9 May 2011, h.15:00 - Sala 301 DEI/A

Study of the modular organization of motor control: experimental and modelling approaches

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Abstract:

An important question in neuroscience is understanding how the central nervous system (CNS) controls the large number of degrees-of-freedom of the musculoskeletal apparatus to perform a wide repertoire of complex motor behaviors. A long standing hypothesis is that the CNS relies on a modular architecture to simplify motor control and motor learning.

I will first present in this talk the results of a series of experiments that I have carried out with human subjects to study the low-dimensional structures underlining the kinematics and electromyographic (EMG) activity recorded from a large set of body muscles during the execution of complex whole-body movements. These results link together, in a hierarchical view of motor control, the joint coordination characterizing whole-body pointing movements with a basic muscle synergistic organization, namely a triphasic pattern.

I will also describe the unsupervised learning algorithms that I used to analyze different biological data, and I will describe how the imposition of specific constrains and priors to the algorithms can lead to well-defined physiological interpretations.

At the end I will present partial results of the work I'm currently carrying on in the framework of an important EU project, AMARSi (Adaptive Modular Architectures for Rich Motor Skills). In a series of experiments in a virtual reality environment we are collecting kinematic data from human subjects during the accomplishments of ad-hoc walking plus pointing motor tasks. Such data are being used, in a theoretical control framework, to extract periodic and non-periodic synergies to generate and control movements of characters in graphical applications and robotics.

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