8. Real brains probably don't use the backpropagation learning procedure, but we looked at several models of biological systems that did. Describe two such models and explain why they are relevant even though backpropagation was used, or criticize them if you think the use of backprop was detrimental.

9. Both the hippocampus and the cerebellum have been described as associative memories. In what ways do these memories differ in their operating characteristics? Which broad architectural features of the hippocampus are missing from the cerebellum, and *vice versa*? What cerebellar structures play a similar *computational* role to the dentate gyrus? Justify your response.

10. We studied three different representations for vectors in the nervous system: maps, cosine-tuned cells, and basis functions. Briefly describe each representation and one model that uses it.

Final Exam:
Computational Models of Neural Systems
Course 15-880(B): Spring 1995

David S. Touretzky

- This is an open-book, open-note, take-home exam.
- Your answers are due by 3pm on Monday, May 15. You may submit your answers either in hardcopy form or by email to dst@cs.cmu.edu.
- You may not discuss the exam with anyone else. However, you may contact either Dave Touretzky (phone 268-7561 or email) or Dave Redish (dredish@cs.cmu.edu) if you need a clarification of an exam question.
- There are 10 questions, each worth 10 points. Each should take no more than half a page of 10 point text to answer.
- Be sure to answer all parts of each question.
- In many cases there is no one ‘‘right’’ answer; all that is required is a reasonable argument supported by an example or two.

Questions

1. Many of the models we studied include a variant of an associative or matrix memory. Describe three mechanisms for improving the function of a simple matrix memory and give an example of a model that uses each one. (Be sure to explain how the memory is improved.)

2. Some of the work we examined treated neurons as continuous functions, while others used more realistic models with spiking neurons. List one advantage and one disadvantage of each of approach. (Don’t say ‘‘more biological’’ with no further explanation. And don’t just list the advantages of one approach as the disadvantages of the other; pick some other point to discuss.)

3. One of the benefits of computer simulations is that they can reveal the weak points in a computational theory, and suggest remedies. Defend this claim using the work of Gluck & Thompson (1987) as an example.

4. The Hasselmo and Schnell (1994) and O’Reilly and McClelland (1994) articles both suggest mechanisms to perform pattern separation and pattern completion in the hippocampus. Are these two models compatible or incompatible? Justify your answer.

5. Briefly describe two very different theories of the function of the hippocampus. How does each theory address (or fail to address) each of the following: (1) recurrent connections in CA3, (2) the existence of place cells, (3) the persistence of place fields in the dark, and (4) anterograde amnesia following hippocampal damage.

6. Compare the Granger & Lynch model of piriform cortex with the Wilson & Bower model. What does each accomplish? How do the approaches and goals of these modeling efforts differ?

7. Compare the circuitry for direction-selective motion detectors in the insect visual system with some model of motion processing in the mammalian visual system. Are the two systems fundamentally similar, or different? Justify your answer. (Either choice can lead to an acceptable answer.)