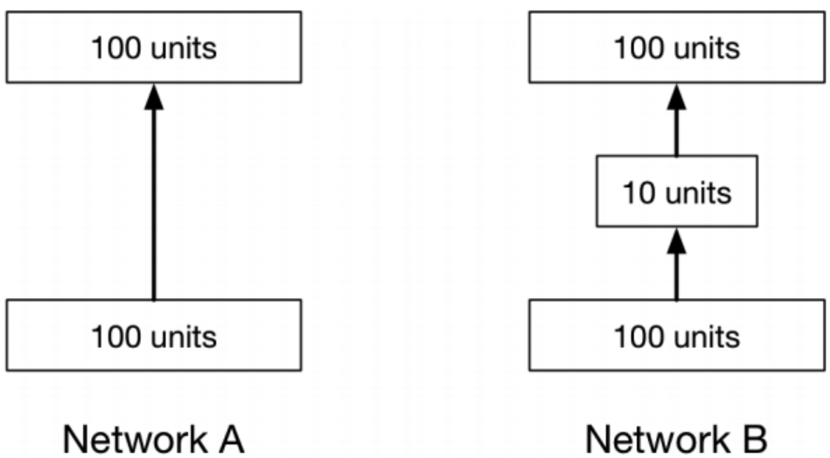
Take-Home Practice on Deep Learning (Non-Graded)

1) Graphically illustrate the difference between "Undercomplete" vs "Overcomplete" autoencoders:

2) Consider the following two multilayer perceptrons where all of the layers use linear activation functions. Both networks receive input vectors of size 25 and the last layer shown is the output layer. (Assume no biases)

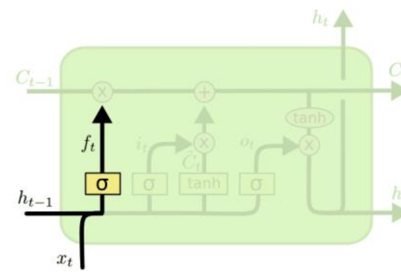


a) Which network do you think has more weights?

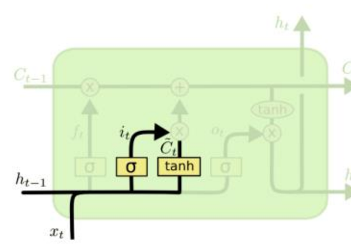
b) Give one advantage of Network B over Network A?

3) Consider the weight vector [0.2, 0.1 0 0.1] that represents weights from the input (X_t = 0.5) of an LSTM Cell to input gate (i), memory cell (c), forget gate (f), and output gate (o). The weight from the previous hidden state (h_{t-1} = 0.02) to these same entities is [0.05, 0.02, 0 0.5], and the biases for each of these gates are [0, 0, 0, 0]. The input σ denotes the sigmoid function.
Useful σ values (rounded): $\sigma(0) = 0.5$, $\sigma(0.1) = 0.52$, $\sigma(0.06) = 0.51$
Useful tanh values (rounded): tanh(0.05) = 0.05, tanh(0.076) = 0.076

If the previous cell state C_{t-1} is 0.1, compute the following:

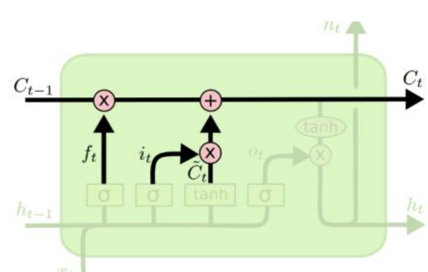


a) Forget gate: f_t =



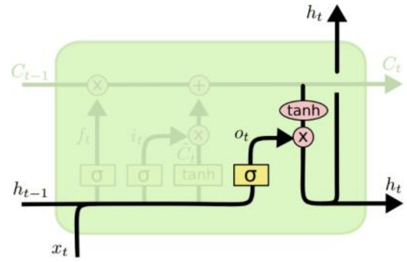
b) Input gate: i_t =

Cell State: $\tilde{C}_t$ =



c) Memory Update: C_t =

d) Output Gate & Hidden State:



o_t =

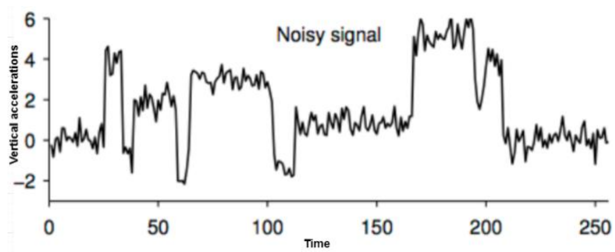
h_t =

4) Neural network architecting.

a) You are given a camera stream from an autonomous car and are tasked with identifying speed bumps. You have 5 million training examples. Illustrate an appropriate network architecture for this task.

b) How would you modify the solution from above if your new task is to detect stop signs, but you only have 1000 training examples.

c) Turning back to the speed bump example (a), in addition to the camera stream, you are now given a signal stream from an accelerometer. Graphically illustrate an appropriate network architecture that incorporates both the camera input and the accelerometer stream (an example of the accelerometer data is shown below, along with a helpful annotation) to identify whether the car has gone over a speed bump.



Example continuous data stream from car accelerometer.

5) CNN -

a) Given the following 4x4 input "image" and 2x2 filter, convolve the filter over the image using a stride of 1.

Image

1	1	2	2
1	1	2	2
1	1	1	2
1	1	1	2

Filter 1

1	1
-1	-1

Result of Filter 1 convolved over the Image

b) Based on the results of the convolution what type of features would you say Filter 1 detects?

c) Design a new 2x2 filter to detect vertical edges in the same image from (a), for convenience the image is repeated below as well as a grid for filling in your filter.

Image

1	1	2	2
1	1	2	2
1	1	1	2
1	1	1	2

Filter 2

d) Convolve your filter of the image and fill in the results in the grid below. (*Did your filter work as expected?)*

Result of Filter 2 convolved over the Image

e) Given the result of the previous image and a new filter below. Fill in the below result grids for, i) a max pooling layer with stride of 1 and size 2x2, ii) applying a ReLU activation.

Output Z

-1	2	0
-1	1	1
0	0	-2

Result of max pooling layer on Output Z.

Result of ReLU activation on Output Z.
