**BME 469: Physiological and computational motor control**

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This graduate level survey course will cover the physiological elements within the vertebrate motor system and the computational problems intrinsic to the production of movement. We will cover the computational issues that arise within motor control, both those issues which are general across the production of movement by any system and those which are specific to biological motor control. Topics will include representation learning, supervised and unsupervised learning, optimal control and estimation, and reinforcement learning. The course will consist of a combination of lectures and paper discussions: lectures will present formal descriptions of computational analyses; papers will illustrate applications of these analyses or computational concepts to issues in the neural control of movement.

You should be prepared to lead a discussion of the paper as in a journal club. All students should read the paper, be able to explain it, and come to class with questions. I might call on people to explain particular figures, equations, etc... There will usually be background lectures prior to the journal club to give students some basic knowledge ahead of the discussion. There will also be occasional problem sets to work with the computational techniques that we cover in the class, so you gain more familiarity with the issues involved and how to implement them. Most of the content will be presented in the lectures but will be supplemented by material posted on Canvas.

Students will perform a final project on one of the topics discussed in the class. It can involve applying one of the computational techniques to your own research, or replicating a paper using computational techniques. All project topics must be approved by me and should be submitted by week 6. The work should then be prepared as a written document – this doesn’t need to be a full paper but should provide a narrative and figures explaining what you did and what you found.

**Course plan (evolving)**

Week 1: Visuomotor representations

Topics: parametric vs. nonparametric representations, gradient descent, radial basis functions

Week 2: Classification, pattern recognition, decision making

Topics: linear classifiers, regression, LMS, backpropagation

Week 3: Feature extraction

Topics: Unsupervised learning, density estimation, Hebb’s rule, k-means, Kohonen nets

Week 4: Dimensionality reduction

Topics: PCA etc…

Week 5: Reinforcement learning

Topics: SARSA, Q-learning

Week 6: Optimal control

Topics: LQR, LQG

Week 7: Cost functions

Topics: minimum jerk, endpoint variance etc…

Week 8: Muscles and mechanics

Topics: passive dynamics, equilibrium point control

Week 9, 10: TBD