

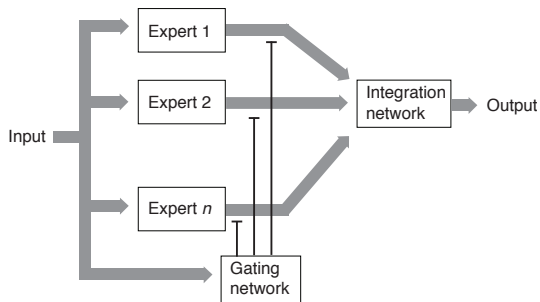
Fundamentals of Computational Neuroscience 2e

Thomas Trappenberg

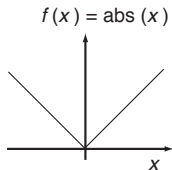
December 11, 2009

Chapter 9: Modular networks, motor control, and reinforcement
learning

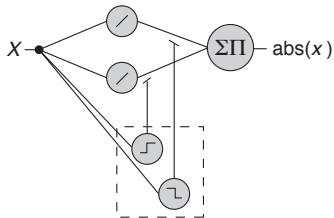
Mixture of experts



A. Absolute function

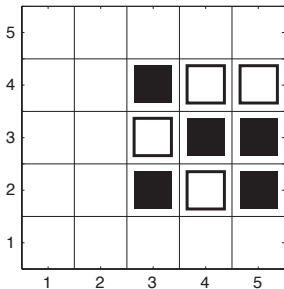


B. Mixture of expert for absolute function

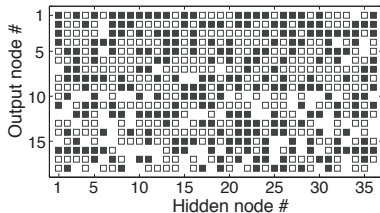


The 'what-and-where' task

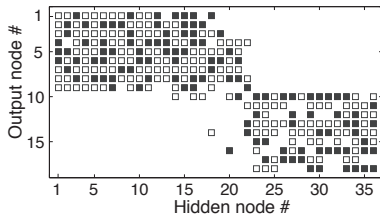
A. Model retina with sample image



B. Without bias towards short connections



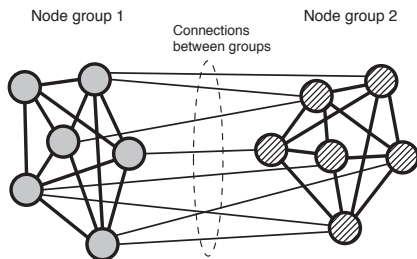
C. With bias towards short connections



Jacobs and Jordan (1992)

Coupled attractor networks

A. Coupled attractor networks

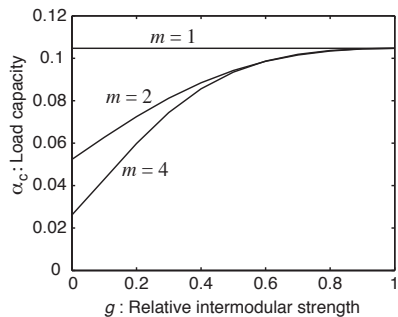


B. The left-right universe with letters

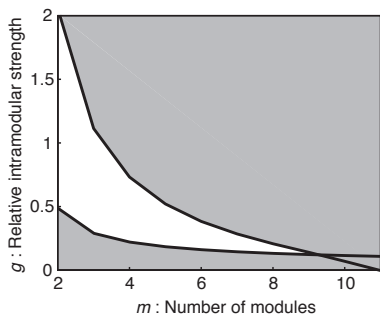
000011100000	111111110000
000011100000	111111111100
000011110000	111000000110
000110110000	111000011100
000110001000	1110001110000
0011100011100	1111111000000
0011111111100	1111111000000
0111111111110	1110001110000
0111000001110	1110000011100
0111000001110	1110000001110
0111000001110	1111111111100
0111000001110	1111111110000

