The Parallel Meaning Bank

TODAY: Computational Semantics,
Meaning Representations and
Discourse Representation Theory

FRIDAY: Producing Meaning Representations

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WHAT IS COMPUTATIONAL SEMANTICS?

Truth Verification

A man is playing the accordion.

Two boys are making music.

A man is playing the accordion.

Two boys are making music.

Reinterpretation

Turn left ~~and~~ or right
to reach San Marco.

What is semantics about?

Checking for new information

Checking for new information

.. when there's more trade, there's more commerce!

Checking for new information

Exclusive To All Newspapers

DIANA WAS STILL ALIVE HOURS BEFORE SHE DIED

A SERIES of previously unseen CCTV images have revealed that Diana was

Contradiction Checking

Contradiction Checking

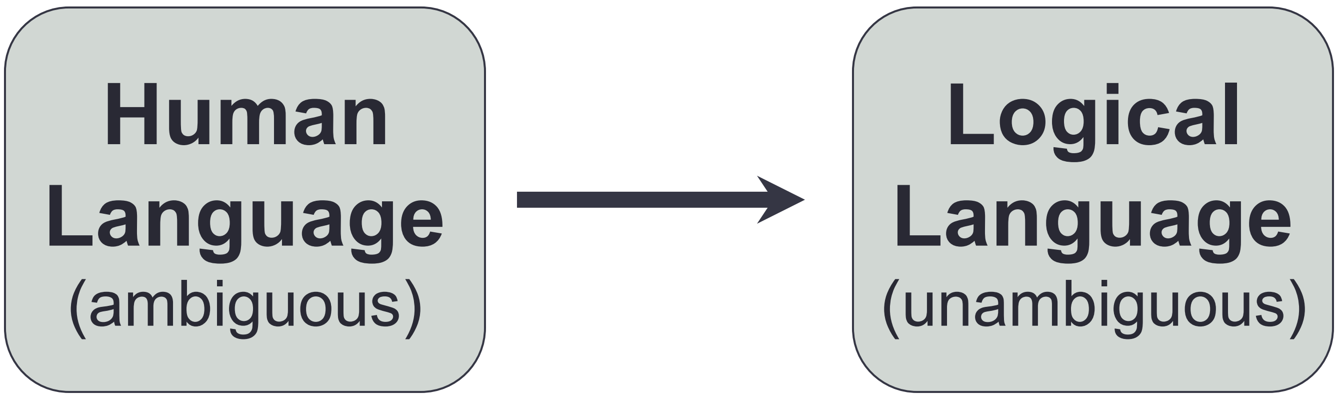
Creating Interpretations

- How do you put an elephant in a fridge?

x y e
x is an elephant y is a fridge e is a “put” event Theme of e is x Destination of e is y

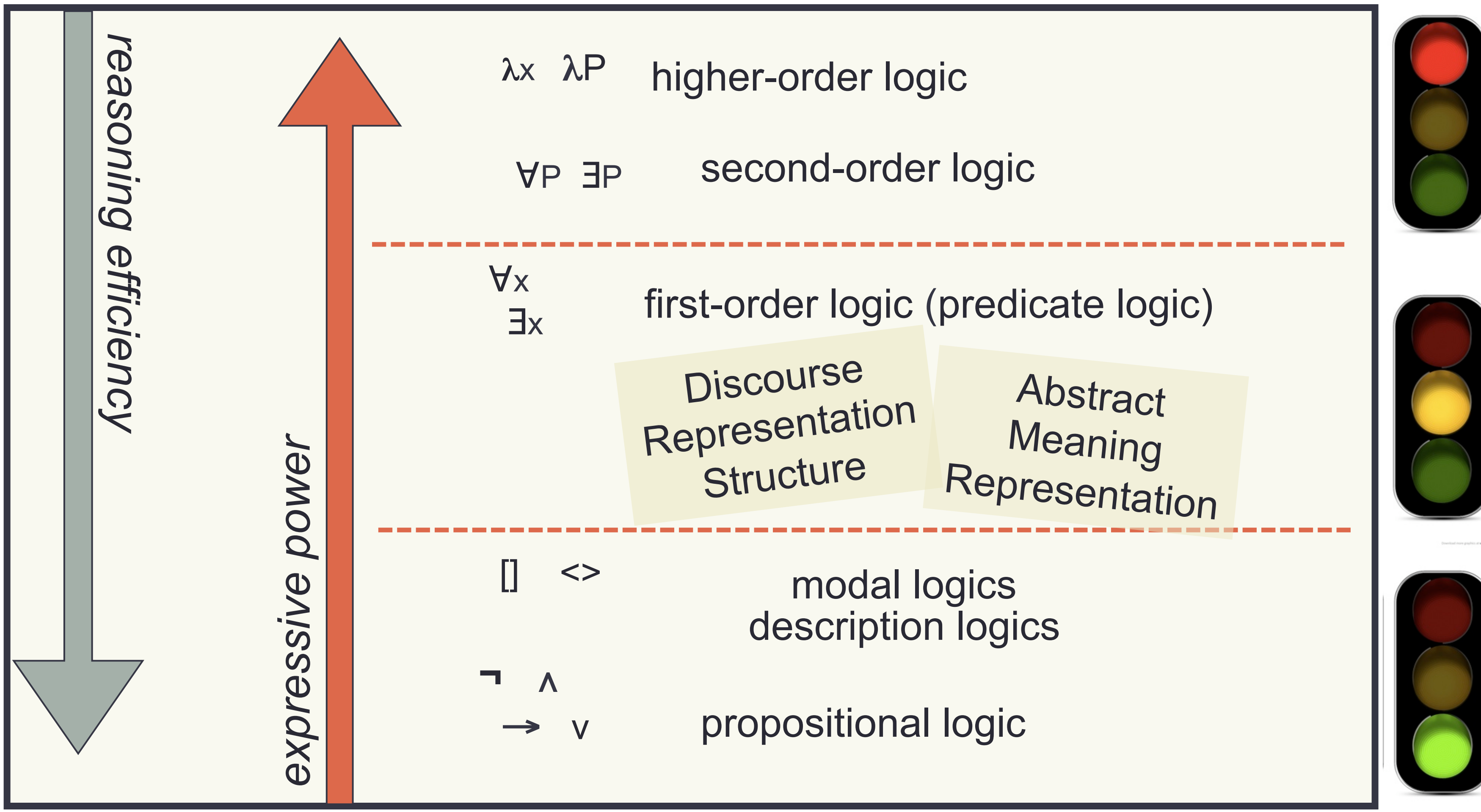
The big idea of computational semantics

- Automate the process of associating semantic representations with expressions of natural language

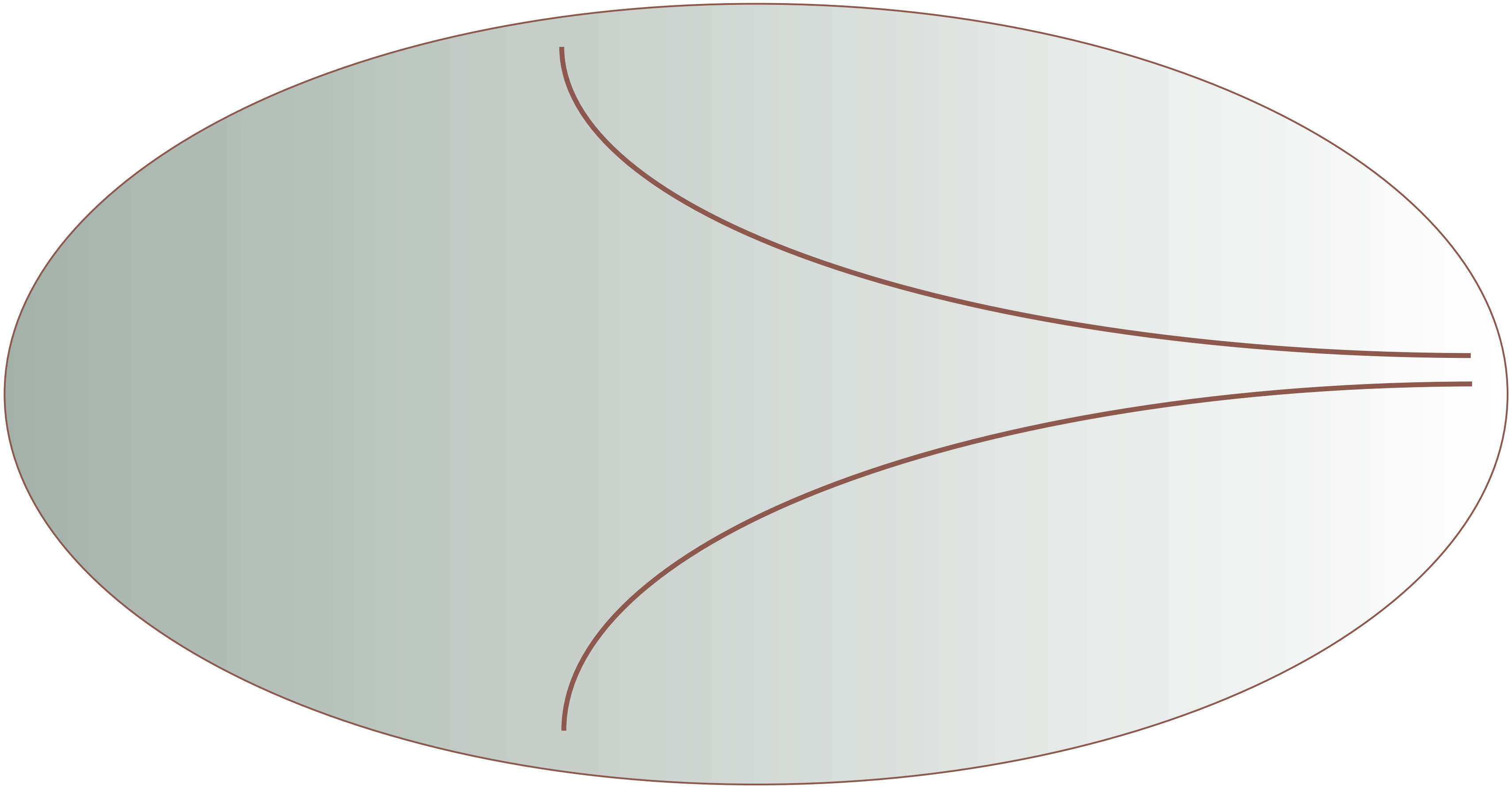


- Use logical representations of natural language to automate the process of drawing inferences

