Course Description
This course will focus on the organization and flow of information within the nervous system, at the levels of molecules, single neurons, and systems of neurons. The basic biophysical structure and function of the nervous system is now moderately well understood. However, the textbooks that describe the biology of the nervous system generally do not discuss information, even though it is universally agreed that the nervous system is an information processing system. The course will relate the biophysical structure and function of the nervous system to the processing of information. In doing so, the course will discuss the fundamental principles of the nervous system that should be helpful in designing intelligent machines that are capable of unsupervised learning. The course will include a review of cellular and systems neurophysiology. However, students are expected to have already taken a course that covers basic neurobiology. Only a minimal knowledge of mathematics is needed.

Credit 3 units
Grading 3 Exams (1/4 each) and two short essays (1/4).
Materials Exams will be based exclusively on lecture materials. Thus reading materials are supplementary to the lectures. For basic neuroscience, students could use Bear, Connors, and Paradiso, *Neuroscience: Exploring the Brain*, or Kandel, Schwartz, and Jessell, *Principles of Neural Science*. The latter book is much more comprehensive than the former, and I would recommend it. Neither book covers information or computational aspects of neural function. The first 3 chapters of Jaynes, *Probability Theory* describe probabilities and logic, and these are freely available on the internet. We will not cover the mathematical aspects of probabilities; we will only cover the most basic principles of the meaning and uses of probabilities, and their relevance to the nervous system. My paper “Towards a general theory of neural computation based on prediction by single neurons,” will also be covered in the course. It is freely available online in the journal *PLoS ONE*.

Lecture Content
1. What is information? Probability theory and the computational goal of the nervous system.
2. Basic biophysical structure and function of the neuron
3. Rules and mechanisms of neuronal learning. Why does a neuron select a particular set of inputs?
4. Sensory systems. The efficient coding hypothesis.
5. How the system selectively processes information of relevance to its goals. Reward signals, dopamine, and selective attention