Neural networks

PSY 200

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Lecture 07

Seeing something that is not there.

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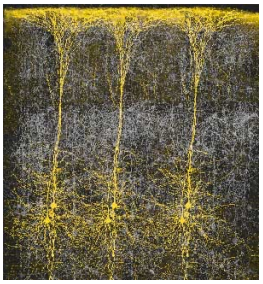
Receptive field

- As we saw last time, a cell's receptive field depends to a large extent on the receptive fields of other cells
  - (e.g., complex cells depend on simple cells)
- Today we look at some issues involved in *networks* of neurons



https://www.youtube.com/watch?v=2qTuZlMvFgY

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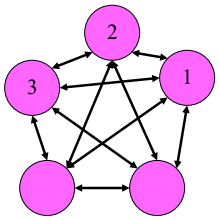
Feedback

- Cell 1 can affect cell 2, which can affect cell 3, which can affect cell 1 again, which…
- What happens to cell firing rates?
  - high firing rate==> active
  - low firing rate ==> inactive



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Resonance hypothesis

- Initially cell firing rates may vary a lot
- In some networks cell firing rates stop changing much (unless outside input changes)
- The remaining active cells are those that support each others' activities through *excitation:* **resonance**
- Inactive cells are *inhibited* by the active cells
- Mental awareness ==> resonance

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A "simple" model

- A cell's activation is *on* or *off* (one or zero)
- Cell connections (synapses or weights) are reciprocal
- Cells update activations one at a time
- Cell activations are calculated with the rule

$$a_i = \begin{cases} 1 \text{ if } \sum w_{ij} a_j > 0 \\ 0 \text{ if } \sum w_{ij} a_j \le 0 \end{cases}$$

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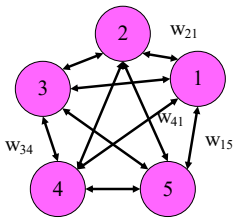
A simple model

- Neural connections (synapses) are described as *weights* on the links between cells
- Input to a cell is the summed multiplication of sending activation and weight
- Reciprocal weights have $w_{ij} = w_{ij}$



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Demonstration

- Cell activities *do* settle down eventually
- Final pattern of activities satisfies constraints of the network connections
- Error correction capabilities
- Can tolerate the loss of some cells
- *Emergent properties* of the network
  - no single cell has these properties

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Feedback

- Feedback in networks can act to "clean up" noisy sensory information to make it *consistent* with what our systems expect
- In a very real way, what we see, hear, taste, smell, touch, and think, is biased by our network's expectation
- A network's expectation is established by its connection weights
  - excitation -- inhibition

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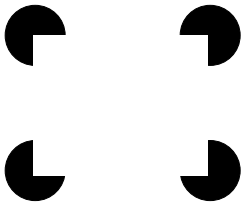
Seeing things that are not there

- Do you see a square in front of the pac men?



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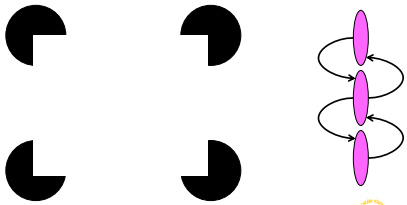
Seeing things that are not there

- Neurons in area V2 of your brain "create" the illusory contours



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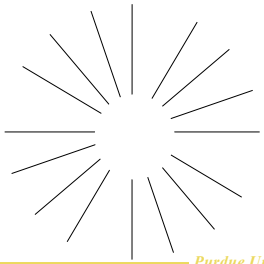
Feedback

- Similar situation with the illusory circle seen here



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Conclusions

- Networks of neurons have properties different from single cells
  - emergent properties
  - stable activities
  - multiple constraints
  - tolerance to errors and cell loss
- Structure of connections (synapses) determines the final pattern of responses

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Next time

- How networks learn
- Changing connections
- Learning rules
- Self-organization
- CogLab due for Implicit Learning

- *A problem with virtual reality.*

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