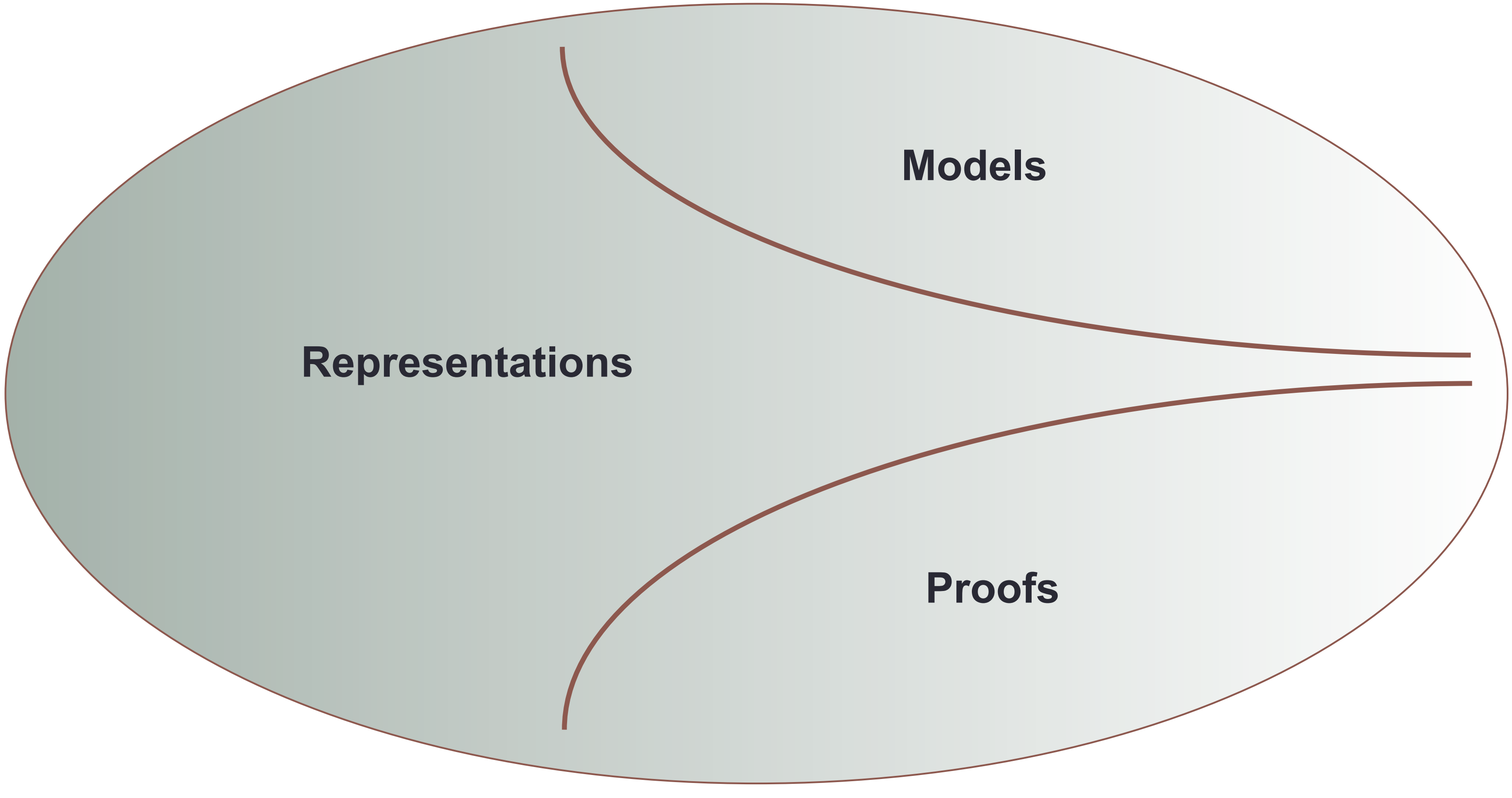
Controlling Inference



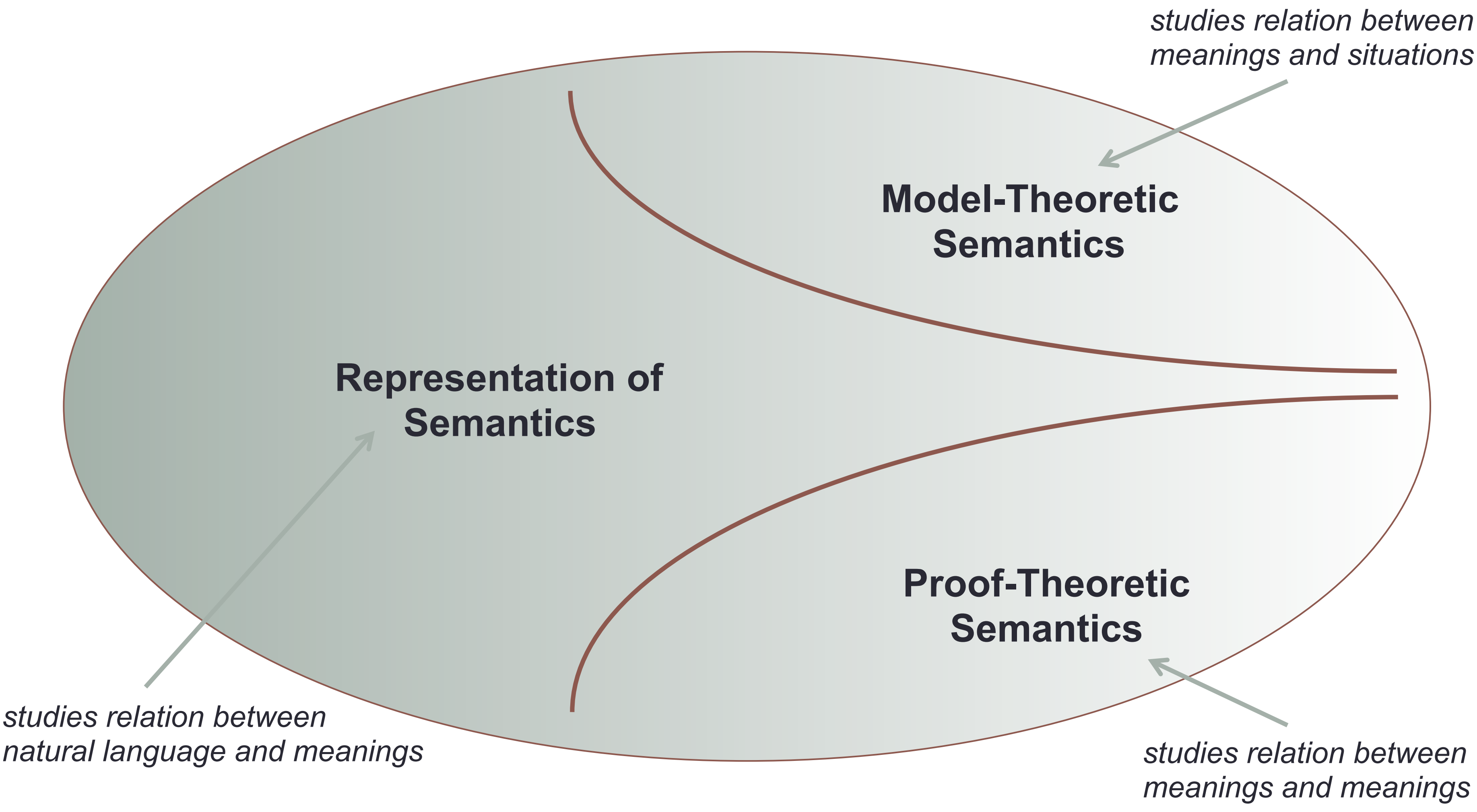
Planet X



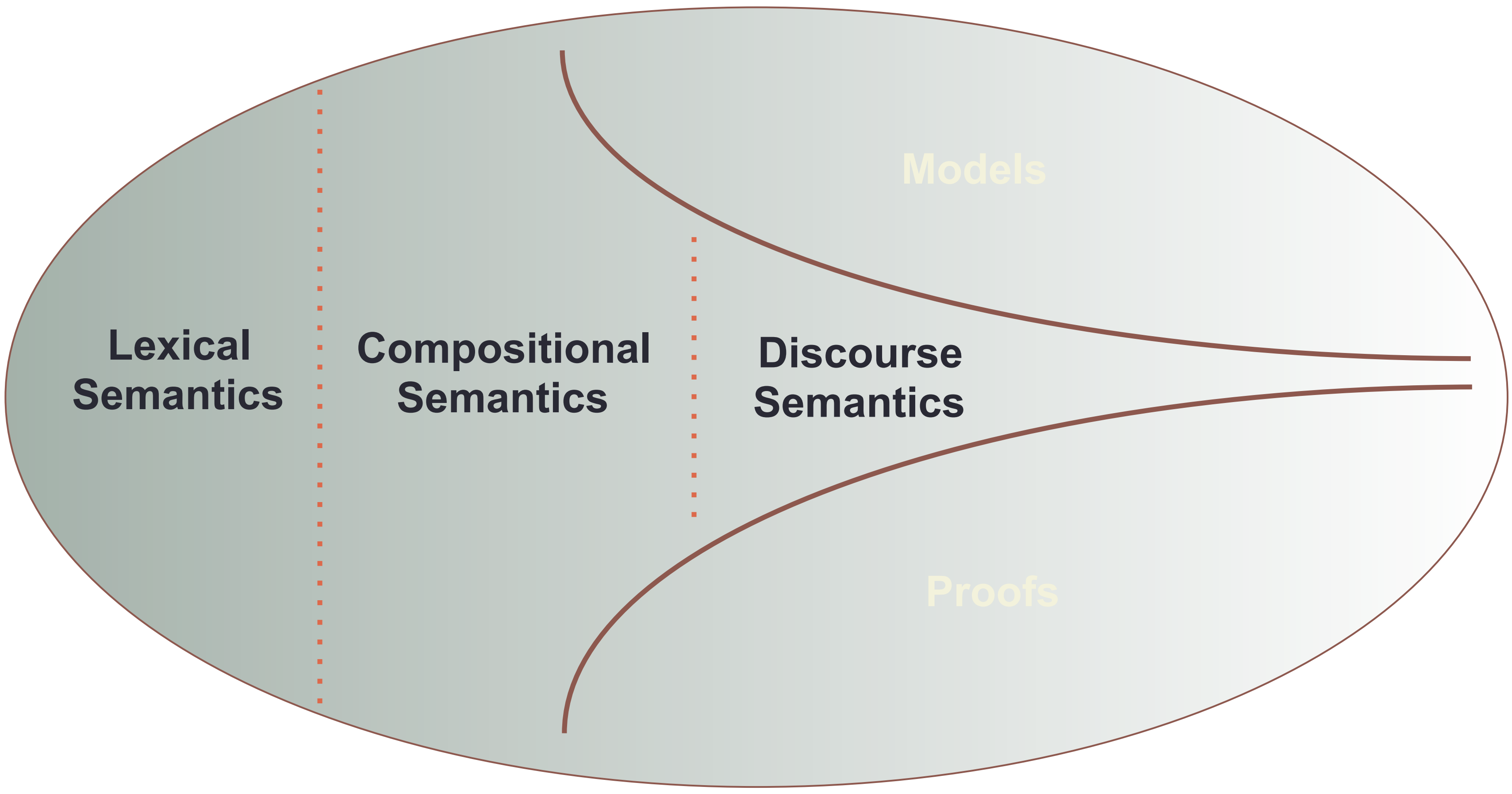
Planet Semantics



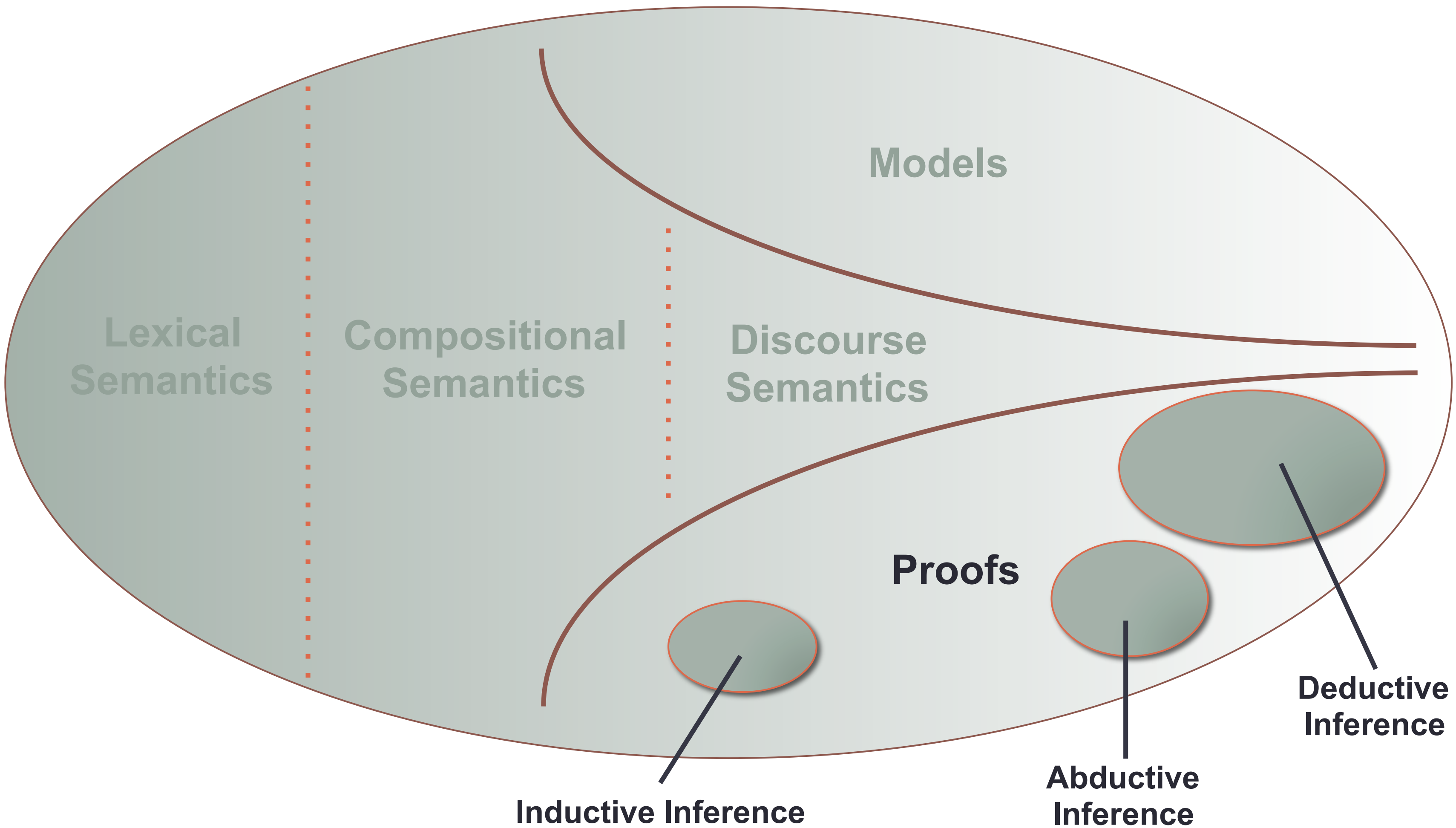
Planet Semantics



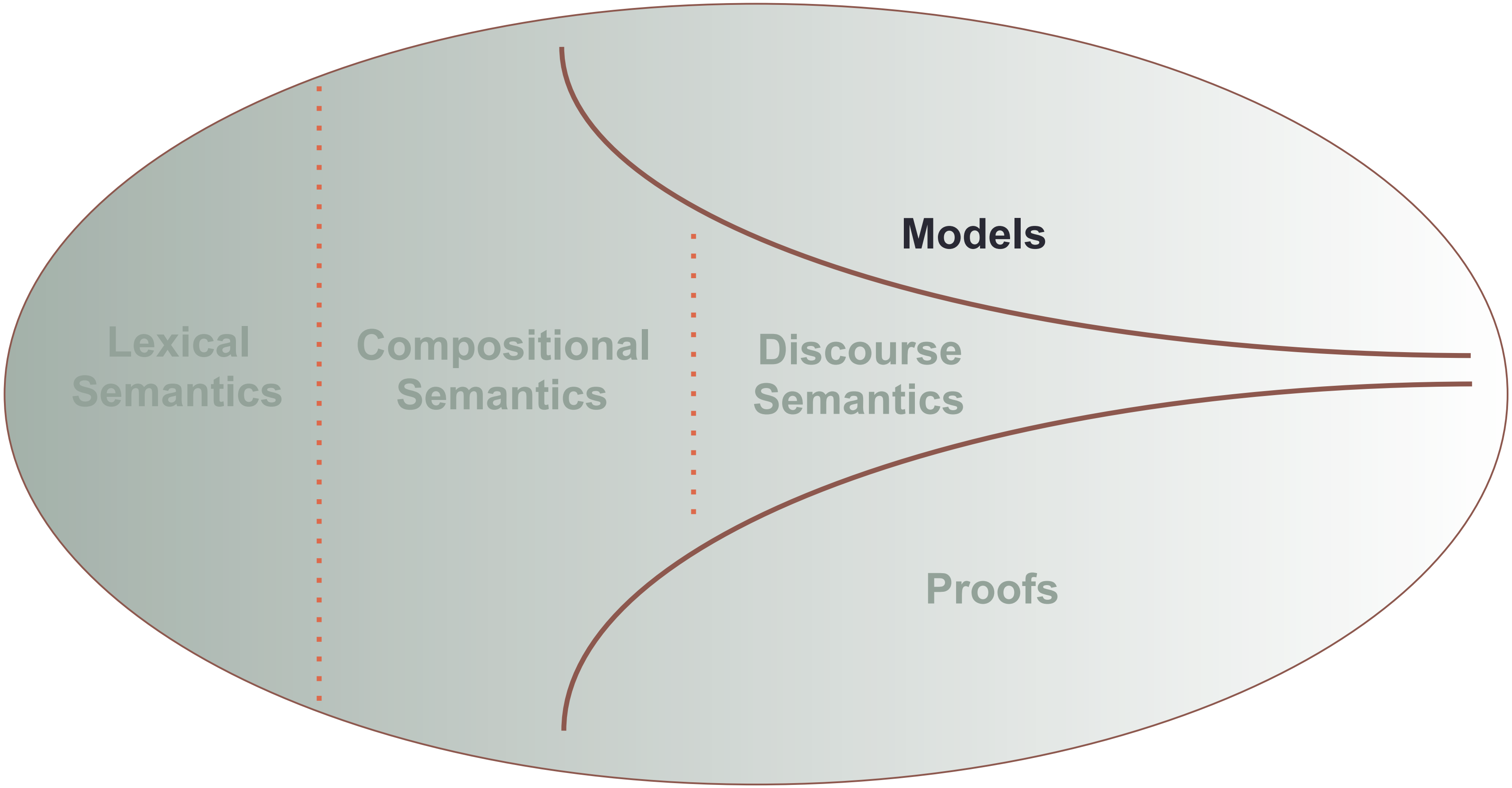
Representation



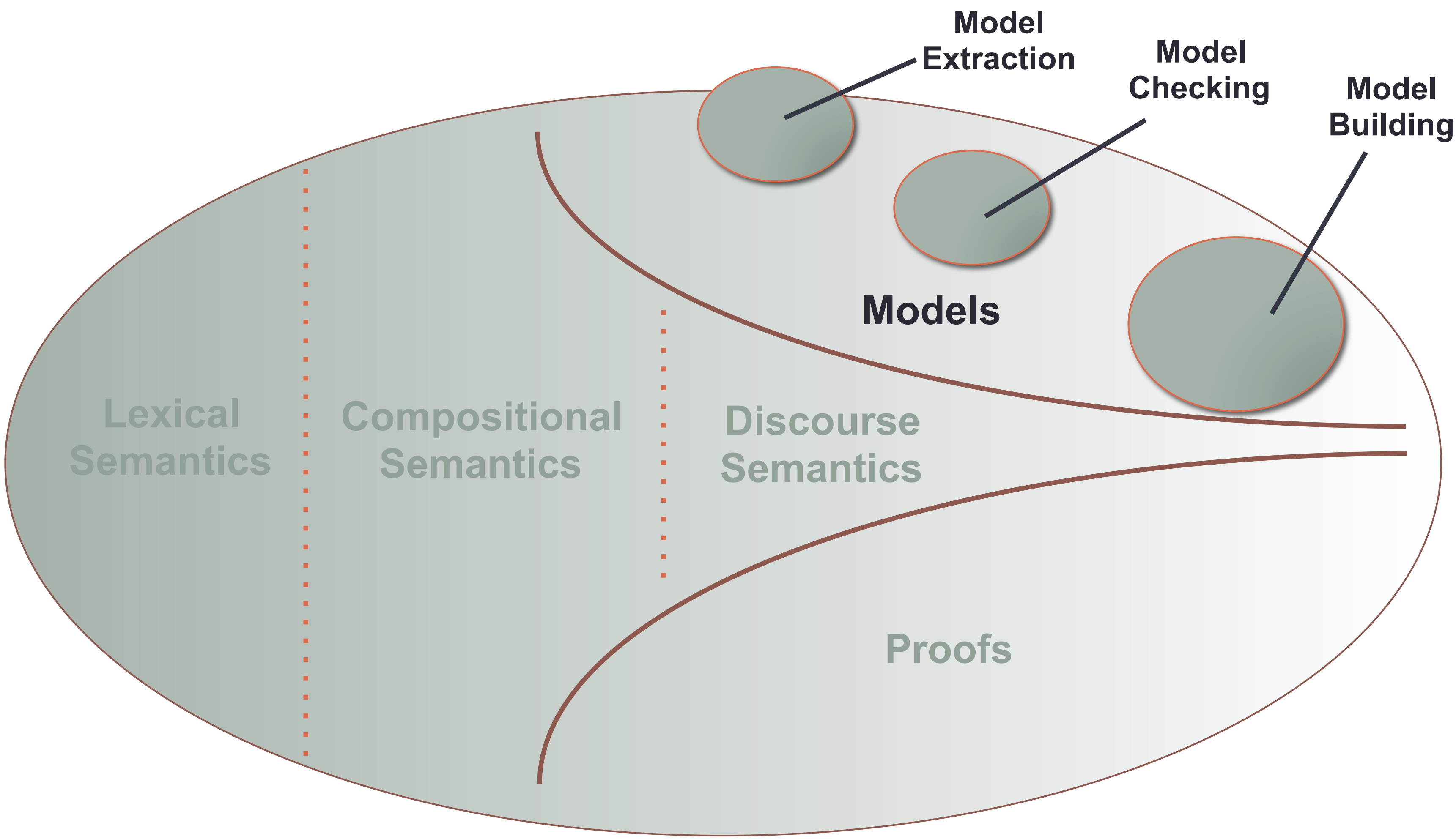
Proof-Theoretical Semantics



Model-Theoretic Semantics



Model-Theoretic Semantics



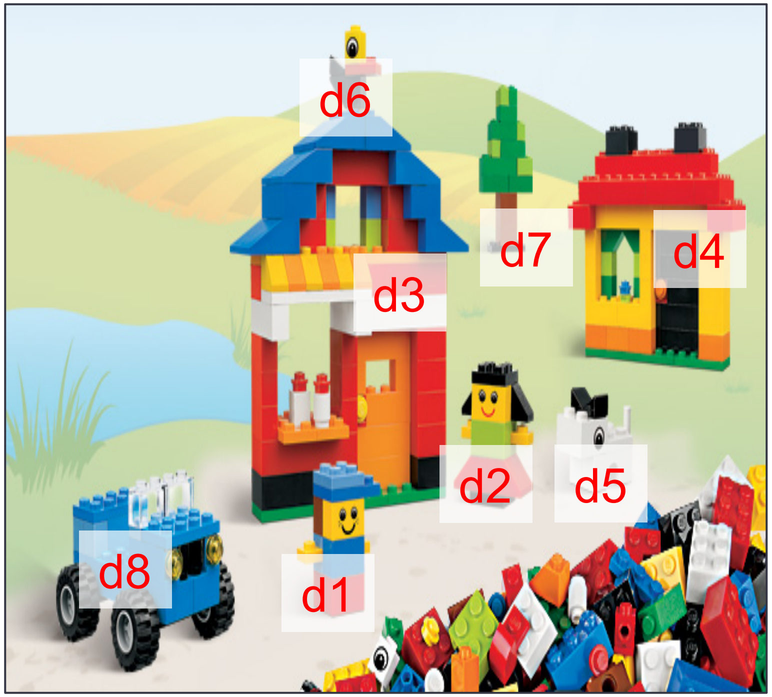
Models

- Model-theoretic semantics
- Alfred Tarski

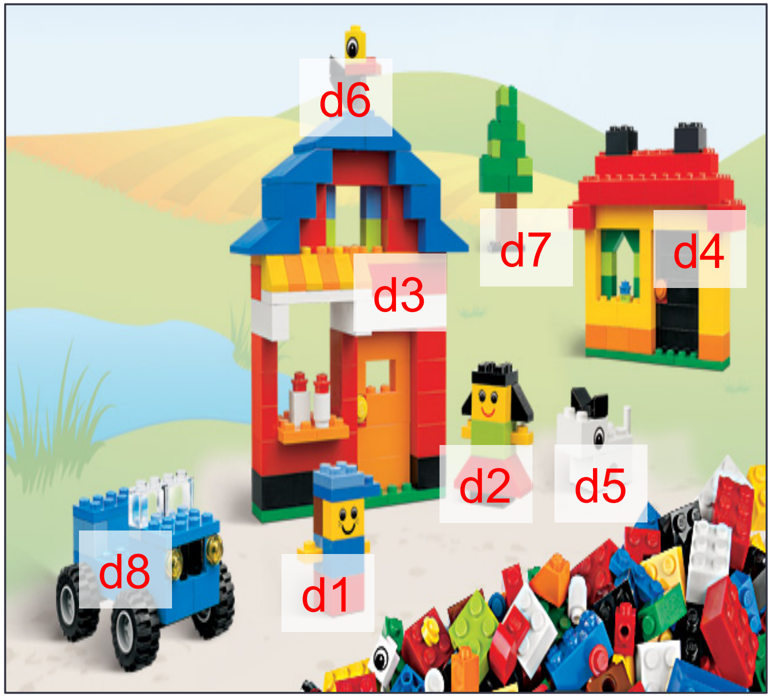
Models: approximations of reality

An example model

An example model

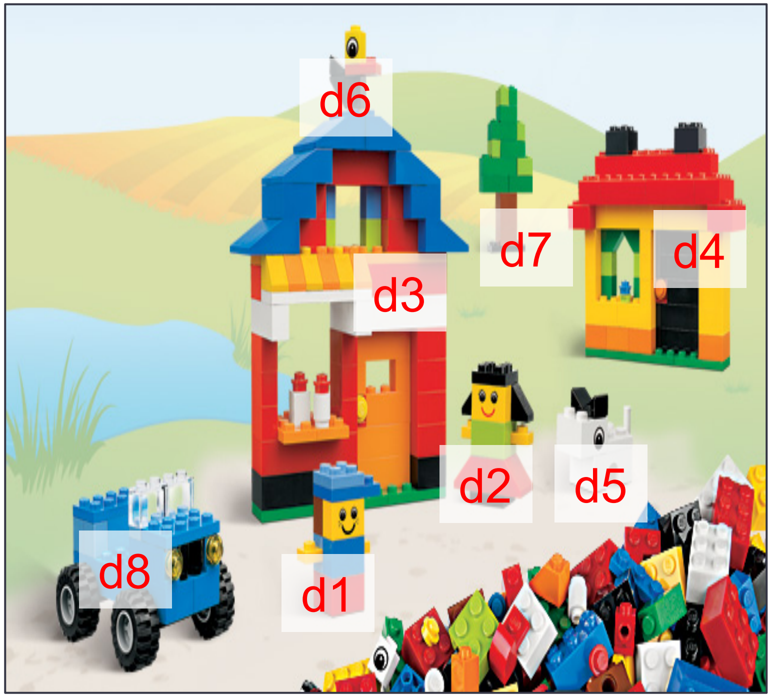


An example model



(non-logical) **symbols**:
man/1, woman/1, house/1, dog/1,
bird/1, car/1, tree/1, happy/1,
near/2, at/2

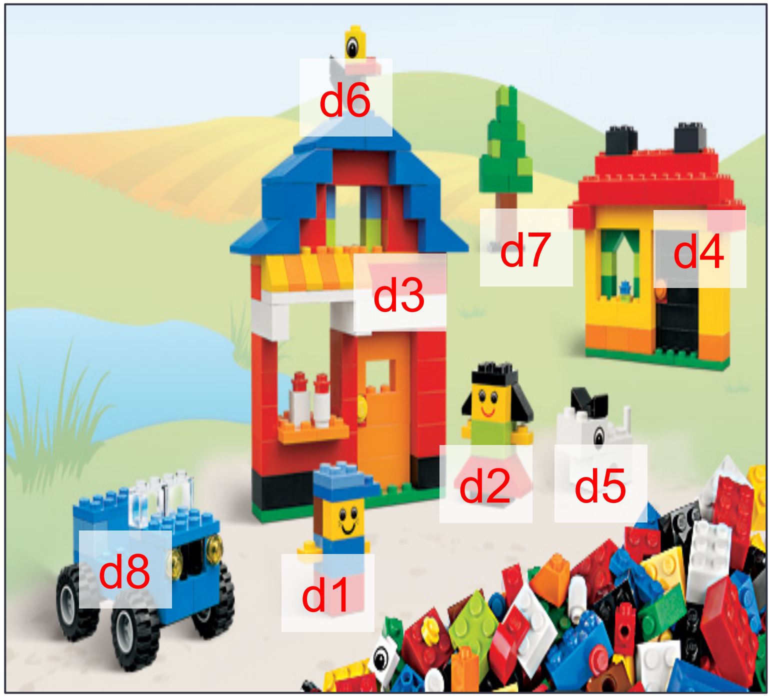
An example model



(non-logical) **symbols**:
man/1, woman/1, house/1, dog/1, bird/1, car/1, tree/1, happy/1, near/2, at/2

VOCABULARY

An example model



(non-logical) **symbols**:
man/1, woman/1, house/1, dog/1, bird/1, car/1, tree/1, happy/1, near/2, at/2

