

Integrating Body and Brain: Computational Approaches for Proprioception and Motor Control

Alexander Mathis, Ph. D.
École Polytechnique Fédérale de Lausanne
Assistant Professor



Alexander Mathis博士は、現在世界中の研究者に利用されている動作解析ソフトウェアである、DeepLabCutの開発者として著名です。今回は、それに加えてAI技術も駆使して、脳神経の活動と身体の動きの関連性を理解するうえで「固有感覚」が重要であることを示した最新の研究結果を紹介していただきます。



Date & Time 10:00~11:30 on Tuesday 28th April
Venue Seminar Room, Institute Building 3
Language This seminar will be given in English.
How to attend No advance booking is required. Please come directly to the venue.

Motor control, the art of coordinating muscles to produce intricate movements, is a marvel of biological intelligence. Understanding how the brain controls movement represents one of neuroscience's grand challenges. Central to this challenge is proprioception, which proves crucial for bodily perception and motor control, despite remaining poorly understood. Specifically, how the nervous system integrates information from numerous distributed receptors throughout the body remains an open question. We leveraged the principle that body and brain evolved as an integrated system to develop an approach for reverse-engineering proprioception. We expressed competing hypotheses of the proprioceptive system as quantifiable computational tasks. We found that neural networks optimized to perform these computational tasks develop representations that generalize to predict neural dynamics in the brain. Validating this approach further, these models reproduced classic proprioceptive illusions without any explicit training on illusion data. Motor control presents another core body-brain integration challenge: how does the nervous system coordinate hundreds of muscles and joints for skilled behavior? To understand motor control, we leveraged emerging fast simulators and took inspiration from the theory of motor learning to develop policies capable of controlling high-dimensional, nonlinear biomechanical models for skilled tasks. Analyzing these models revealed human-like low-dimensional control spaces and insights into principles of sensorimotor control.