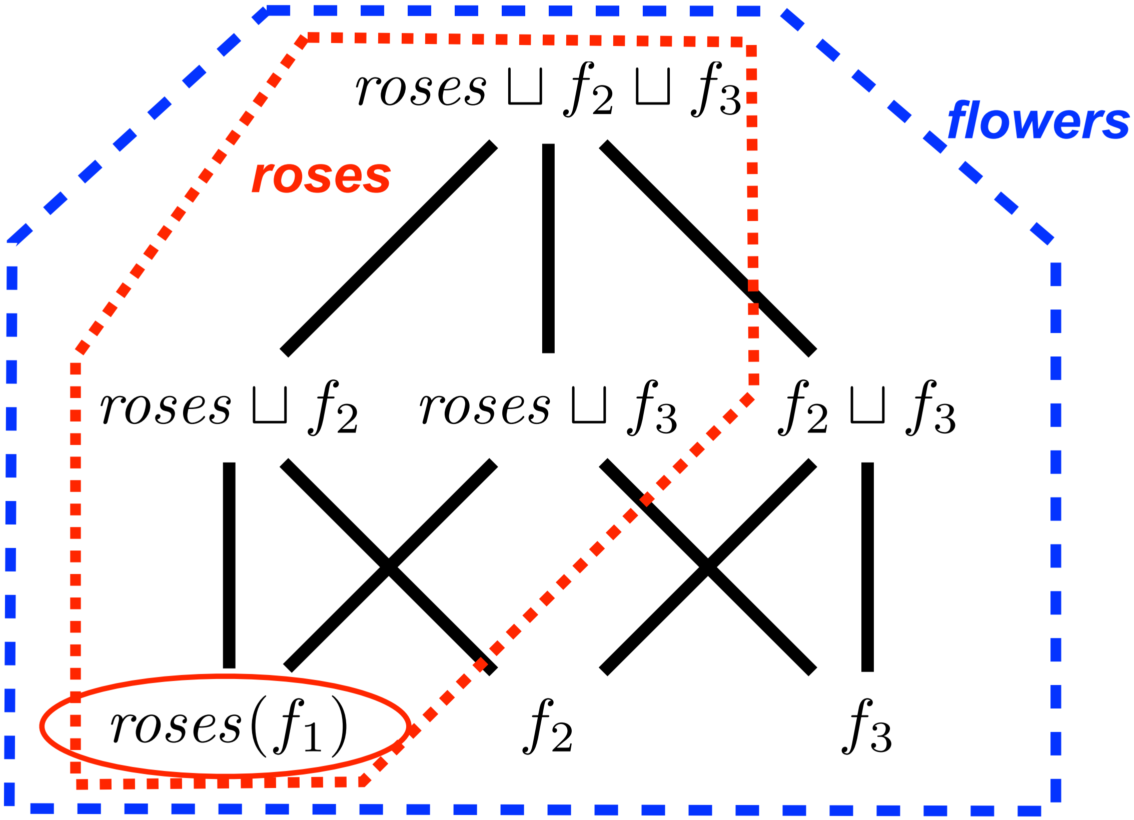

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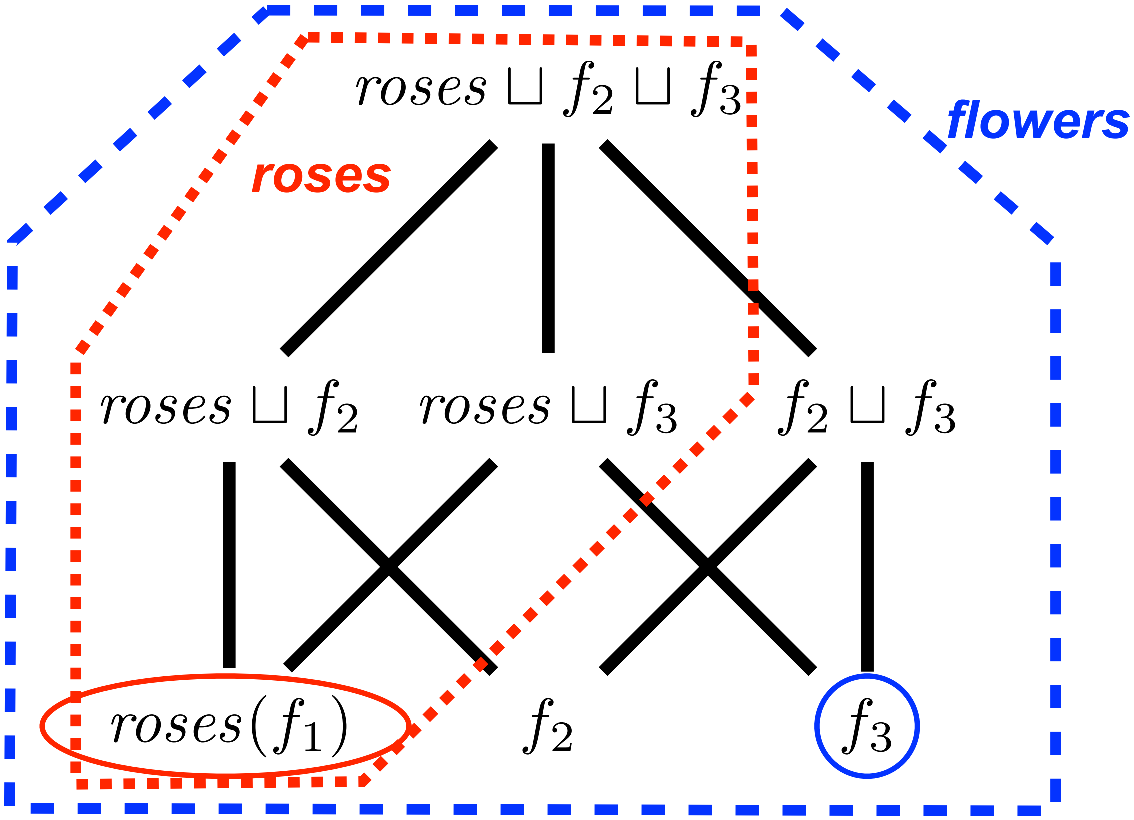

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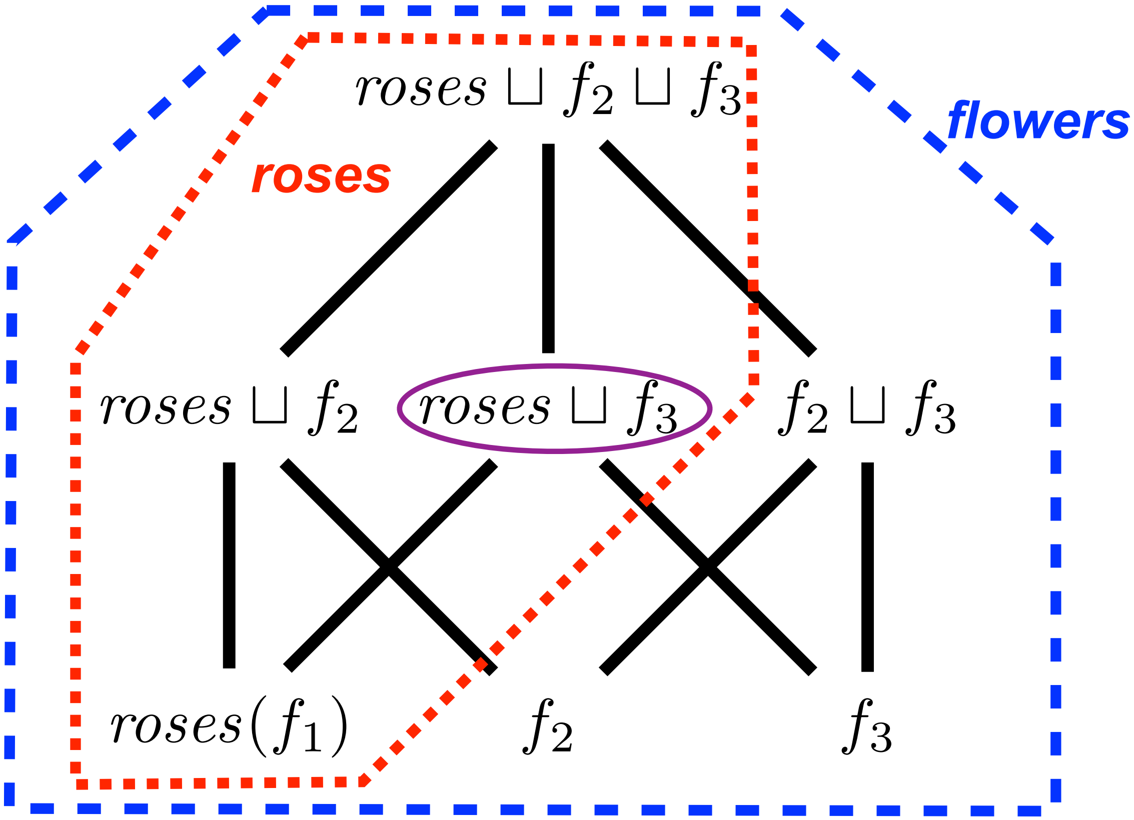

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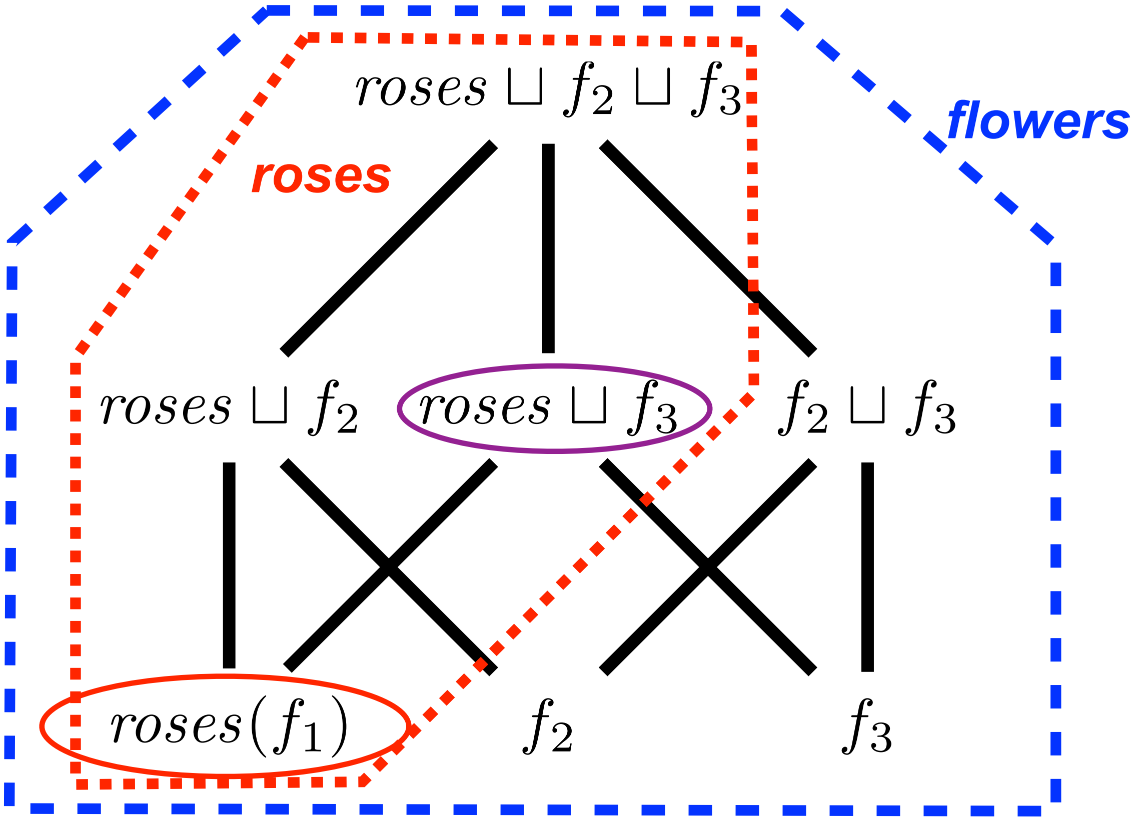

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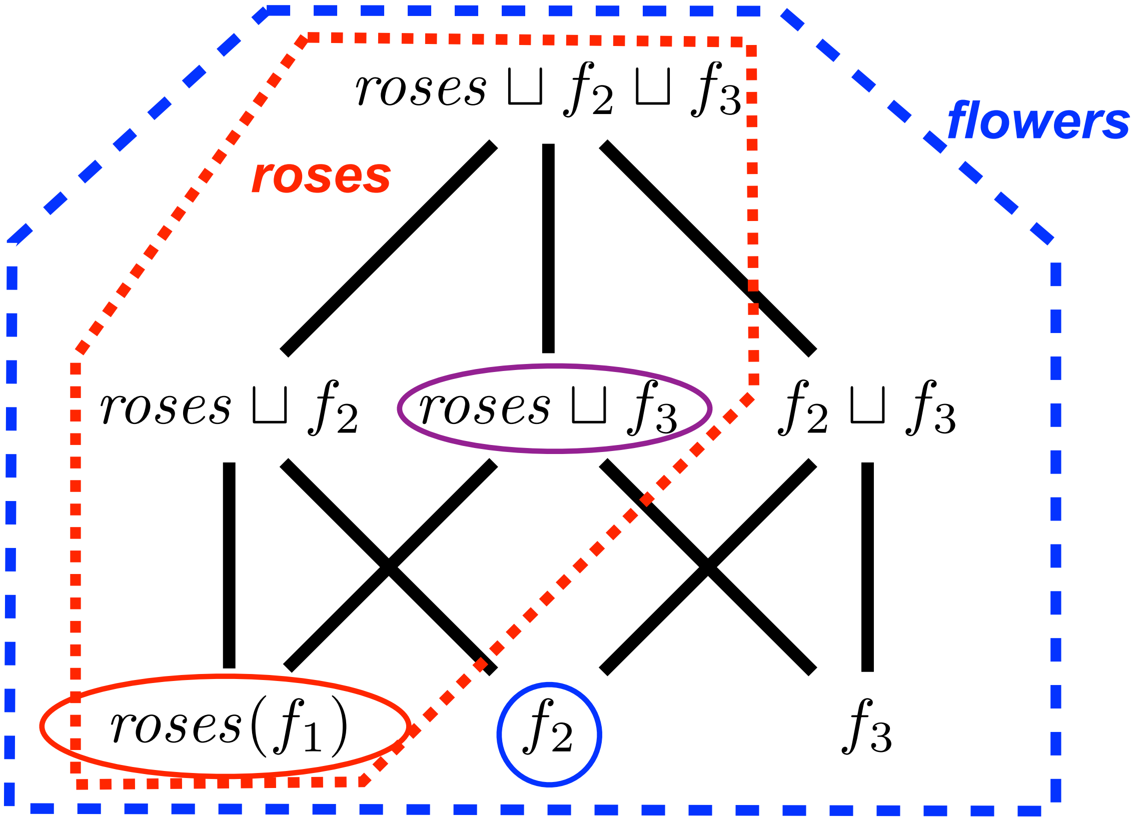

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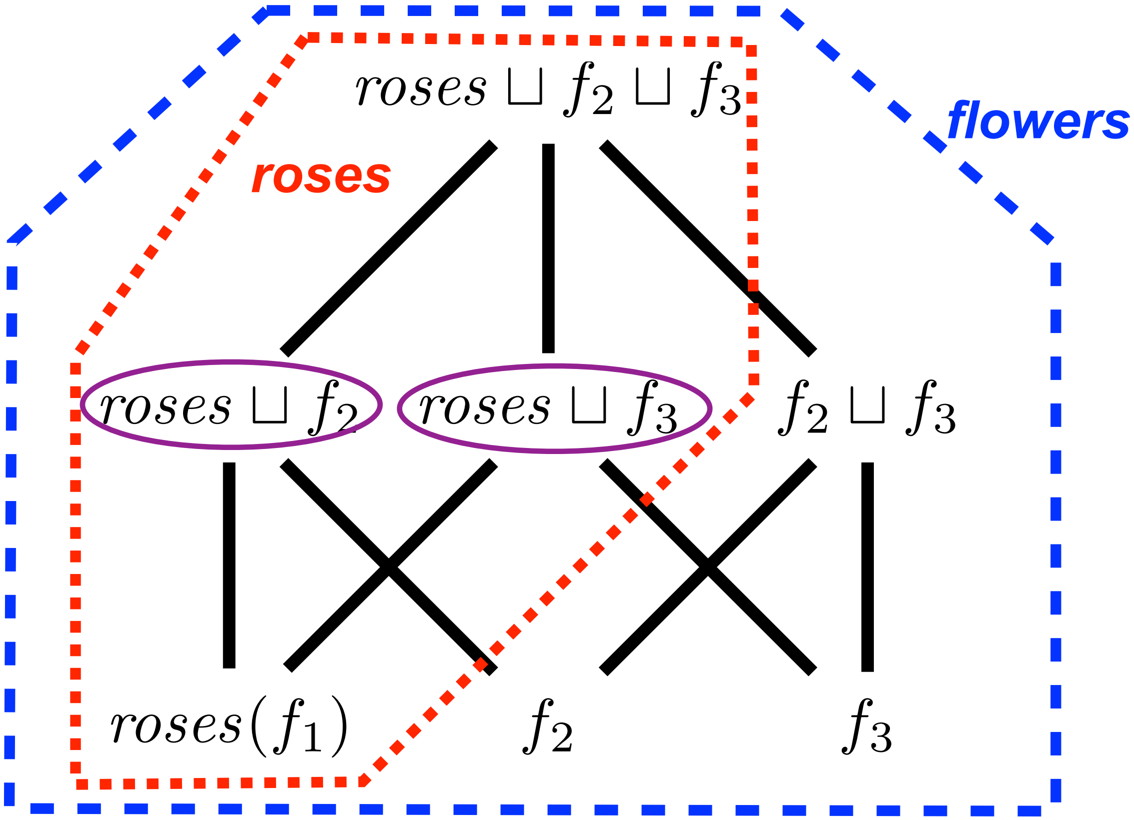

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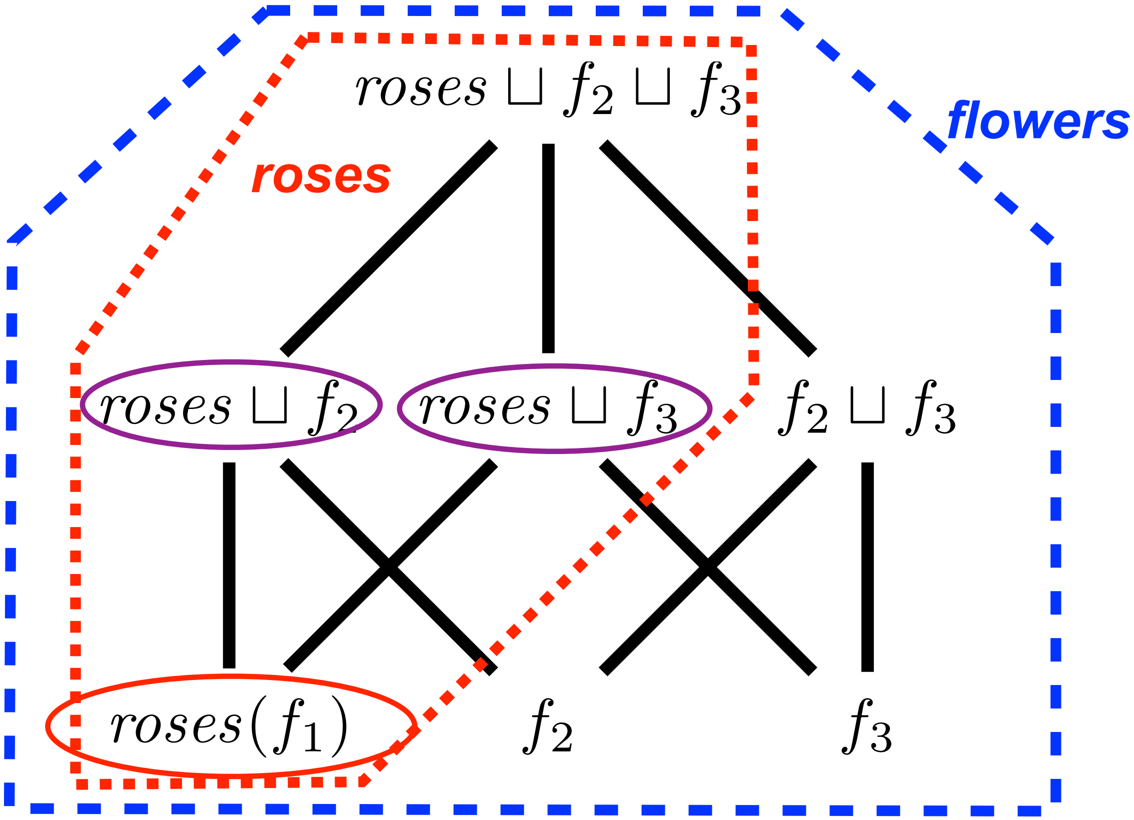

