



UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Motor Control

2324-1-I0201D131-I0201D196M

Aims

Study of the principles of sensorimotor control and of the involved neural structures

Contents

Computational principles of sensorimotor control
Sensorimotor learning
Involved neural structures

Detailed program

Introduction to sensorimotor control

Marr Marr's levels of analysis
Planning and control
Direct and inverse kinematics
Direct and inverse dynamics

Control schema and prediction

Feedforward e feedback control
Internal models (inverse e forward)
State estimation
Bayesian inference

Optimality

Trajectory planning
Cost functions: minimum jerk, minimum torque, minimum variance
Optimal feedback control
Minimum intervention principle

Sensorimotor learning

Adaptation
Task e prediction error

Cerebellum

Functions
Cerebellar microcircuit
Cerebellar learning

Motor cortical regions

Primary motor cortex
Premotor cortex
Descendent pathways

Spinal circuitry

Spinal cord
Muscle proprioceptors
Spinal reflexes and their modulation

Control of locomotion

Central Pattern Generator (CPG)
CPG modulation by sensory afferents and sovraspinal regions

Prerequisites

Teaching form

in presence

Textbook and teaching resource

This course has been developed based on two books and several scientific articles. The teaching resources specific for each topic will be communicated during the classes.

Textbooks:

Kandel E., et al. (2021). Principles of Neural Science. (6th ed). McGraw Hill. Capitoli 30-36.
Purves D., et al. (2021). Neuroscienze. (5th ed. italiana; 6th ed. americana). Zanichelli. Capitoli 16-19.

Scientific papers (required):

Marr D. (2010) Vision: A Computational Investigation Into the Human Representation and Processing of Visual Information. The MIT Press. Capitolo 1.
Wolpert D, Ghahramani Z. (2000). Computational principles of movement neuroscience. Nat Neurosci. Nat Neurosci 3 (Suppl 11), 1212–1217.

Kawato M. (1999). Internal models for motor control and trajectory planning. *Curr Opin Neurobiol.* 9(6):718-27.
Todorov E. (2004). Optimality principles in sensorimotor control. *Nat Neurosci.* 7(9):907-915.

Scientific papers (suggested):

Körding KP, Wolpert DM. (2004). Bayesian integration in sensorimotor learning. *Nature.* 427(6971):244-7
Shadmehr R, Mussa-Ivaldi F. (1994) Adaptive representation of dynamics during learning of a motor task. *JNeurosci.* 14(4):3208-24
Morasso, P. (1981) Spatial control of arm movements. *Exp Brain Res* 42, 223–227.
Todorov E, Jordan MI. (2002). Optimal feedback control as a theory of motor coordination. *Nat. Neurosci.* 5(11):1226-1235.
Shadmehr R, Krakauer JW. A computational neuroanatomy for motor control. *Exp Brain Res.* 2008 Mar;185(3):359-81

Semester

Annual

Assessment method

Described in the subject's syllabus

Office hours

By appointment

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING
