UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Controllo Motorio

2526-1-I0201D131-I0201D196M

Aims

At the end of the course students will have to know the principles of sensorimotor control and the underlying 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
Descedent pathways

Spinal circuity
Spinal cord
Muscle proprioceptors
Spinal reflees and their modulation

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

Prerequisites

Neuroanatomy basic knowledge

Teaching form

Standard teaching in presence: topics are discussed by the teacher in the classroom
Integrated teaching in presence: students will perform presentations to deepen the topics proposed by the teacher .

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 senosrimotor 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

2nd term

Assessment method

Described in the subject's syllabus

Office hours

By appointment
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Sustainable Development Goals

GOOD HEALTH AND WELL-BEING | QUALITY EDUCATION | REDUCED INEQUALITIES