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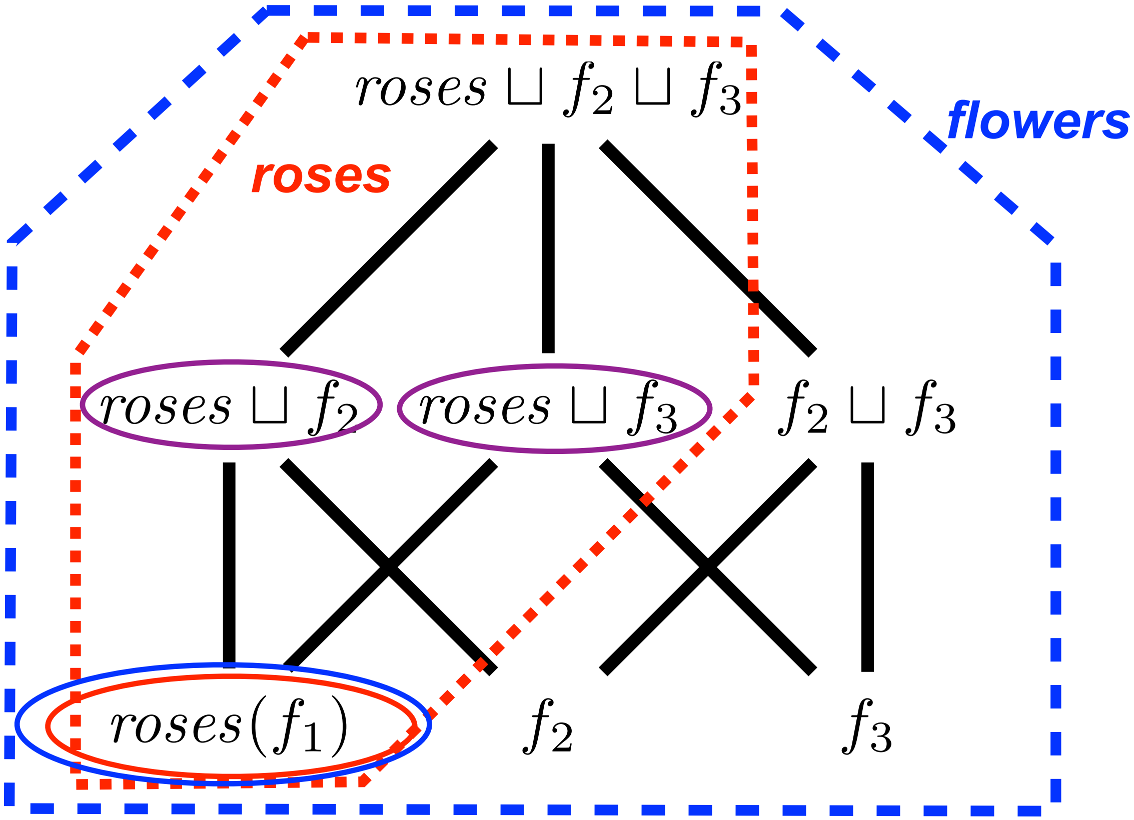

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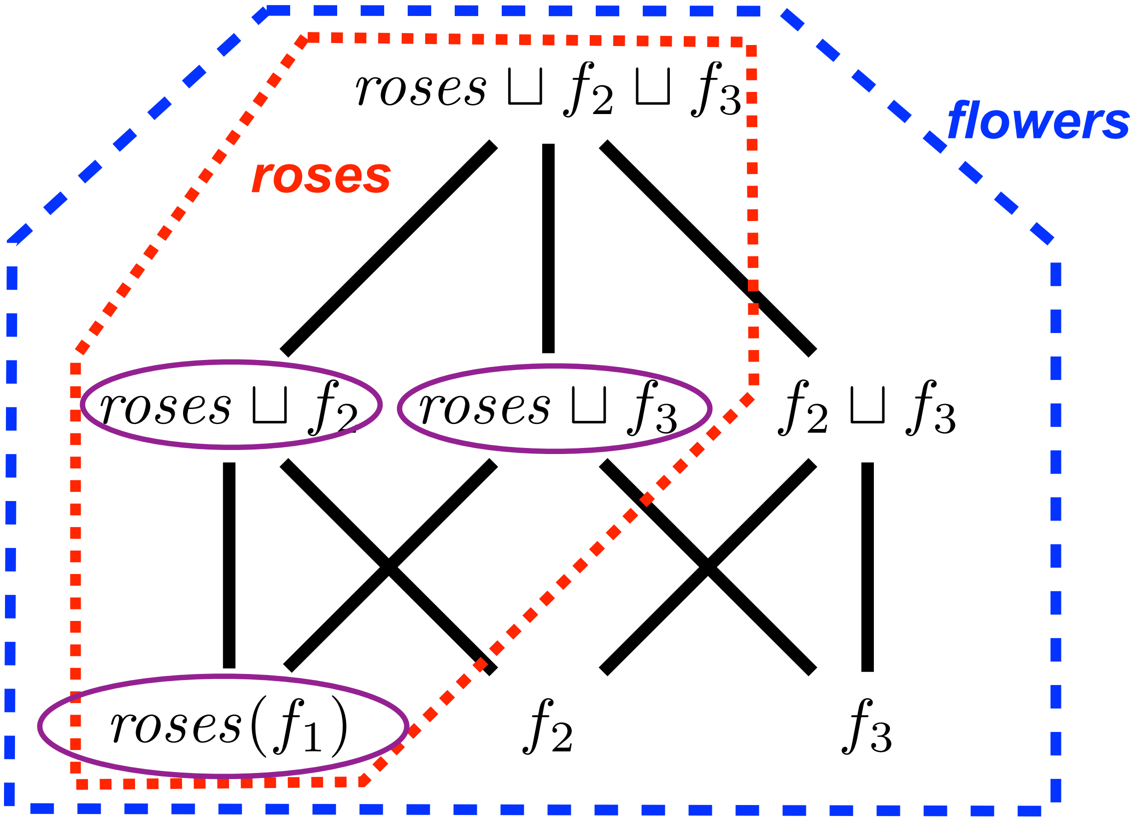

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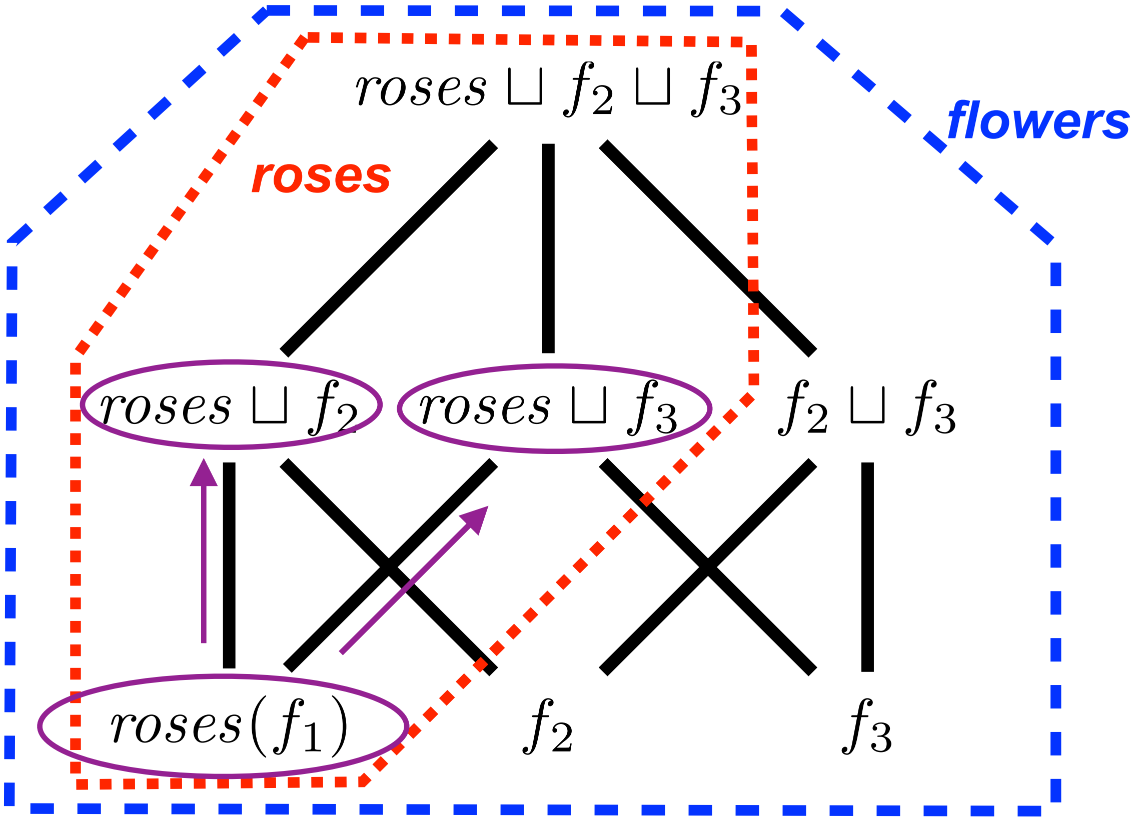

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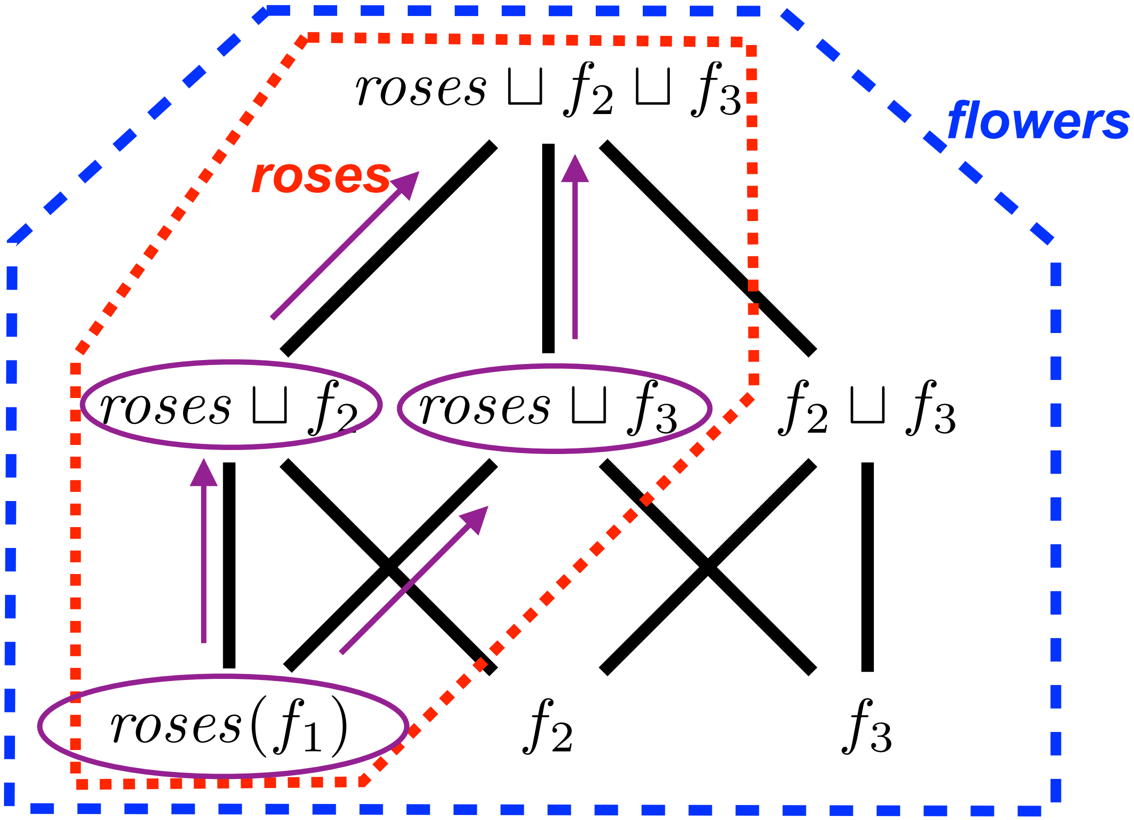

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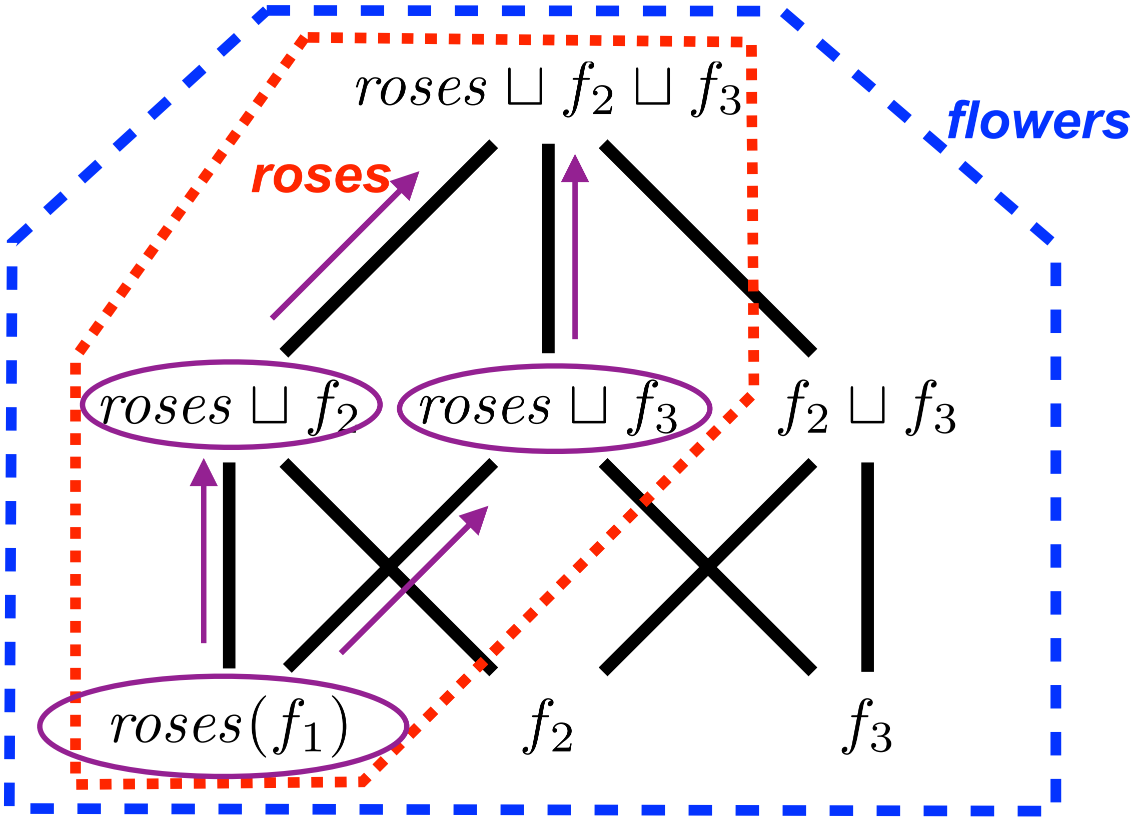

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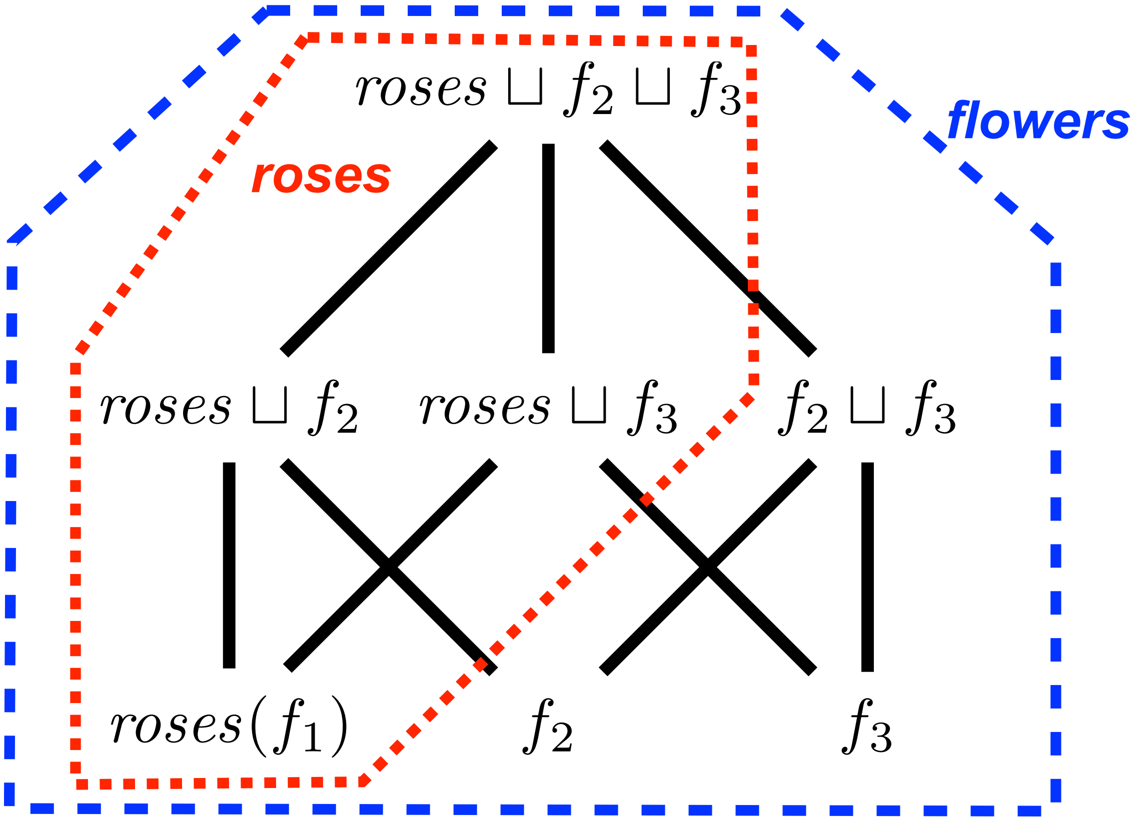

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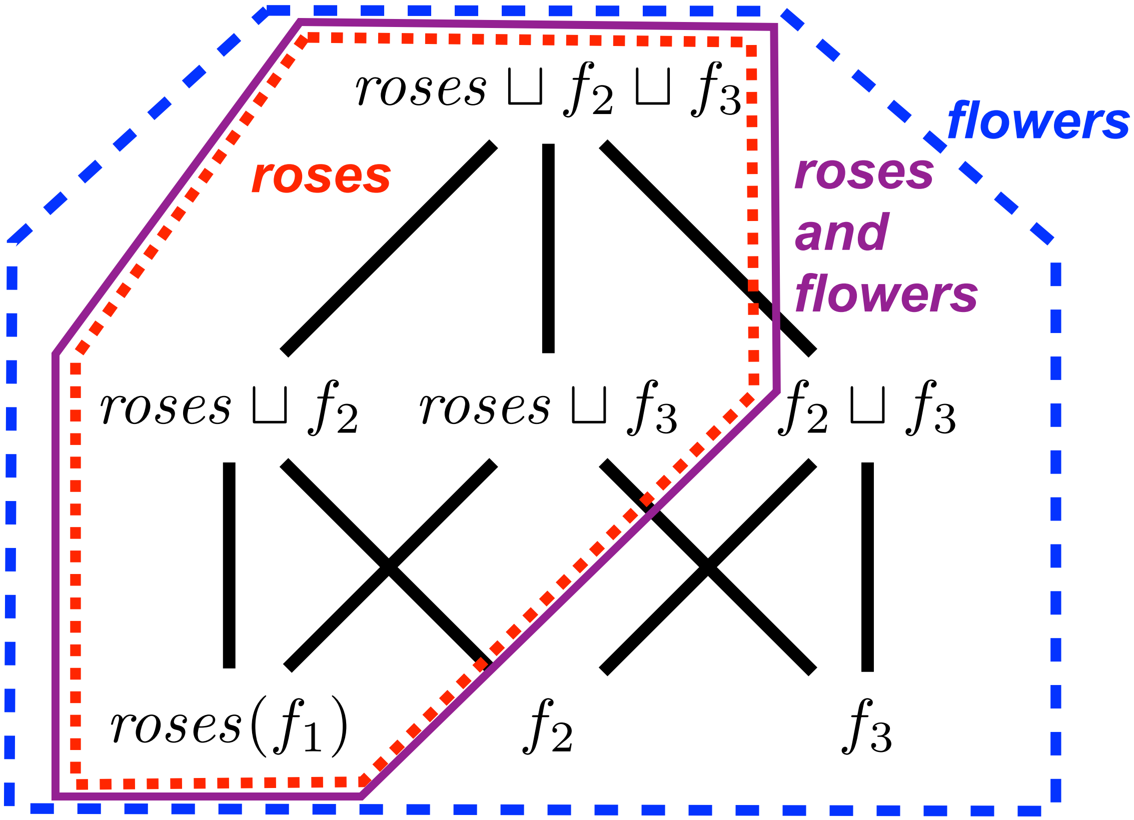

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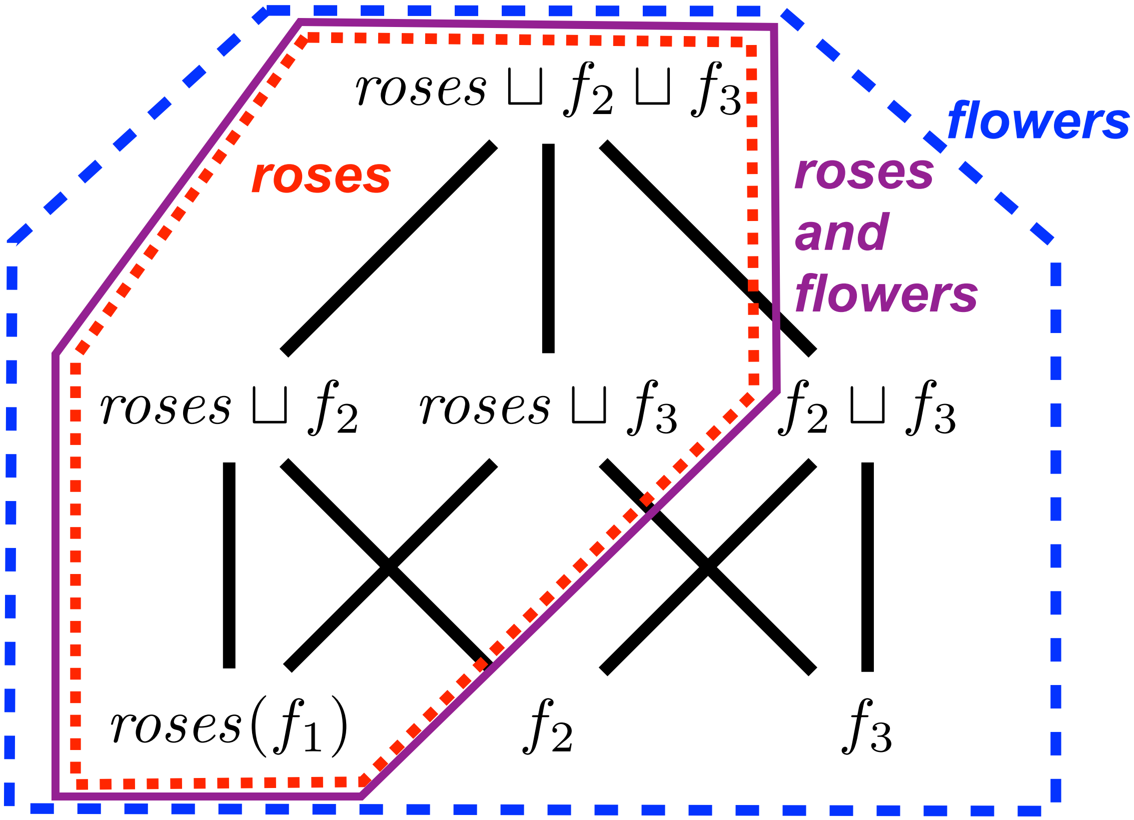