M=<D,F>
D={d1,d2,d3,d4,d5,d6,d7,d8}
F(man)={d1}
F(woman)={d2}
F(house)={d3,d4}
F(dog)={d5}
F(bird)={d6}
F(tree)={d7}
F(car)={d8}
F(happy)={d1,d2}
F(near)={(d5,d2),(d2,d5)}
F(at)={(d6,d3)}

A first-order model

- A first-order model <D,F> has two parts:
  - D: a domain (the universe) of objects (entities)
  - F: an interpretation function
- The interpretation functions maps symbols from our vocabulary to members of the domain
  - Zero-place symbols (constants) are mapped to a single domain member
  - One-place symbols (predicates) are mapped to a set of domain members
  - Two-place symbols (relations) are mapped to a set of ordered pairs of domain members

An example model

M=<D,F>

D={d1,d2,d3,d4}

F(mia)=d2

F(honey-bunny)=d1

F(vincent)=d4

F(yolanda)=d3

F(customer)={d1,d2,d4}

F(robber)={d3}

F(love)=Ø

A very small model

M=<D,F>
D={d5}

A very large model

M=<D,F>

D={d1,d2,d3,d4,d5,d6,d7,d8,d9,d10

F(man)={d1,d4,d12}

F(woman)={d2,d3}

F(car)={d14,d13}

F(love)={(d2,d1), (d4,d4)}

F(hate)={(d5,d1), (d1,d4),(d2,d2)}

