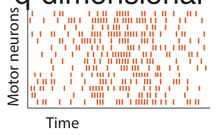
Neural commands

(Bio)Mechanics

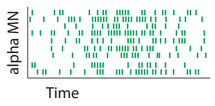
(a)

Upper motor neuron activity
> 1000 dimensions
q-dimensional



(b)

Lower motor neuron activity
> 100 dimensions
r-dimensional

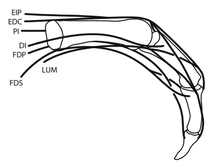


(d)

Feasible Activation Set
Convex Polytope embedded in n-dimensional space

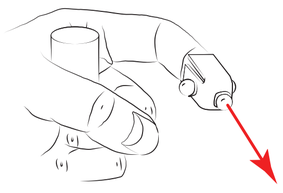
(e)

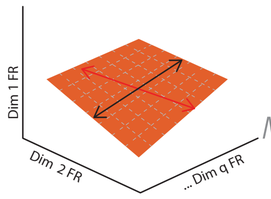
Biomechanical and muscular properties
n-muscle system
n=7 for index finger



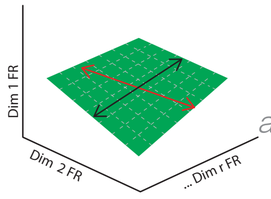
(f)

Mechanical definition of the task





Low-dimensional approximation to M1 cortical manifold



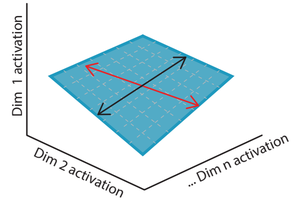
Low-dimensional approximation to alpha-MN manifold

Theories of sensorimotor control

(g)

Low-dimensional control
e.g., Muscle synergies
Uncontrolled manifold

Low-dimensional approximation to feasible activation set



(h)

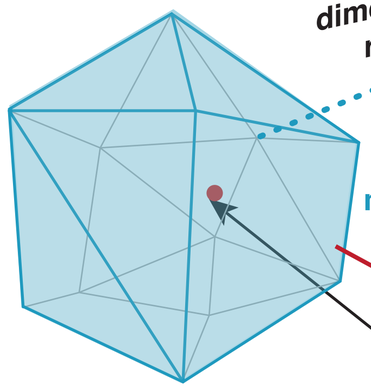
Probabilistic control
e.g., Bayesian inference
Exploration-Exploitation

Full-dimensional manifold of all valid muscle activation patterns

(i)

Optimization
e.g., Optimal Control
Model-Predictive Control

Presumed fitness landscapes for all valid muscle activation patterns



dimensionality reduction

All valid muscle activation patterns

uniform sampling

One valid muscle activation pattern

Polytope embedded in 7-D

Presumed cost functions