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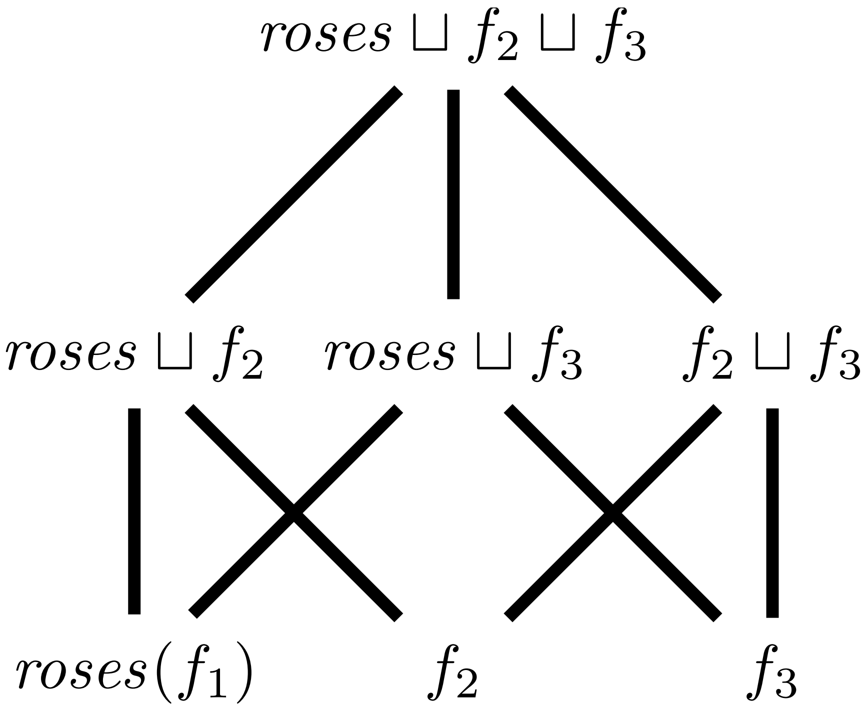
We sell ***roses****.*

We sell ***flowers****.*

We sell ***roses and flowers****.*

The literal semantics of ***roses and flowers*** *should be the same as that of* ***roses****!*

The semantic puzzle



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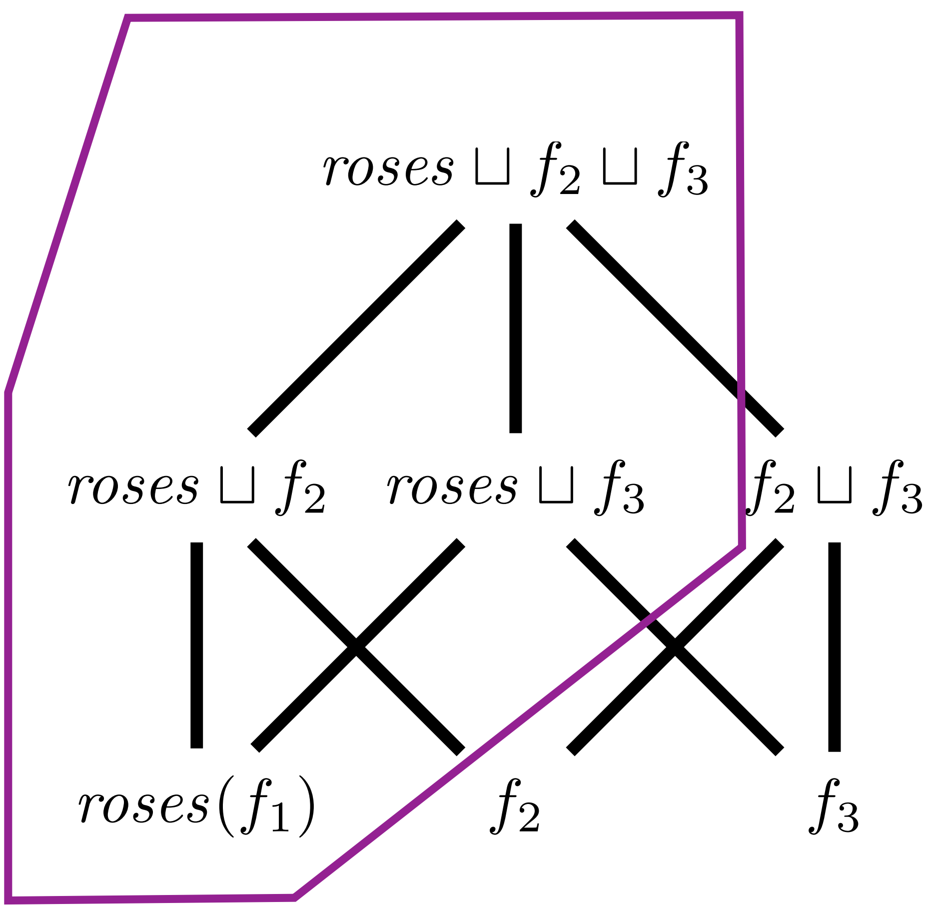
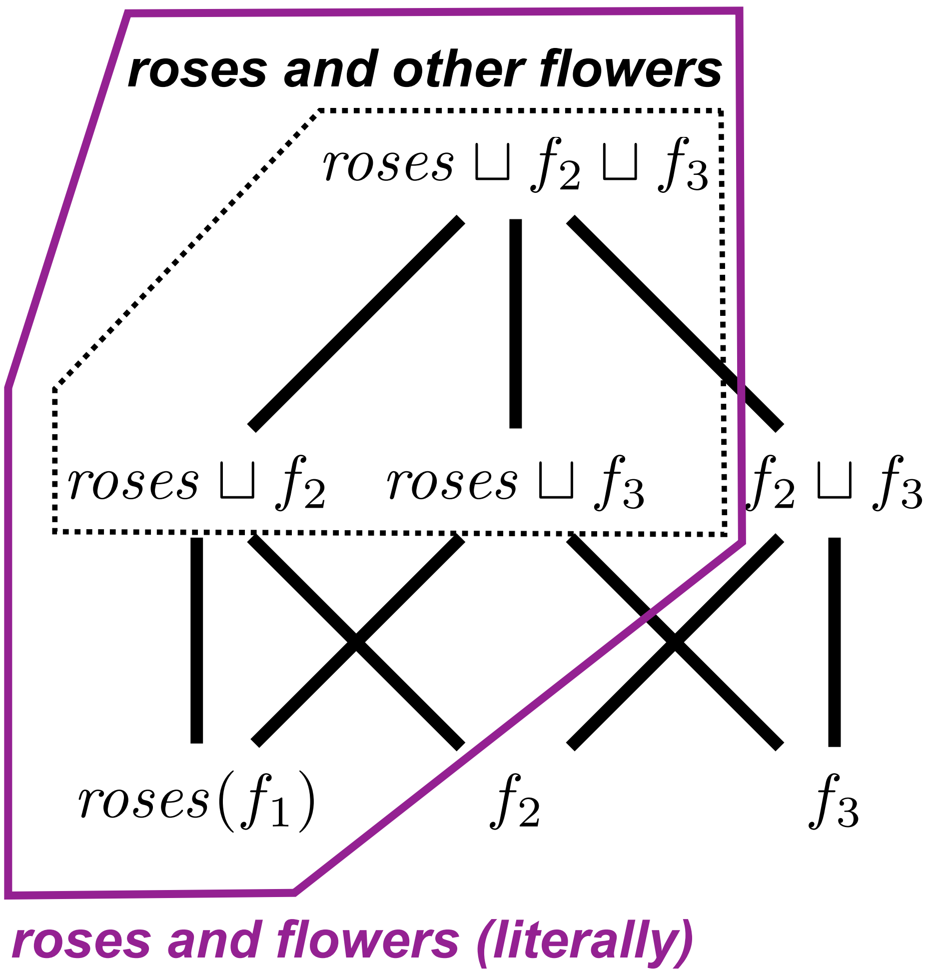


roses and flowers (literally)

The semantic puzzle



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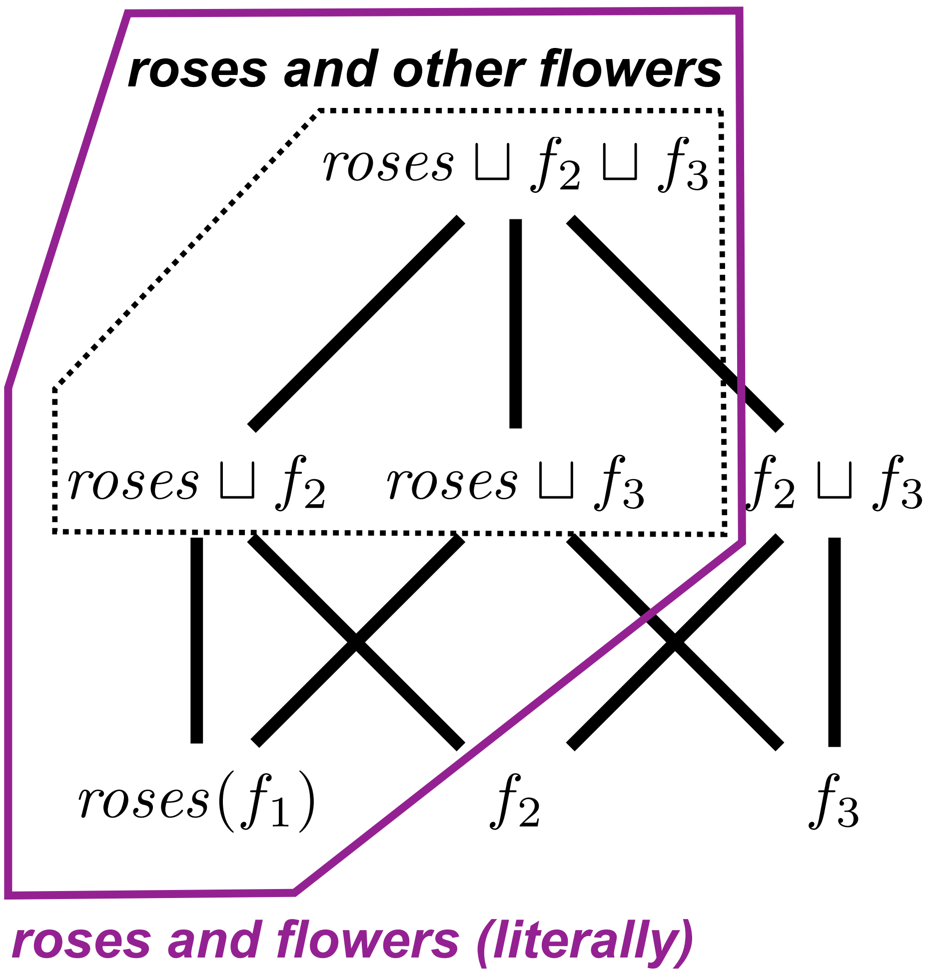

- *roses and flowers* is interpreted to commit the speaker to *more* than its literal meaning

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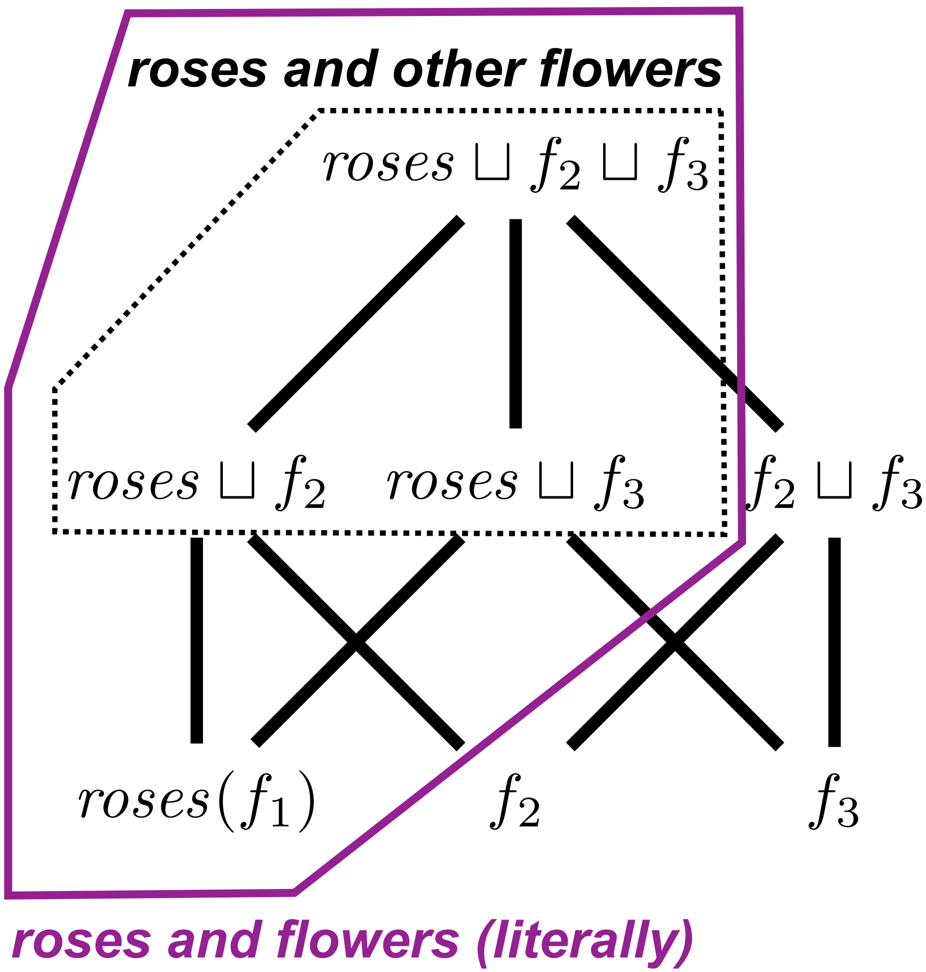

- *roses and flowers* is interpreted to commit the speaker to *more* than its literal meaning
- **Where does this interpretation come from?**

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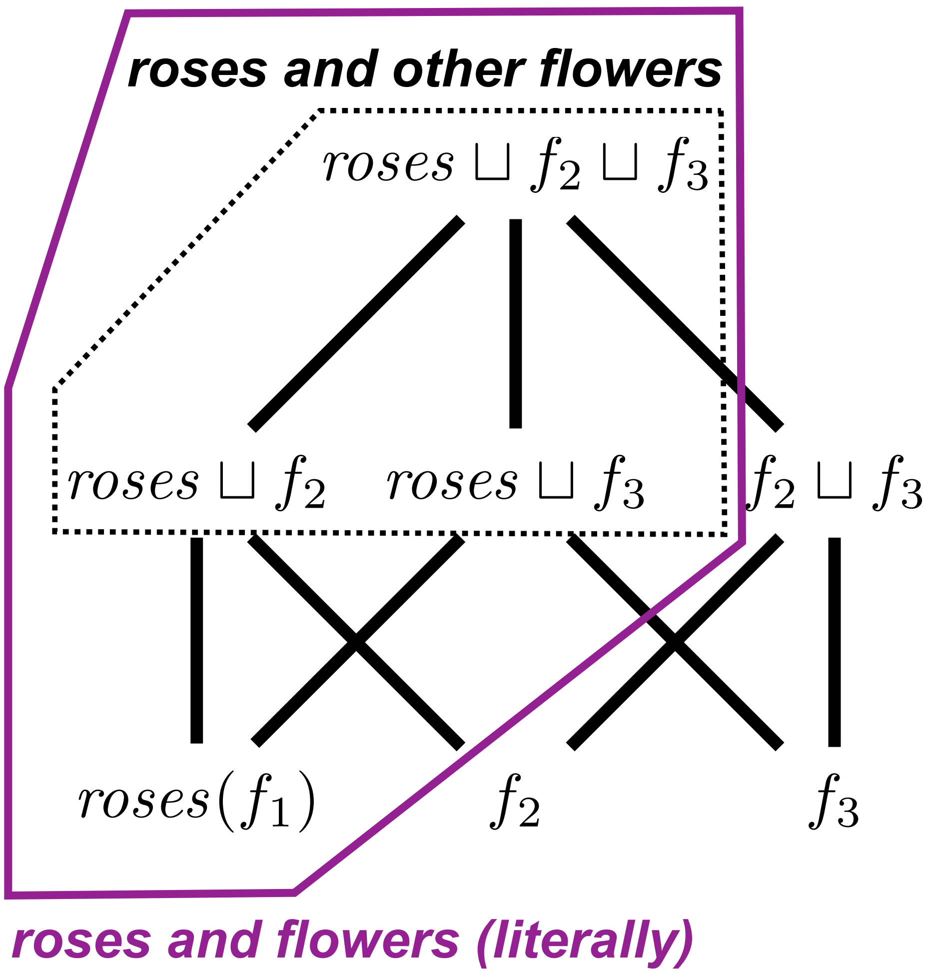

- *roses and flowers* is interpreted to commit the speaker to *more* than its literal meaning
- **Where does this interpretation come from?**
- Approach pursued here: **it is a conversational implicature**

Conversational implicature

- Inference in context by which an utterance communicates more than what is literally said
- Driven by world knowledge and by alternative utterances —*what could have been said*
- Two major cases:
  - Quantity (Q-)implicature: the negation of an alternative utterance with a stronger meaning is inferred

    (I ate all of the apples)
  - Informativity (I-)implicature: reasoning to the typical case (Levinson 2000)

Conversational implicature

UCSD

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    (I ate all of the apples)

  - Informativity (I-)implicature: reasoning to the typical case (Levinson 2000)

    The cup is on the table→The cup is ***in contact with*** *the table*

The theoretical challenge and intuition

roses and other flowers

roses and flowers *flowers*

What provides the division of these alternatives' pragmatic labor (Horn, 1984)?

roses

The theoretical challenge and intuition

R: the *roses* flower type **OF**: any other flower type

roses and other flowers

roses and flowers *flowers*

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- Alternative utterance set, and challenges:

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  - So I'll interpret roses and flowers as a shortened form that means **R⊔OF**.

The theoretical challenge and intuition

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Why no quantity implicature?

roses and flowers *flowers*

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Rational Speech Act Theory

Assumptions:

- Speaker and listener beliefs represented as probability distributions over world states
- Joint communicative goal:
  - align the listener's beliefs with those of the speaker
  - but maintain brevity while doing so!
- Grammar and the literal meanings of words are common knowledge between speaker and listener
- Speaker and listener can recursively reason (probabilistically) about each other

(Frank & Goodman, 2012; Goodman & Stühlmuller, 2013; see also Jäger, 2012)

Q-implicature in rational speech-act theory

I ate some of the apples→I didn't eat all of the apples

$$P^{(0)}_{Listener}(m|u,\mathcal{L}) \propto \mathcal{L}(m,u)P(m)$$

$$P^{(n)}_{Speaker}(u|m) \propto \left[P^{(n-1)}_{Listener}(m|u)e^{-c(u)}\right]^{\lambda}$$

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Utterance

"Literal" lexicon

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I ate some of the apples→I didn't eat all of the apples

World state

Utterance

"Literal" lexicon

0/1 filter function

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(Jäger, 2012; Frank & Goodman, 2012; Goodman & Stühlmuller, 2013)

Q-implicature in rational speech-act theory

I ate some of the apples→I didn't eat all of the apples

World state

Utterance

"Literal" lexicon

0/1 filter function

Prior expectations about world state

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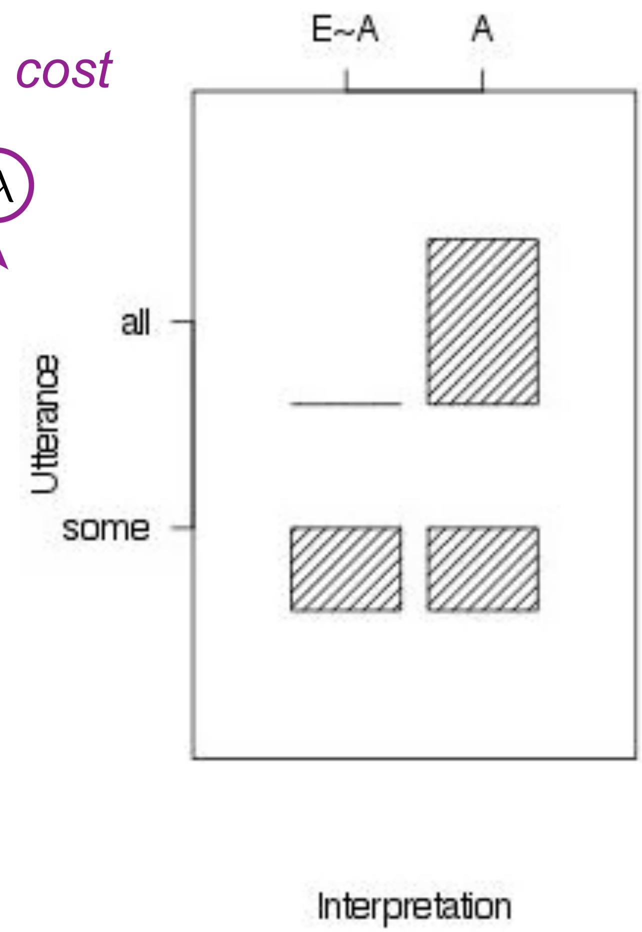

