

Zoo400 Final Exam: May 13, 1999

NAME: _____

There is only 1 best answer per question. (1 pt each)

1. A 3x7 feedforward matrix can be alternatively represented as a full-connectivity matrix of what dimension?
(E)
2. Reduced firing below spontaneous rate resulting in reduced release of neurotransmitter GABA is indicative of the following state*weight multiplication according to slow potential theory:
(D)
3. In the physical limulus eye, wraparound
(D)
4. According to the Cajal neuron doctrine
(C)
5. The physiological basis for the rate coding interpretation of the squashing function is:
(C)
6. All of the following are properties of a Hopfield network EXCEPT
(E)
7. Which vector operation is analogous to the multiplication of the incoming states times weights onto a single neuron in a neural network?
(A)
8. Which units show symmetrical connectivity (unit 1 projects to unit 2 with the same strength as unit 2 projects to unit 1) in the following weight matrix?

$$\begin{pmatrix} 0.4 & -0.2 & 0.1 & 2 \\ 0.2 & -1.3 & 0.7 & -1.1 \\ 0.3 & 0 & -0.2 & -0.2 \\ -3 & -1.1 & 1.1 & -0.7 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \\ d \end{pmatrix}$$

(E)

9. According to Hebb's rule

(B)

10. Which of the following is **NOT** true about lateral inhibition?

(D)

11. When viewing a portion of a particular object, we can recall or visualize the entire object (i.e. I see rosy cheeks and a button nose and I think of Santa). This is an example of

(C)

The following question refers to the following figure presenting a limulus experiment.

12. The figure illustrates

(C)

13. The following are all methods used for looking at physiology EXCEPT:

(A)

14. A cell in the limulus eye more strongly inhibits those cells that are

(B)

15. Summation of associative memory matrices constructed from outer-products is a linear-algebra algorithm to produce a multi-memory matrix. This is a non-local procedure. The corresponding local procedure in a network of processing units would use:

(C)

16. One potential problem with the local procedure described in the previous question that would not be found with the non-local algorithm would be:

(C)

17. The original Hebb's rule states that **ONLY** coincident activity in pre- and postsynaptic neurons produces an augmentation in synaptic strength between the neurons. Which of the following is not consistent with the original Hebb's rule in the context of an outer-product associative memory model:

(C)

18. Biological systems are typically adapted to have maximal responsiveness to particular types or patterns of stimuli that are salient (important) for the organism. From what we know of limulus eye physiology, which of the following is likely to be particularly salient:
(E)
19. Consider a connectivity matrix for a 7 unit limulus simulation with symmetrical inhibition but without wrap-around with a maximal projection distance for any given unit of 3 units to either side. All of the following are locations of 0s in this matrix except: [Hint: draw the matrix, row and column numbering starts with 1]
(D)
20. The brain doesn't use matrices and vectors. The process of using matrix algebra to understand memory to is an example of
(D)
21. According to rate coding theory, neurons can encode negative values so long as they have:
(D)

The following questions refer to the heteroassociative network constructed with an outer product using f as an input and g as an output:

22. Which of the weights is 0?
(E)
23. Utilizing a linear activation function without squashing ($f(x)=x$) for this heteroassociative matrix, presentation of the f will yield:
(D)
24. The correct output in this case can be obtained by normalization or by thresholding or both. Appropriate normalization in this case requires dividing by:
(B)
25. In an heteroassociative memory, what property of multiple vector pairs prevents crosstalk between memories?
(A)
26. Which of the following is not true in standard linear algebra:
(E)

27. Maximum rate of neuron firing is limited by the duration of the action potential. An approximate value for maximum rate would be:
(D)

The following refers to the vectors $A = [1010]$ and $B = [1101]$.

28. Let M be an outer product associative memory matrix with A as the input and B as the output. What is the result of multiplying $M * C^T$ where $C = [1001]$.
(D)

29. Which of the following is not an accurate order-of-magnitude measure?
(D)

30. Converting a matrix representation of an associative memory to pictorial form can be done by [NB: assume vector on right W^*s]
(A)

31. Which of the following is indicative of reduced activity [according to neurobiology/rate coding theory/slow potential theory.]
(B)

32. Dale's law states that each neuron only uses 1 primary neurotransmitter for all of its projections. An easy way to address Dale's law in an artificial neural network is:
(D)

33. Which of the following sequences would **NOT** represent the ordering of sensory transduction in the limulus eye?
(E)

A large dendrite is 500μ long and has a diameter of $4 \mu m$. Calculate the following using the assumption that the dendrite is a cylinder.