Limit on modularity

A. Load capacity

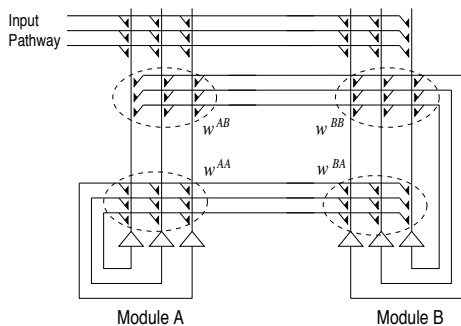


B. Bounds on intermodular strength

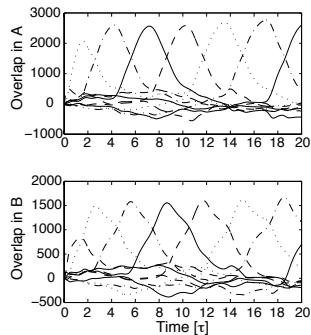


Sequence learning

A. Modular attractor model

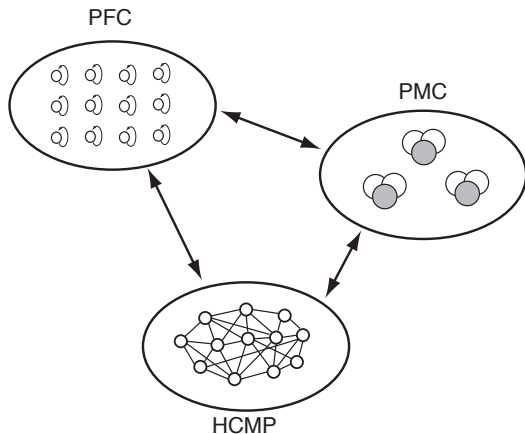


B. Time evolution of overlaps



Lawrence, Trappenberg and Fine (2006); (Sommer and Wennekers (2005))

