Chapter 9: Modular networks, motor control, and reinforcement learning
The What-and-Where task

Jacobs and Jordan, 1992

Coupled attractor networks

Jacobs and Jordan, 1992
Limit on modularity

A. Load capacity

B. Bounds on intermodular strength

Sequence learning

A. Modular attractor model

B. Time evolution of overlaps
Working memory

Limit on working memory

A. One object

B. Two objects

C. Four objects
Motor learning and control

Forward model controller
Reinforcement learning

The basal ganglia

A. Outline of basic BG anatomy

Cerebral cortex

Putamen

Caudate nucleus

Globus pallidus

Thalamus

Subthalamic nucleus

Substantia nigra

Superior colliculi

B. Recordings of SNc neurons and simulations

Stimulus A

Stimulus A

Reward

No reward

Stimulus B

Pattern 1

Pattern 2

Pattern 3

Pattern 4

Episodes

Reward
Temporal difference learning

A. Linear predictor node

\[ r_1(n), r_2(n), r_3(n), r_4(n) \]

\[ V(t) \]

\[ V(t-1) \]

\[ r(t) \]

B. Temporal delta rule

\[ r_1^{(n-1)}(t), r_2^{(n-1)}(t), r_3^{(n-1)}(t), r_4^{(n-1)}(t) \]

\[ V(t) \]

\[ V(t-1) \]

\[ r(t) \]

\[ \gamma V(t) \]

C. Temporal difference rule

\[ r_1^{(n-1)}(t), r_2^{(n-1)}(t), r_3^{(n-1)}(t), r_4^{(n-1)}(t) \]

\[ V(t) \]

\[ V(t-1) \]

\[ r(t) \]

\[ \gamma V(t) \]

Actor-critique and Q-learning

B. Actor-critic model of BG

D. Q-learning model of BG

Primary reinforcement

Cerebral cortex

Matris module

SP

Basal ganglia

Striatum

Thalamus

state / action coding

reward prediction

action selection
Actor-critique controller

Further readings


Yaneer Bar-Yam (1997), Dynamics of complex systems, Addison-Wesley.


James C. Houk, Joel L. Davis, and David G. Beiser (eds.) (1995), Models of information processing in the basal ganglia, MIT Press.
