Final projects

Introduction to Neural Networks

This course teaches you how to understand cognitive and perceptual aspects of brain processing in terms of computation. Writing a computer program encourages you to think clearly about the assumptions underlying a given theory. Getting a program to work, however, tests just one level of clear thinking. By speaking and writing about your work and presenting it, you will learn to think through the broader implications of your final project, and to effectively communicate the rationale and results in words.

Your final project will involve: 1) a computer program/simulation and;

2) a 2000 to 3000 word final paper describing your simulation. For your computer project, you should do one of the following:

1) Devise a novel application for a neural network model studied in the course;

2) Write a program to simulate a model from the neural network literature;

3) Design and program a method for studying some problem in perception, cognition or motor control.

This could be a program that tests a behavioral hypothesis about human perception and/or cognition, and whose results you can interpret in terms of underlying neural computations.

Completing the final paper involves 3 steps:

- Outline (2% of grade). You will submit a working title and paragraph outline by the deadline noted in the syllabus and give a brief oral presentation of your project plan. These outlines will be critiqued in order to help you find an appropriate focus for your papers. (Consult with the instructor for ideas well ahead of time).
- Complete draft (5% of grade).. You will then submit a complete draft of your paper (2000-3000 words). Papers must include the following sections: Abstract, Introduction, Methods, Results, Discussion, and Bibliography. Use citations to motivate your problem and to justify your claims. Figures should be numbered and have figure captions. Cite authors by name and date, e.g. (Marr & Poggio, 1979). Use a standard citation format, such as APA. Papers should be emailed to the instructor by the deadline indicated in the syllabus. There should be a page number on each page.
- Peer commentary (5% of grade). Each student will submit a paragraph on an anonymous paired project draft.
- Final draft (28% of grade). You will submit a final revision for grading. (28% of grade). The final draft must be turned in by the date noted on the syllabus.

If you choose to write your program in Mathematica, or Python your paper and program can be formatted as a Mathematica or IPython notebook.

Groups

- You can work in a group of up to 2 people.
- If you do work with a partner, your *brief proposals* and *final papers* should include a statement of the individual responsibilities of each member of the group.
  - Except for the Methods section, your write-ups should be independent.
  - For example, "Y came up with the idea. X wrote the simulation part of the program, and Y wrote the analysis part. Both X and Y analyzed the data, and both wrote the Methods. X and Y wrote the Introduction, Results and Discussion sections independently."

Project ideas

If you are currently working on a research study in a lab, you can do a related computer project for this course. When you write up your report, make sure you explain how your study is related to neural networks.

Project ideas

- Look at: http://gandalf.psych.umn.edu/users/kersten/kersten-lab/coursepapers/SampleFinalProjects.nb.pdf

Project ideas

Wolfram demonstration site

http://demonstrations.wolfram.com/NeuralImpulsesTheActionPotentialInAction/

http://demonstrations.wolfram.com/KNearestNeighborKNNClassifier/

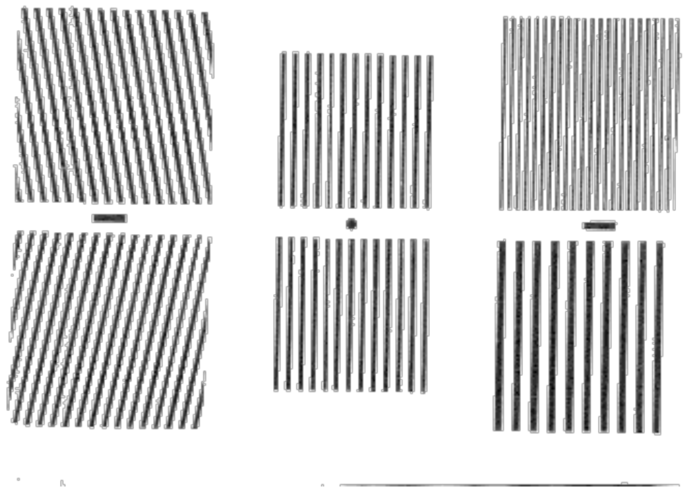
Project ideas

Extend your knowledge beyond the course material. E.g.

- learning feature hierarchies
  - recent progress in "deep learning"
    - RBMs, dropout
  - task-dependency, flexibility
- temporal learning
- temporal prediction and adaptation
  - e.g. use familiar musical tunes to manipulate timing and predictability of adaptors
- dynamic flows
- combining graphical object structures with naturalistic image input, e.g. for detecting human bodies

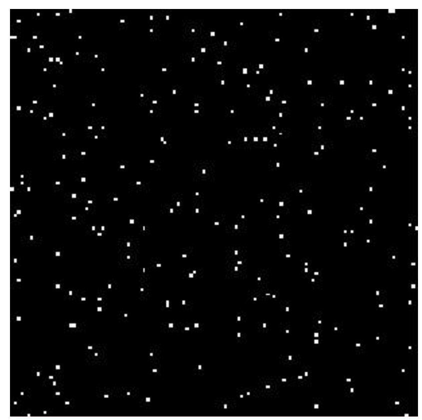
Project ideas

- Surface interpolation
  - Sparse stereo and uncertainty
  - Surface segmentation and expectation-maximization
- Bayesian figure-ground separation
- Can the value of a dangerous view be predicted?
- Perceptual organization, occlusion and affine transformations
  - can transformations be learned and transferred?
- Perceptual organization, occlusion and uncertainty
- Uncertainty in size and depth perception
- Deep convolutional networks applied to learning of small natural images

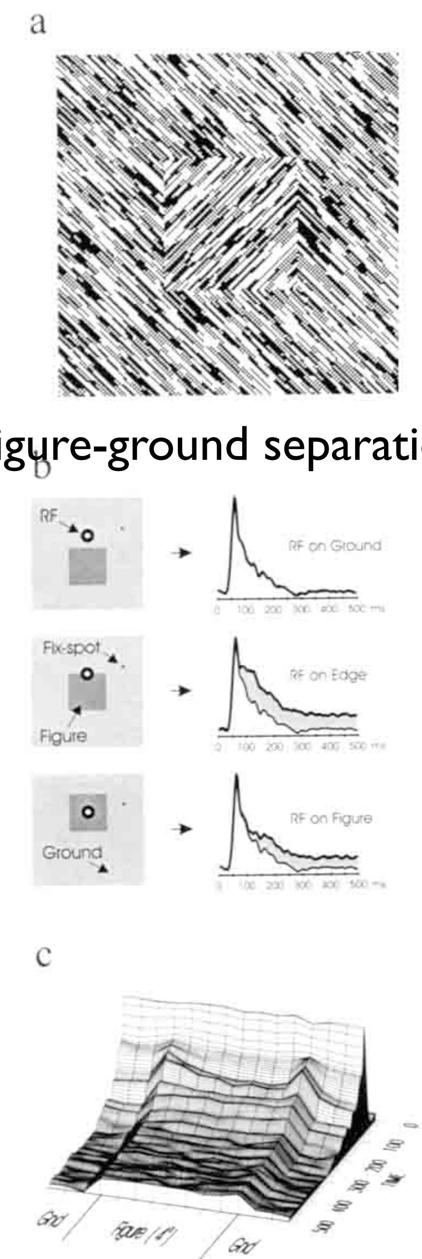


Visual adaptation: Use music to manipulate timing and predictability

3D game programming and the value of a view



Surface completion and uncertainty



Bayesian figure-ground separation

Bayesian account of the interactions between size, depth, and uncertainty