Today's goals
To explore some of the computational aspects of mapping from the visual world to the brain.

Today's readings

The visual pathways

Magno- and parvocellular pathways

Topographic mapping

Stained V1 in the mouse, showing the areas that were activated by the visual stimulus. (Note also the cortical magnification of the fovea.)
Systematicity: Penfield's homunculus

Visual topographic mapping

The higher visual areas become increasingly attuned to bigger receptive fields, with bilateral inputs (see, e.g., Tootell et al., 1998), and less clear retinotopic mapping.

Does the brain ever throw away information?

Systematicity

Systematicity is pervasive in the brain, most clearly nearer the sensorium. It is a way of importing relationships and larger-scale representation into the brain "for free".
Vision as serving a purpose

The frog and its visual world

Ecological realism vs abstract stimuli

Pond-like backgrounds versus white backgrounds (Lettvin, Maturana, McCulloch, and Pitts).

There's never a “null” context.

The risk of researching a technique; the assumptions become incorporated into the science in an invisible way.

The frog's brain

Dorsal View

Ventral View
The frog's retina

What the frog's eye tells the frog's brain

Lettvin, Maturana, McCulloch & Pitts (1959)

Five types of ganglion cells – each a “feature detector”.
Each is interested in an aspect of the environment.
Contrast detectors (light/dark in a small area).
Convexity detectors (small, dark and moving).
Changing contrast detectors (moving edges).
Dimming detectors (dimming from edge or centre of the visual field)
Dark detectors (overall light intensity)

The frog's visual world
Looking further into amphibian vision

“Together, our results indicate that the salamander retina uses a population code in which every point in visual space is represented by multiple neurons with subtly different visual sensitivities” Segev et al. (2006).

We see a history of progress through reinterpretation. New analyses subsume earlier ones and introduce new concepts.
Vision as object recognition

The task becomes one of identifying invariant features.

Vision as search

The task becomes one of looking for objects.

Recognition by components

Biederman (1987)

There is clear agreement on the parts that (some) things contain.
Recognition as parsing

Is something like syntax going on? – Combining invariances in a rule-governed way.

Marr’s approach

Is it correct to try and “start simple and work up from there”?

Marr’s approach

Building bottom-up versus building top-down.
**Edges versus surfaces**  
Biederman & Ju (1988)

Naming and verification tasks showed no difference between photographs and cartoons.

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**The importance of edges**  
Hochberg & Brooks (1962)

A 19-month old boy had previously only learned to name toys and other objects.  
He was given line drawings of known objects.  
There was no evidence of learning being required.

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**Is simplicity really the answer?**
Complexity and situatedness

- movement parallax
- binocularity
- light source

Challenges

Understand the relationship between objects, activity and whole scenes.
Decide how much we wish to base artificial systems on human cognition.
Appreciate the relationship between “clever” syntax-like solutions and “dumb” brute-force solutions.
(Never be satisfied with one-or-the-other binary choices.)

References