

Zoo400 Quiz 4: Apr 1, 1999

NAME: _____

1. Convert and use the following matrices.

A. Draw a diagram of the recurrent neural network represented by the following matrix and vector combination. Do not show connections that have 0 weight.

$$\begin{pmatrix} 4 & 0 & 1 & 2 \\ 0 & -3 & 1 & -1 \\ 4 & 0 & -2 & -2 \\ -3 & -1 & 3 & -3 \end{pmatrix} \begin{pmatrix} -1 \\ 2 \\ 1 \\ -2 \end{pmatrix}$$

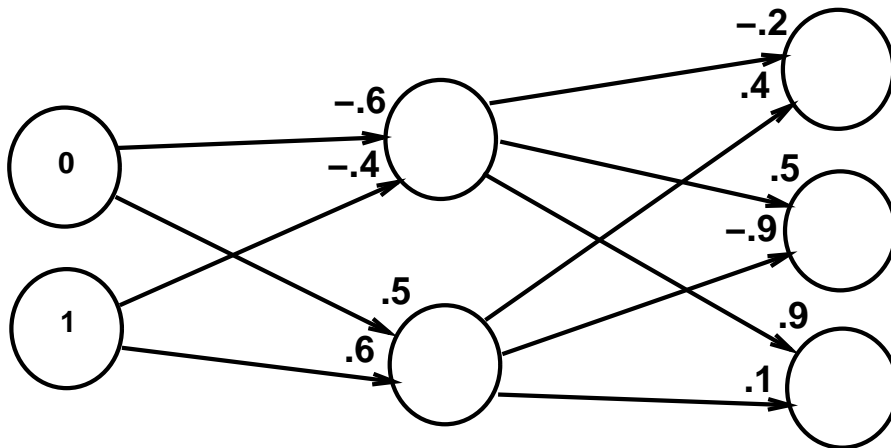
B. Show the output vector after **2 iterations** utilizing a thresholding activation function $f(x)=1$ when $x > 0$, $f(x)=0$ when $x \leq 0$.

C. Draw a diagram of the recurrent neural network represented by the following matrix and vector combination. Do not show connections that have 0 weight. Separate out any unit(s) that have no recurrent connectivity and indicate below with the word 'input' or 'output' which type of feedforward unit(s) is/are thereby represented.

$$\begin{pmatrix} 3 & 2 & 0 & 0 \\ 1 & -1 & 0 & 0 \\ 0 & -2 & 0 & 0 \\ 2 & -3 & 0 & 0 \end{pmatrix} \begin{pmatrix} 2 \\ 1 \\ 0 \\ 0 \end{pmatrix}$$

D. Show the output vector after **2 iterations** utilizing a thresholding activation function $f(x)=1$ when $x > 0$, $f(x)=0$ when $x \leq 0$.