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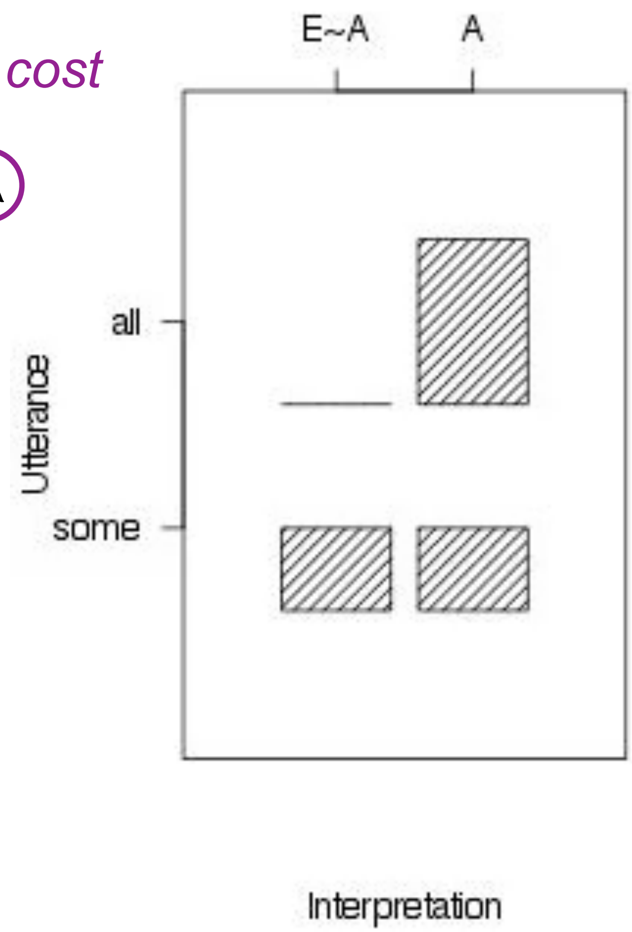

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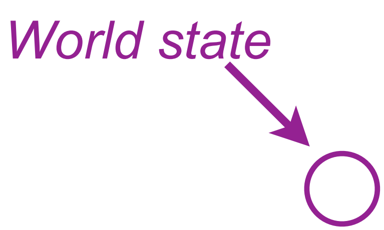

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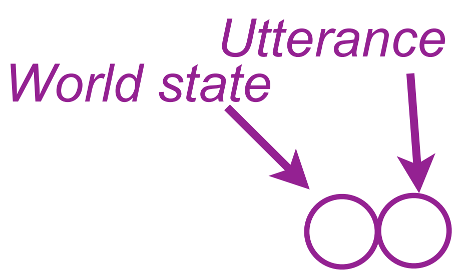

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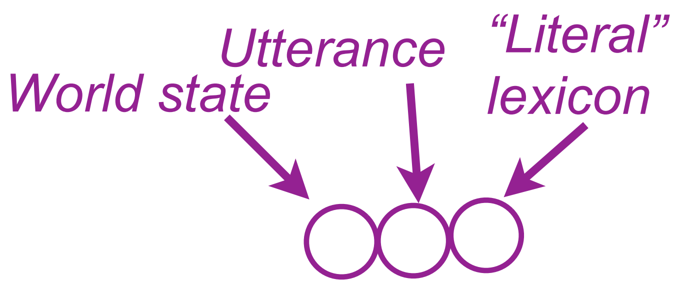

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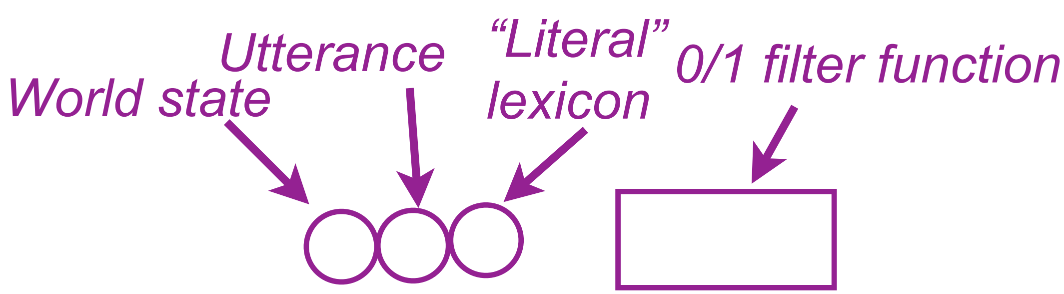

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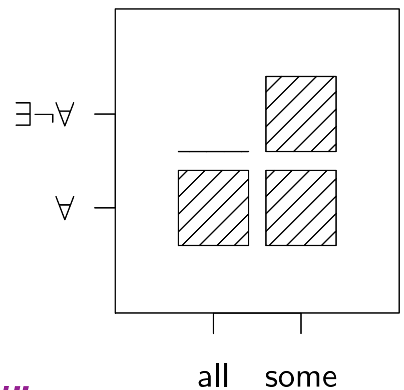

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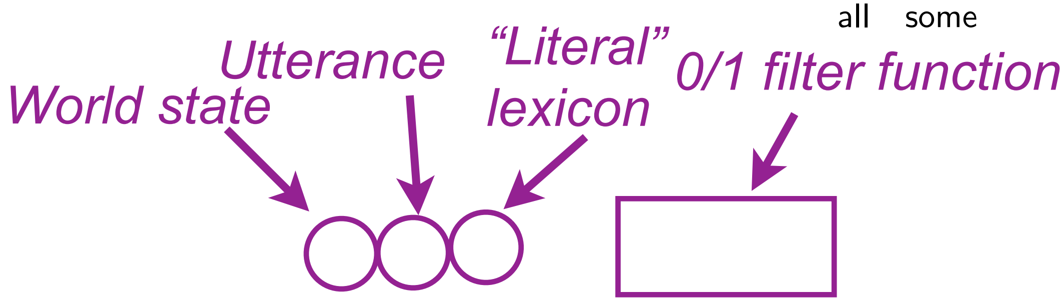

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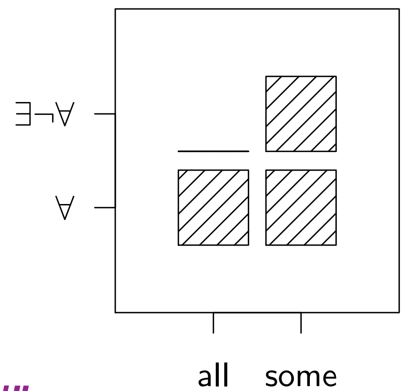

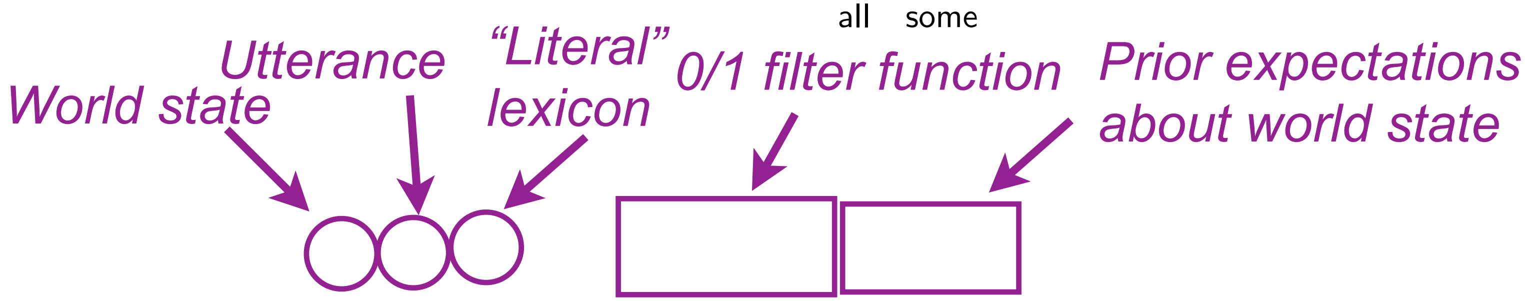

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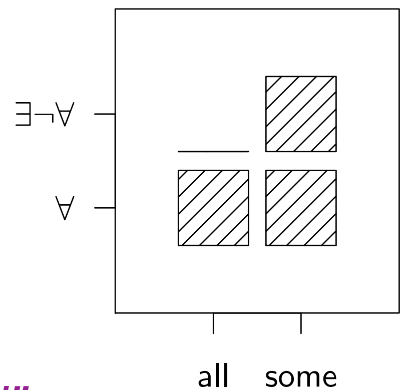
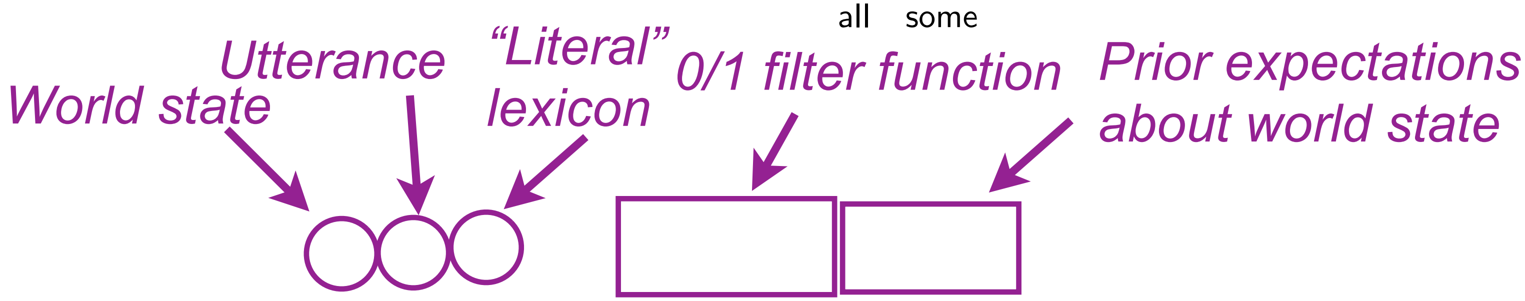


$$P(\forall) = P(\exists\neg\forall) = \frac{1}{2}$$



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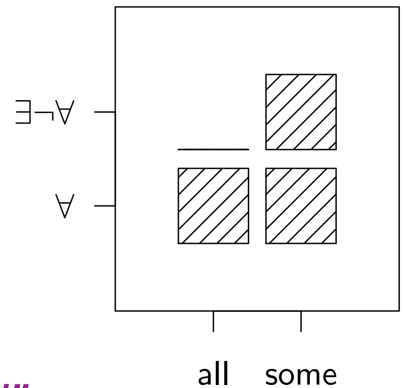

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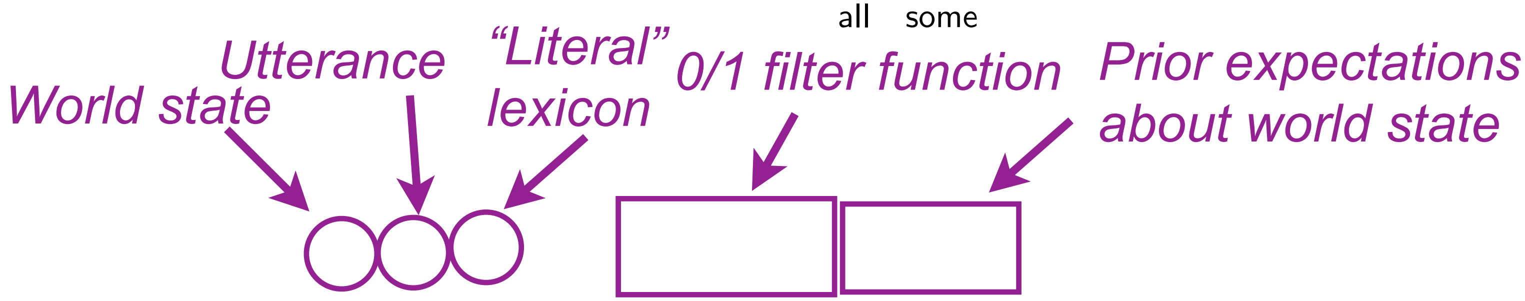

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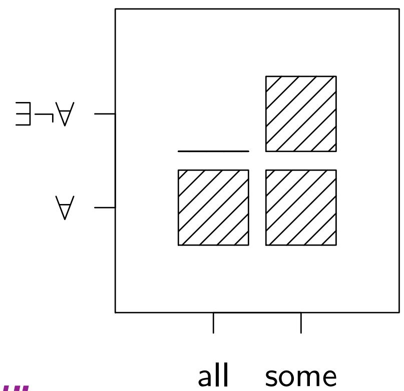

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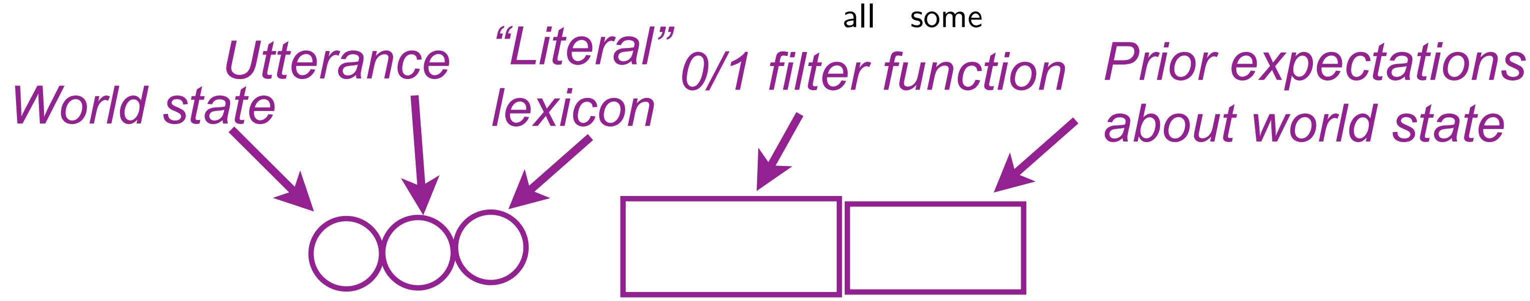

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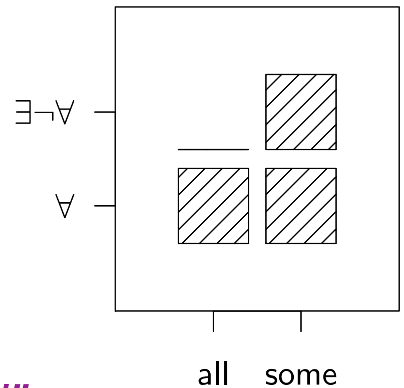

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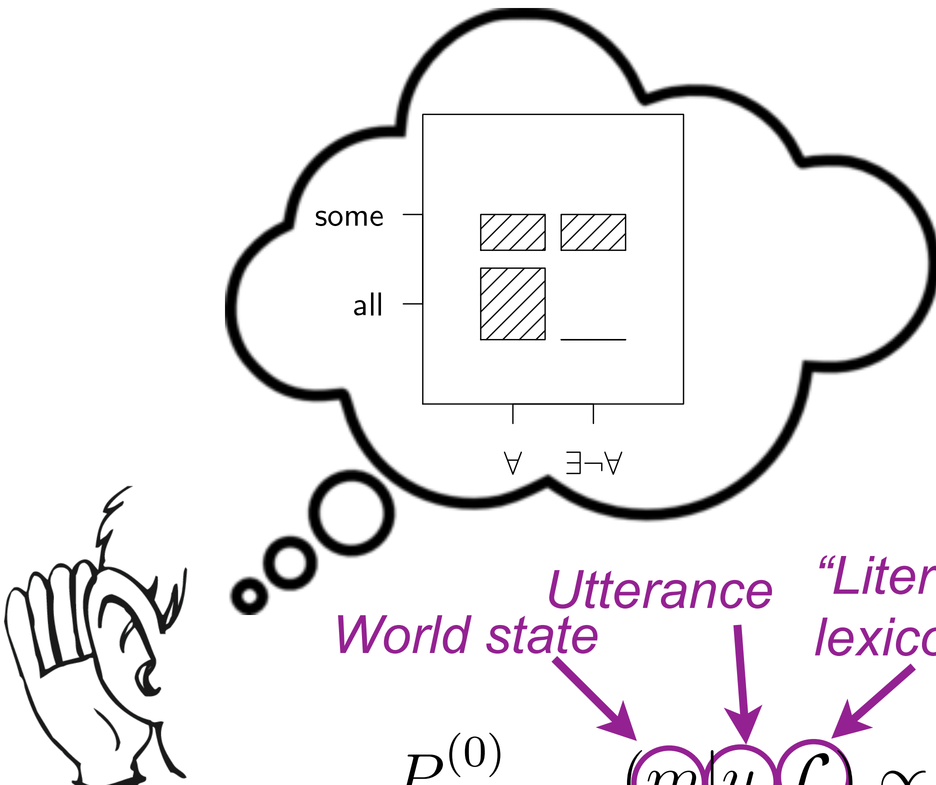

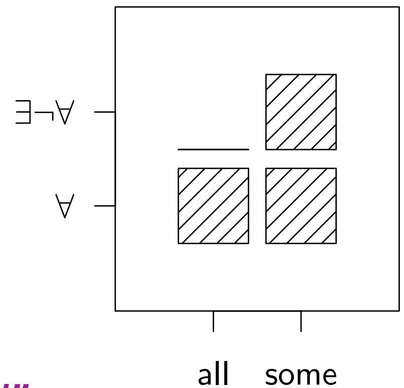

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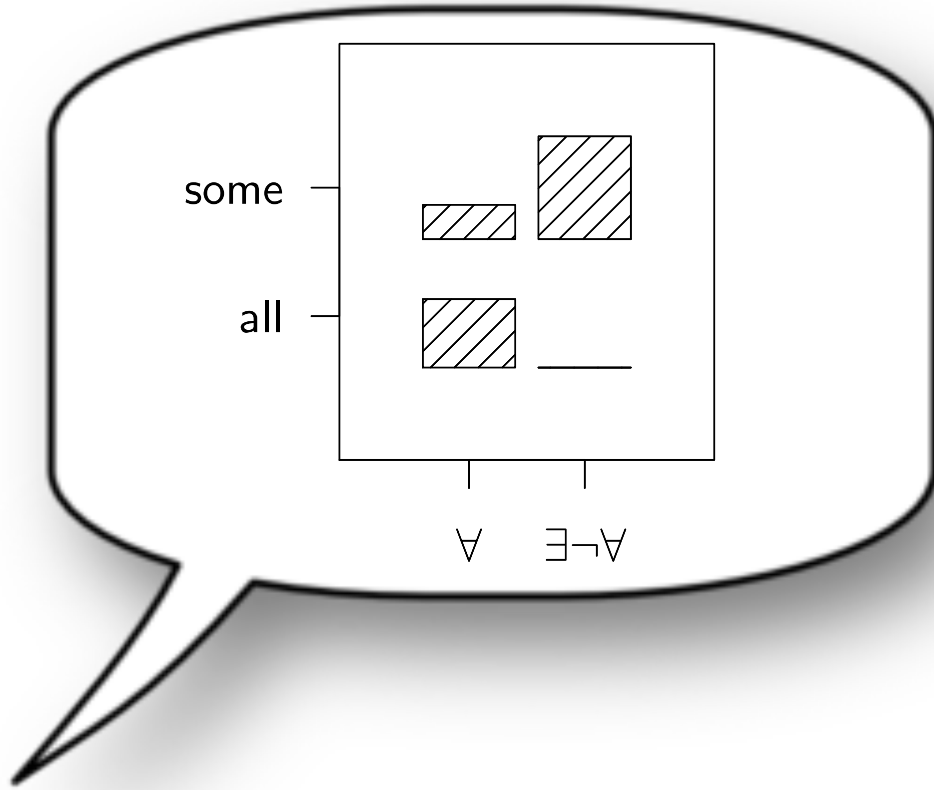
Speaking in RSA



$$c(\text{some}) = c(\text{all}) = 0$$

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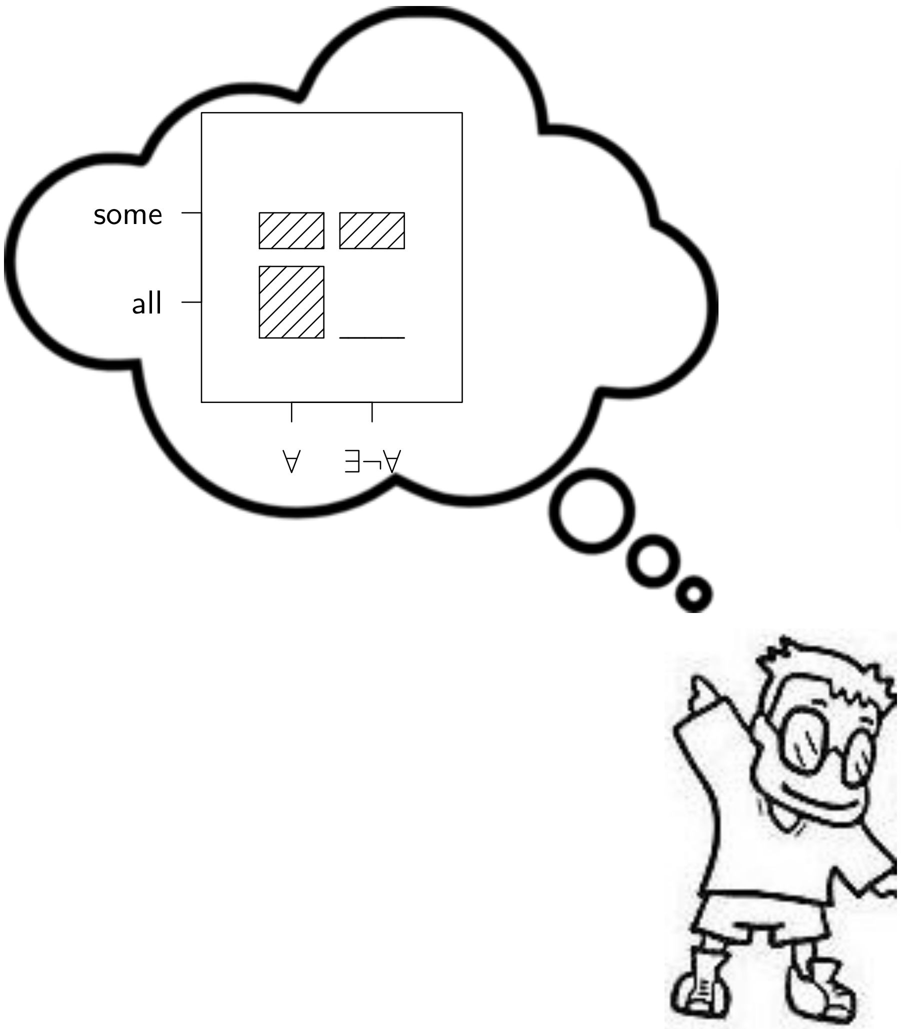

