

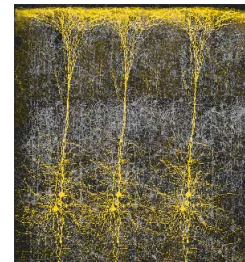
Neural networks

PSY 200
 Greg Francis
 Lecture 07

Seeing something that is not there.

Receptive field

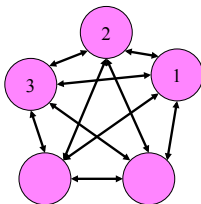
- As we saw last time, a cell's receptive field depends to a large extent on the receptive fields of other cells
 - (e.g., complex cells depend on simple cells)
- Today we look at some issues involved in networks of neurons



<https://www.youtube.com/watch?v=2qTuZIMvFgY>

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



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

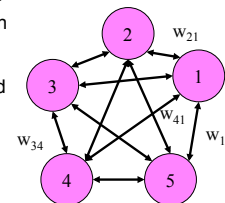
A "simple" model

- 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

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

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 $w_{ij} = w_{ji}$



Demonstration

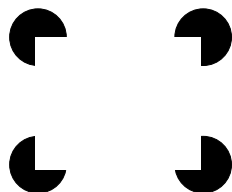
- Cell activities *do* settle down eventually
- Final pattern of activities satisfies constraints of the network connections
- Error correction capabilities
- Can tolerate the loss of some cells
- *Emergent properties* of the network
 - ♦ no single cell has these properties

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

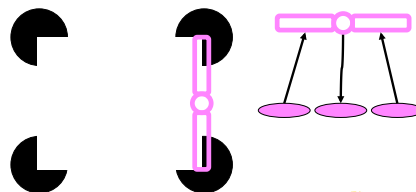
Seeing things that are not there

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



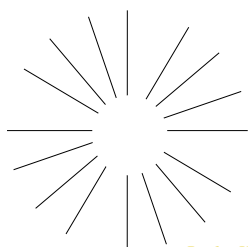
Seeing things that are not there

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



Feedback

- Similar situation with the illusory circle seen here



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

Next time

- How networks learn
- Changing connections
- Learning rules
- Self-organization

- *A problem with virtual reality.*

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