1. Which of the following statements are true? Check all that apply.

'**Option A: RIGHT**: The cost function $J(w)$ for logistic regression trained with $m \geq 1$ examples is always greater than or equal to zero.

'**Option B: RIGHT**: Linear regression is difficult to apply for classification problems unless you apply a threshold on the output value.

- [Hope this explains why linear regression is not the best fit for classification problems!]
- [You can apply linear regression for classification by assigning a threshold]

~~Option C: WRONG:~~ For logistic regression, sometimes gradient descent will converge to a local minimum and fail to find the global minimum.

- I assume the cost function is cross-entropy.
- [not sure] Cross-entropy is a convex function so local-minimum same as global minimum in any convex function.

Option D: RIGHT For linear regression with the least squares cost function, the local minimum is the global minimum.

- Least squares cost function is convex function
- Any local minimum of a convex function is also a global minimum.

Accepted Answer: A,B,C,D

2.

Suppose you have the following training set, and fit a logistic regression classifier

$$\hat{y} = h(x; w) = \sigma(w_0 + w_1 x_1 + w_2 x_2)$$

Example	x_1	x_2	y
1	0.5	1	1
2	1.5	1	1
3	1	2	0
4	1	3	1

Which of the following are true? Check all that apply.

Option A: RIGHT: At the optimal value of **w**, we will have J(**w**) ≥ 0.

- Cross-entropy value always non-negative. see option-A of question-1
- This option is bit strange. It won't have any direct relation with the question. if they used "J(w)=0", it may make some sense!!

Option **B**: WRONG:

If we train gradient descent for enough iterations, for some examples $x^{(i)}$ in the training set it is possible to obtain predictions $\hat{y} > 1$

- The value of y_hat is the output ofsigmoid function. The range of sigmoid is [0, 1]. So the value of y_hat cannot be greater than1.

Option C: RIGHT: Adding polynomial features like $h(x;w) = \sigma(w_0 + w_1 x_1 + w_2 x_2 + w_3 x_1^2 + w_4 x_1 x_2 + w_5 x_2^2)$ could increase how well we can fit the training data.

- More feature make the model complex. Complex model overfit the training data easily if there is no regularization. See the below program to see the Cross-entropy value before and after adding polynomial features .

Option **D**: WRONG: The data set is linearly separable

- See the below image. You cannot draw a straight line so that all green dots in one side and red dot in other side.

```
from sklearn.datasets import load_iris
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import log_loss
X = [[0.5,1], [1.5, 1], [1, 2], [1,3]]
y = [1,1,0,1]
clf = LogisticRegression( solver='lbfgs').fit(X, y)
print("Cross-entropy before poly: %0.4f" % (log_loss(y,clf.predict_proba(X)),))

Xpoly = []

for x in X:
  item = x
  item.append(x[0]**2) # adding x1^2
  item.append(x[1]**2) # adding x2^2
  item.append(x[0]*x[1]) # adding x1*x2
  Xpoly.append(item)

clfpoly = LogisticRegression(solver='lbfgs').fit(Xpoly, y)
print("Cross-entropy after poly: %.4f" %(log_loss(y,clfpoly.predict_proba(Xpoly)),
```

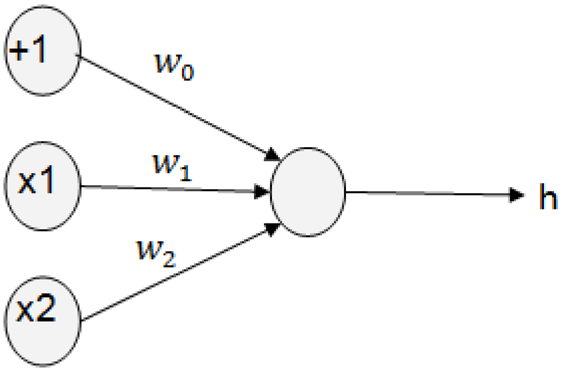
```
x1_1 = [0.5, 1.5, 1] # x1 with ouput 1
x2_1 = [1, 1, 3] # x2 with ouput 1
x1_0 = [1] # x1 with ouput 0
x2_0 = [2] # x2 with ouput 0


import matplotlib.pyplot as plt
plt.plot(x1_1, x2_1, "go")
plt.plot(x1_0, x2_0, "ro")
plt.xlabel("X1")
plt.ylabel("X2")

plt.show()
```

3

For the following logistic regression network, which choice of weights would result in the AND gate (Choose all that apply).



