UNIVERSITY OF CALIFORNIA, BERKELEY
Department of Electrical Engineering and Computer Sciences

EE290-O: Neural Control of Movement (2 units)
Fall 2007

Instructors

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Prof. Rich Ivry
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Course description

This course is about neuro motor control, i.e. how the brain controls movement. It is oriented to graduate students from engineering, neuroscience, and psychology programs, covering the computational and neural basis of volitional and postural motor control in general, and of reaching and pointing in particular. We will also provide some tutorials to supplement the textbook material.

Prerequisite

None

Textbook

The Computational Neurobiology of Reaching and Pointing. A Foundation for Motor Learning. Reza Shadmehr and Steven P. Wise. MIT Press. ISBN: 0-262-19508-9
(available at Cal Store)

Class Meeting Time

Wednesdays, 1-3pm, 521 Cory Hall

Grading

Presentation and class participation	50%
Final project	50%

Class Structure
Classes will typically be in two 60 min slots. During Weeks 2-7, the instructors will use the first half of the class to present tutorials or research-oriented lectures. The second half of these weeks will be devoted to discussion of the textbook readings for that week. This discussion will be lead by a student and will consist of a 10-minute summary of the assigned readings followed by group discussion. To foster discussion, the student presenter should introduce three discussion questions. During Week 8, the tutorial will be replaced by short group presentations of their proposed research projects. During Weeks 9-12, there will be student presenters, one for each half of the class. The final weeks will be used for group presentations.

Final Project
A final project will be conducted by research groups. The size will likely be 2 or 3 students per group, although a final decision will be made once things have settled down. By week 6, teams should be formed and each team should have a faculty mentor, chosen to best match the focus of your project. Ideally each group will include a partnership of at least one student from engineering and one from neuroscience/psychology.

Between weeks 6 and 8 you should discuss the project proposal with your advisor. In week 8 students will present their project proposals (5min per group) during the first slot of the class. Final projects will be presented during weeks 14 and 15.

Teams will have a lot of latitude in choosing their projects, but they should be do-able in 5-8 weeks of time. Your project might involve a behavioral study, a modeling project, or perhaps use a technology such as EMG or TMS. The instructors can provide guidance here and help provide resources. Ideas might be something such as:

- Using Recurrent Artificial Neural Networks to generate neurally plausible models of arm movement.
- Model a competitive process involved in hand selection when reaching for an object.
- Behavioral study of hierarchical effects in the planning of action sequences.
- Use of TMS to disrupt learning of mirror-reversed drawing.
- Writing a grant proposal on brain-machine interface related topics such as:
    - Strategies for impedance control of exoskeletons
    - Encoding biomimetic feedback (e.g. prosthetic proprioception)

<u>Schedule of Classes and Readings</u>

Week 1, August 29
Orientation

Week 2, September 5
Tutorial (Rich Ivry: Overview of Motor System with focus on Motor Learning)
Chapters 1-4 (introduction, evolution, history of motor learning, definitions)

Week 3, September 12
Tutorial (David Zipser)
Chapters 5-6 (spinal cord, brainstem, forebrain)

Week 4, September 19
Research lecture (Jose Carmena: Brain-Machine Interfaces 1)
Chapters 7-8 (force, feedback, limb stability)

Week 5, September 26
Research lecture (Jose Carmena: Brain-Machine Interfaces 2)
Chapters 9-10 (computing end effector location: theory and experiments)

Week 6, October 3
Research lecture (David Zipser)
Chapters 11-12 (computing target location and difference vectors 1)

Week 7, October 10
Tutorial (Rich Ivry: Control Processes in Action Planning)
Chapters 13-14 (computing difference vectors 2; planning displacements and forces)

Week 8, October 17
Project proposals
Chapter 15 (aligning vision and proprioception 1)

Week 9, October 24
Chapters 16-17 (aligning vision and proprioception 2; remapping, predictive updating and autopilot control)

Week 10, October 31
Chapters 18-19 (planning to reach or point)

Week 11, November 7
Chapters 20-21 (predictions of force)

Week 12, November 14
Chapters 22-23 (predictions of force; predicting inputs and correcting errors)

Week 13, November 21
Thanksgiving break

Week 14, November 28
Project presentations

Week 15, December 5
Project presentations