Dynamic Data - Driven Brain - Machine Interfaces (DDDBMIs)

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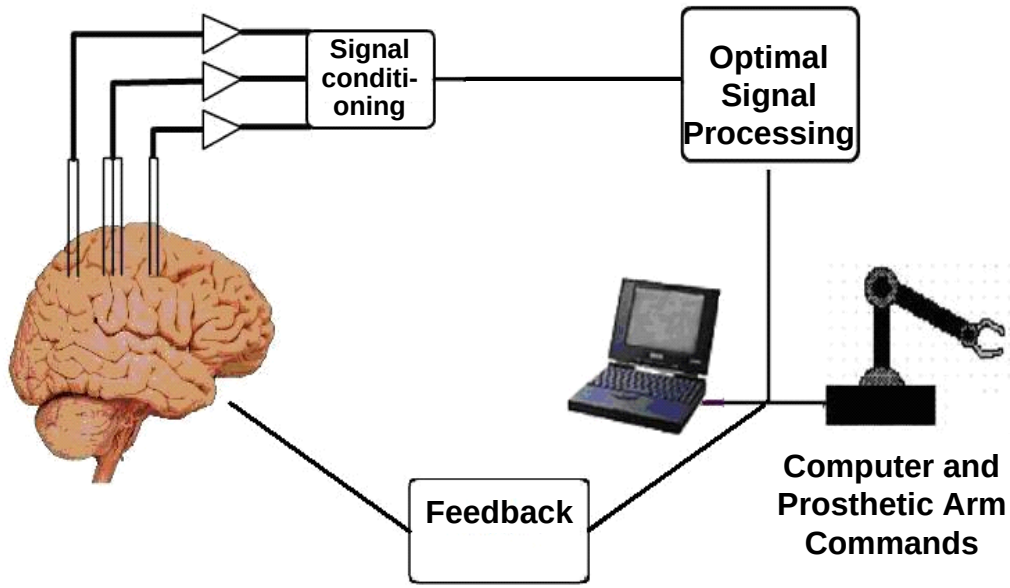
Brain Machine Interfaces (BMIs)