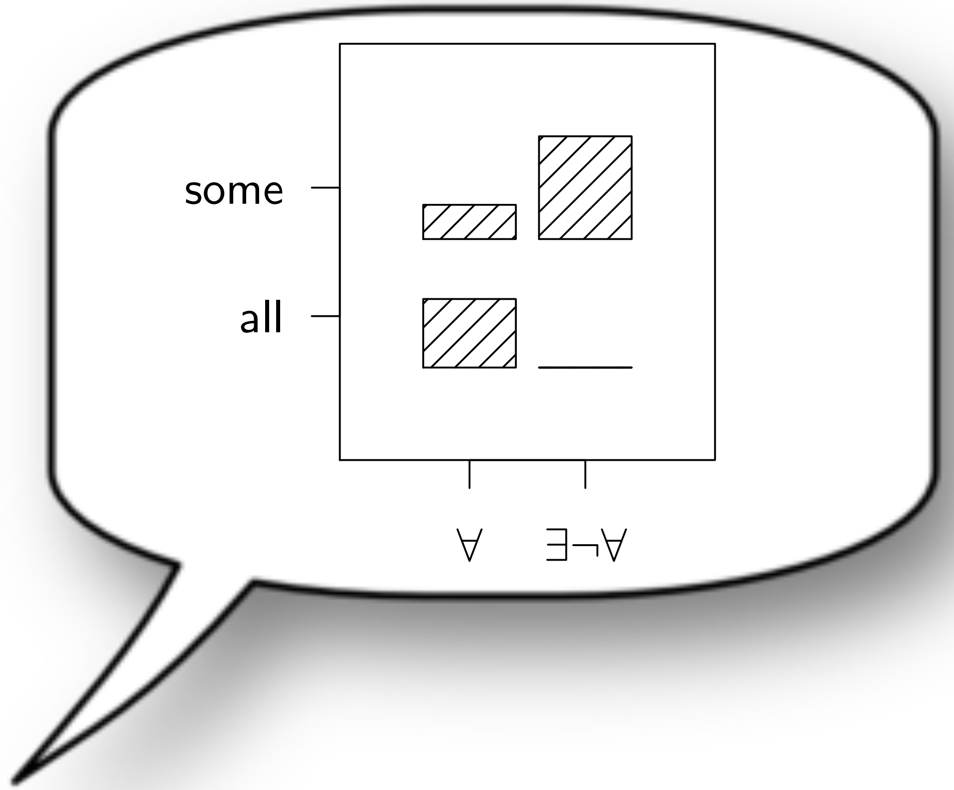

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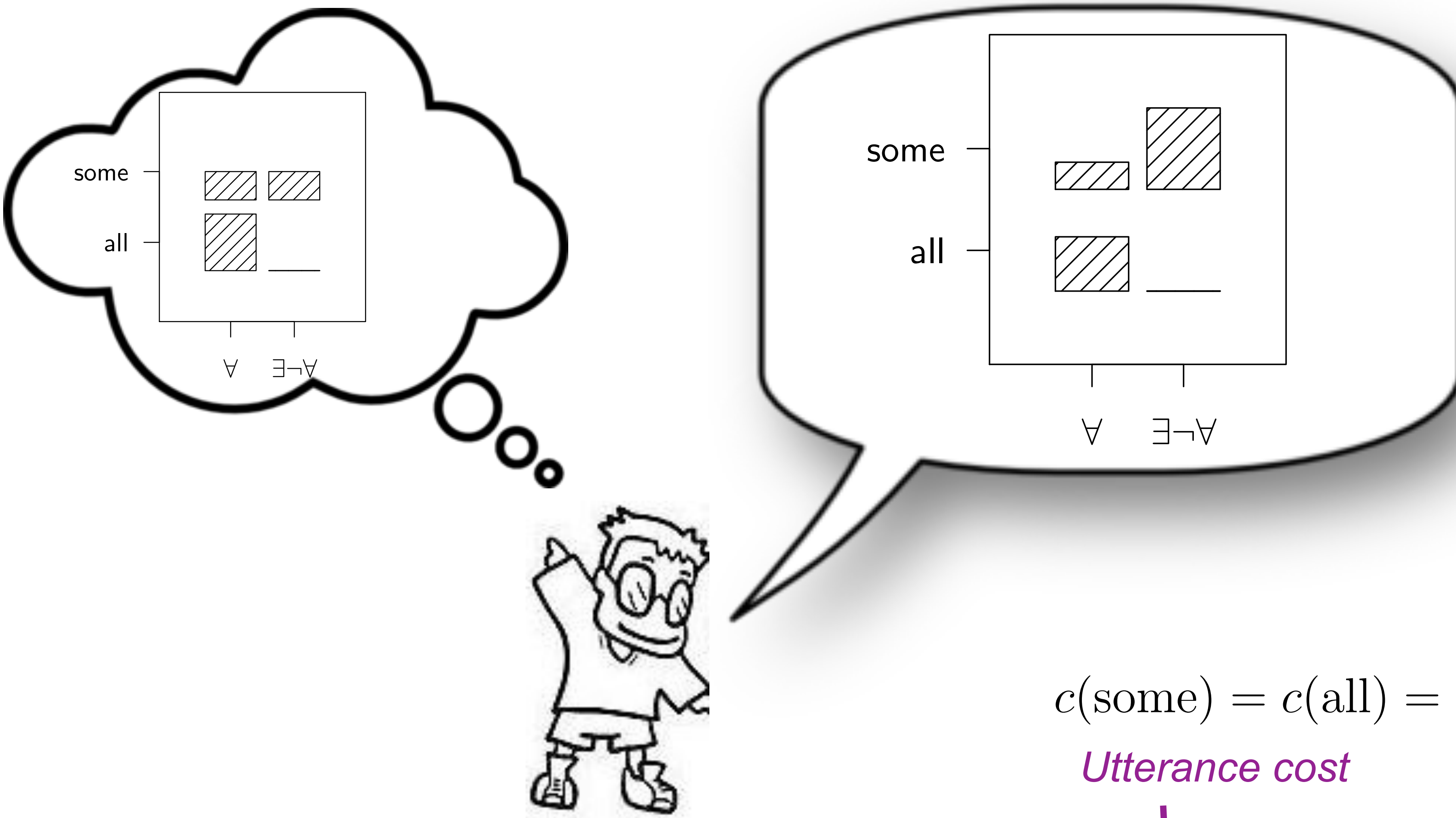

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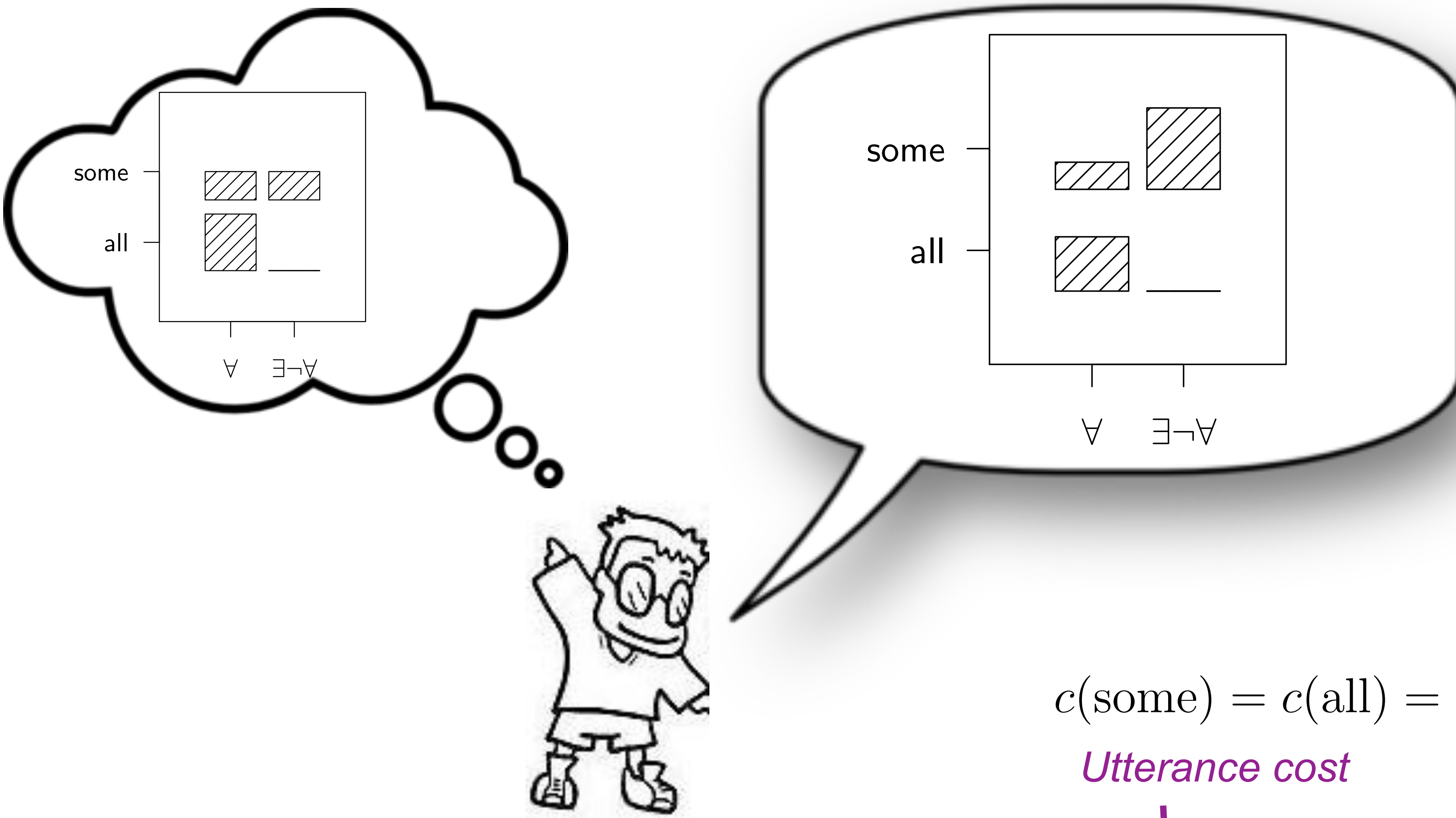

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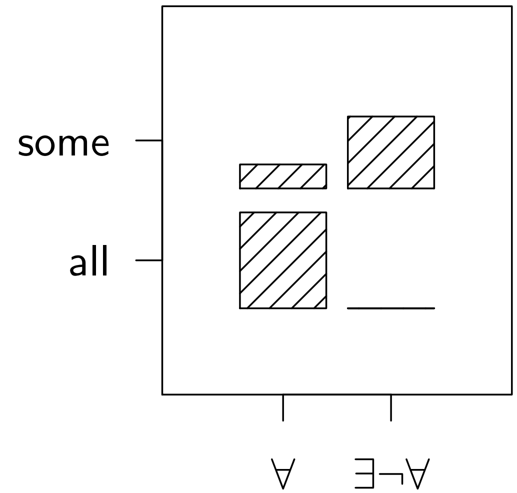
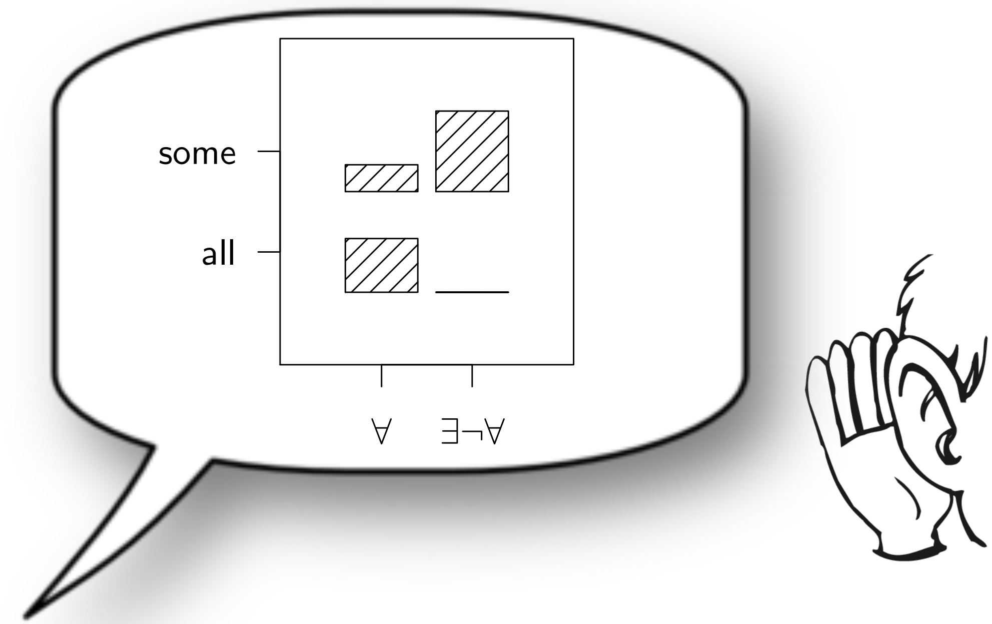
"Greedy optimality" parameter

The pragmatic listener





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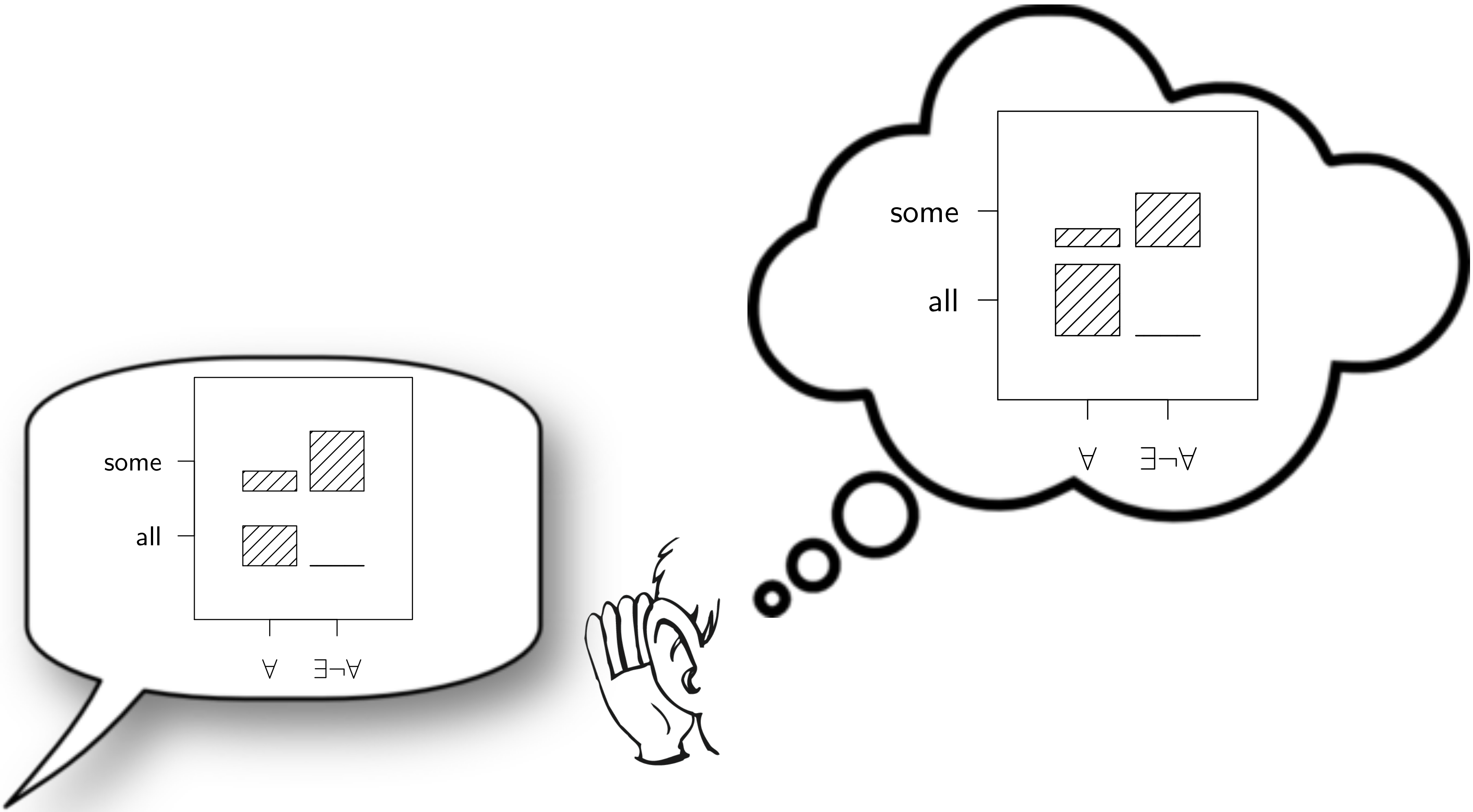

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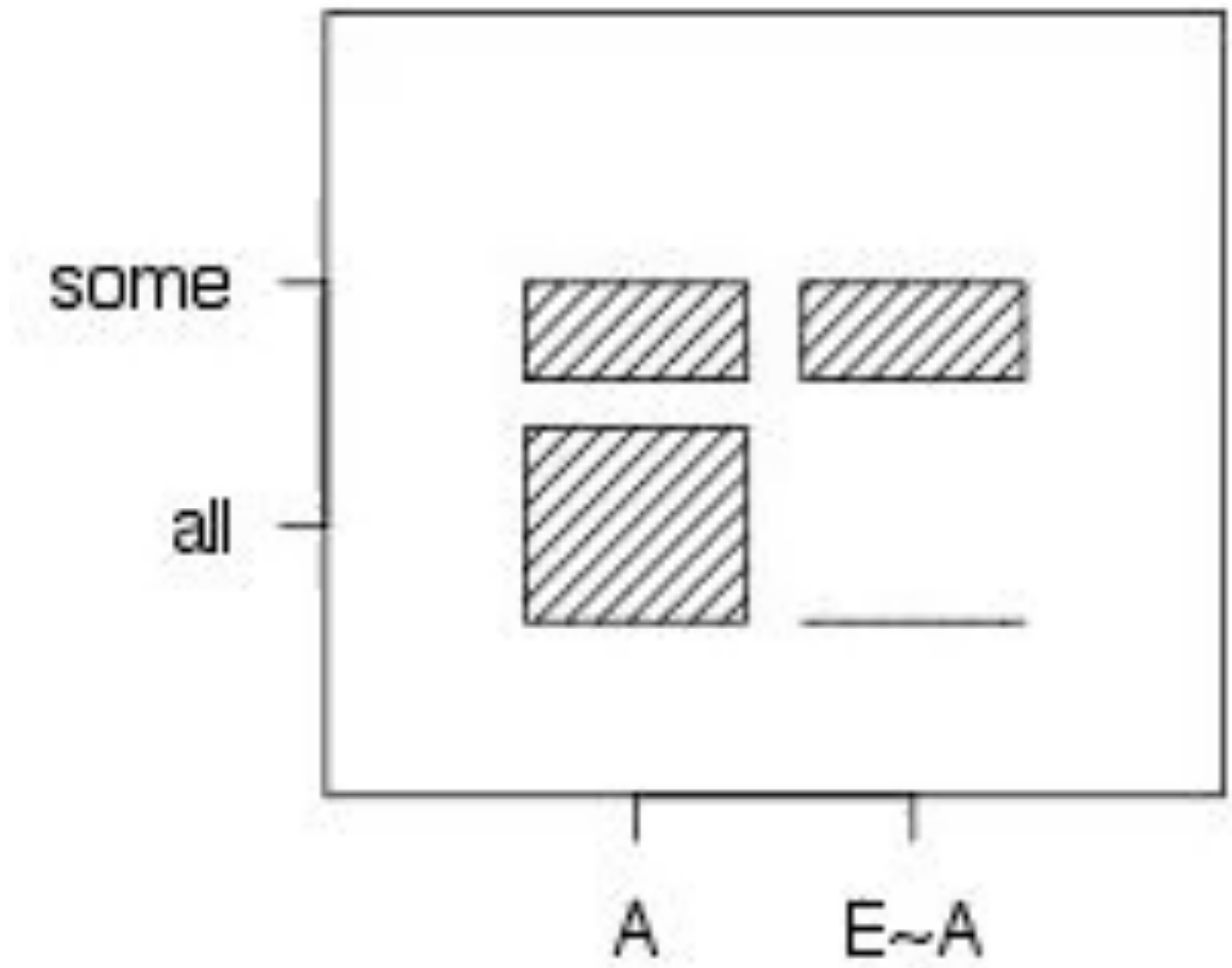
Speaker—listener recursion

