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Networks

Layers and layers of detectors...

1. What aspects of our thoughts/behaviors can you see this being applied to? How?
2. What aspects of our thoughts/behaviors can you *not* see this being applied to? Why not?

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Networks

1. Biology: The cortex
2. Excitation:
 - Unidirectional (transformations)
 - Bidirectional (pattern completion, amplification)
3. Inhibition: Controlling bidirectional excitation.
4. Constraint Satisfaction: Putting it all together.

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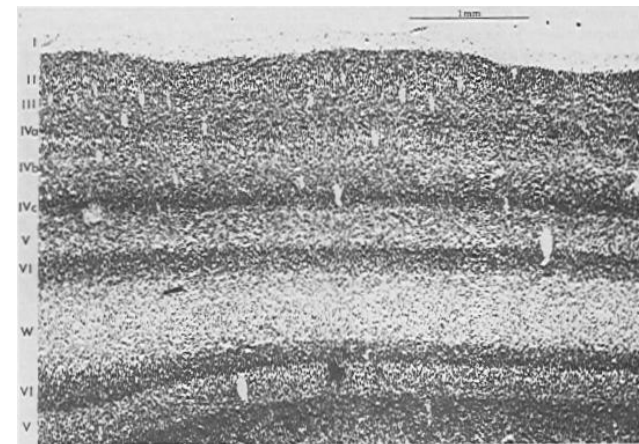
Cortex

How can we even talk about “cortex” (as opposed to visual cortex, prefrontal cortex, motor cortex, Broca’s area, etc.)?

- Equipotential (transplantation, rerouting).
- Consistent structure across areas.

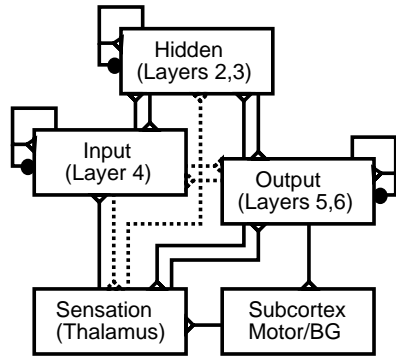
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Laminar Structure of Cortex



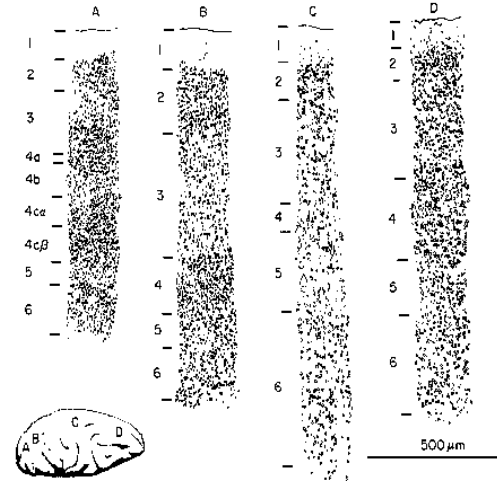
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Laminar Structure of Cortex



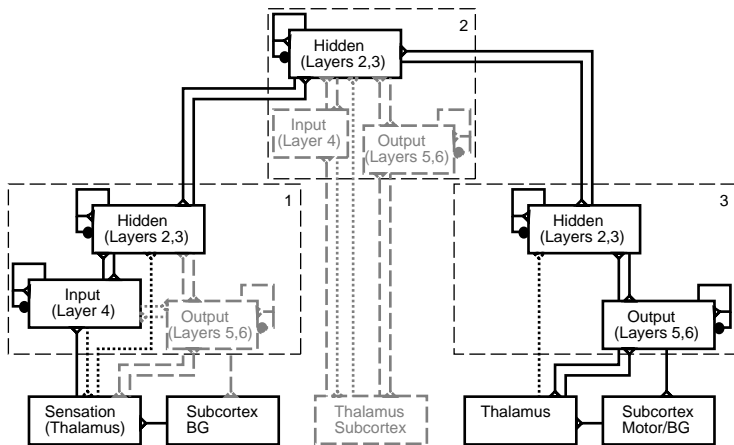
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Area Structure of Cortex



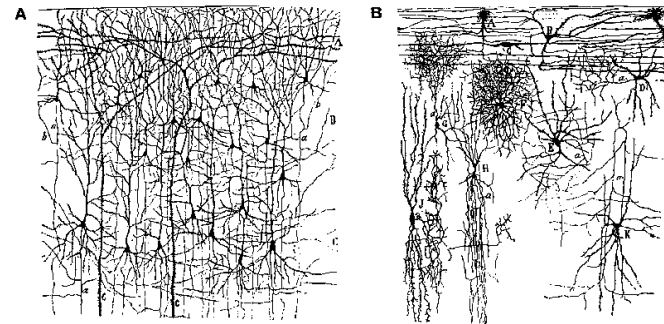
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Area Structure of Cortex



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Cortex: Neurons

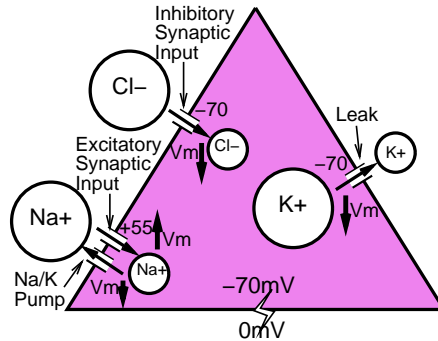


Two **separate** populations:

- Excitatory (glutamate): Pyramidal, Spiny stellate.
- Inhibitory (GABA): Chandelier, Basket.

