

### Simple Animal Minds (and Plants)

**From last week: central features of human cognition that we would expect to find in biologically-inspired superintelligence:**

- Viewpoint-invariant representations
- Language-like mental representations that are recursive and combinatorial.
  - o Combinatorial: our thoughts are built out of familiar constituents combined according to rules.
  - o Productive/recursive: in principle, one can entertain and produce an infinite number of distinct representations because the mind has combinatorial syntax.
- One or more global workspaces: the ability to integrate information from different senses and cognitive capacities.
- Mental processing that can be understood via functional decomposition, i.e. decomposing a capacity into causally organized parts.

**Central questions for this class:**

- Do simple animals, like bees, have minds? Do plants have minds?
- What are minimal necessary and sufficient conditions for having a mind? Is a belief-desire cognitive architecture sufficient for mindedness?
- What is minimally involved in thinking, and in having beliefs and desires?
- How does behavioral evidence bear on what cognitive architecture something has?

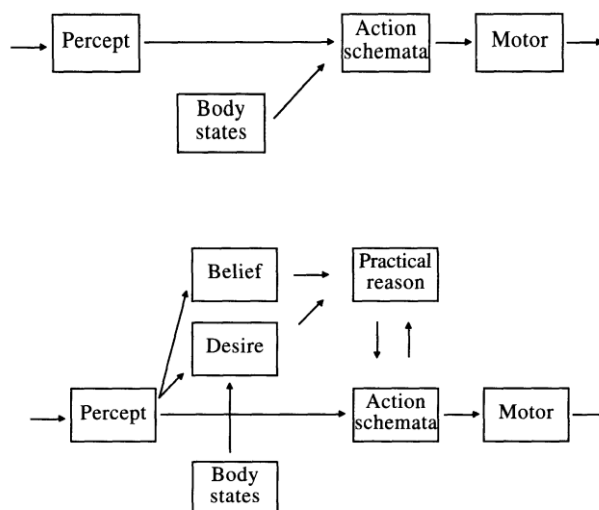
	Conscious?	Beliefs&Desires?	Learn?	Respond to reasons?	Have minds?
Chimps					
Cats					
Rats					
Bees					
Plants					

#### Simple Animal Minds

- What is Carruthers' central question?
- What is his answer?
- What is his main argument?

#### Two kinds of cognitive architecture (next page)

- Why is (1) not enough for having a mind?
- Is (2) enough for having a mind?



### Why should we think that bees have cognitive architecture (2)?

The bee dance! “They generally dance in a figure-of-eight pattern on a vertical surface in the dark inside the hive. The angle of movement through the center of the figure of eight, as measured from the vertical, corresponds to the angle from the expected direction of the sun for the time of day. (E.g., a dance angled at 30 to the right of vertical at midday would represent 30 west of south, in the northern hemisphere.) And the number of 'waggles' made through the center of the figure of eight provides a measure of distance. (Different bee species use different innately fixed measures of waggles-to-distance.)”

### What does doing the bee dance and responding to it require bees to believe and want?

### Plants: do they also have cognitive architecture (2)?

“During the day, the mallow uses motor tissue at the base of its stalks to turn its leaves towards the Sun, a process that’s actively controlled by changes in water pressure inside the plant (called *turgor*). The magnitude and direction of the sunlight is encoded in light-sensitive tissue, spread over the mallow’s geometric arrangement of leaf veins, and stored overnight. The plant also tracks information about the cycle of day and night via its internal circadian clocks, which are sensitive to environmental cues that signal dawn and dusk.

Overnight, using information from all these sources, the mallow can predict where and when the Sun will rise the next day. It might not have concepts such as ‘the Sun’ or ‘sunrise’, but it stores information about the light vector and day/night cycles that allows it to reorient its leaves before dawn so that their surfaces face the Sun as it climbs in the sky. This also allows it to re-learn a new location when plant physiologists mess with its ‘head’ by changing the direction of the light source. When the plants are shut in the dark, the anticipatory mechanism also works offline for a few days. Like other foraging strategies, this is about optimising available resources – in this case, sunlight.”