NB: use $\pi = 3$ Area of a cylinder = $\pi \cdot diam \cdot length$.

Volume of a cylinder is $\pi \cdot diam^2 \cdot length/4$.

34. The area of the dendrite in cm^2 is:
(C)

35. The volume of the dendrite in cm^3 is:
(C)

36. If depolarization of the membrane allows calcium ions to enter the dendrite at a rate of $6 \times 10^{10} \text{ ions/s} \cdot \text{cm}^2$ what will be the average concentration of ions (in ions/μ^3) in the cytoplasm after 25 ms (assume uniform distribution and no diffusion out of the dendrite)
(D)
37. A content addressable memory
(B)
38. The delta rule reduces error in a memory matrix by:
(D)
39. Increasing the length constant of inhibition in the limulus model will tend to have the following effect following stimulation by a spatial step luminance function (low light level on one side with sharp boundary to high light level on other side)
(E)
40. The following are all likely to be aspects of central nervous system function EXCEPT
(E)
41. The linearity observed in the limulus retina is relatively unusual for sensory systems. A logarithmic relation is more common. What is the primary advantage of the logarithmic relation?
(C)
42. Which is an example of a “hack” on the PDP8
(B)

Interspike intervals: 8 ms, 12 ms, 16 ms, 8 ms, 9 ms

43. Given the interspike intervals above (in ms), we would say that the firing rate of the cell is most likely about:
(B)
44. If we wish to detect rates down to 5 Hz, we need to use a slow potential (EPSP) with a total duration of about: [hint: this is total duration, not tau from the alpha function]
[double hint: need to be able to detect multiple spikes]
(E)

45. If we use the slow potentials needed for the low frequencies mentioned in the previous question, the integration of high frequencies may result in:
(B)
46. The following are all essential parts of a PDP8 digital computer EXCEPT
(D)
47. The point attractors of a Hopfield network represent
(B)
48. Assuming that a cell does not have endogenous (internal) firing mechanisms, the following condition is necessary to produce a spontaneous rate consistent with rate coding theory:
(D)
49. To fully define a dynamical system requires knowledge of all of the following EXCEPT:
(A)
50. Which of the following statements is true about orthogonal vectors (NB a/b vector means a binary vector consisting of numbers that are either a or b)
(D)
51. Ascii and bitmaps are 2 alternative ways of encoding the letter 'A'. An advantages of a bitmap for encoding letters is that
(D)

The following questions refer to this network:

52. If we represent the feedforward network with 3 matrices, the following are the correct matrix dimensions:
(D)
53. If we represent the entire network with a single matrix, the following is the correct matrix dimension:
(D)
54. In matrix B, the value at row 1, col 2 (numbering from 1) is:
(C)

55. Assuming the activation function shown, what would be the summed input (ie before application of the activation function to that unit) for the output (rightmost) unit after the information feeds forward (NB $f(0)=0$ for the activation function):
(A)
56. Assuming the activation function shown, what would be the state of the output (rightmost) unit after the information feeds forward (NB $f(0)=0$ for the activation function):
(A)
57. The primary cause of crosstalk in an associative network is:
(A)
58. Mach bands in the limulus simulation demonstrate the phenomenon of
(A)
59. Given n element 0/1 vectors with p 1 values (and $n - p$ 0 values), how many mutually orthogonal vectors can be constructed? [hint: try it with some example short vector]
(E)
60. A motor area involved in sequencing
(C)
61. structure #1
(D)
62. structure #5
(E)
63. Control of the face and a passageway from brain to body:
(E)
64. Relaying of sensation up to consciousness:
(B)

The following refer to the vectors $A = [1111]$ and $B = [1100]$.

65. Suppose that the elements of A represent the input states to a neuron from neighboring cells. Suppose B is the weights of the connections. What is the total summed input to the neuron?

(C)

66. When viewing a particular object, we can recall associations of that object (i.e. I see Santa and think of presents). This is an example of

(A)

Here are 2 vector pairs

Pair 1 – Input (f_1): (-1 1 -1 1) → Output (g_1): (-1 -1 1 -1)

Pair 2 – Input (f_2): (-1 -1 1 -1) → Output (g_2): (1 -1 -1 1)

67. If these 2 vector pairs are likely to have crosstalk problems, which of the following f/g pairs would not give crosstalk problems if combined with f_1/g_1 ?

(C)

68. Electron microscopy but not light microscopy can be used to see which of the following:

(C)

69. Which of the following supports the hypothesis that the central nervous system uses rate coding?

(E)

70. Which of the following is NOT true of Marr's 3 levels of investigation?

(B)