- The process of recursion strengthens the implicature



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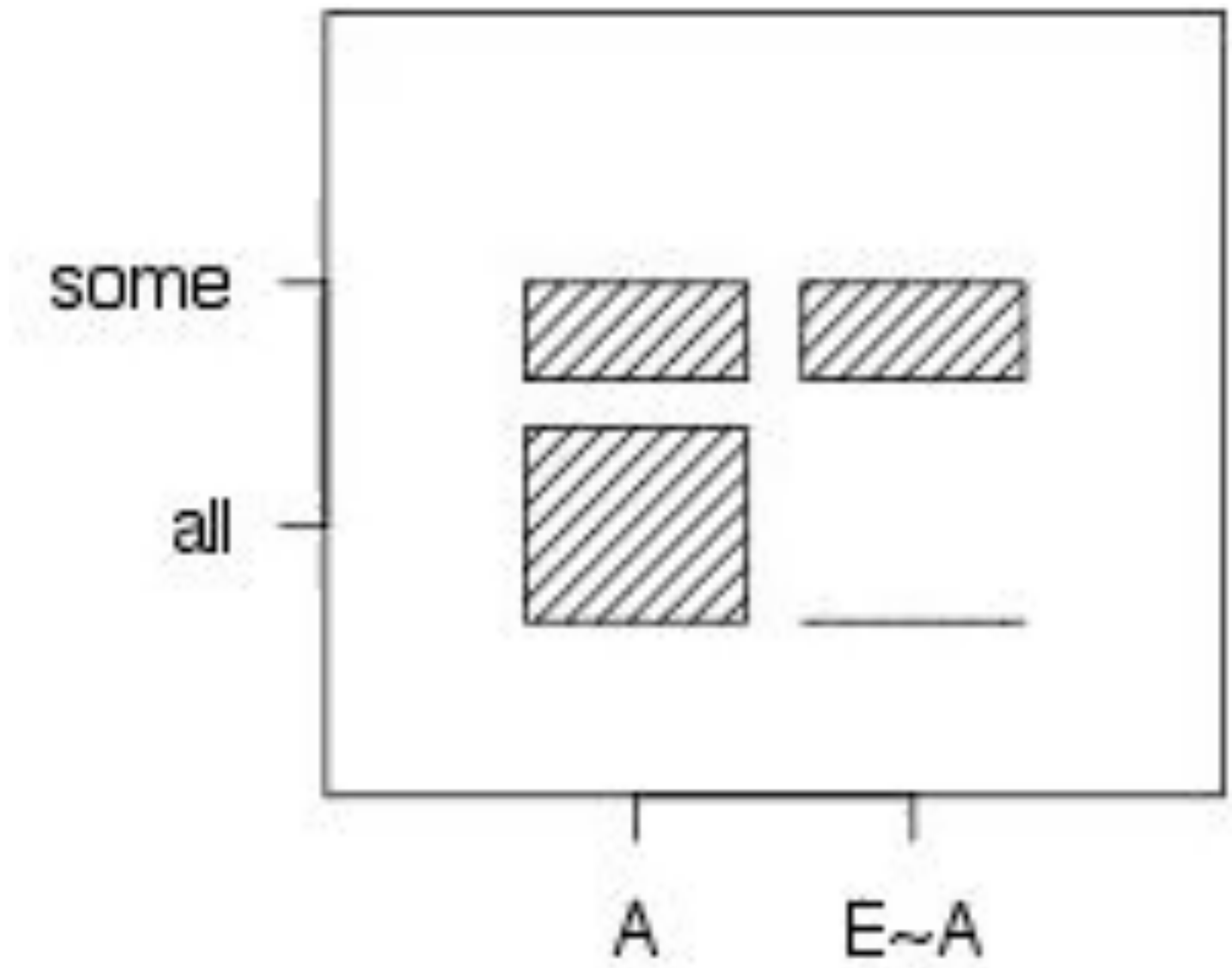


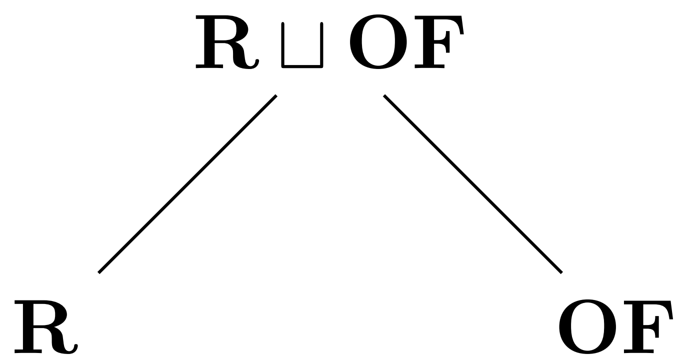
Other successes of RSA theory

- Basic Rational Speech Act theory's virtues:
  - Quantitative fit to human interpretations in simple communication games (Frank & Goodman, 2012)
  - Accounts for effect of speaker knowledgeability of world state on implicature (Goodman & Stühlmuller, 2013)
- More advanced variants can account for:
  - Simple cases of Horn's division of pragmatic labor (Bergen, Goodman, & Levy, 2012)
  - Vagueness and context-sensitivity of relative adjectives (Lassiter & Goodman, 2013)
  - Disjunctive expressions (Bergen, Levy, & Goodman, unpublished*)

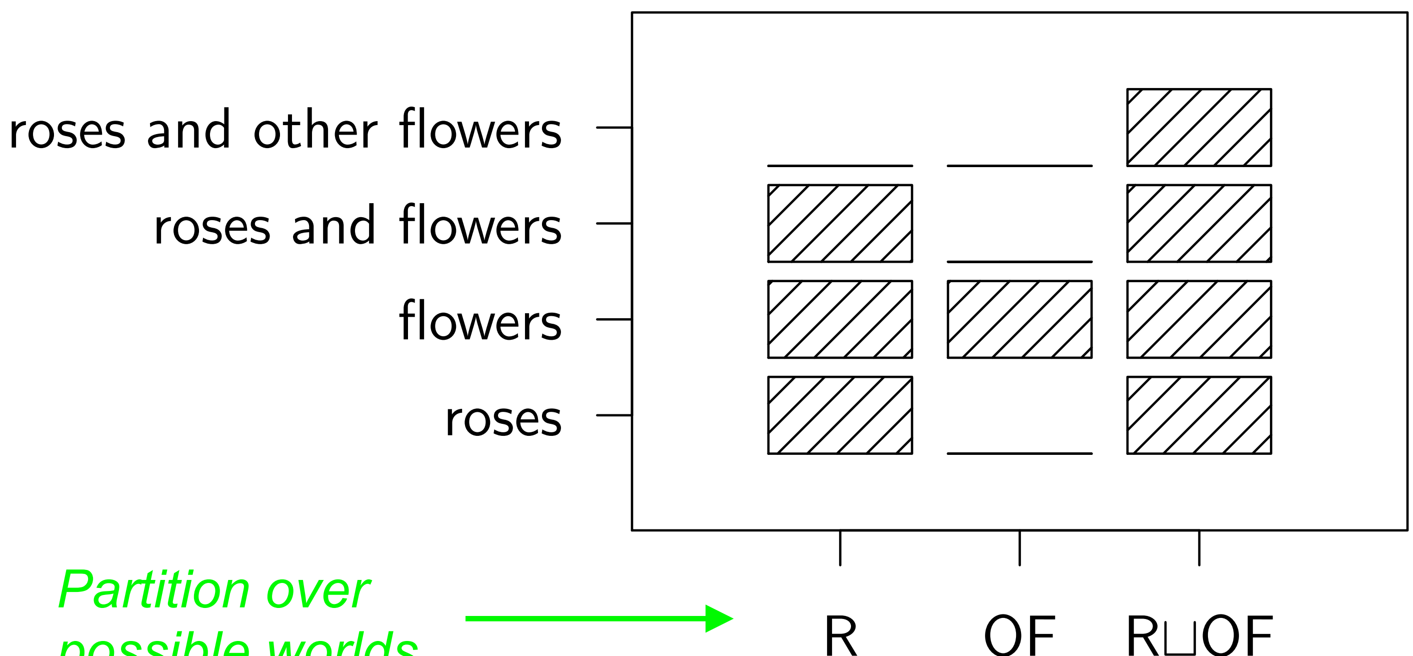
**Draft now available online!*

Basic RSA for *roses and flowers*

- We'll simplify to two flower "types":



- The corresponding lexicon:



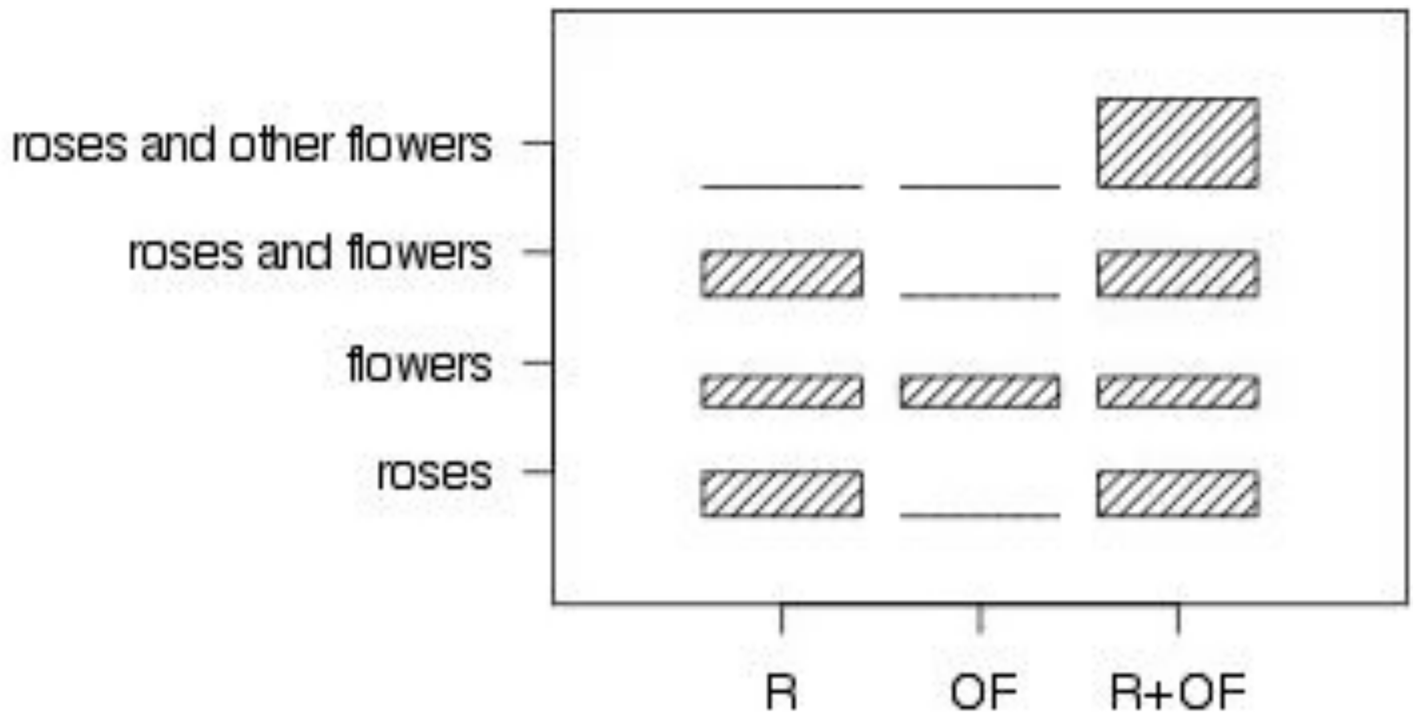
Partition over possible worlds

Basic RSA for *roses and flowers*

- Basic RSA is unable to break the symmetry between *roses* and *roses and flowers* in the lexicon

$$P(R) = \frac{1}{3}$$
$$P(OF) = \frac{1}{3}$$
$$P(R \sqcup OF) = \frac{1}{3}$$

$$c(\text{roses}) = c(\text{flowers}) = 0$$
$$c(\text{roses and flowers}) = 0.1$$
$$c(\text{roses and other flowers}) = 0.15$$



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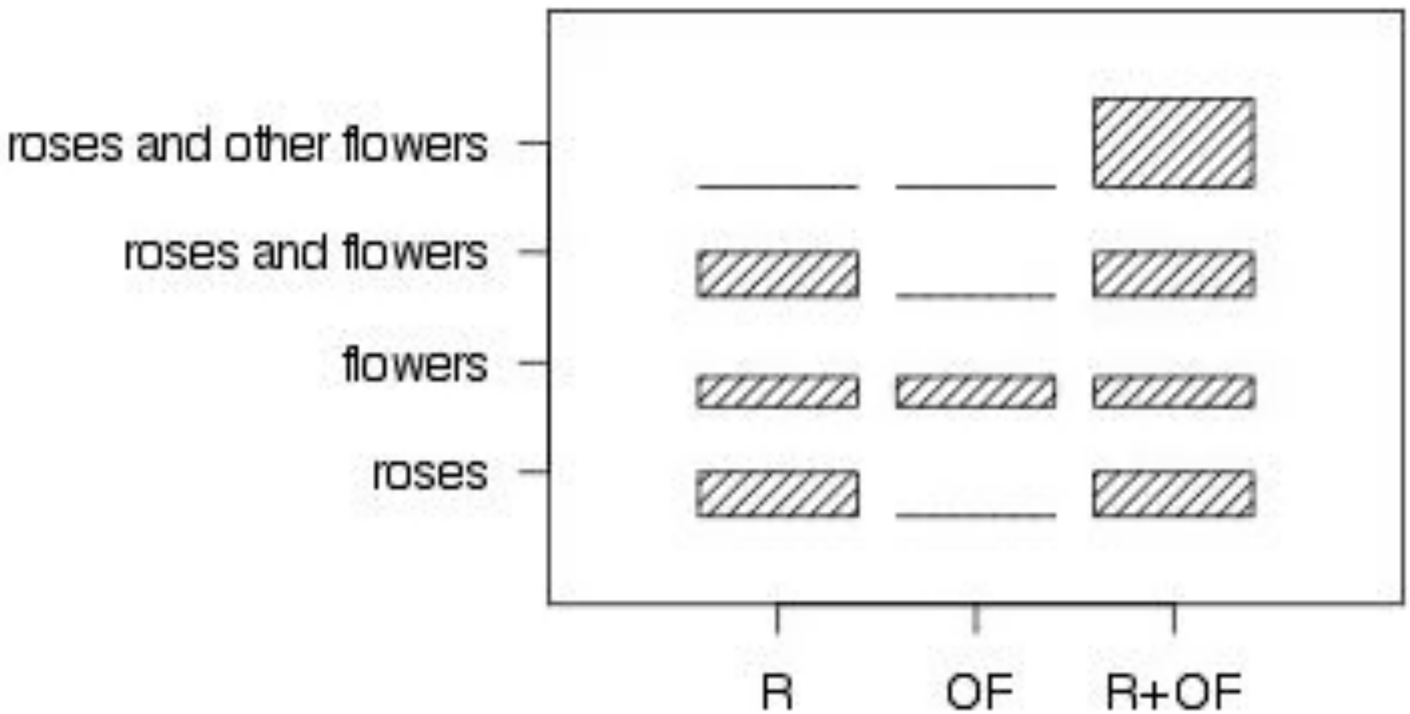

Refined word meanings and compositionality

- But we can extend the formalism in two respects:
  - Allow a distinction between a word's *literal meaning* from its *context-specific refined meaning*

  - Require that a word's context-specific refined meaning is preserved through semantic composition
- Bergen, Levy, and Goodman (unpublished) call this COMPOSITIONAL LEXICAL UNCERTAINTY

RSA with lexical uncertainty

$$
\begin{aligned}
P^{(0)}_{Listener}(m|u,\mathcal{L}) &\propto \mathcal{L}_u(m)P(m) \\
P^{(1)}_{Speaker}(u|m,\mathcal{L}) &\propto \left[P^{(0)}_{Listener}(m|u,\mathcal{L})e^{-c(u)}\right]^{\lambda} \\
P^{(1)}_{Listener}(m|u) &\propto P(m)\sum_{\mathcal{L}} P(\mathcal{L})P^{(1)}_{Speaker}(u|m,\mathcal{L}) \\
P^{(n)}_{Speaker}(m|u) &\propto \left[P^{(n-1)}_{Listener}(m|u)e^{-c(u)}\right]^{\lambda} && n>1 \\
P^{(n)}_{Listener}(m|u) &\propto P(m)P^{(1)}_{Speaker}(u|m) && n>1
\end{aligned}
$$

(Bergen, Goodman, and Levy 2012)

RSA with lexical uncertainty

Speaker considers literal listener behavior for each set of possible lexical refinements

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(Bergen, Goodman, and Levy 2012)

RSA with lexical uncertainty

Speaker considers literal listener behavior for each set of possible lexical refinements

Pragmatic listener marginalizes over possible lexical refinements

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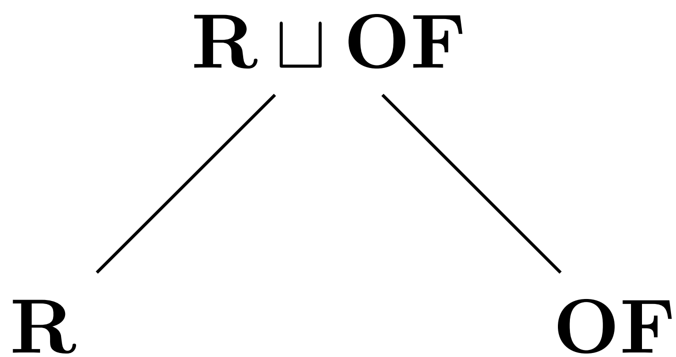
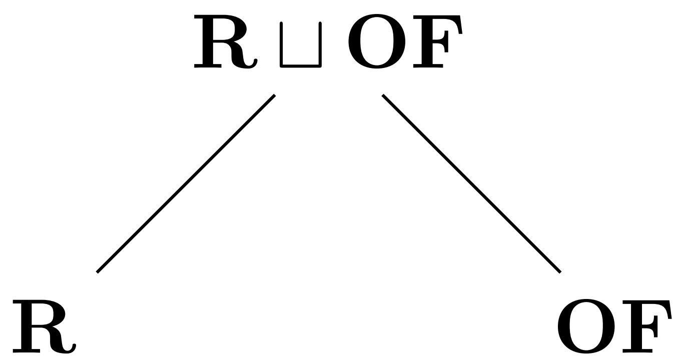
Compositional lexical uncertainty



Compositional lexical uncertainty

- Let *roses*, *flowers*, and *other flowers* each be refinable to any upward-closed set on the lattice



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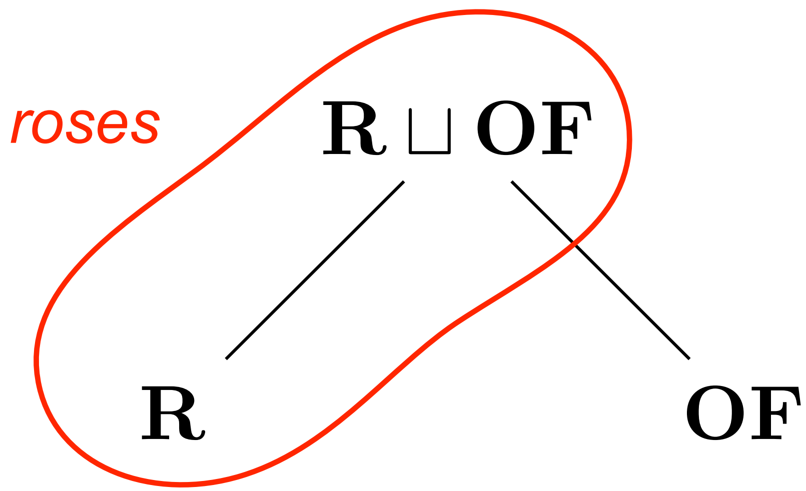

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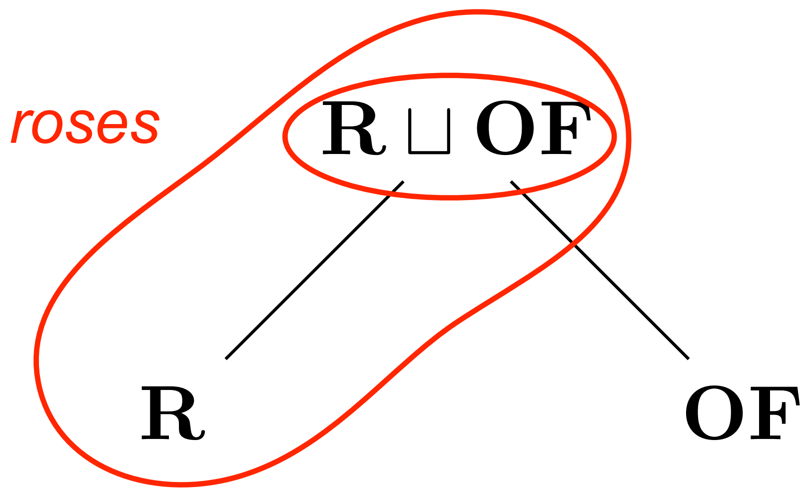

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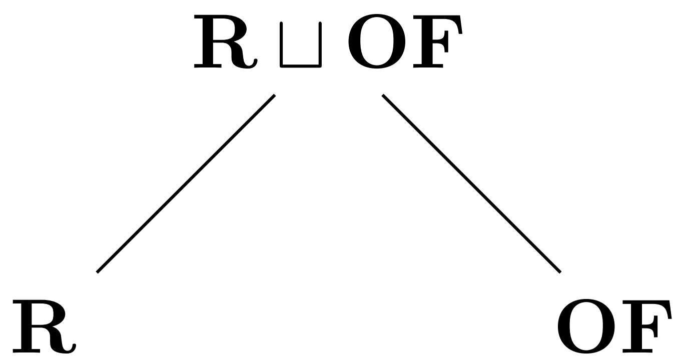

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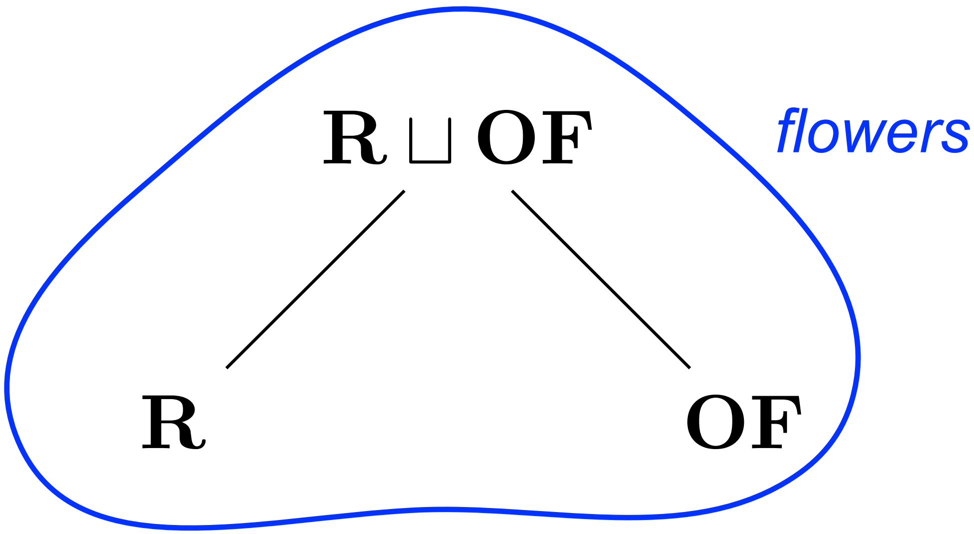

