CompSci 182 / CogSci 110 / Ling 109
Midterm Examination, Spring 2000
Prof. Jerome Feldman

1. (5 points) The first lecture included some details of molecular binding and structural change. Discuss three specific cases where this chemical level is helpful in understanding neural systems.

2. (10 points) Complete the following table comparing neural and symbolic computation; approximate answers will suffice.

	digital/symbolic computation	neural/connectionist computation
speed (operations/second)		
robustness		
number of simultaneously active processing units		
ability to adapt		
number of connections		

3. (10 points total) Backpropagation

   Consider a multi-layer feedforward neural network using the sigmoid activation function and back-propagation learning. Assume the following:

   - sigmoid activation function: $y_i = \frac{1}{1+e^{-x_i}}$
   - incoming activation for node i: $x_i = \sum_j w_{ji} y_j$, where j ranges over nodes with weights into node i
   - sum-squared error: $E = \frac{1}{2} \sum_i (t_i - y_i)^2$, where i ranges over the network's output units

   (a) (4 points) The sigmoid function is the standard output activation function in neural networks. Give biological and computational advantages of using this function.

   (b) (6 points) The following equations give the partial derivative needed for the backpropagation weight update rule:

$$\frac{\partial E}{\partial w_{ji}} = \frac{\partial E}{\partial y_i} \cdot \frac{\partial y_i}{\partial x_i} \cdot \frac{\partial x_i}{\partial w_{ji}} \quad (1)$$

$$\frac{\partial E}{\partial w_{ji}} = -y_j \cdot (t_i - y_i) \cdot [y_i(1 - y_i)] \quad (2)$$

   For each term in (2), identify the partial derivative in (1) from which it was derived.

4. (10 points total) Consider the following concepts:

   - stumble
   - yellow
   - car

   (a) (3 points) Discuss for each concept whether it is a basic-level, superordinate or subordinate category.

   (b) (7 points) How do you think the brain represents concrete concepts like these? (This question is similar to the first (ungraded) homework assignment, but you should have a better answer by now.)

5. (5 points) Draw the network architecture described by the following tlearn configuration file:

```
NODES:
nodes = 4
inputs = 3
outputs = 2
output nodes are 3-4
CONNECTIONS:
groups = 0
1 from i1-i2
2 from i2-i3
3-4 from 1-2
1-4 from 0
```

6. (10 points total) Short answers; justify your answers (briefly).

   (a) (2 points) Does precision wiring in a connectionist network imply that learning cannot take place? Why or why not?

   (b) (2 points) Can a winner-take-all connectionist network be used to model the Necker cube phenomenon?

   (c) (2 points) Starting with randomly assigned weights, is backpropagation guaranteed to find a solution for all problems for which a solution exists? Why or why not?

   (d) (2 points) At birth are there more, fewer, or the same number of neural connections as there are in adulthood?

   (e) (2 points) What image schema(s) would be crucial for representing the meaning of “through”?