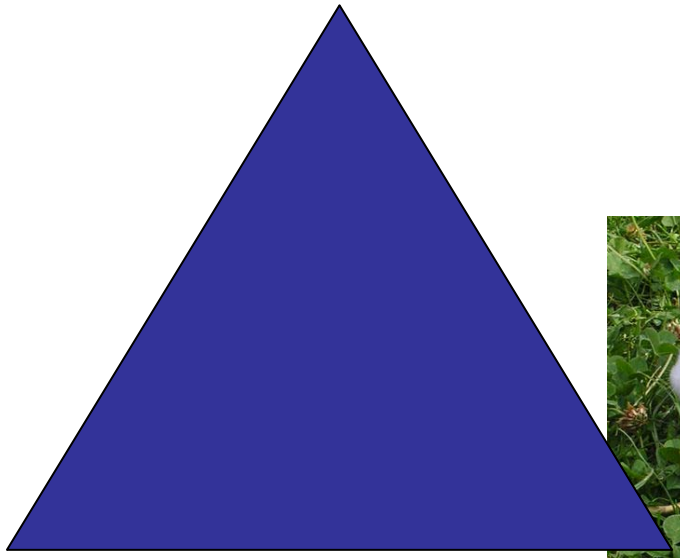
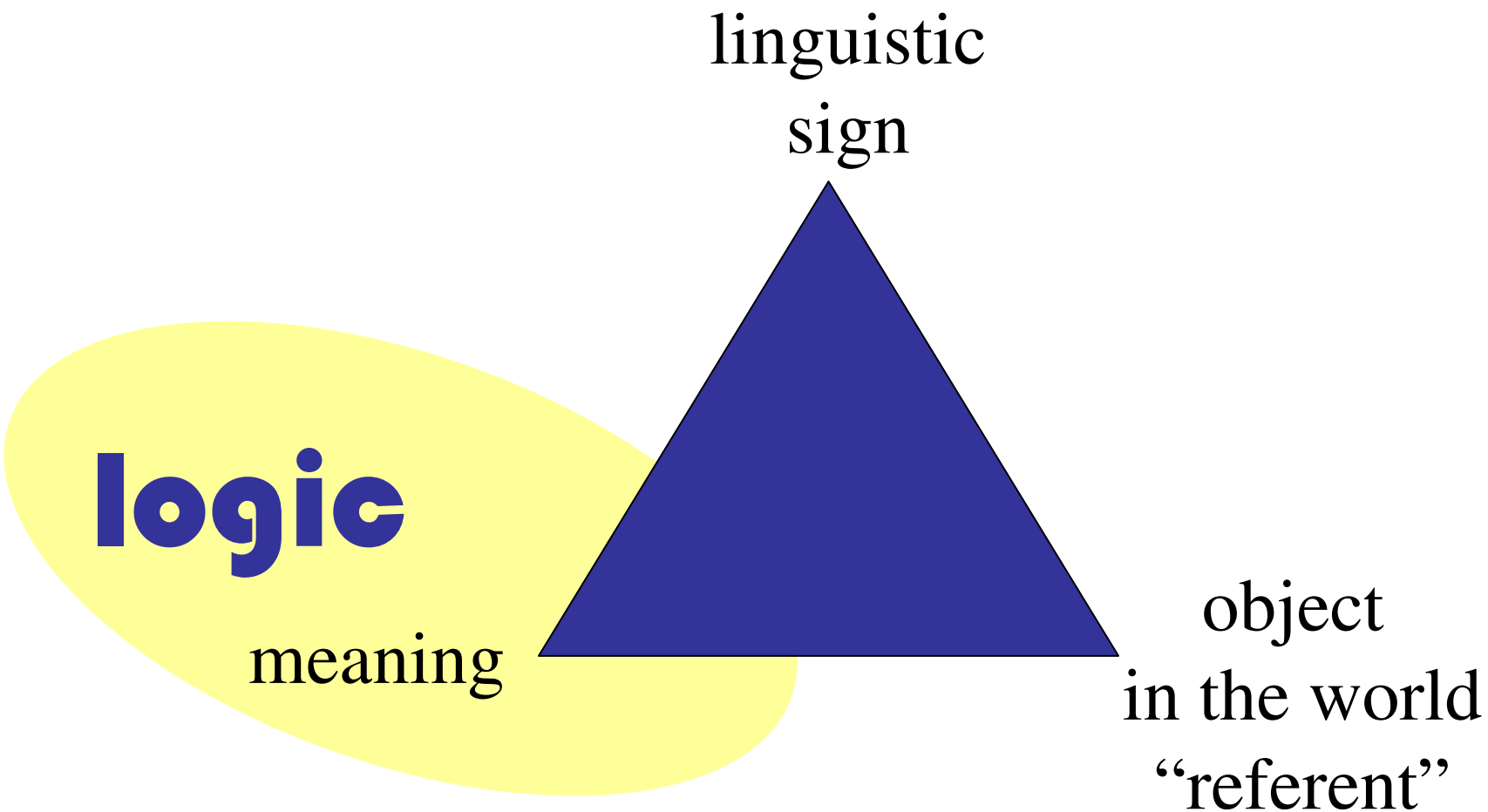
The semiotic triangle