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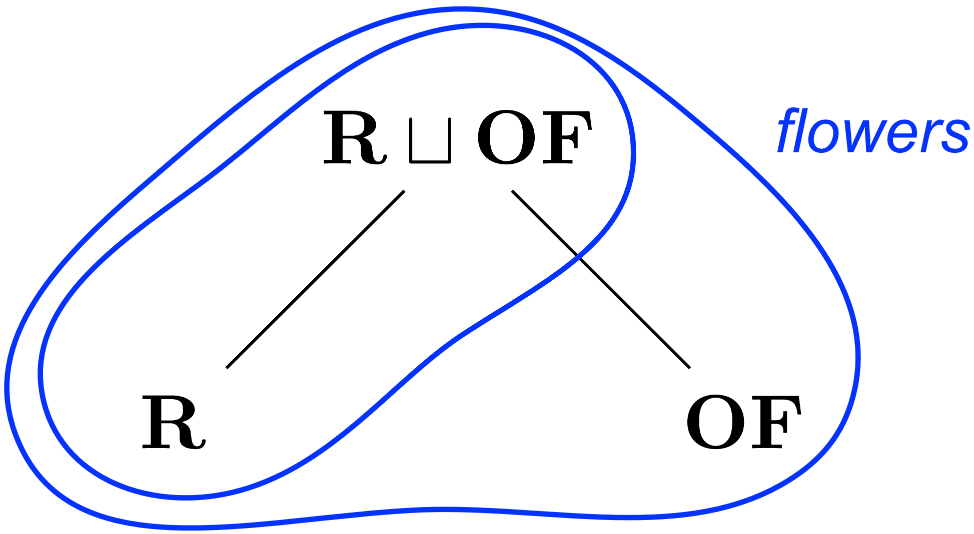

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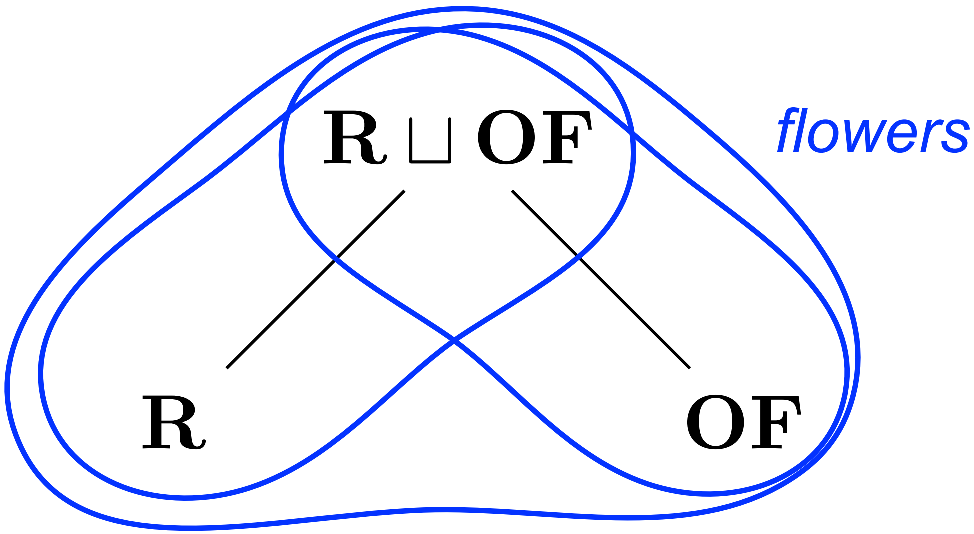

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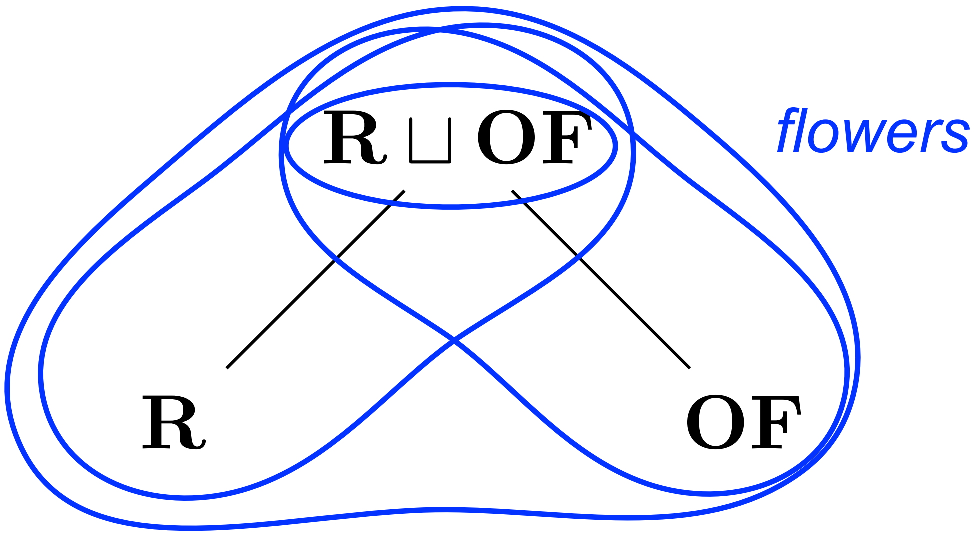

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$$\begin{tikzcd} & \mathbf{R} \sqcup \mathbf{OF} \arrow[dl, dash] \arrow[dr, dash] & \\ \mathbf{R} & & \mathbf{OF} \end{tikzcd}$$

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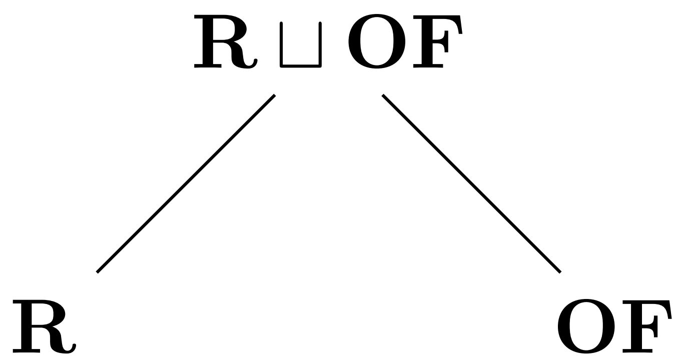

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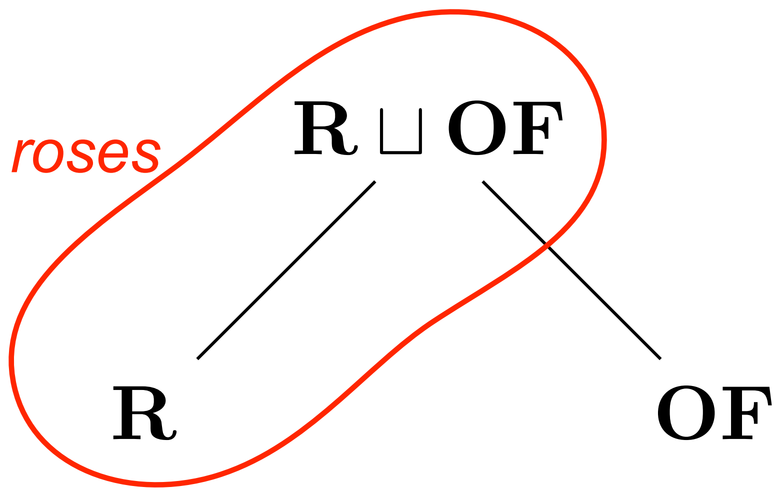

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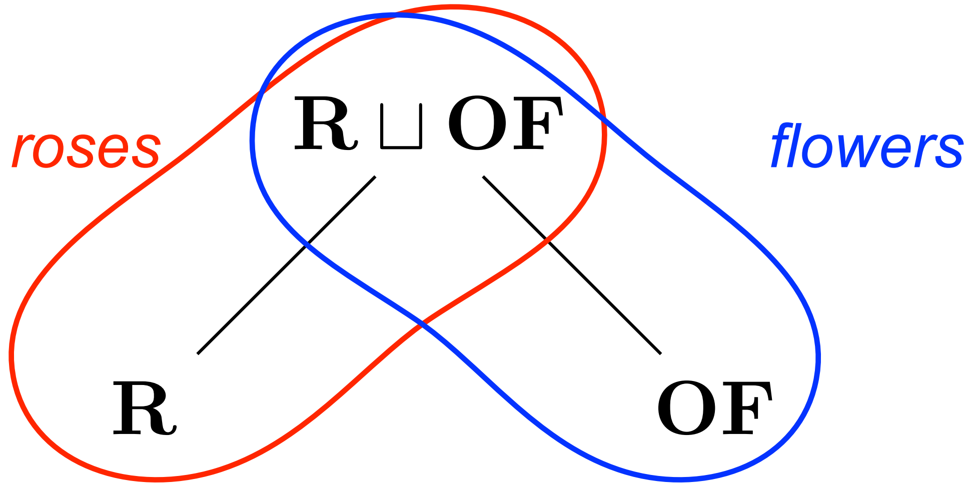

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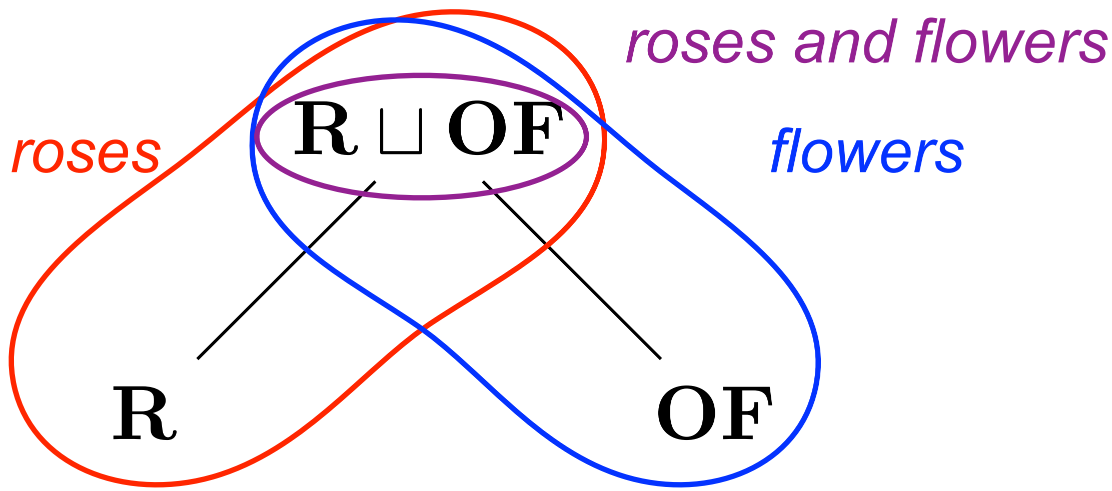

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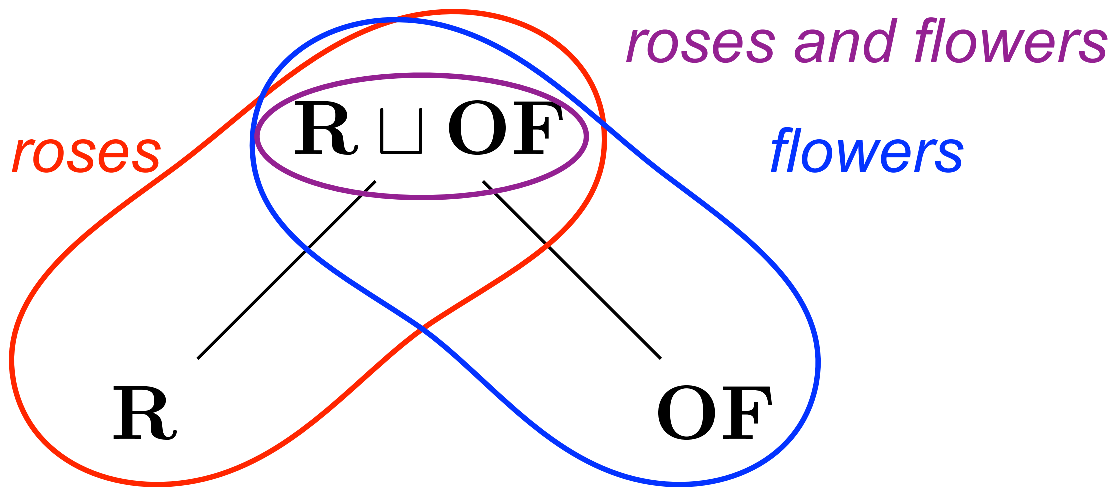

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- Final constraints: every utterance in the alternative set must have a meaning, and every meaning must be expressible by some utterance

Pragmatic listening after lexical uncertainty

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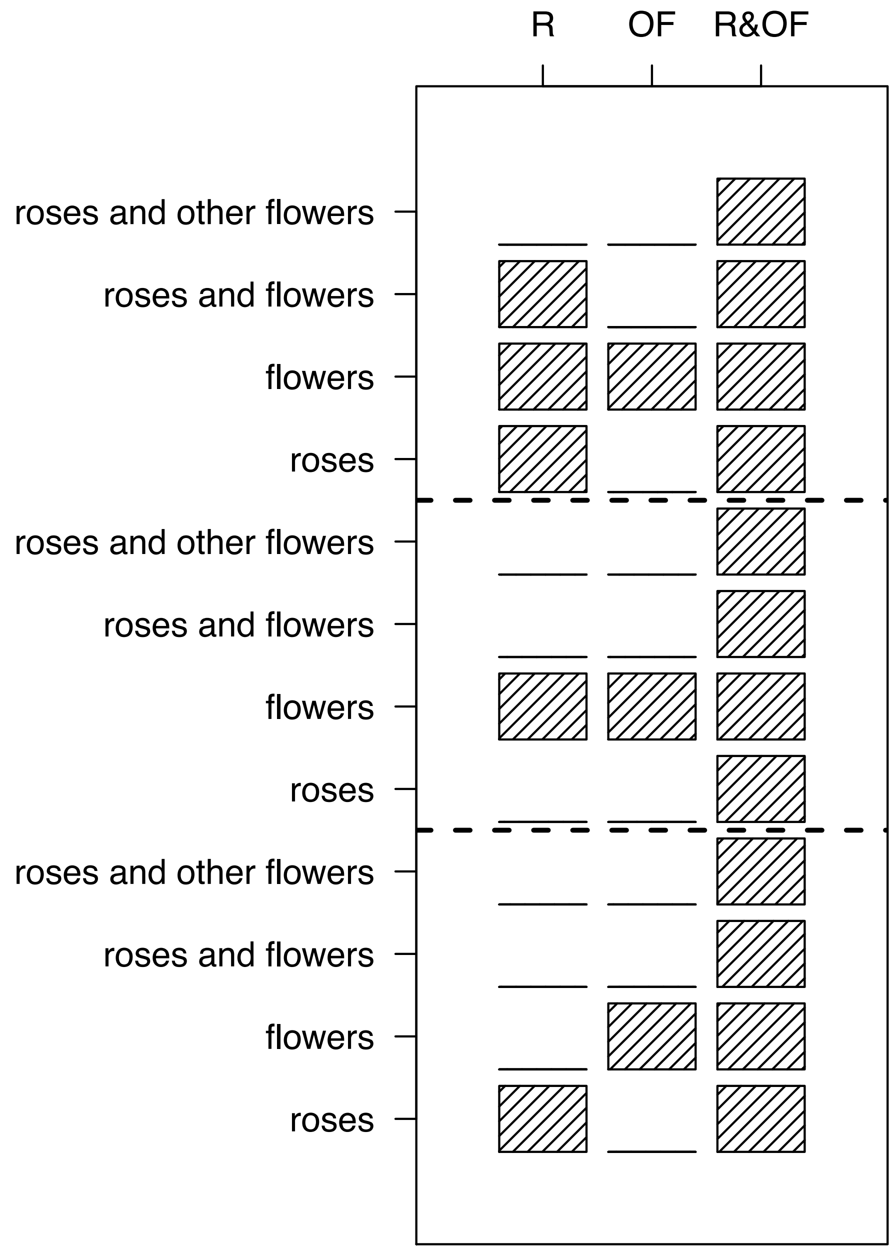

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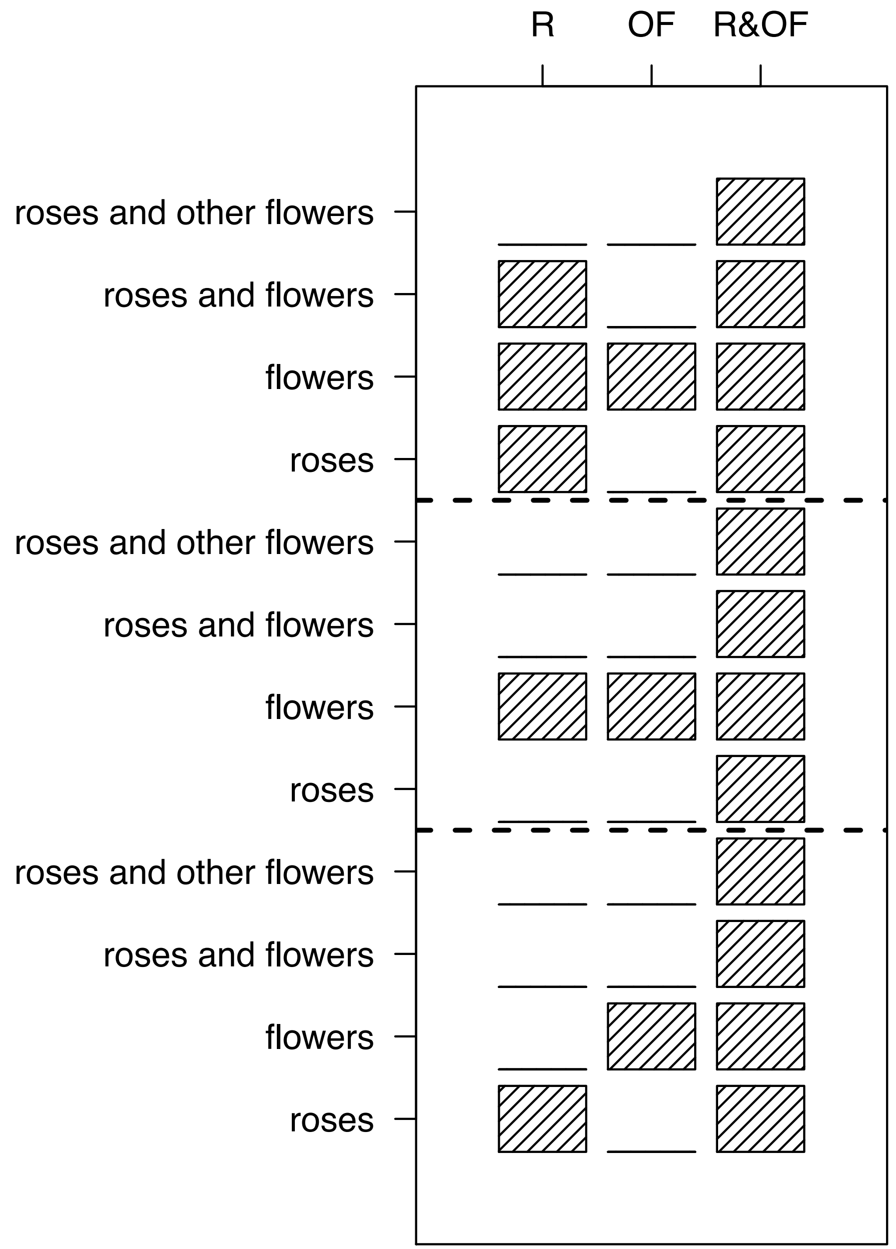

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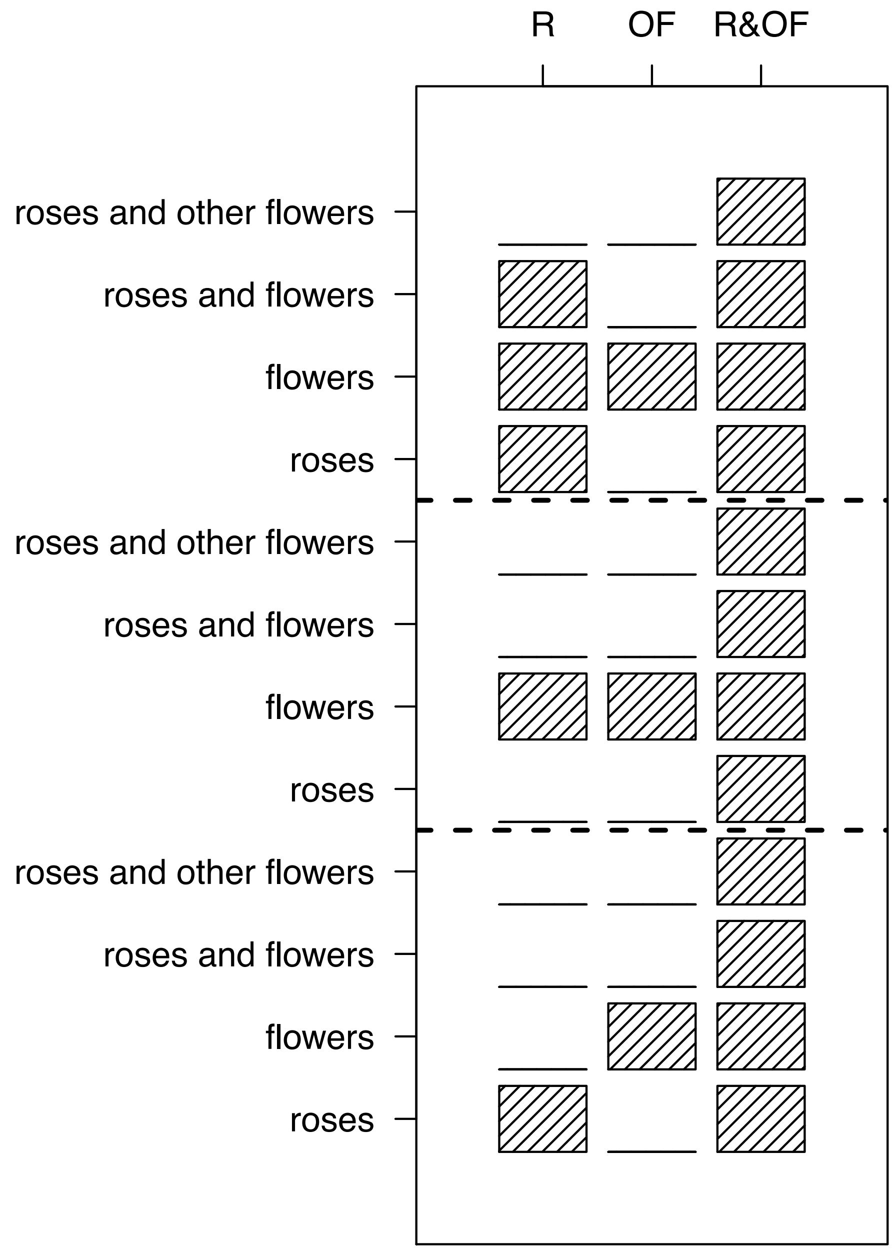

