

# Compsci 571 HW6

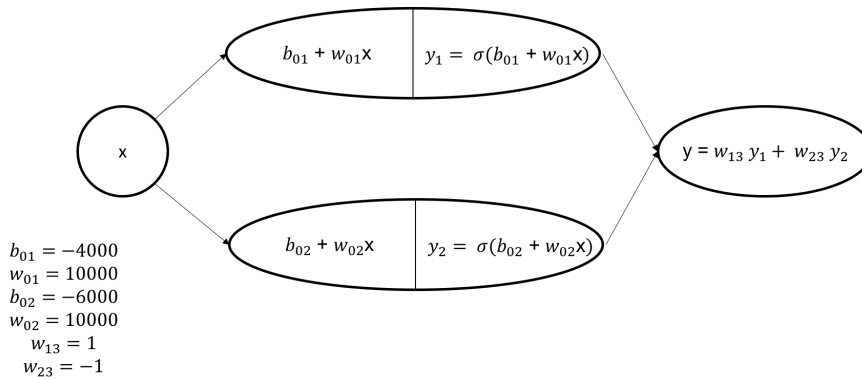
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April 5, 2018

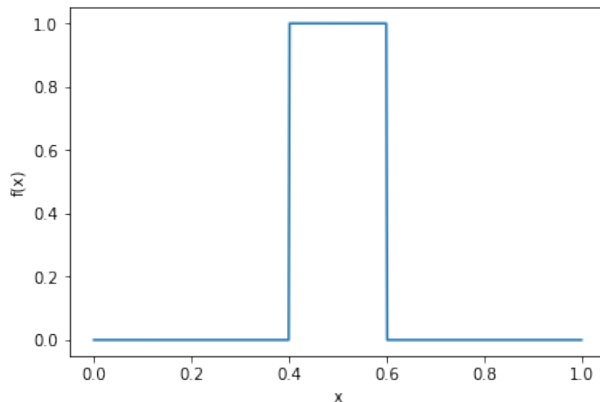
## 1 Neural Networks and Universal Approximation Theorem

### 1.1

(a) The NN architecture is like following:



The implementation is in `q1.ipynb`. The approximated function is as following:



The minimal number of hidden neurons is 2, because the bump is a combination of 2 step functions, and each neuron (with the sigmoid activation function) is able to approximate one step function with any given step direction, location and height.

(b) In the NN,  $w_{01}$  determines the steepness of the step-up part of the bump,  $w_{02}$  determines the steepness of the step-down part of the bump.  $-\frac{b_{01}}{w_{01}}$  determines the step-up location,  $-\frac{b_{02}}{w_{02}}$  determines the step-down location. And  $w_{13}$  and  $w_{23}$  determine the height of the bump.

### 1.2

(a)

(b)

(c)

## **2 EM**

## **3 Clustering**

(a) See the implementation in `q3.ipynb`.

(b) See the implementation in `q3.ipynb`.

(c)

(d)