“rabbit”



4 legged mammal
with long ears that
eats grass and
hops around
a lot …

The semiotic triangle



Logic

- is one way of being very clear about just what something means
- what is being ‘commited to’ in the meaning

What do sentences mean?

- *Capturing common meanings…*
  - The boy kicked the ball
  - The ball was kicked by the boy

What do sentences mean?

- *Detecting strange utterances*
  - That bachelor is married.
  - The old woman is young.

What do sentences mean?

- *Resolving ambiguities*
  - He chased the rabbits in the field
  - She listened to the radio in the street

What do sentences mean?

- *Resolving ambiguities*
  - Every man climbed one mountain
  - One mountain was climbed by every man

What do sentences mean?

- Capturing common meanings…
  - The boy kicked the ball
  - The ball was kicked by the boy
- Detecting strange utterances
  - That bachelor is married.
  - The old woman is young.
- Resolving ambiguities
  - He chased the rabbits in field
  - She listened to the radio in the street
  - Every man climbed one mountain
  - One mountain was climbed by every man

Logic

- The investigation of ‘sound argument’
- Relation to Ancient Greek *rhetoric* (e.g., Aristotle)

- What patterns of argument can be guaranteed to lead to correct conclusions?

- One Example:

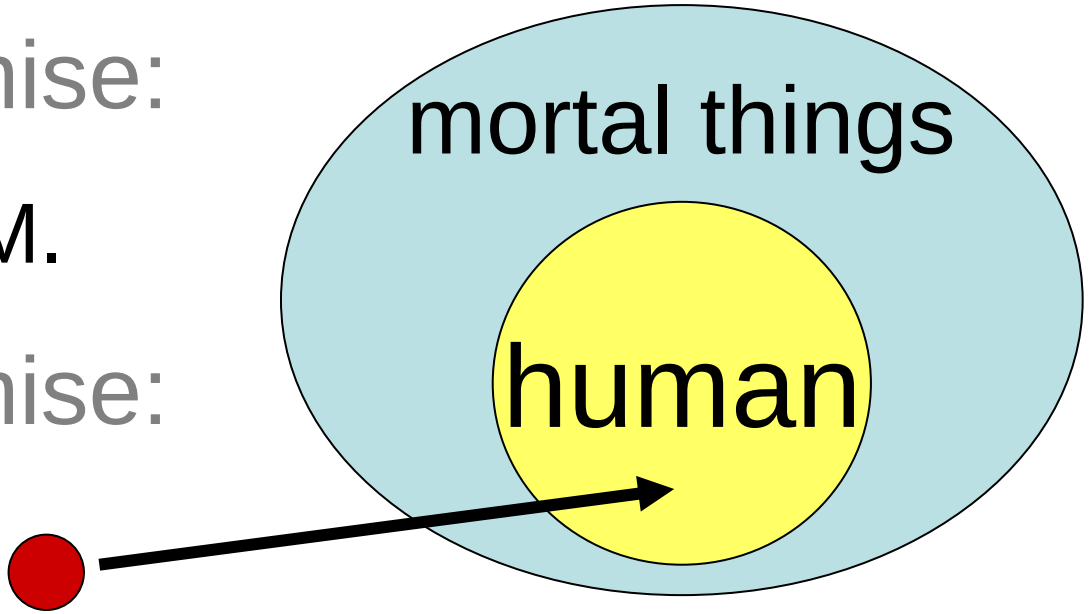
The syllogism

The syllogism

- Major premise:
  - All humans are mortal.
- Minor premise:
  - Socrates is human.
- Conclusion:
  - Socrates is mortal.

The syllogism

- Major premise:
  - All H are M.
- Minor premise:
  - S is H.
- Conclusion:
  - S is M.



The Language of Logic

- Major premise:
  - All H are M.
- Minor premise:
  - S is H.

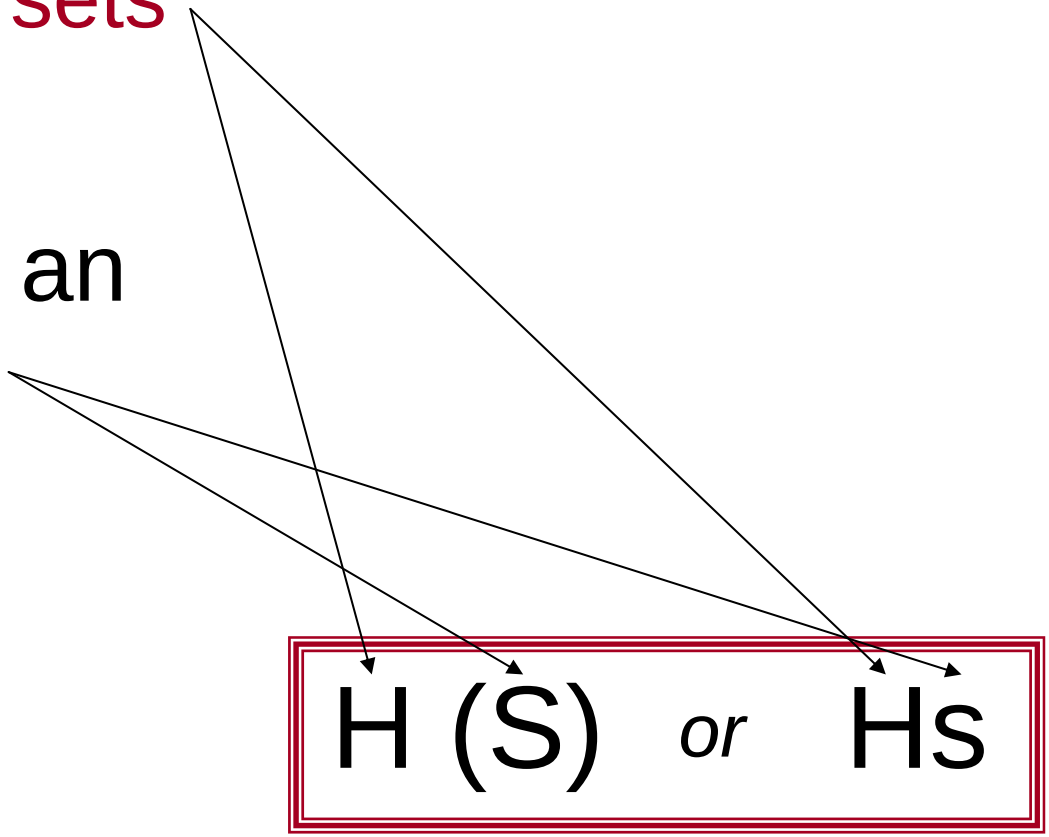
H (S) *or* Hs

- Conclusion:
  - S is M.