2. Convert and use the following 2:2:3 feedforward network.

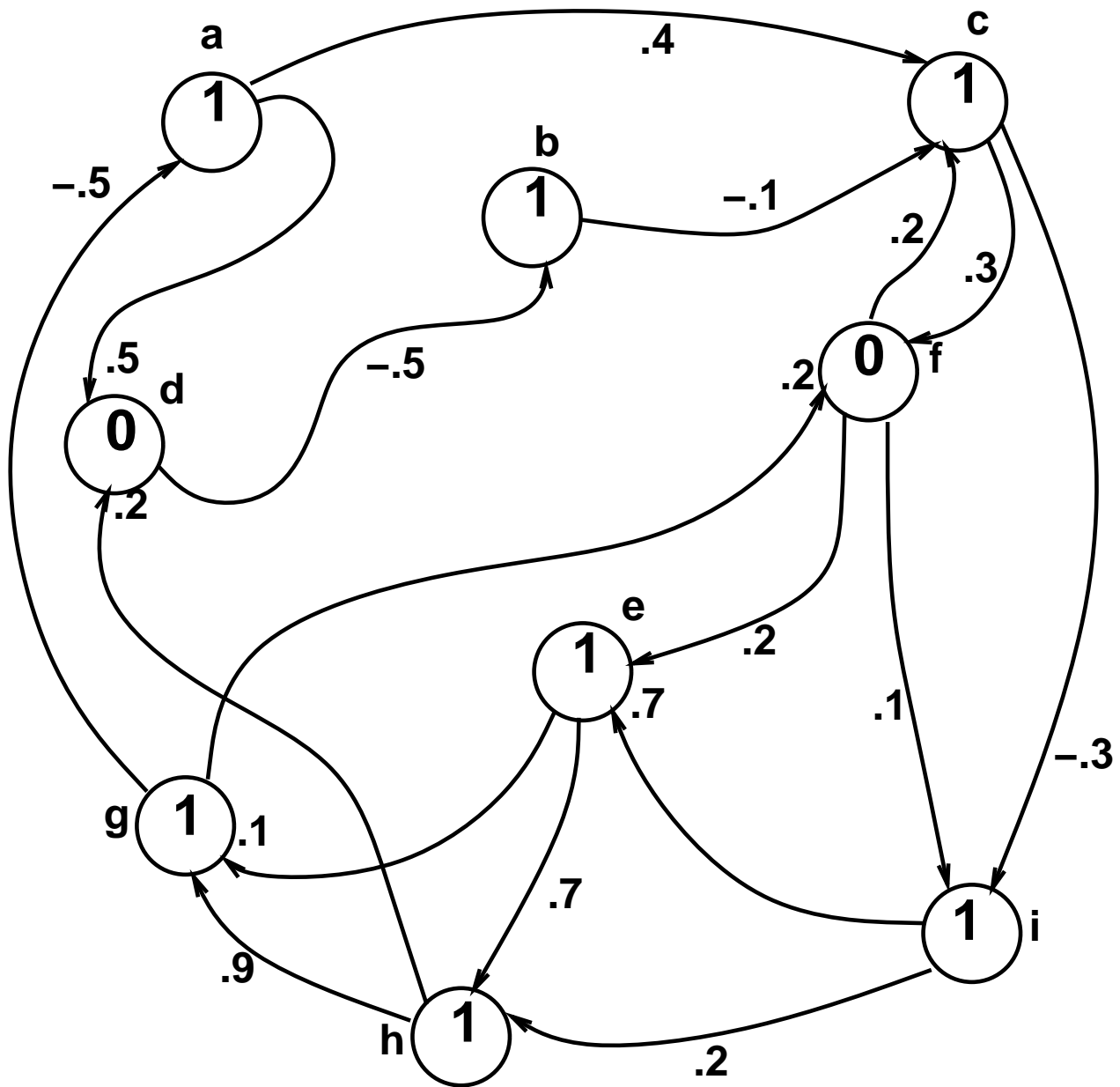


A. Calculate the output vector (2 iterations). Use $f(x) = 10x$ as the activation function for all units (NB: don't apply this to the values given for the input – the inputs are 'clamped' to these values). Use 2 matrices, each representing one feedforward stage.

B. Now represent the same network as a recurrent network using a single 7x7 matrix and a vector. Initially undefined unit states can be assumed to be 0. Take the units in order from top to bottom and left to right (ie top input, bottom input, top hidden, bottom hidden, top output, mid output, bottom output).

$$\begin{pmatrix} \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \end{pmatrix} \begin{pmatrix} \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \\ \text{---} \end{pmatrix}$$

3. The following questions pertain to the recurrent network:



A. Represent the network as a matrix. Use the unit ordering indicated by the letters a-i.

$$\begin{pmatrix} \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \\ \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} & \text{---} \end{pmatrix} \begin{pmatrix} 1 \\ 1 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 1 \\ 1 \end{pmatrix}$$

B. Using this matrix calculate the state vector through 2 iterations. Use the thresholding activation function: $f(x)=1$ when $x > 0$, $f(x)=0$ when $x \leq 0$.

C. Represent the input and the results of each iteration as a 3x3 bitmap picture using white for 0 and black for 1. Use 'print ordering' for the bitmap (left to right then next row).