

# Brain Modeling and Machine Learning

## CMPU 395

Örjan Ekeberg

Fall, 2009

- 1 Who am I?
  - Affiliation
  - Research
- 2 What is Machine Learning?
  - Applications
  - Types of Learning
  - What about Brain Modeling?
- 3 About the Course
  - Textbook
  - Course Contents
  - Assignments
  - Grading

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## Who am I?

- **Örjan Ekeberg**
- Dept. Computational Biology  
School of Computer Science and Communication  
Royal Institute of Technology  
Stockholm, Sweden
- **STINT Fellow**  
The Swedish Foundation for International Cooperation in  
Research and Higher Education



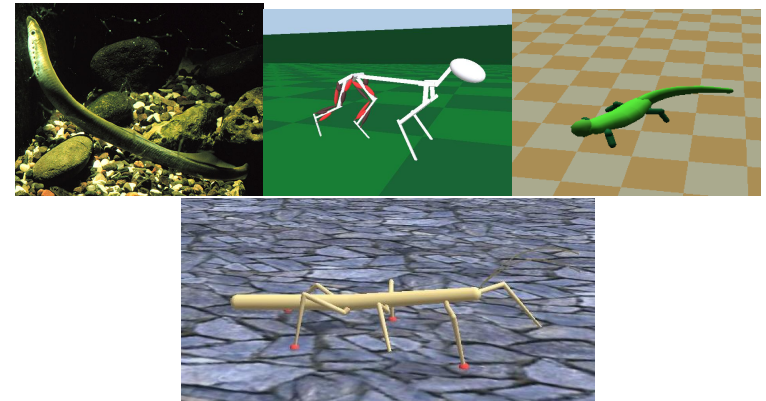
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## Who am I?

### My research

Simulation of the neural control of movements.



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## Applications

### Sample Applications

- Speech recognition
- Autonomous driving
- Games: Backgammon
- Autonomous robots
- Spam-filter for e-mail

### Role of Learning

**Data mining** Transform data into knowledge

**Vaguely specified tasks** Robotics, speech, vision, games

**Adaptive programs** User adaptable programs/devices

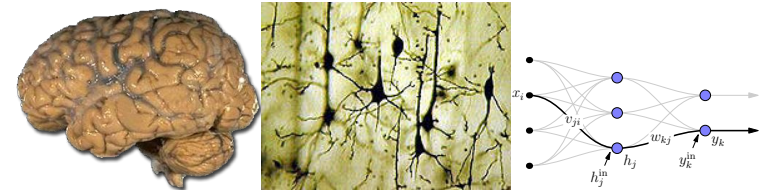
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## Types of Learning

- Supervised Learning
  - Regression
  - Classification
- Unsupervised Learning
  - Data Modeling
  - Compression
- Reinforcement Learning
  - Behavior Selection
  - Planning
- Evolutionary Learning
  - General Purpose Optimization

## What about Brain Modeling?



- Mathematical models of neurons
- Abstractions of neurons
- Neurally inspired network models

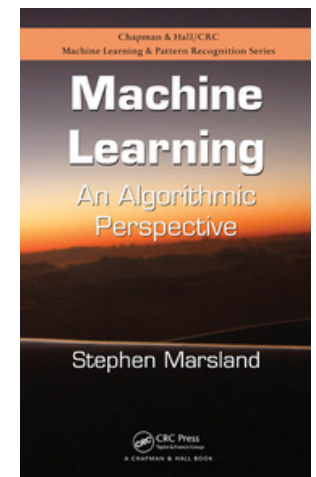
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## Textbook

Stephen Marsland

Machine Learning, an Algorithmic  
Perspective

CRC Press, April 2009



## Course Contents

- Models of Neurons
- Abstract vs Detailed Models
- Feedforward Networks
- Support Vector Machines
- Decision Trees
- Competitive Learning
- Network Dynamics
- Reinforcement Learning
- Genetic Algorithms

## Assignments

- Work in pairs
- Short written report
- Programs are not important, insights are

Software tools:

- Python
- NumPy — Numeric extension to Python
- Matplotlib (pylab) — Plotting extension
- SciPy — Scientific Python

## Assignments

- 1 Hodgkin-Huxley Modeling
- 2 Exploring Multi-Layer Perceptrons
- 3 Build a Support Vector Machine
- 4 Experiments with Self-Organizing Maps
- 5 Using Attractor Networks to Store Associations
- 6 Reinforcement Learning

## Grading

- Assignments (60 %)
- Participation (10 %)
- Final exam (30 %)
- Assignment grades  $B$  and  $A$  require you to *explore more*
- Missed assignment deadline  $\Rightarrow$  reduced grade
- Collaboration  $\iff$  Cheating