M (S) *or* Ms

The Language of Logic

- Human and Mortal are
  - classes or sets
- Socrates is an
  - individual



The Language of Logic

Predicates

- **“one place”**
  - door (x)
  - accountant (x)
  - book (x)
  - human (x)
  - mortal (x)

The Language of Logic

- The investigation of ‘sound argument’
- Relation to Ancient Greek rhetoric

- What patterns of argument can be guaranteed to lead to correct conclusions?

Connectives
‘and’ : $\wedge$ ‘or’: $\vee$ ‘not’: $\neg$ ‘implies’ $\rightarrow$

The syllogism

- Major premise:
  - All humans are mortal. $Hx \rightarrow Mx$
- Minor premise:
  - Socrates is human. Hs
- Conclusion:
  - Socrates is mortal. Ms

Logical formulae

- what about events and actions?
  - Socrates runs
  - Aristotle chases Socrates
  - The gods gave Aristotle a good idea

Logical formulae

- what about events and actions?
  - Socrates runs
  - Aristotle chases Socrates
  - The gods gave Aristotle a good idea

runs (Socrates)

Logical formulae

- what about events and actions?
  - Socrates runs
  - Aristotle chases Socrates
  - The gods gave Aristotle a good idea

chase (Aristotle, Socrates)

Logical formulae

- what about events and actions?
  - Socrates runs
  - Aristotle chases Socrates
  - The gods gave Aristotle a good idea

give (Gods, Aristotle, Idea)

Logical formulae

- what about events and actions?

  – The gods gave Aristotle a good idea

a: Aristotle

Gods (g) ∧
Idea (i) ∧
Good (i) ∧
give (g, a, i)

Logic

Predicates

- **“one place”**
  - door (x)
  - accountant (x)
  - book (x)
  - run (x)
- **“two place”**
  - eat (x, y)
  - chase (x, y)
  - read (x, y)
- **“three place”**
  - give (x, y, z)

Connectives

‘and’ : $\wedge$ ‘or’: $\vee$ ‘not’: $\neg$ ‘implies’ $\rightarrow$

What do sentences mean?

- Capturing common meanings…
  - The boy kicked the ball
  - The ball was kicked by the boy
- Detecting strange utterances
  - That bachelor is married.
  - The old woman is young.
- Resolving ambiguities
  - He chased the rabbits in field
  - She listened to the radio in the street
  - Every man climbed one mountain
  - One mountain was climbed by every man

More logical formulae

- “If someone chases someone else then both people run”

what predicates?
what connectives?

Logical formulae: definitions

- “If someone chases someone else then both people run”

$$\text{chase}(x, y) \rightarrow \text{run}(x) \wedge \text{run}(y)$$

$$\mathbf{x \neq y} \wedge$$
$$\text{person}(x) \wedge \text{person}(y) \wedge \text{chase}(x, y)$$
$$\rightarrow \text{run}(x) \wedge \text{run}(y)$$

Logic

- This gives us a language for making meanings clear…

- … but we can still write meanings in lots of different ways
  - … what is a *good* way?
  - … are some ways better than others?

Representing the World

“a red ball”

http://squeegie.org/index.php

Ontology

Representing the World

$red(x) \wedge ball(x)$

http://squeegie.org/index.php

“the logical level”

$Rx \wedge Bx$

M. R. Genesereth and N. J. Nilsson 1987. *Logical Foundation of Artificial Intelligence.* Morgan Kaufmann, Los Altos, California.

R. J. Brachman 1979. On the Epistemological Status of Semantic Networks. In N. V. Findler (ed.), *Associative Networks: Representation and Use of Knowledge by Computers*. Academic Press.

Representing the World

- ‘redness’
- ‘ballness’

http://squeegie.org/index.php

are fundamentally different!

“the ontological level”

N. Guarino 1994. The Ontological Level. In R. Casati, B. Smith and G. White (ed.), *Philosophy and the Cognitive Science*. Hölder-Pichler-Tempsky, Vienna.