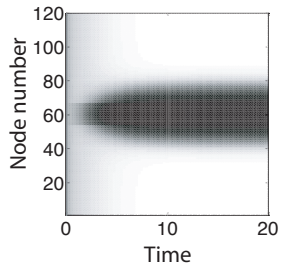
Working memory



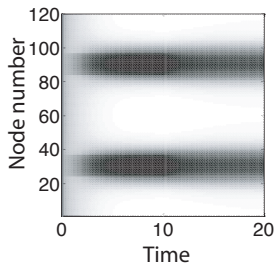
O'Reilly, Braver, and Cohen 1999

Limit on working memory

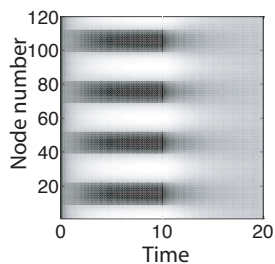
A. One object



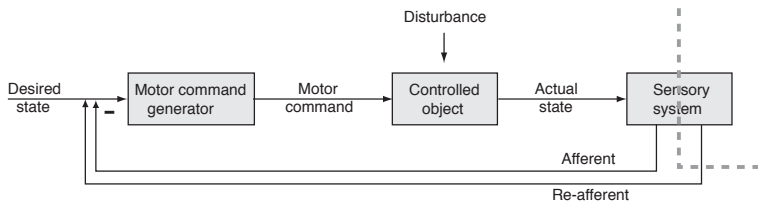
B. Two objects



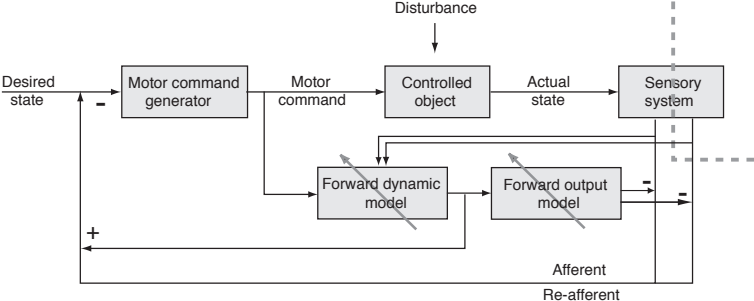
C. Four objects



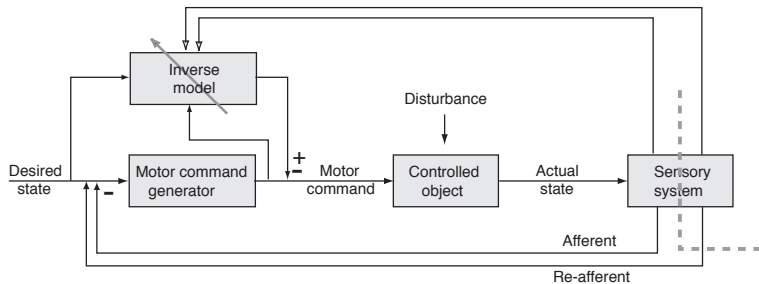
Motor learning and control



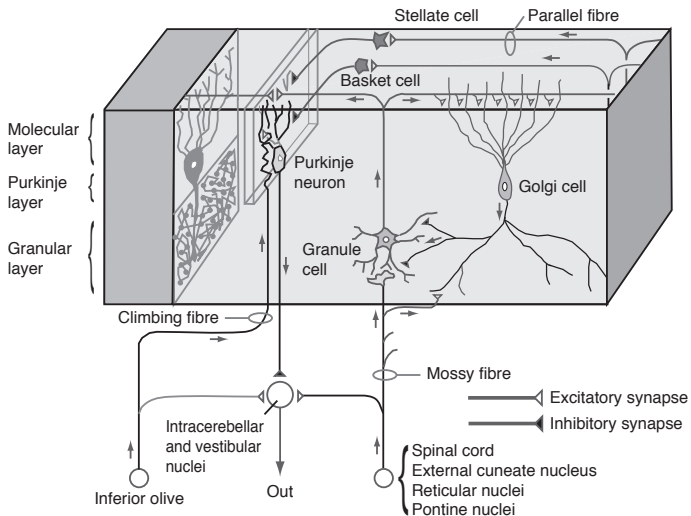
Forward model controller



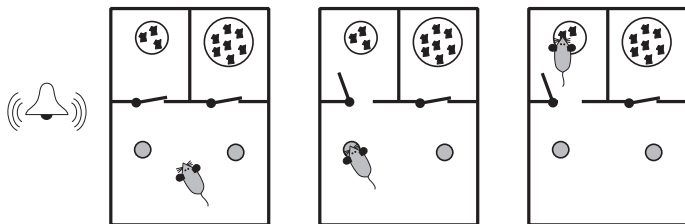
Inverse model controller



Cerebellum

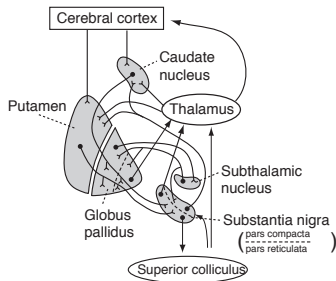


Reinforcement learning

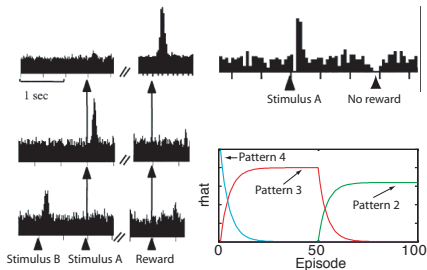


Basal Ganglia

A. Outline of basic BG anatomy

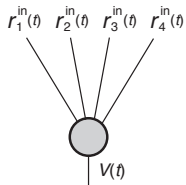


C. Recordings of SNc neurons and simulations

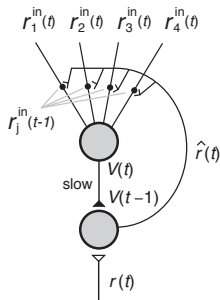


temporal difference learning

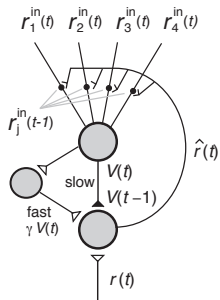
A. Linear predictor node



B. Temporal delta rule

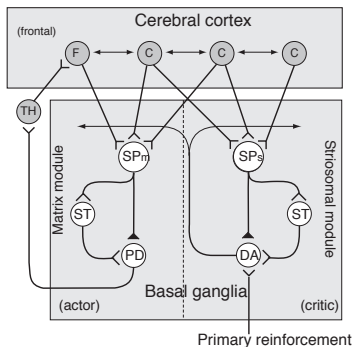


C. Temporal difference rule

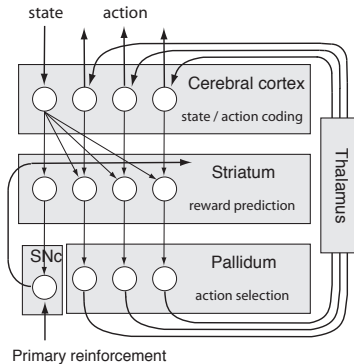


Actor-critique and Q-learning

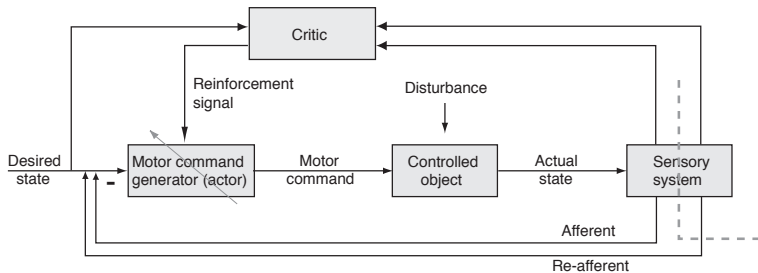
B. Actor-critic model of BG



D. Q-learning model of BG



Actor-critique controller



Further Readings

- Robert A. Jacobs, Michael I. Jordan, and Andrew G. Barto (1991), **Task decomposition through competition in a modular connectionist architecture: the what and where tasks**, in **Cognitive Science** 15: 219–250.
- Geoffrey Hinton (1999), **Products of experts**, in **Proceedings of the Ninth International Conference on Artificial Neural Networks**, ICANN '99, 1:1–6.
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- Peter Dayan and Laurence F. Abbott (2001), **Theoretical Neuroscience**, MIT Press.