F(chopper)={d10}

Finite models

- In practice we can only work with finite models (obviously)
- But it is easy to find a description that is satisfiable but does not have a finite model

Alternative names for models

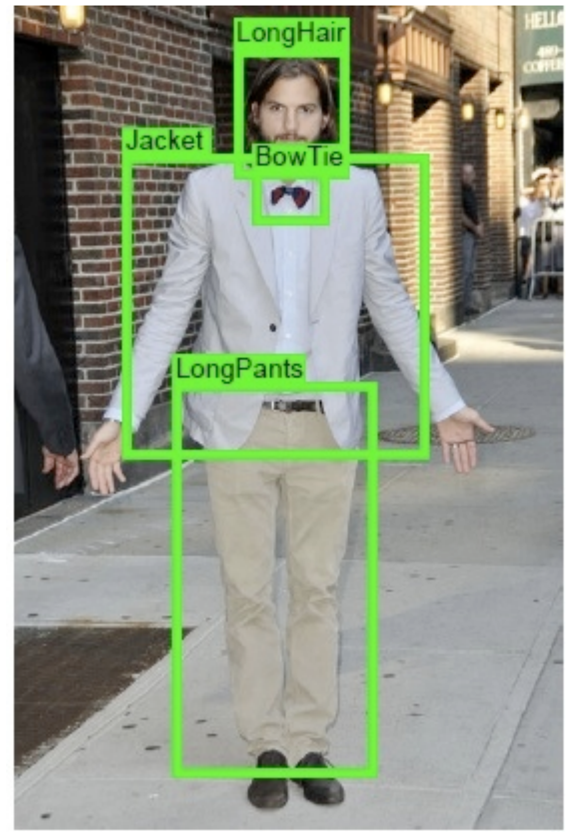
- Interpretation
- Structure

Model Extraction

- The task of mapping sensory input (an image, video, or audio) to a model

Input: **image**
Output: model

M=<D,F>
D={d1,d2,d3,d4,d5}
F(Jacket)={d2}
F(LongHair)={d3}
F(Has)={(d1,d3)}
....



source: Joo, Wang & Zhu (2013)

FIRST-ORDER LOGIC (FOL)

FORMULA IN FOL =
MEANING REPRESENTATION =
SEMANTIC REPRESENTATION

Ingredients of a first-order language

1. All **symbols** in the vocabulary – the non-logical symbols of the first-order language
2. Enough **variables** (a countably infinite collection):
   x, y, z, etc.
3. The **connectives** ¬ (negation), ∧ (conjunction),
   ∨ (disjunction), and → (implication)
4. The **quantifiers** ∀ (the universal quantifier) and
   ∃ (the existential quantifier)
5. Some **punctuation** symbols:
   brackets and the comma.

