—Assignment10—

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Question 1

(1) What are the differences between Machine Learning (ML) and Deep Learning (DL)(0.5')?

Answer:

1. ML algorithms almost always require structured data, whereas DL networks rely on layers of the ANN (artificial neural networks).
2. DL requires much more data than a traditional ML algorithm because neural networks need millions of data to identify edges.

(2) Why Deep Learning is useful(0.5')?

Answer:

1. Manually designed features which are needed in ML are often over-specified, incomplete and take a long time to design and validate.
2. Learned Features which are easy to adapt, fast to learn.
3. DL provides a very flexible, almost universal, learnable framework for representing world, visual and linguistic information.
4. DL can learn both unsupervised ad supervised.
5. Effective end-to-end joint system learning.
6. Utilize large amounts of training data.

Question 2

(a)

Answer:

$$output = \sigma(w_1x_1 + w_2x_2 + w_3x_3 + b)$$

(b)

Answer:

$$z_1 = 1 \times 1 + (-1) \times 2 + 2 = 1$$
$$z_2 = 1 \times 2 + (-1) \times (-1) - 4 = -1$$
$$\sigma(z_1) = \frac{1}{1+e} = 0.73$$
$$\sigma(z_2) = \frac{1}{1+e^{-1}} = 0.27$$
$$y = \sigma(1 \times \sigma(z_1) + 1 \times \sigma(z_2) + 1) = \frac{1}{1+e^{-2}} = 0.88$$

Question 3

(a) training:

Answer:

$$z_1 = 1 \times (-1) + 2 \times 0 + 1 \times 0 = -1$$

$$z_2 = 1 \times 2 + 2 \times 1 + 1 \times 0 = 4$$

$$z_4 = 1 \times 0 + 2 \times 0 + 1 \times 1 = 1$$

$$\sigma(z_1) = 0$$

$$\sigma(z_2) = 4$$

$$\sigma(z_4) = 1$$

$$t_1 = \sigma(z_1) \times (-1) + \sigma(z_2) \times 2 + \sigma(z_4) \times (-4) = 4$$

$$t_2 = \sigma(z_1) \times 1 + \sigma(z_2) \times 0 + \sigma(z_4) \times (-2) = -2$$

$$y_1 = \sigma(t_1) = 4$$

$$y_2 = \sigma(t_2) = 0$$

(b) testing:

Answer:

$$z_1 = (-1 + 2 \times 2.5) \times 0.75 = 3$$

$$z_2 = (4 + 2 \times 0) \times 0.75 = 3$$

$$z_3 = [(1 \times 3 + 2 \times (-1) + 2 \times 0 + 1 \times (-2)] \times 0.75 = -0.75$$

$$z_4 = (1 + 2 \times 0) \times 0.75 = 0.75$$

$$\sigma(z_1) = 3$$

$$\sigma(z_2) = 3$$

$$\sigma(z_3) = 0$$

$$\sigma(z_4) = 0.75$$

$$t_1 = [\sigma(z_1) \times (-1) + \sigma(z_2) \times 2 + \sigma(z_3) \times 0 + \sigma(z_4) \times (-4)] \times 0.75 = 0$$

$$t_2 = [\sigma(z_1) \times 1 + \sigma(z_2) \times 0 + \sigma(z_3) \times (-1) + \sigma(z_4) \times (-2)] \times 0.75 = 1.125$$

$$y_1 = \sigma(t_1) = 0$$

$$y_2 = \sigma(t_2) = 1.125$$

Question 4

(a)

Answer:

For A:

$$z_1 = 2 \times 10 + 2 \times 0 = 20$$
$$z_2 = 2 \times 0 + 2 \times 10 = 20$$
$$z_3 = 2 \times (-10) + 2 \times (-10) + 300 = 260$$
$$\sigma(z_1) = 1$$
$$\sigma(z_2) = 1$$
$$\sigma(z_3) = 1$$
$$t = \sigma(z_1) \times 40 + \sigma(z_2) \times 40 + \sigma(z_3) \times 40 - 100 = 20$$
$$y = \sigma(t) = 1$$

For B:

$$z_1 = -5 \times 10 + 30 \times 0 = -50$$
$$z_2 = -5 \times 0 + 30 \times 10 = 300$$
$$z_3 = -5 \times (-10) + 30 \times (-10) + 300 = 50$$
$$\sigma(z_1) = 0$$
$$\sigma(z_2) = 1$$
$$\sigma(z_3) = 1$$
$$t = \sigma(z_1) \times 40 + \sigma(z_2) \times 40 + \sigma(z_3) \times 40 - 100 = -20$$
$$y = \sigma(t) = 0$$

For C:

$$z_1 = 20 \times 10 + 20 \times 0 = 200$$
$$z_2 = 20 \times 0 + 20 \times 10 = 200$$
$$z_3 = 20 \times (-10) + 20 \times (-10) + 300 = -100$$
$$\sigma(z_1) = 1$$
$$\sigma(z_2) = 1$$
$$\sigma(z_3) = 0$$
$$t = \sigma(z_1) \times 40 + \sigma(z_2) \times 40 + \sigma(z_3) \times 40 - 100 = -20$$
$$y = \sigma(t) = 0$$

(b)

Answer:

We have: (when t is a integer)

$$\sigma(t) = 1 \Longleftrightarrow \sigma(t) > 0.999 \Longleftrightarrow t \geq 7$$

$$\sigma(t) = 0 \Longleftrightarrow \sigma(t) < 0.001 \Longleftrightarrow t \leq -7$$

Since:

$$t = \sigma(z_1) \times 40 + \sigma(z_2) \times 40 + \sigma(z_3) \times 40 - 100$$

And according to Figure 7, $\sigma(z_1)$,$\sigma(z_2)$,$\sigma(z_3)$ can either be 0 or 1.

So:

$$y = \sigma(t) = 1 \Longleftrightarrow \sigma(z_1) = 1, \sigma(z_2) = 1, \sigma(z_3) = 1$$

And:

$$\sigma(z_1) = 1 \Longleftrightarrow z_2 \geq 7 \Longleftrightarrow x_1 \geq 0.7 \Longleftrightarrow x_1 \geq 1$$

$$\sigma(z_2) = 1 \Longleftrightarrow z_2 \geq 7 \Longleftrightarrow x_2 \geq 0.7 \Longleftrightarrow x_2 \geq 1$$

$$\sigma(z_3) = 1 \Longleftrightarrow z_3 \geq 7 \Longleftrightarrow x_1 \times (-10) + x_2 \times (-10) + 300 \geq 7 \Longleftrightarrow x_1 + x_2 \leq 29$$

Thus:

$$y = 1 \Longleftrightarrow x_1 \geq 1, x_2 \geq 1, x_1 + x_2 \leq 29$$

$$y = 0 \Longleftrightarrow otherwise$$

Therefor the dicision boundary is :

$$x_1 \geq 1, x_2 \geq 1, x_1 + x_2 \leq 29$$