

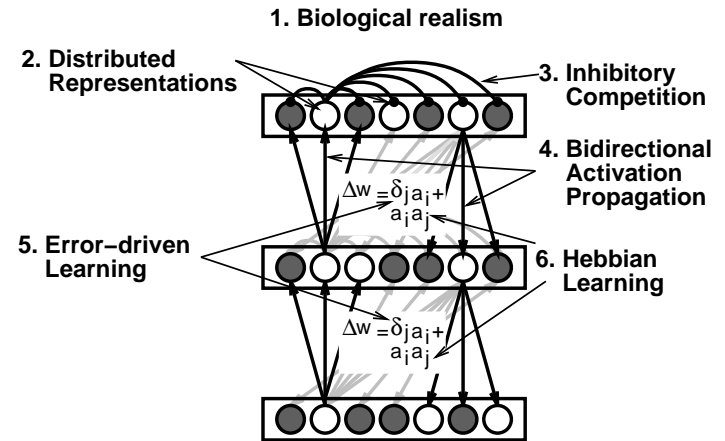
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Transitioning

- from Part I: Basic Mechanisms.
- to Part II: Perception, Attention, Memory, Language, Higher Level Cognition

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Part I: Basic Mechanisms



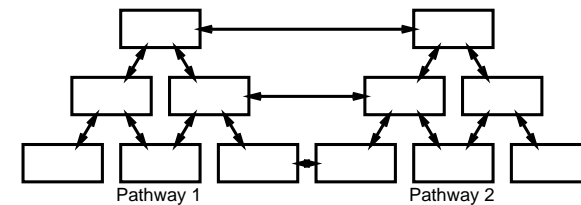
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Transitioning

1. What do you see as the most exciting possibilities for these models?
2. What do you see as the biggest challenges for these models?

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Possibilities: Structural Principles



- Hierarchical sequence of transformations.
- Specialized pathways.
- Intra-pathway interactions.
- Higher-level association areas.
- Large-scale distributed representation.
- Dedicated and content-specific.

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Dedicated & Content-Specific

Neurons are dedicated to specific content (i.e., they are tuned to detect specific things) Brain is not a general-purpose CPU. Tradeoff between specificity & knowledge-dependency vs generality & flexibility. Traditional symbolic AI fails because it lacks “common sense”

Time flies like an arrow.
Fruit flies like an apple.

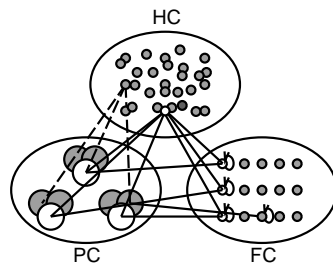
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Possibilities: Dynamic Principles

- Constraint satisfaction
- Attractors (amplification, bootstrapping...)
- Inhibitory competition: attention.

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Possibilities: Tripartite Functional Organization



PC = posterior perceptual and motor cortex.

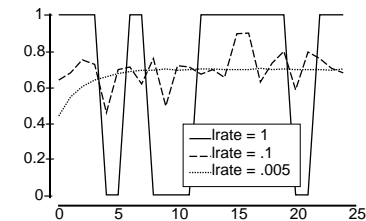
FC = prefrontal cortex.

HC = hippocampus and related structures.

Defined by set of functional *tradeoffs*.

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Slow vs Fast Learning

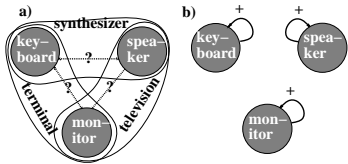


Learning must be *slow* to capture (statistical) structure (averaging).

But you also have to be able to learn rapidly.

Tradeoff solved by 2 systems: cortex learns slowly, hippo rapidly.

9 Active Memory vs Overlapping Distributed Reps



Overlapping distributed representations are useful for capturing information about the world.

But overlap & interconnectivity cause spread, which is not useful for maintaining information over time.

Tradeoff solved by two systems: PC has overlapping distributed representations, FC is isolated for maintenance.

10 Possibilities: Important Distinctions

- Controlled vs Automatic Processing.
- Declarative/Procedural vs Explicit/Implicit.

Consciousness = influence (on Constraint Satisfaction):

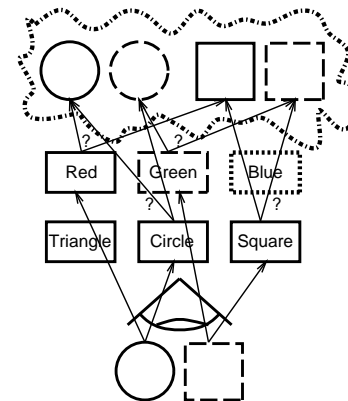
- Centrality: more influence on other areas.
- Duration: longer = more influence.
- Intensity: higher = more influence.

11 Challenges

Networks are good at some things, but have problems with others..

- Nobody's perfect: People tend to be bad at same things networks are..
- Don't throw the baby out w/the bathwater!

12 Challenges: The Binding Problem



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The Binding Problem: Potential Solutions

- Attention: only focus on one item.
- Encode conjunctions: no need to have all possible conjunctions separately represented.
- Nobody's perfect: people make tons of binding errors..

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Challenges: Recursion and Subroutine-like processing

- In middle of processing, need to perform same processing (recursion) or different processing (subroutine)
- Easy in standard serial computer (store current state, call subroutine w/appropriate arguments)
- Harder when data and processing not separated!
- HCMP, PFC keep track of prior state information
- Nobody's perfect...
The mouse the cat the dog bit chased squeaked.

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Challenges: Generalization

How to recognize new inputs given dedicated, specialized reps?

- Distributed representations: combinations of existing features.
- Abstraction: learn that all dogs might bite, not just that Spike bit me..
- Nobody's perfect: Transfer is not good at all.

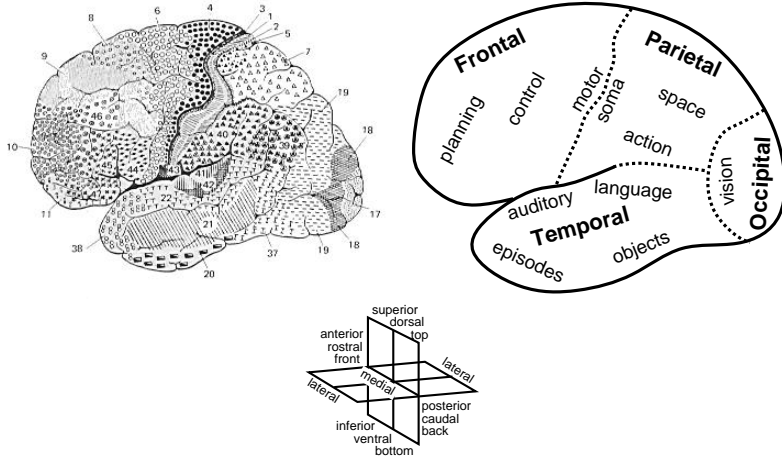
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Challenges (from RRs)

- Differences among brain areas?

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General Functions of the Cortical Lobes



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Other Areas

- Hippocampus (rapid learning).
- Thalamus (sensory input, attention).
- Amygdala (emotion, affective associations).
- Basal ganglia (BG) (sequences, motor control, gating of PFC?).
- Cerebellum (motor learning, cognitive role via timing?).
- Midbrain neuromods: VTA - dopamine, raphe - serotonin.

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Challenges (from RRs)

- Differences among brain areas?
- Differences among individuals?
- Others?