The satisfaction definition for FOL

$M, g \models R(\tau_1, \cdots, \tau_n)$	*iff*	$(I^g_F(\tau_1), \cdots, I^g_F(\tau_n)) \in F(R)$,
$M, g \models \tau_1 = \tau_2$	*iff*	$I^g_F(\tau_1) = I^g_F(\tau_2)$,
$M, g \models \neg\phi$	*iff*	not $M, g \models \phi$,
$M, g \models (\phi \wedge \psi)$	*iff*	$M, g \models \phi$ and $M, g \models \psi$,
$M, g \models (\phi \vee \psi)$	*iff*	$M, g \models \phi$ or $M, g \models \psi$,
$M, g \models (\phi \rightarrow \psi)$	*iff*	not $M, g \models \phi$ or $M, g \models \psi$,
$M, g \models \exists \mathrm{x}\phi$	*iff*	$M, g' \models \phi$, for some x-variant g' of g,
$M, g \models \forall \mathrm{x}\phi$	*iff*	$M, g' \models \phi$, for all x-variants g' of g.

$I^g_F(\tau)$ is F(c) if the term τ is a constant c, and g(x) if τ is a variable x.

Model Checking

- The task of the determining whether a given model satisfies a formula (or a set of formulas)

Input: **model + formula**
Output: true or false

Model Checking

M=<D,F>
D={d1,d2,d3,d4}
F(mia)=d1
F(honey-bunny)=d2
F(vincent)=d3
F(yolanda)=d4
F(customer)={d1,d3}
F(robber)={d2,d4}
F(love)={(d4,d2),(d3,d1)}

Q1: Does M satisfy: $\exists x(customer(x) \wedge \exists y(customer(y) \wedge love(x,y)))$

Q2: Does M satisfy: $\exists x(robber(x) \wedge love(x,x))$

The Parallel Meaning Bank

- *Input*:
  texts (English, Dutch, German, Italian)

- *Output*:
  Discourse Representation Structures (DRS)

DRSs are the meaning representations proposed by Discourse Representation Theory. They are first-order representations.

A SIMPLE EXAMPLE

Tom is grinning.

x1 e1 t1

male(x1)
    Name(x1, tom)
grin(e1)
    Time(e1, t1)
    Agent(e1, x1)
time(t1)
    t1 = now

Tom is grinning.

There are three discourse referents in this DRS

x1 e1 t1

male(x1)
  Name(x1, tom)
grin(e1)
  Time(e1, t1)
  Agent(e1, x1)
time(t1)
  t1 = now

Tom is grinning.

There are seven conditions in this DRS

x1 e1 t1
male(x1)
Name(x1, tom)
grin(e1)
Time(e1, t1)
Agent(e1, x1)
time(t1)
t1 = now

Tom is grinning.

The non-logical symbols in this DRS

x1 e1 t1
male(x1) Name(x1, tom) grin(e1) Time(e1, t1) Agent(e1, x1) time(t1) t1 = now

Tom is grinning.

The constants
in this DRS

x1 e1 t1

male(x1)
    Name(x1, <u>tom</u>)
grin(e1)
    Time(e1, t1)
    Agent(e1, x1)
time(t1)
    t1 = <u>now</u>

Tom is grinning.

There are three concept conditions in this DRS

x1 e1 t1
male(x1)
Name(x1, tom)
grin(e1)
Time(e1, t1)
Agent(e1, x1)
time(t1)
t1 = now

Tom is grinning.

There are three role conditions in this DRS

x1 e1 t1
male(x1)
Name(x1, tom)
grin(e1)
Time(e1, t1)
Agent(e1, x1)
time(t1)
t1 = now

Tom is grinning.

x1 e1 t1
male(x1)
Name(x1, tom)
grin(e1)
Time(e1, t1)
Agent(e1, x1)
time(t1)
t1 = now

There is one comparison condition in this DRS

Tom is grinning.

x1 is a male person with the name "tom"

x1 e1 t1
male(x1) Name(x1, tom) grin(e1) Time(e1, t1) Agent(e1, x1) time(t1) t1 = now

Tom is grinning.

x1 e1 t1

male(x1)
    Name(x1, tom)
grin(e1)
    Time(e1, t1)
    Agent(e1, x1)
time(t1)
    t1 = now

e1 represents a a grinning event with agent x1 and time t1

Tom is grinning.

x1 e1 t1

male(x1)
    Name(x1, tom)
grin(e1)
    Time(e1, t1)
    Agent(e1, x1)
time(t1)
    t1 = now

t1 is a time point equal to the utterance time

Tom is grinning.

x1 e1 t1
male(x1)
Name(x1, tom)
grin(e1)
Time(e1, t1)
Agent(e1, x1)
time(t1)
t1 = now

in first-order logic

$\exists x \exists e \exists t(male(x) \& Name(x,tom) \& grin(e) \& Time(e,t) \& Agent(e,t) \& time(t) \& t=now)$

Tom is grinning.

A first-order model
M=<D,F>

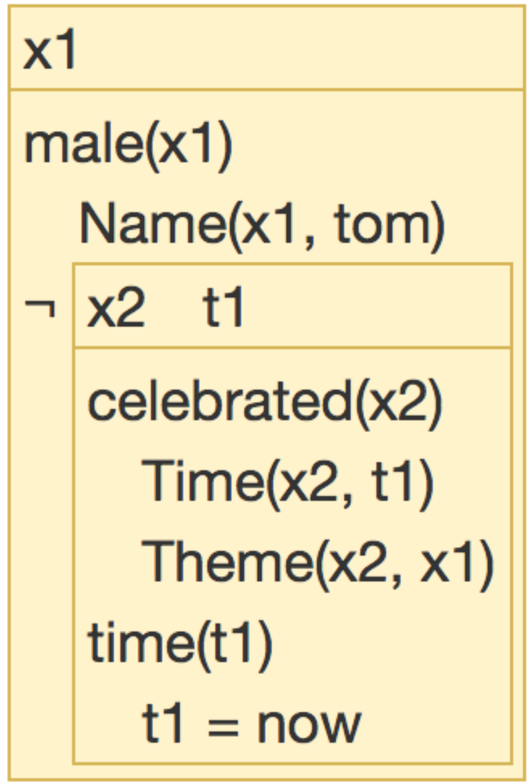
D={d1,d2,d3,d4}
F(male)={d1}
F(grin)={d3}
F(time)={d4}
F(Time)={(d3,d4)}
F(Agent)={(d3,d1)}
F(Name)={(d1,d2)}
F(now)=d4
F(tom)=d2

x1 e1 t1

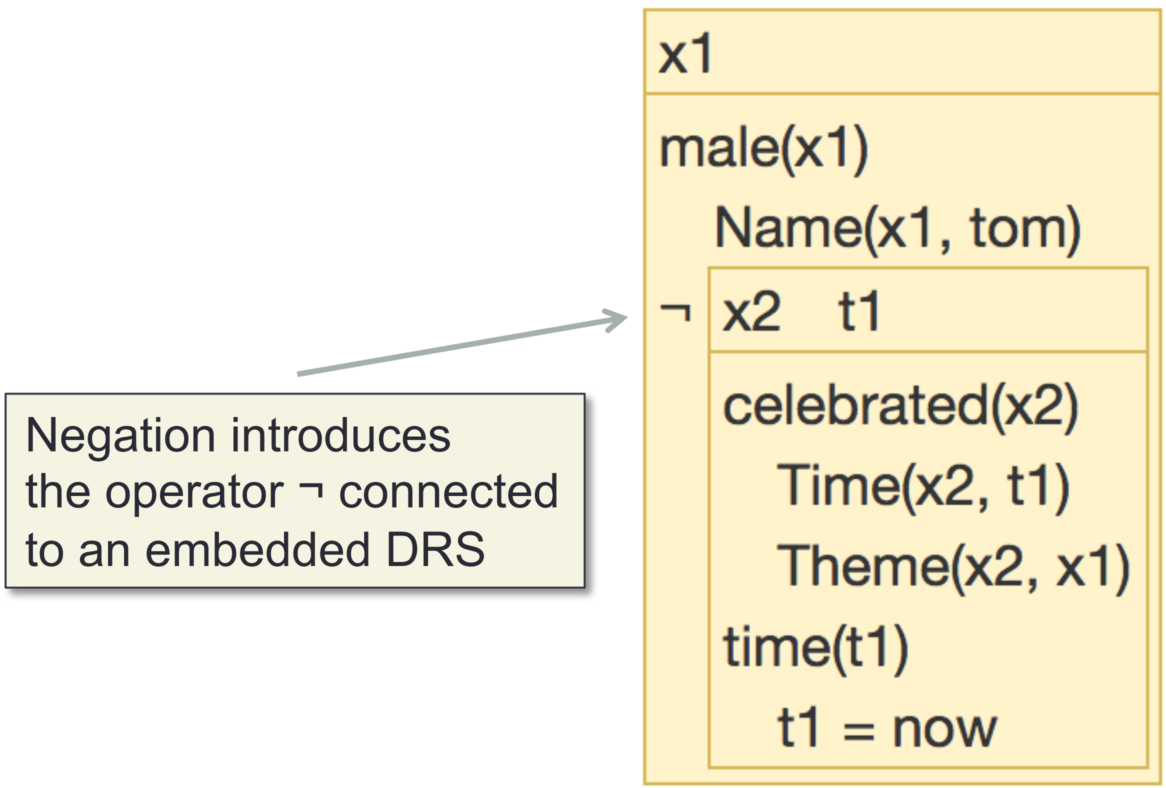
male(x1)
    Name(x1, tom)
grin(e1)
    Time(e1, t1)
    Agent(e1, x1)
time(t1)
    t1 = now

AN EXAMPLE WITH NEGATION

Tom is not famous.



Tom is not famous.



Tom is not famous.

x1

male(x1)
Name(x1, tom)

¬ x2 t1

celebrated(x2)
Time(x2, t1)
Theme(x2, x1)
time(t1)
t1 = now

Why use the symbol “celebrated” here?

Tom is not famous.

x1

male(x1)
Name(x1, tom)

¬ x2 t1

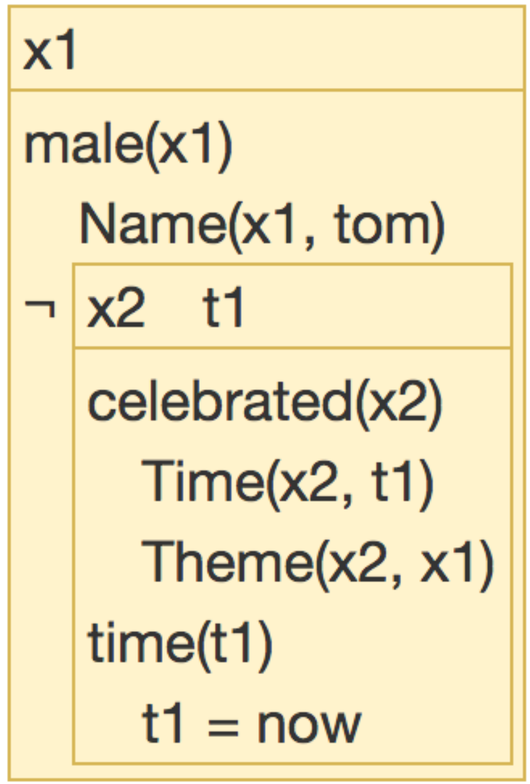
celebrated(x2)
Time(x2, t1)
Theme(x2, x1)
time(t1)

Why use the symbol “celebrated” here?