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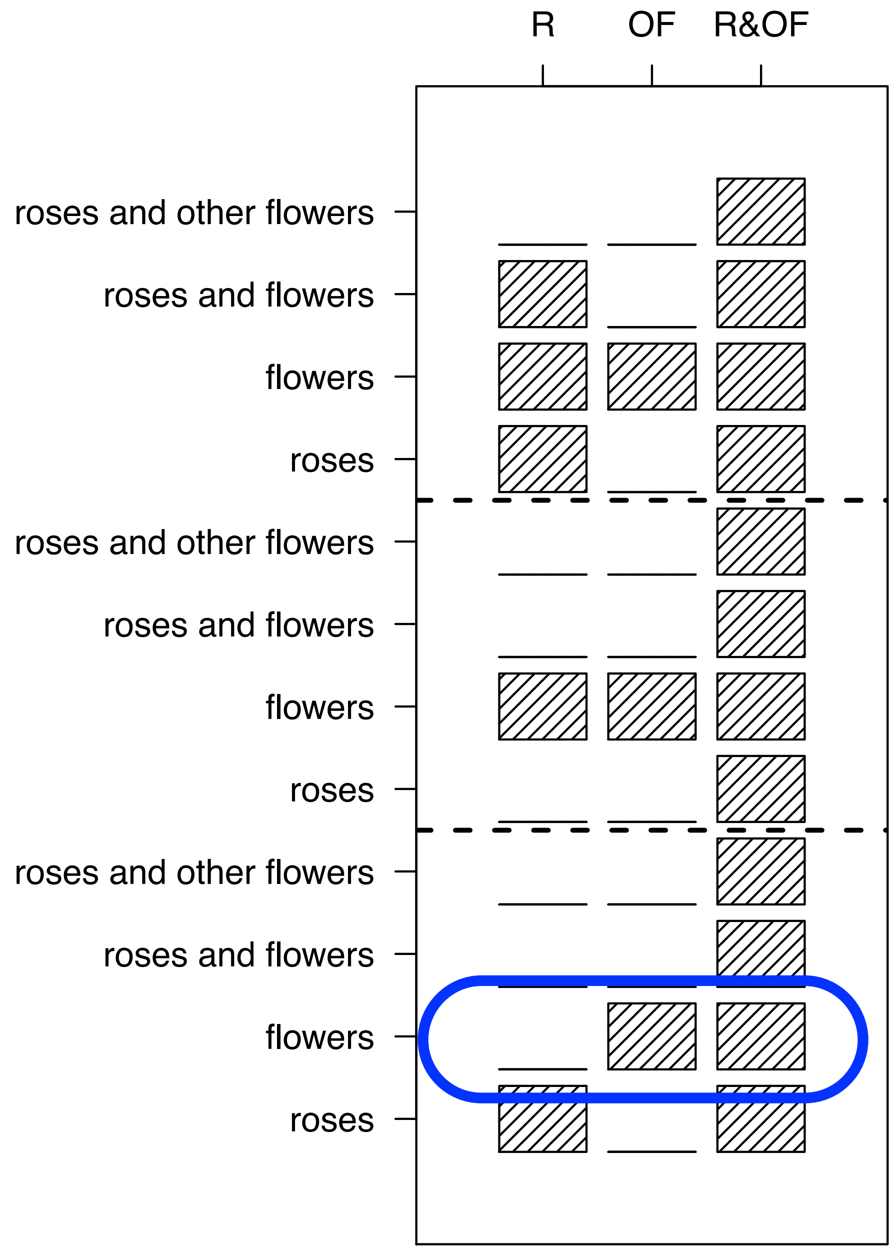

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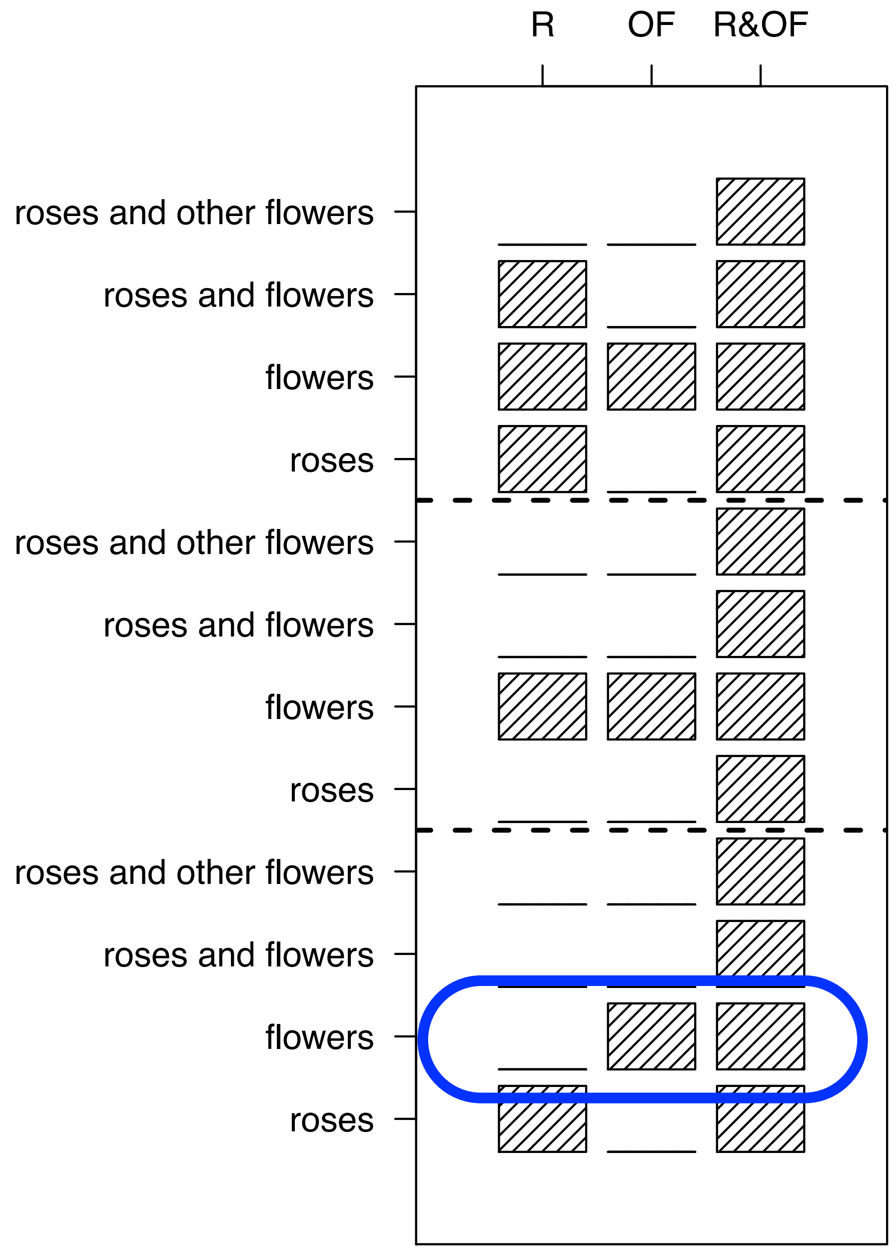

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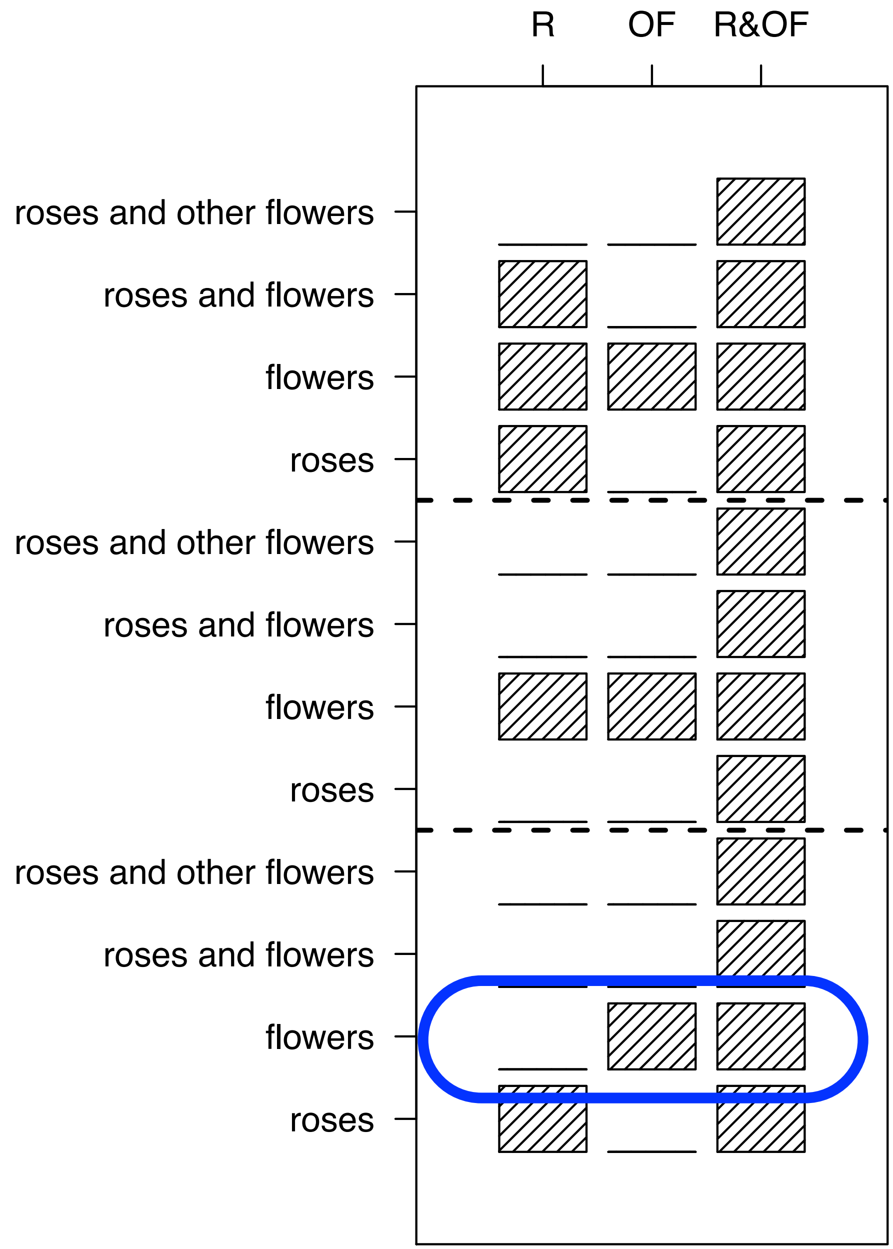

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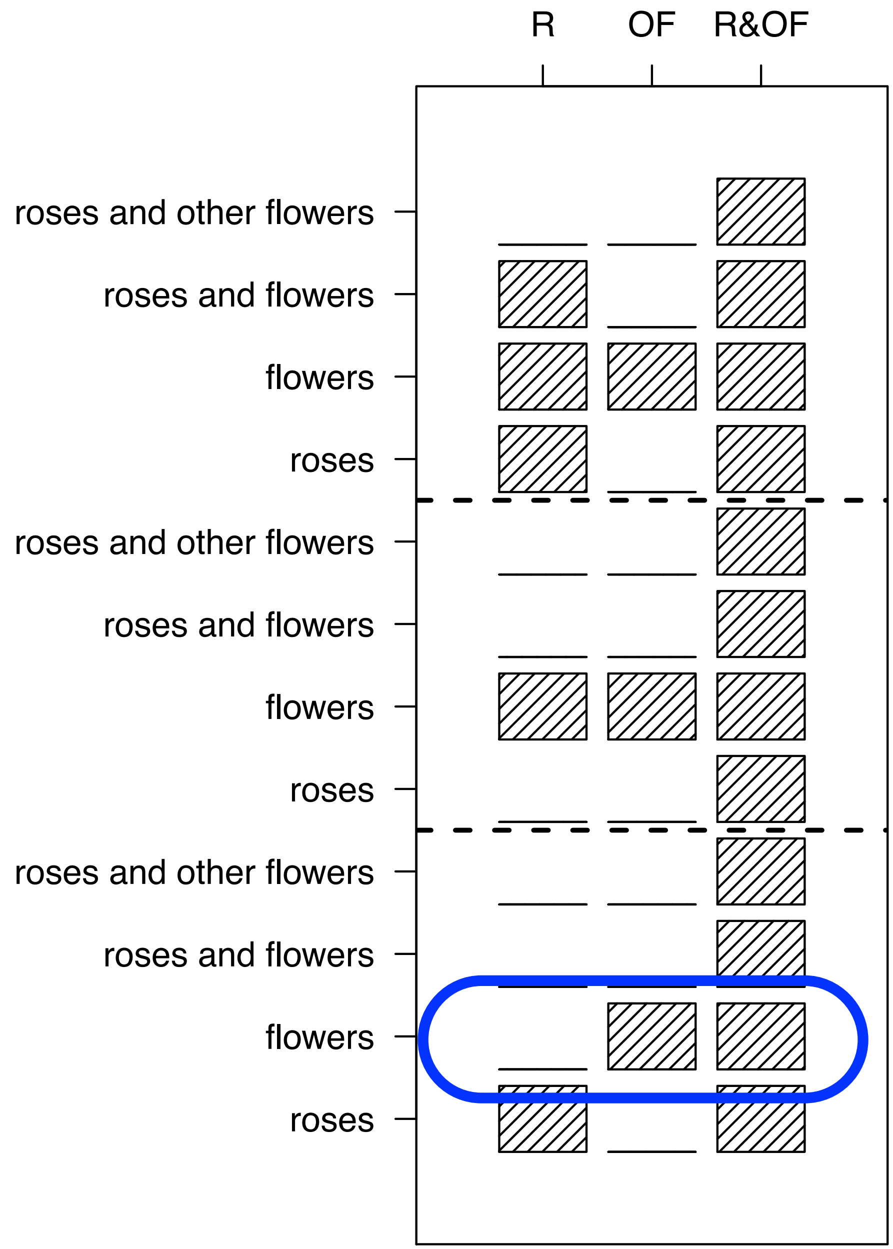
- Not all of them include **R**
- This breaks the overall symmetry between *roses* and *roses and flowers*
- It also makes **R&OF** the "typical case" for *roses and flowers*
- This and considerations of brevity overwhelm the pressure for Q-implicature from *roses and other flowers*



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- Found out that it's been around for a while
- Found out that it is interpreted as *roses and other flowers*
- Showed why its literal semantics shouldn't mean that
- Showed how its interpretation can nevertheless be accounted for under a rational speech-act theory

Many thanks to...

- Funders:
  - National Science Foundation
  - Alfred P. Sloan Foundation
  - Center for Advanced Study in the Behavioral Sciences
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  - Gerhard Jäger
  - Dan Lassiter
  - Beth Levin
  - Stanley Peters
  - Chris Potts
  - Judith Tonhauser
- SALT organizers and reviewers
- All of you for listening!

Meet lattice for events

UCSD

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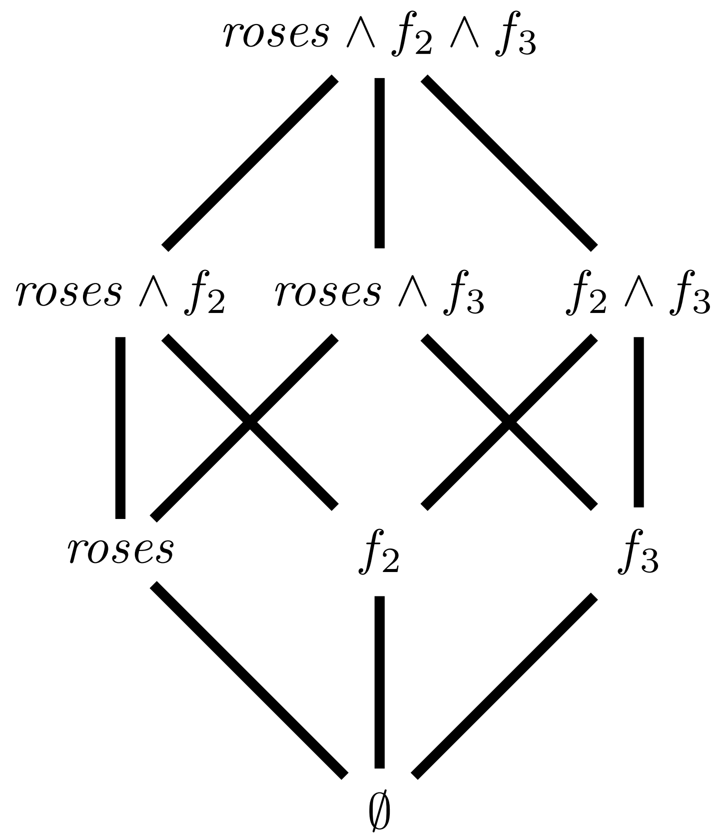

UCSD

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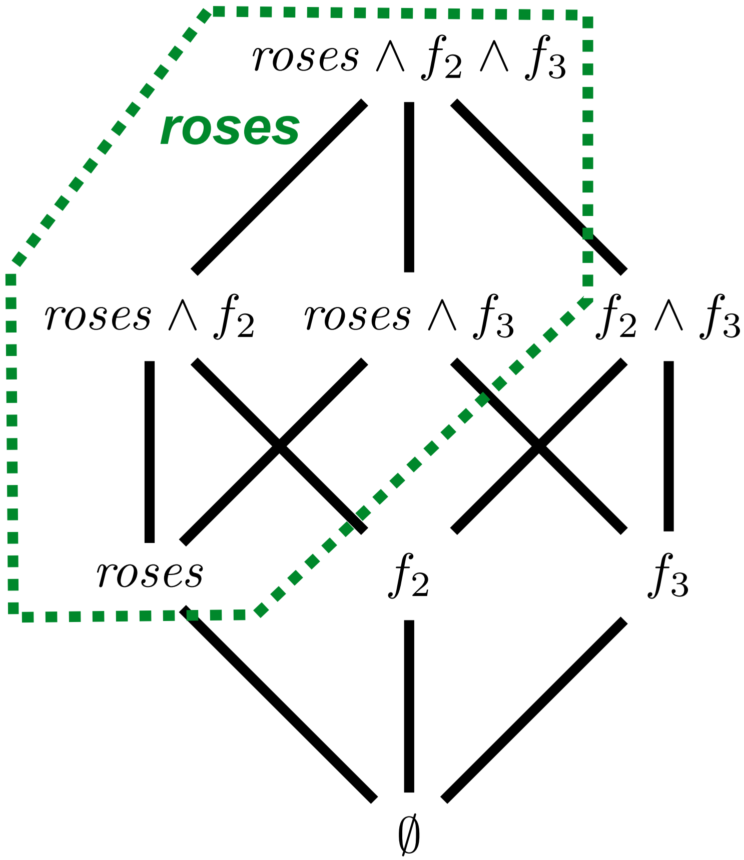

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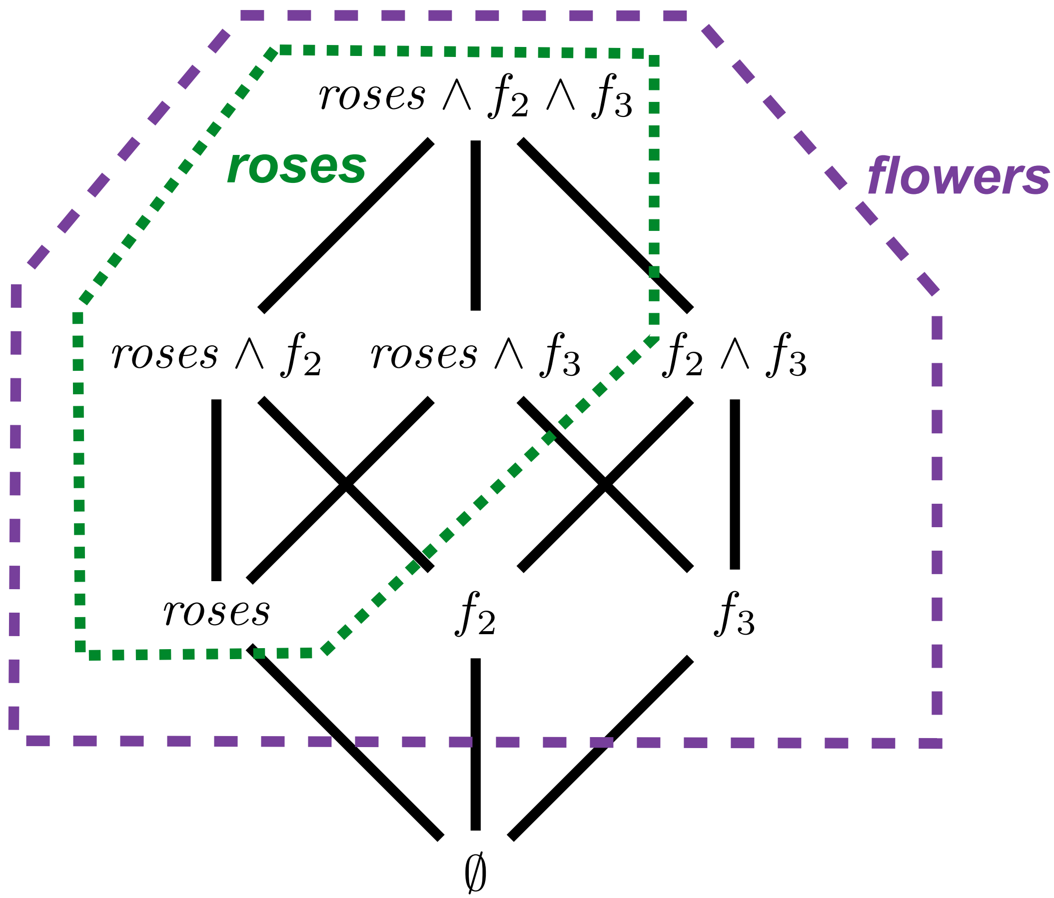

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