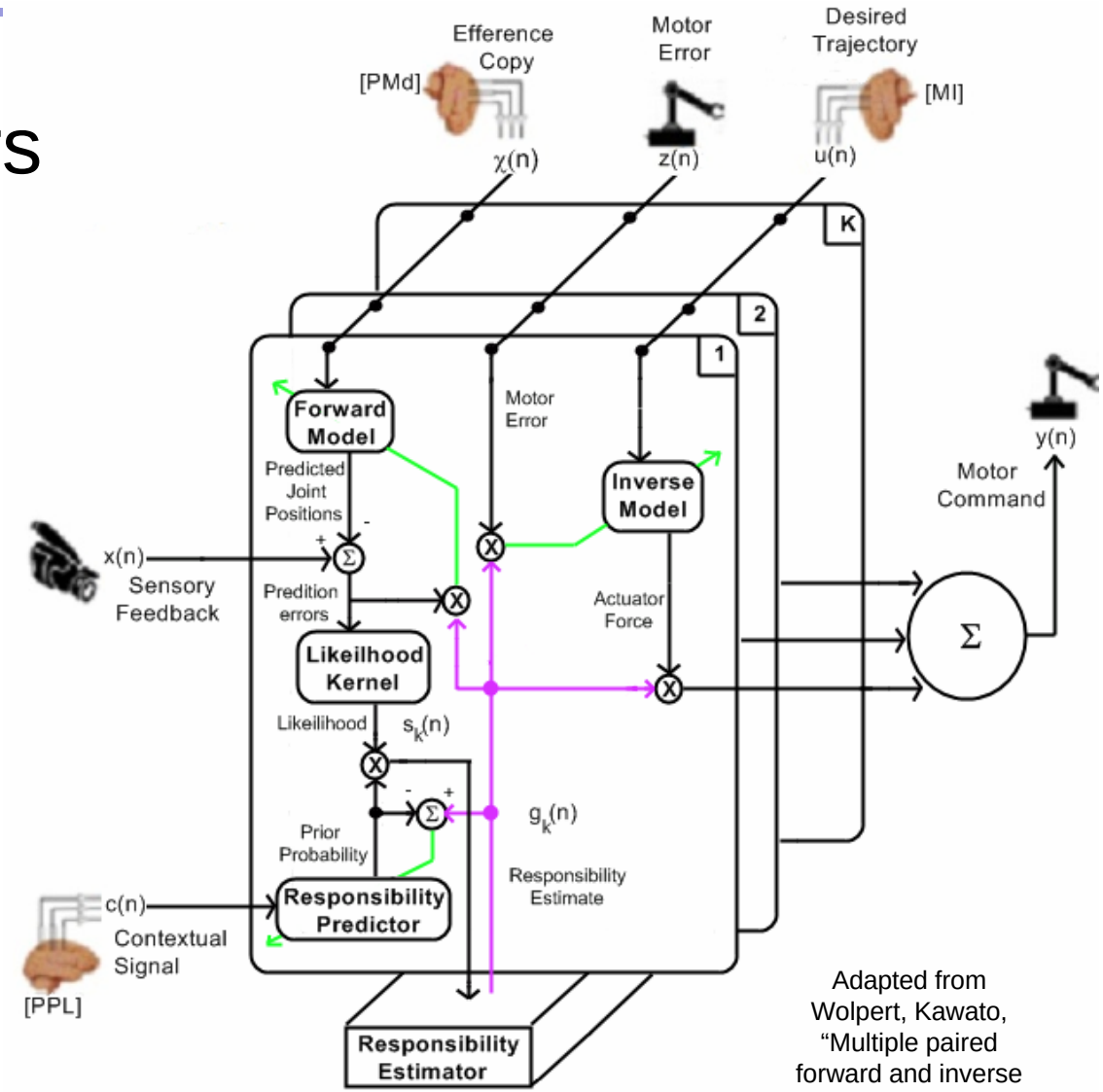
- Motor BMIs
  - Translate brain electrical activity into commands to external devices
  - Command BMIs or BCIs– EEG-based
  - Trajectory control BMIs – based on neuronal firings/fields

- Signal processing
  - Many possible models
  - Real-time (20-200 ms)
  - Feedback and training



Kawato's model

- multiple model pairs
  - forward (planning): sensory input from motor commands
  - inverse (execution): motor commands from trajectory info
- output combines several models
  - data dependent
  - dynamic