Adjective

- S: (adj) celebrated, famed, far-famed, **famous**, illustrious, notable, noted, renowned (widely known and esteemed) *"a famous actor"; "a celebrated musician"; "a famed scientist"; "an illustrious judge"; "a notable historian"; "a renowned painter"*

Tom is not famous.



in first-order logic

$$\exists x(male(x)\&Name(x,tom)\&\neg\exists e\exists t(celebrated(e)\&Time(e,t)\&Theme(e,x)\&time(t)\&t=now)$$

Tom is not famous.

A first-order model
M=<D,F>

D={d1,d2,d3}
F(male)={d1}
F(celebrated)={}
F(time)={}
F(Time)={}
F(Theme)={}
F(Name)={(d1,d2)}
F(now)=d3
F(tom)=d2

x1
male(x1) Name(x1, tom) ¬ [x2 t1 | celebrated(x2), Time(x2, t1), Theme(x2, x1), time(t1), t1 = now]

AN EXAMPLE WITH IMPLICATION

Everyone smiled at me.

x1

person(x1)

⇒

e1 t1 x2

smile(e1)

Recipient(e1, x2)

Time(e1, t1)

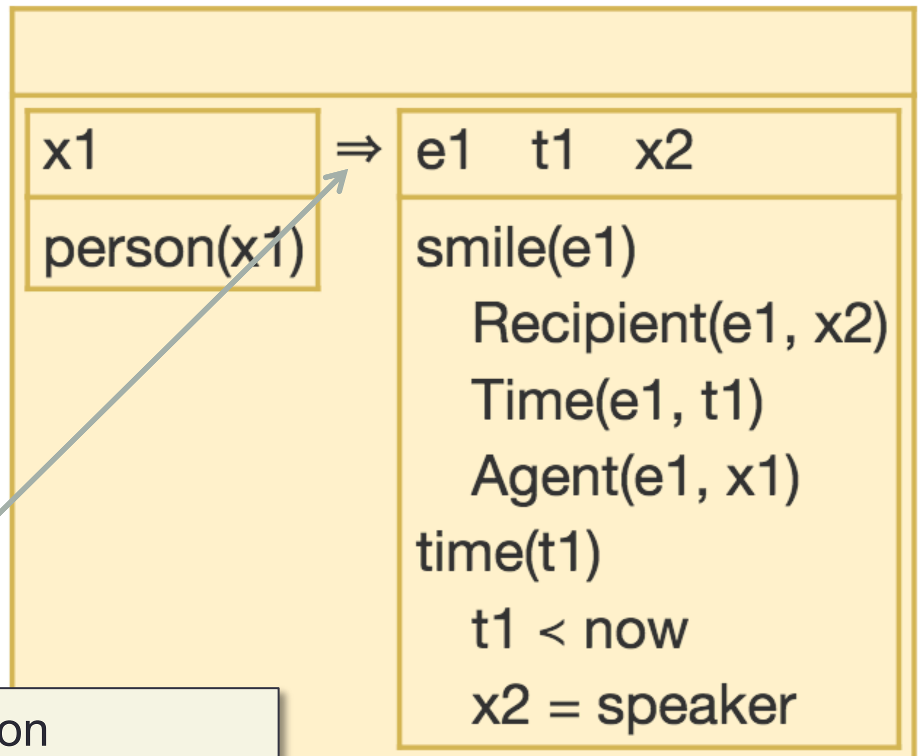
Agent(e1, x1)

time(t1)

t1 < now

x2 = speaker

Everyone smiled at me.



Universal quantification
Introduces the operator =>
connecting two embedded DRSs

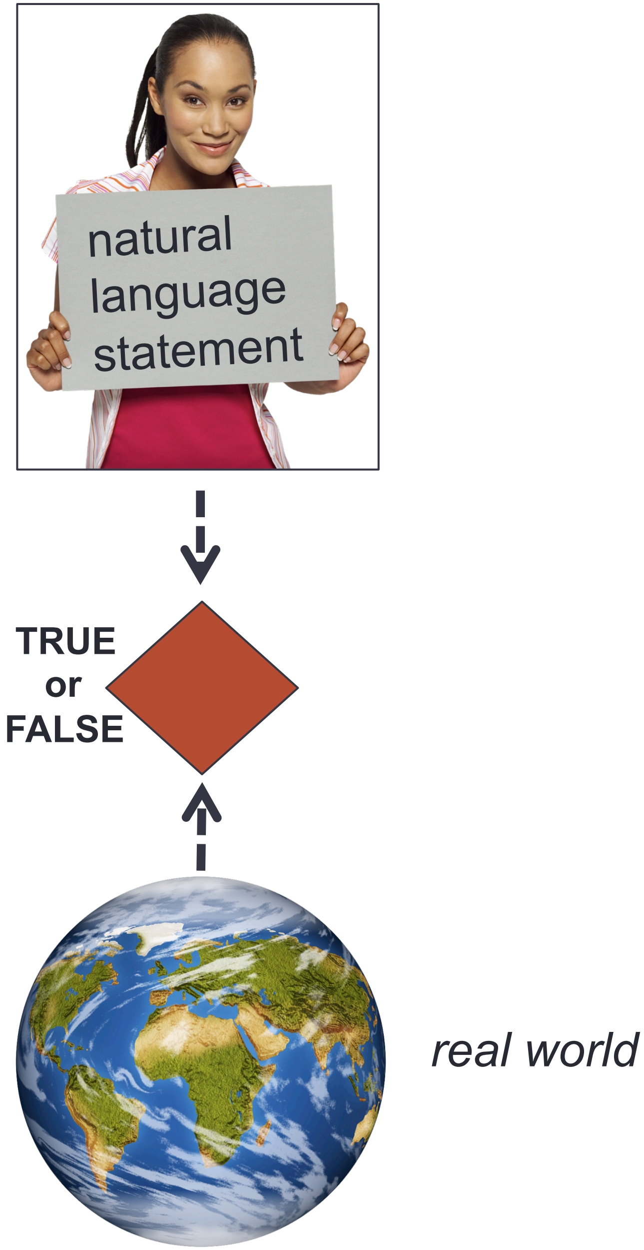
Everyone smiled at me.

x1	⇒	e1 t1 x2
person(x1)		smile(e1) Recipient(e1, x2) Time(e1, t1) Agent(e1, x1) time(t1) t1 < now x2 = speaker

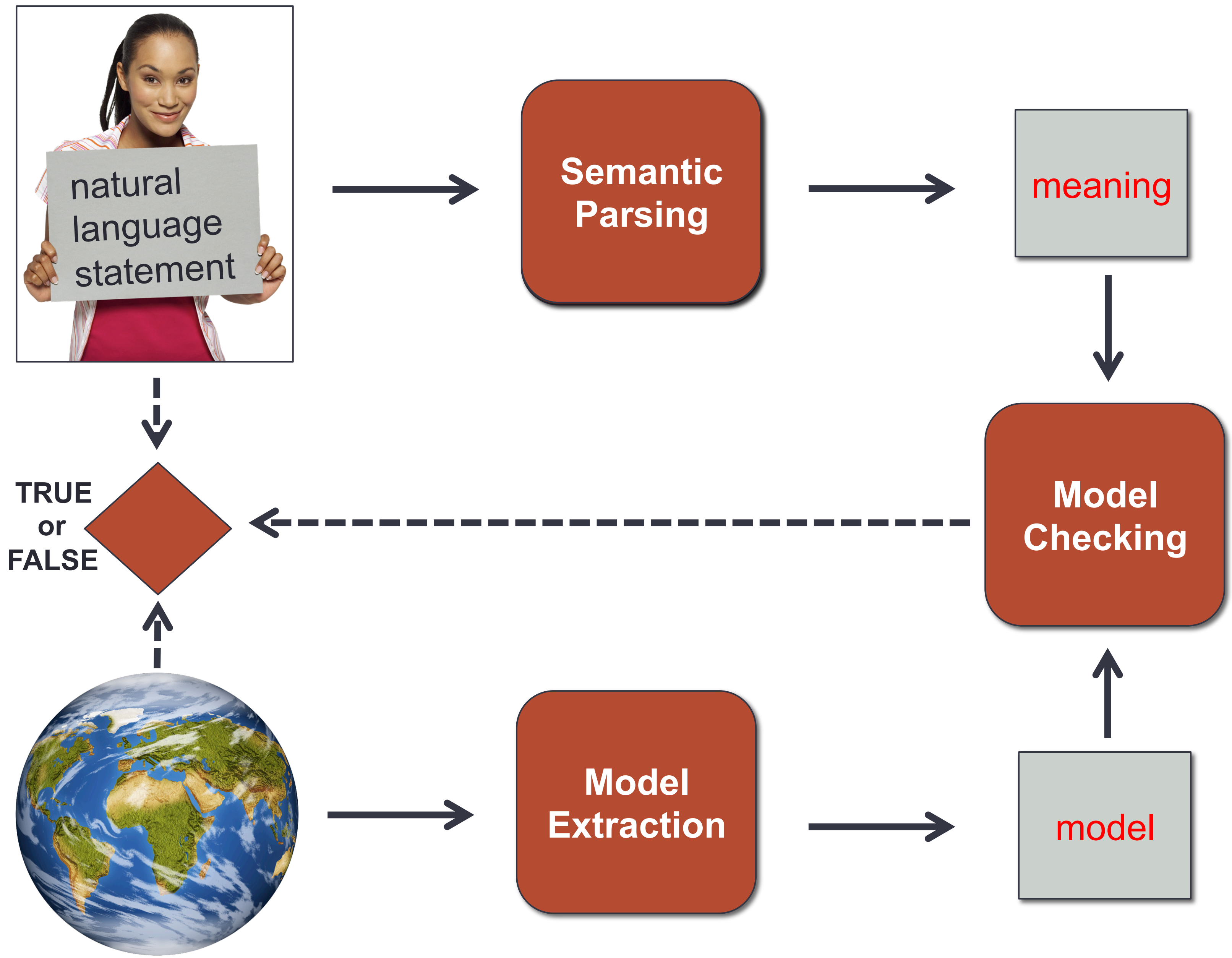
in first-order logic

∀x(person(x)→∃e∃t(smile(e)&Recipient(e,speaker)&Time(e,t)&Agent(e,x)& …)

