The semiotic triangle

“rabbit”

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

- **logic**
- **meaning**
- **linguistic sign**
- **object in the world “referent”**
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
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• Detecting strange utterances
  – That bachelor is married.
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• Resolving ambiguities
  – He chased the rabbits in field
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  – 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.  

–Conclusion:  
  • S is M.

\[
\begin{align*}
\text{H (S) or Hs} \\
\text{M (S) or Ms}
\end{align*}
\]
The Language of Logic

– Human and Mortal are
  • classes or sets

– Socrates is an
  • individual

\[ H (S) \text{ or } Hs \]
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?

<table>
<thead>
<tr>
<th>Connectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘and’: ∧</td>
</tr>
</tbody>
</table>
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

\[
\text{Gods (g)} \land \\
\text{Idea (i)} \land \\
\text{Good (i)} \land \\
give (g, a, i)
\]

a: Aristotle
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’: ∧  ‘or’: ∨  ‘not’: ¬  ‘implies’: →
What do sentences mean?

• Capturing common meanings…
  – The boy kicked the ball
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• 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”

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

\[
x \neq y \ \wedge \\
\text{person} \ (x) \ \wedge \ \text{person} \ (y) \ \wedge \ \text{chase} \ (x, \ y) \\
\rightarrow \ \text{run} \ (x) \ \wedge \ \text{run} \ (y)
\]
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”
Ontology
Representing the World

\[ \text{red}(x) \land \text{ball}(x) \]

“the logical level”

\[ R_x \land B_x \]


“the ontological level”


• ‘redness’
• ‘ballness’

are fundamentally different!
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

the knowledge level

the ontological level

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

∃x. Rx ∧ 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

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’

```
               Sem-Obj
            /     \
       Phsy-Obj     Situation
         /     \
      Animate-Being   Person   Thing
          /     \
       Change   Action   State

                     Phys-Obj
                 Person
```