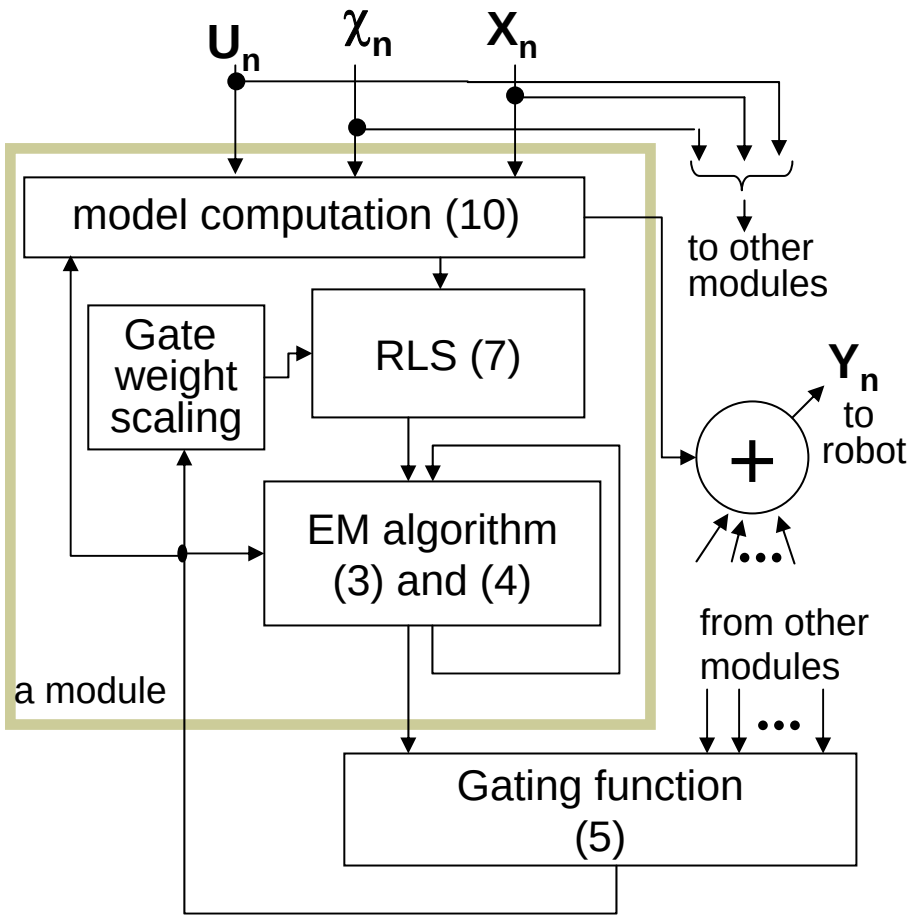


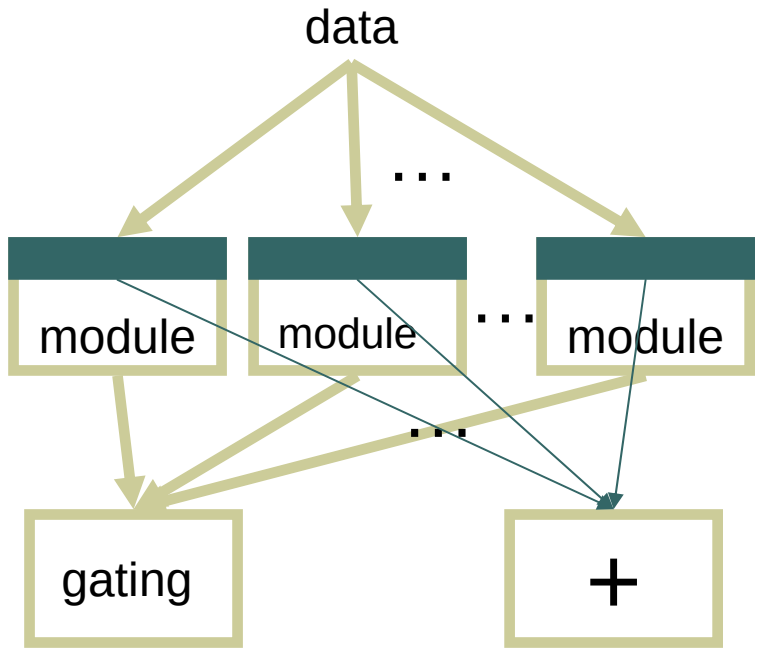
Adapted from Wolpert, Kawato, "Multiple paired forward and inverse models for motor control," Neural Networks 11 (1998)

General considerations

- Number of model pairs
  - 10s – 100s for simple tasks (e.g. press lever)
  - 1000s (?) for complex tasks
- Type of models
  - Linear (filters): Wiener, NLMS, PVA, …
  - Nonlinear (neural nets): TDNN, RMLP, RNN, NMCLM
  - State-based: Kalman filters, Bayesian classifiers, HMMs
- Complexity of models
  - $O(n)$, $O(n^2)$, $O(mn^2)$, $O(n^3)$, …
  - for n neurons, m models

Basic computation structure





10 – 500 ms soft

10 – 100 ms hard

- Online – real-time (hard and soft deadlines)
- Offline – recreation of experiments from data in storage

Requirements for Grid-based DDDBMIs

1. resource discovery based on quality of service specifications and scheduling based on virtual machine reservations,
2. dynamic steering of applications to computing resources based on run-time feedback from application inputs.