The Big Picture



The Big Picture



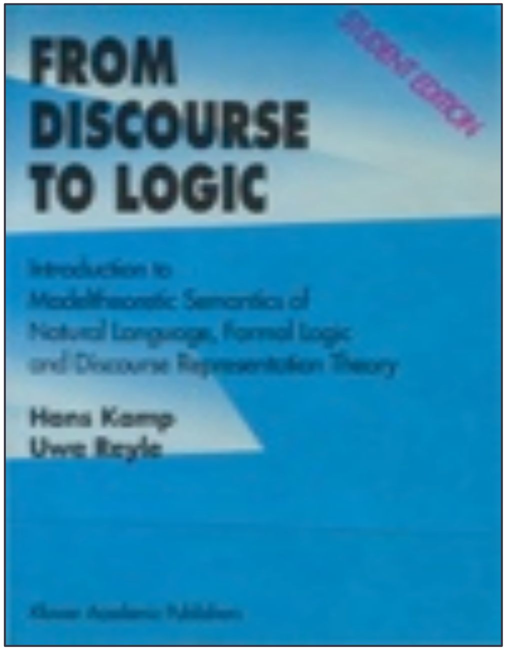
Parallel Meaning Bank

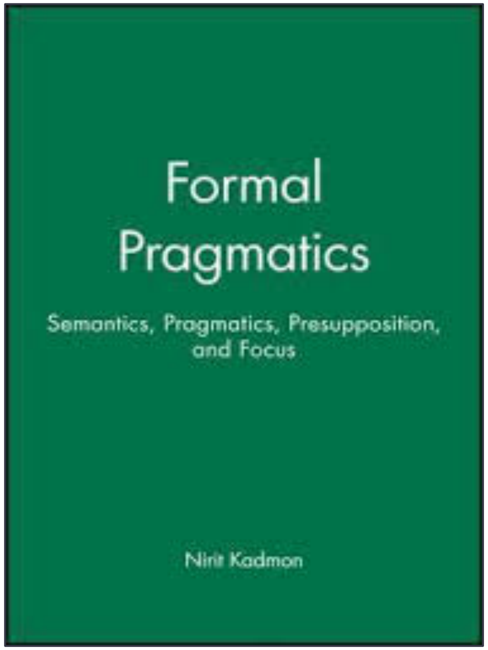
Motivation

- Integrate Lexical and Formal Semantics
- Gold-standard meanings
- Multi-lingual (not just English)
- Resource for parsing/translation

pmb.let.rug.nl

Discourse Representation Theory





Hans Kamp, Irene Heim, Nirit Kadmon, Rob van der Sandt,
Bart Geurts, David Beaver, Jan van Eijck, Uwe Reyle,
Robin Cooper, Reinhard Muskens, Nicholas Asher, Alex Lascarides

DRS example

```
Damon showed me his
stamp album.
```

x1 x2 e1 t1
male.n.02(x1)
Name(x1, damon)
time.n.08(t1)
t1 < now
show.v.04(e1)
Time(e1, t1)
Recipient(e1, speaker)
Theme(e1, x2)
Agent(e1, x1)
stamp_album.n.01(x2)
Owner(x2, x1)

Most likely interpretation

41/2289: Tom is stuck in his sleeping bag.

sleeping_bag.n.01(x)

in his sleeping~bag

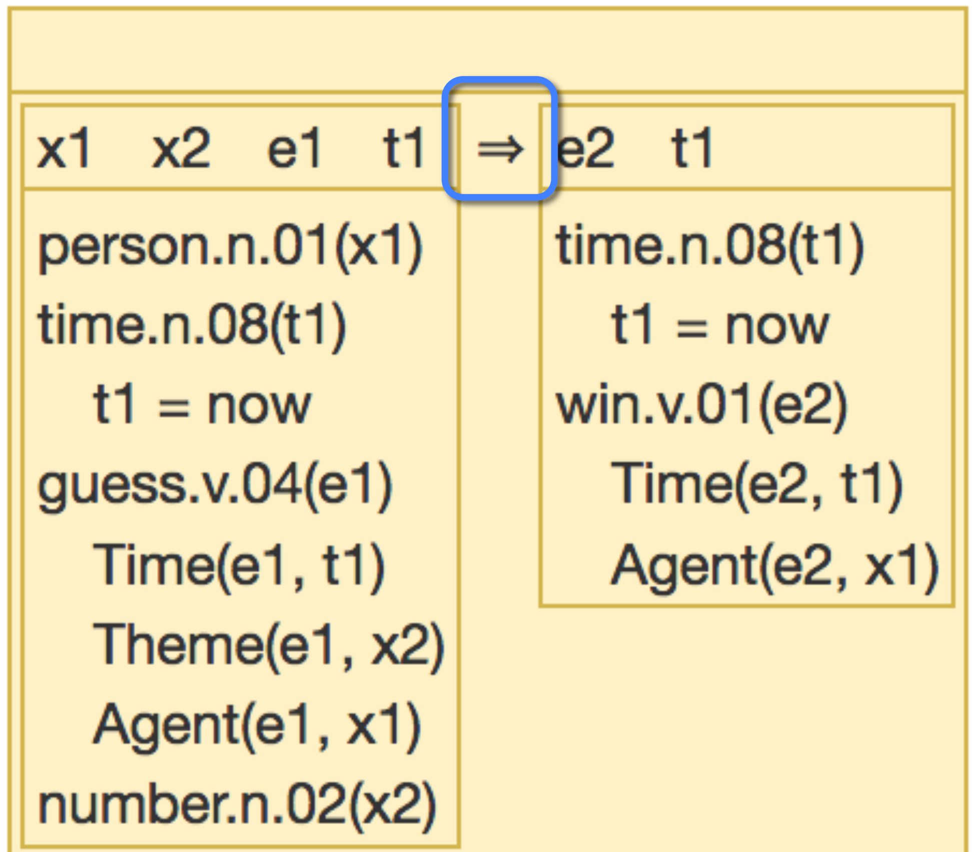
PP

λv1.

x1 x2
Location(v1, x2) male.n.02(x1) sleeping_bag.n.01(x2) User(x2, x1)

Quantification

```
Whoever guesses the
number wins.
```



Negation

My uncle isn't young, but he's healthy.

```
     | x1  x2                    |        | x1  s2  t2          |
b1 ::| uncle.n.01(x2)            | ➡ b4 ::| male.n.02(x1)       |
     |   Of(x2, speaker)         |        |   Attribute(x1, s2) |
     | person.n.01(x1)           |        | time.n.08(t2)       |
     |   Role(x1, x2)            |        |   t2 = now          |
     | ¬ | s1  t1              | |        | healthy.a.01(s2)    |
     |   | time.n.08(t1)       | |        |   Time(s2, t2)      |
     |   |   t1 = now          | |
     |   | young.a.01(s1)      | |
     |   |   Time(s1, t1)      | |
     |   |   Attribute(x1, s1) | |
CONTRAST(b1, b4)
```

Pronouns

`My uncle isn't young, but he's healthy.`

```
b1 :: | x1  x2                     |   ⇒   b4 :: | x1  s2  t2            |
      |----------------------------|             |-----------------------|
      | uncle.n.01(x2)             |             | male.n.02(x1)         |
      |   Of(x2, speaker)          |             |   Attribute(x1, s2)   |
      | person.n.01(x1)            |             | time.n.08(t2)         |
      |   Role(x1, x2)             |             |   t2 = now            |
      | ¬ | s1  t1               | |             | healthy.a.01(s2)      |
      |   |----------------------| |             |   Time(s2, t2)        |
      |   | time.n.08(t1)        | |
      |   |   t1 = now           | |
      |   | young.a.01(s1)       | |
      |   |   Time(s1, t1)       | |
      |   |   Attribute(x1, s1)  | |
CONTRAST(b1, b4)
```

Verb phrase coordination

```
Tom grabbed his umbrella and headed for the
elevator.
```

b1 :: x1 x2 e1 t1

male(x1)
    Name(x1, tom)
time(t1)
    t1 < now
grab(e1)
    Time(e1, t1)
    Theme(e1, x2)
    Agent(e1, x1)
umbrella(x2)
    User(x2, x1)

⇒ b4 :: e2 x3 t2

time(t2)
    t2 < now
head(e2)
    Time(e2, t2)
    Destination(e2, x3)
    Theme(e2, x1)
elevator(x3)

CONTINUATION(b1, b4)

Possessives

Jane Austen’s books a
very beautiful!

x1 x2 s1 s2 t1

female.n.02(x1)
    Name(x1, jane~austen)
book.n.01(x2)
    Attribute(x2, s1)
    Creator(x2, x1)
time.n.08(t1)
    t1 = now
beautiful.a.01(s1)
    Time(s1, t1)
    Degree(s1, s2)
very.r.01(s2)

Spatial expressions

```
There's a parrot in the
birdcage.
```

e1 x1 t1 x2 x3
time(t1)
t1 = now
be(e1)
Location(e1, x3)
Time(e1, t1)
Theme(e1, x1)
parrot(x1)
location(x3)
STI(x3, x2)
birdcage(x2)

Measure phrases

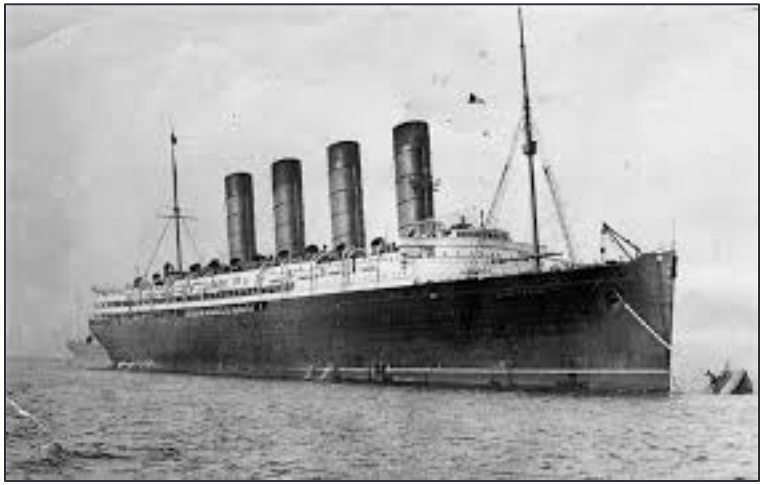
```
Tom bet $300 on the
race.
```

x1	x2	e1	x3	t1

male.n.02(x1)
  Name(x1, tom)
time.n.08(t1)
  t1 < now
bet.v.02(e1)
  Time(e1, t1)
  Theme(e1, x3)
  Asset(e1, x2)
  Agent(e1, x1)
measure.n.02(x2)
  Unit(x2, dollar)
  Quantity(x2, 300)
race.n.02(x3)

Comparison

More than 1,500 people died when the Titanic sank in 1912.



x1	n1	x2	e1	t1	x3	e2

quantity.n.01(n1)
    n1 > x2
person.n.01(x1)
    Quantity(x1, n1)
quantity.n.01(x2)
    x2 = 1500
die.v.01(e1)
    Time(e1, t1)
    Patient(e1, x1)
vehicle.n.01(x3)
    Name(x3, titanic)
sink.v.04(e2)
    Time(e2, t1)
    Patient(e2, x3)
time.n.08(t1)
    YearOfCentury(t1, 1912)
    t1 < now

Lists

I visited cities such as New York, Chicago and Boston.

x1 x2 x3 x4 x5 e1 t1
time.n.08(t1)
t1 < now
visit.v.01(e1)
Time(e1, t1)
Theme(e1, x1)
Agent(e1, speaker)
city.n.01(x1)
Sub(x1, x2)
city.n.01(x3)
Name(x3, new~york)
city.n.01(x4)
Name(x4, chicago)
entity.n.01(x2)
Sub(x2, x5)
Sub(x2, x4)
Sub(x2, x3)
city.n.01(x5)
Name(x5, boston)

Discourse relations

`Tom will be absent today because he has a cold.`

b1 :: [t1 x1 s1 t2]

- male.n.02(x1)
    - Attribute(x1, s1)
    - Name(x1, tom)
- time.n.08(t2)
    - now $\sqsubset$ t1
    - t2 $>$ now
    - t2 $\sqsubset$ t1
- absent.a.01(s1)
    - Time(s1, t2)
- day.n.03(t1)

$\Rightarrow$ **b3 ::** [x1 x2 e1 t3]

- male.n.02(x1)
- time.n.08(t3)
    - t3 = now
- have.v.16(e1)
    - Time(e1, t3)
    - Stimulus(e1, x2)
    - Experiencer(e1, x1)
- cold.n.01(x2)

EXPLANATION(b1, b3)

Date expressions

Carl Smith died
on August 8.


```
x1   e1   t1
--------------------------
male.n.02(x1)
   Name(x1, carl~smith)
die.v.01(e1)
   Time(e1, t1)
   Patient(e1, x1)
time.n.08(t1)
   DayOfMonth(t1, 08)
   MonthOfYear(t1, 08)
   t1 < now
```

Kamp 2018

$$e \quad t \quad d \quad d'$$

$$t \prec n \quad e \subseteq t$$
$$\mathrm{day}(d) \quad \mathrm{day}(d') \quad n \subseteq d' \quad d \supset\subset d' \quad e \subseteq d$$
$$e : \text{rain'}$$

e1 t1 x1 t2

rain.v.01(e1)
Time(e1, t1)
time.n.08(t1)
now ⊏ t2
t1 ⊏ x1
t1 < now
day.n.03(x1)
x1 ⋈ t2
day.n.03(t2)

It rained yesterday.