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The Neuron and its Ions



Glutamate \rightarrow opens Na^+ channels \rightarrow Na^+ enters (excitatory)

GABA \rightarrow opens Cl^- channels \rightarrow Cl^- enters if $V_m \uparrow$ (inhibitory)

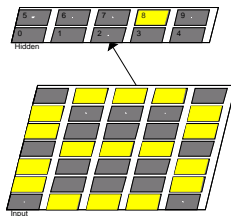
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Networks

1. Biology: Cortical layers and neurons
2. Excitation:
 - Unidirectional (transformations)
 - Bidirectional (pattern completion, amplification)
3. Inhibition: Controlling bidirectional excitation.
4. Constraint Satisfaction: Putting it all together.

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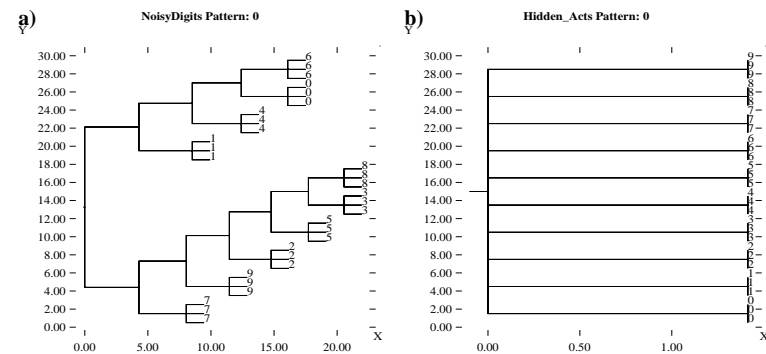
Excitation (Unidirectional): Transformations



- Detectors work in parallel to *transform* input activity pattern to hidden activity pattern.
- Emphasizes some distinctions, collapses across others.
- Function of what detectors detect (and what they ignore).
- Simulations.

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Emphasizing/Collapsing Distinctions

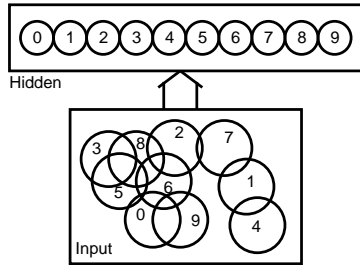


Emphasize distinctions: Different digits separated, even though they have perceptual overlap.

Collapse distinctions: Noisy digits categorized as same, even though they have perceptual differences.

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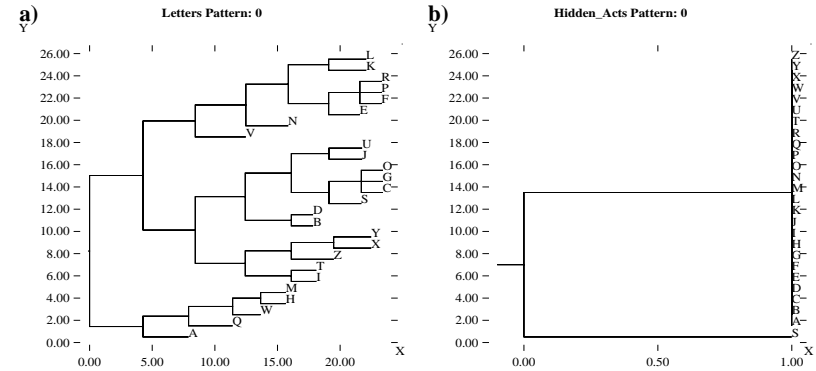
Emphasizing/Collapsing Distinctions



Other (more interesting) examples?...

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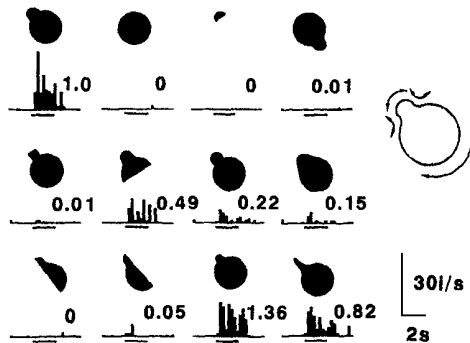
Detectors are Dedicated, Content-Specific



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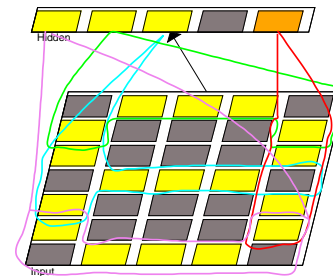
Localist vs. Distributed Representations

Localist = 1 unit responds to 1 thing (e.g., digits, grandmother cell).
 Distributed = Many units respond to 1 thing, one unit responds to many things.



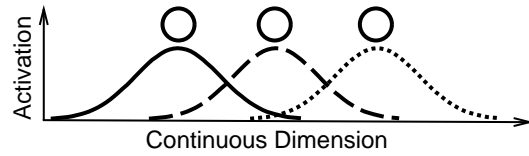
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Digits With Distributed Representations



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Advantages of Distributed Representations



Robustness: Redundancy.

Similarity: As a function of overlap.

Generalization: Can use novel combinations.

Efficiency: Fewer total units required.