The ontological level

- defining the distinct kinds of entities that need to be distinguished
- identifying their necessary properties
- formalising those properties

- a sounder, more robust modelling of the world

Levels

perception

http://squeegie.org/index.php

the knowledge level

the ontological level

- entities that are colours
- entities like physical objects
- physical objects bear attributes

the logical level

$\exists x.\ Rx \wedge Bx$

Using Knowledge Representation for Language Processing

Linguistic Knowledge

Word Semantics

e.g, WordNet

Linguistic Knowledge

- Typically bundled into ‘frames’

John kicked the ball on Tuesday

- **Frame** semantics

‘Davidsonian’ semantics

Charles Fillmore: ‘case grammar’

John kicked the ball on Tuesday

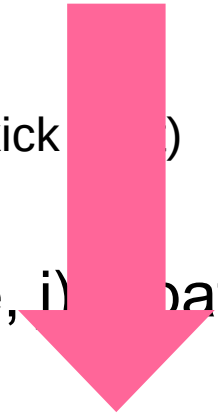
kick (j,b,t)

- doesn’t really help us put the meaning together out of the parts
- doesn’t really seem ‘ontologically’ appropriate

‘Davidsonian’ semantics

Charles Fillmore: ‘case grammar’

John kicked the ball on Tuesday



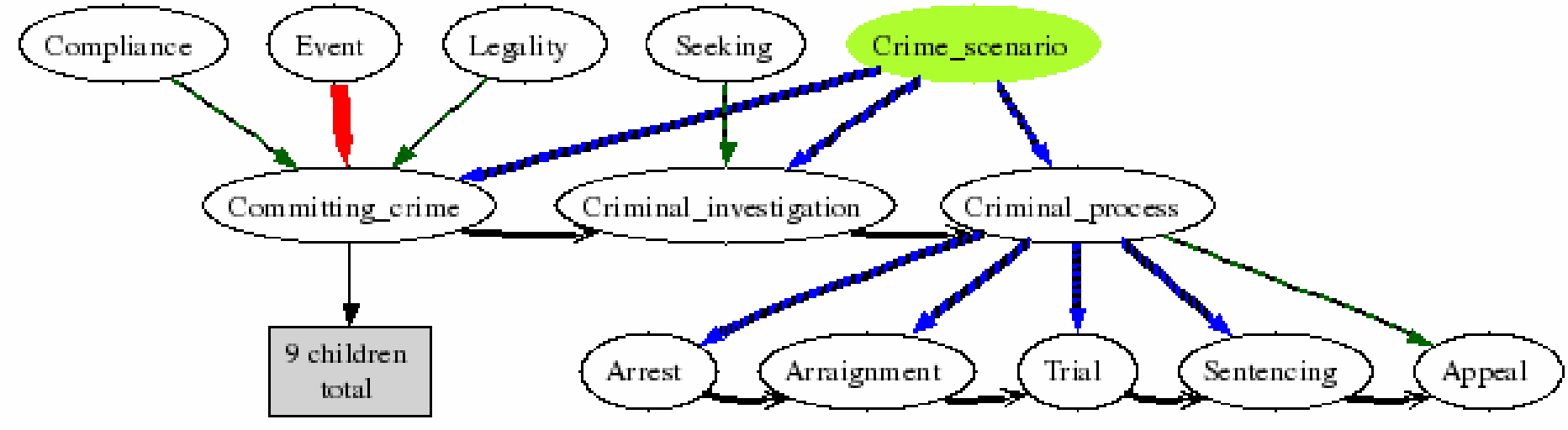
kick (

event (e) ∧ actor (e, j) ∧ patient (e, b) ∧ time (e, t)

∃y event ∧ has.actor (j) ∧ has.patient (b) ∧ has.time (t)

Description Logic

Frame Semantics



e.g, FrameNet

Semantic Hierarchies

‘Ontologies’