Evaluating Meaning Representations

Semantic Evaluation

- Check for logical equivalence
- Use standard theorem provers for first-order logic (Blackburn & Bos 2005)
- Discrete score:
  0 (no proof)
  1 (proof)

Syntactic Evaluation

- Check matching clauses
- Implementations:
  - Allen et al. 2008
  - Smatch (Cai & Knight 2013)
  - Counter (van Noord et al. 2018)
- Continuous score:
  0.00 (no matches)
  0.X (some but not all)
  1.00 (perfect match)

Clause Notation

```
b1 REF e1            % It [0...2] rained [3...9]
b1 TPR t1 "now"      % rained [3...9]
b1 rain "v.01" e1    % rained [3...9]
b1 REF t1            % rained [3...9] yesterday [10...19]
b1 Time e1 t1        % rained [3...9] yesterday [10...19]
b1 time "n.08" t1    % rained [3...9] yesterday [10...19]
b1 REF t2            % yesterday [10...19]
b1 REF x1            % yesterday [10...19]
b1 TAB x1 t2         % yesterday [10...19]
b1 TIN "now" t2      % yesterday [10...19]
b1 TIN t1 x1         % yesterday [10...19]
b1 day "n.03" t2     % yesterday [10...19]
b1 day "n.03" x1     % yesterday [10...19]
                     % . [19...20]
```

Parallel MEANING BANK

e1 t1 x1 t2
rain.v.01(e1)
Time(e1, t1)
time.n.08(t1)
now $\sqsubset$ t2
t1 $\sqsubset$ x1
t1 $<$ now
day.n.03(x1)
x1 $\bowtie$ t2
day.n.03(t2)

```
It rained yesterday.
012345678901234567890
```

Van Noord et al. 2018

01/3445: He smiled.

x_1 e_1 t_1
male.n.02(x_1)
smile.v.01(e_1)
Time(e_1, t_1)
Agent(e_1, x_1)
time.n.08(t_1)
$t_1 \prec$ now

SPAR DRS

~~b1 REF x1~~
b1 male n.02 x1
~~b3 REF t1~~
b3 TPR t1 "now"
b3 time n.08 t1
k0 Agent e1 x1
~~k0 REF e1~~
k0 Time e1 t1
k0 smile v.01 e1

00/3514: She fled Australia.

x_1 x_2 v_1 t_1
female.n.02(x_1)
flee.v.01(v_1)
Time(v_1, t_1)
Source(v_1, x_2)
Theme(v_1, x_1)
time.n.08(t_1)
$t_1 \prec$ now
country.n.02(x_2)
Name(x_2, australia)

~~b1 REF x1~~
b1 female n.02 x1
~~b3 REF t1~~
b3 TPR t1 "now"
b3 time n.08 t1
b0 Theme v1 x1
b0 Source v1 x2
~~b0 REF v1~~
b0 Time v1 t1
b0 flee v.01 v1
~~b2 REF x2~~
b2 Name x2 "australia"
b2 country n.02 x2

Figure 4: The SPAR DRS (Section 5.1) matches the DRS of 00/3514 PMB document with an F-score of 54.5%. If redundant REF-clauses are ignored, the F-score drops to 40%. These results are achieved with the help of the mapping {k0↦b0, e1↦v1}.

DRS and interlinguality

Logical symbols

- ☐negation
- ☐conditionals
- ☐scope (boxes)
- ☐variables

Non-logical symbols

- ☐predicates (concepts)
- ☐constants (names)
- ☐relations (roles)
- ☐comparison operators

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Kamp 2018

$e \quad t \quad d \quad d'$
$t \prec n \quad e \subseteq t$ $\text{day}(d) \quad \text{day}(d') \quad n \subseteq d' \quad d \supset\subset d' \quad e \subseteq d$ $e : \text{rain'}$

e1 t1 x1 t2
rain.v.01(e1)   Time(e1, t1)   time.n.08(t1)   now ⊏ t2   t1 ⊏ x1   t1 < now   day.n.03(x1)   x1 ⋈ t2   day.n.03(t2)

`It rained yesterday.`

Representing Predicate Symbols

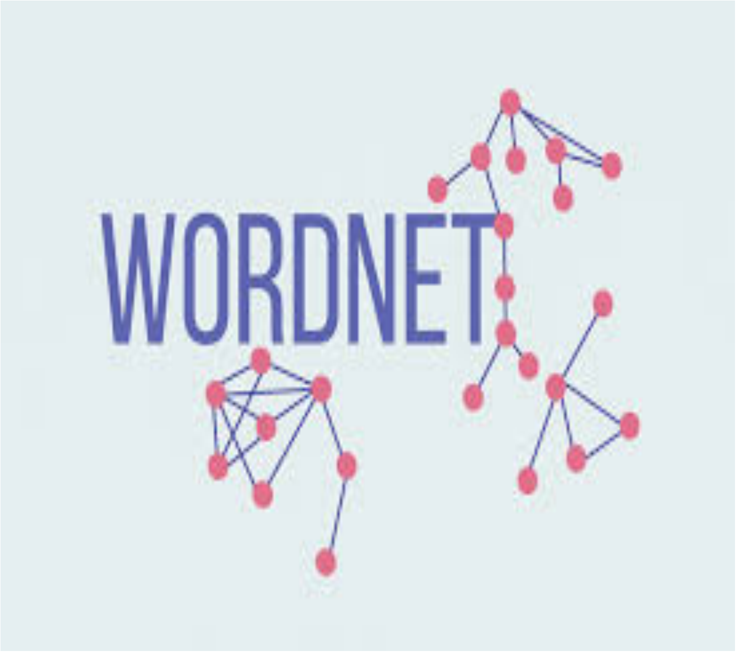
- Wordnet Synsets
- Wordnet encodings
- Word embeddings
  - static: word2vec
  - dynamic: Elmo, Bert, XLNet

WordNet

- words meanings via *synonym sets* (synsets)
- relations between synsets (hyperonymy)

{plant, factory}

{plant, flora}



WordNet

- words meanings via *synonym sets* (synsets)
- relations between synsets (hyperonymy)

{plant.n.01, factory.n.01}

{plant.n.02, flora.n.01}

WordNet

- words meanings via *synonym sets* (synsets)
- relations between synsets (hyperonymy)

08293644 :: {plant.n.01, factory.n.01}

07253221 :: {plant.n.02, flora.n.01}

Interlingual WordNet

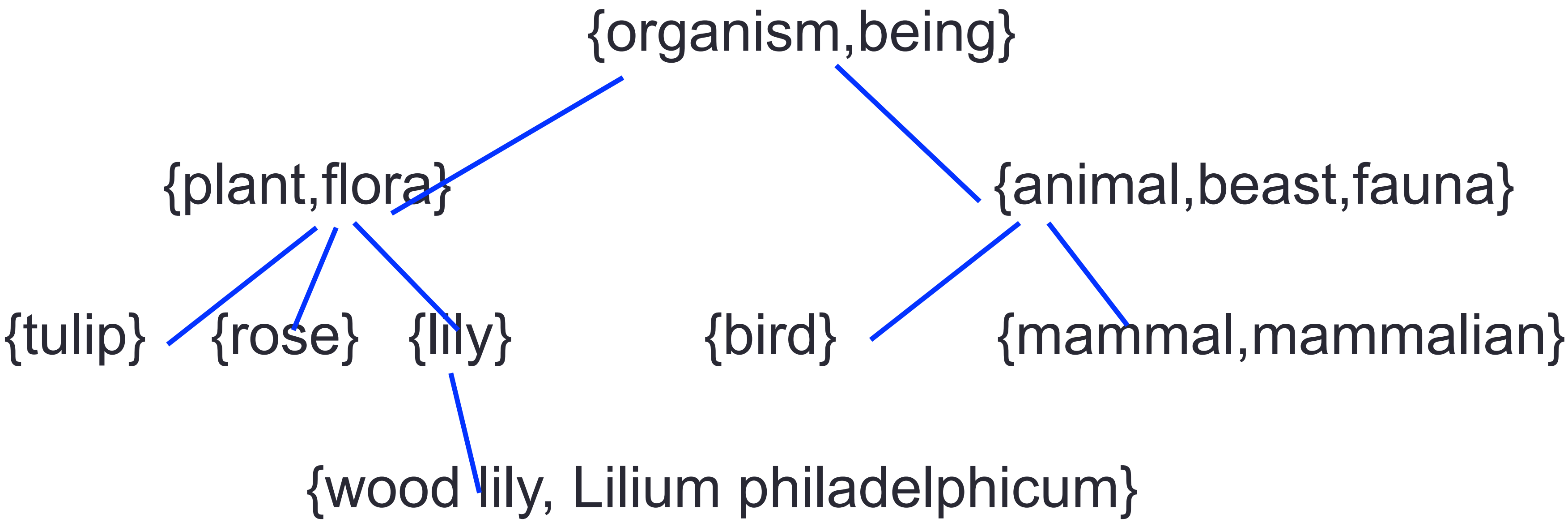
- words meanings via *synonym sets* (synsets)
- relations between synsets (hyperonymy)

{plant.n.01.en, factory.n.01.en, fabriek.n.01.nl}

{plant.n.02.en, flora.n.01.en, pflanze.n.01.de}

Knowledge in WordNet

- words meanings via *synonym sets* (synsets)
- relations between synsets (hyperonymy)



Representing Concepts: WordNet

x1 e1 t1

08293641(x1)
15160774(t1)
    YearOfCentury(t1,1650)
    t1 < now
02431950(e1)
    Time(e1,t1)
    Theme(e1,x1)

`This school was founded in 1650.`

Representing Concepts: WordNet

x1 e1 t1

school.n.01(x1)
time.n.08(t1)
    YearOfCentury(t1,1650)
    t1 < now
found.v.02(e1)
    Time(e1,t1)
    Theme(e1,x1)

`This school was founded in 1650.`

The Parallel Meaning Bank

TODAY: Computational Semantics,
Meaning Representations and
Discourse Representation Theory

FRIDAY: Producing Meaning Representations
Tokenisation, Semantic Tagging, Composition