- **A.** w0 = -11, w1= 6,w2= 6
- **B.** w0 = -11, w1= 20, w2= 20
- **C.** w0 = -35, w1 = 20, w2= 20
- **D.** w0 = 25, w1 = 10, w2 = -30

The AND table is given

```
x1| x2| h

------------

0 | 0 | 0

0 | 1 | 0

1 | 0 | 0

1 | 1 | 1
```

```
inputs = [
    [0,0],
    [0,1],
    [1,0],
    [1,1]
]
outputs = [0, 0, 0, 1]

option_A = {"w0": -11, "w1": 6, "w2": 6}
option_B = {"w0": -11, "w1": 20, "w2": 20}
option_C = {"w0": -35, "w1": 20, "w2": 20}
option_D = {"w0": 25, "w1": 10, "w2": -30}

h = lambda x1,x2, w0, w1, w2: 1 if (w0+x1*w1+x2*w2) >= 0 else 0

h_expand = lambda input, option: h(input[0], input[1], option["w0"], option["w1"],
```

```
def isSatisfyAND(option):
  for input,output in zip(inputs, outputs):
    if(h_expand(input, option)!=output):
      return False
  return True


print("Option A: ", "RIGHT" if isSatisfyAND(option_A) else "WRONG")
print("Option B: ", "RIGHT" if isSatisfyAND(option_B) else "WRONG")
print("Option C: ", "RIGHT" if isSatisfyAND(option_C) else "WRONG")
print("Option D: ", "RIGHT" if isSatisfyAND(option_D) else "WRONG")
```

4

Consider the data provided below.

Example	x_1	x_2	y
1	0	0	0
2	0	1	1
3	1	0	1
4	1	1	0

We will try to fit this using a Neural Network with one hidden layer consisting of two neurons. Also assume that the activation function and the cost function are the sigmoid and binary cross entropy, respectively. Answer the following questions (From 4-7)

What is the total number of weights (including bias) connecting the input to the first hidden layer.

Here input layer contains 2 inputs. The inputs connected to two neurons in the hidden layer. Each neurons in the hidden layer will have seprate bias-weight. Total weights = 2 inputs * 2 hidden neurons + 2 bias for two hidden layer neurons = 6 weights

ANSWER#4: 6 Output layer can have one or two neurons. If it is one, use sigmoid. For two, use softmax. Usually it will be one. And the question says we need to use sigmoid. So I conclude the output layer contain only one neuron.

The two neurons in the hidden layer connected to oe neuron in the output layer. The neron in the output layer will have bias-weight. Total weights = 2 hidden layer neurons * 1 ouput neuron + 1 bias for the ouput layer neurons = 3 weights

ANSWER#5: 3

```
import math

def a(x):
  return 1.0 / (1 + math.exp(-x))

z = lambda w0, w1, w2, x1, x2: w0+x1*w1+x2*w2
```

```
inputs =[
    [0, 0],
    [0, 1],
    [1, 0],
    [1, 1]
]
outputs = [0, 1, 1, 0]


def y(x1, x2):
  hidden_layer_neuron1z = z(1, 1, 1, x1, x2)
  hidden_layer_neuron2z =z(1, 1, 1, x1, x2)

  hidden_layer_neuron1a = a(hidden_layer_neuron1z)
  hidden_layer_neuron2a = a(hidden_layer_neuron2z)
  output_layer_neuronz = z(1, 1, 1, hidden_layer_neuron1a, hidden_layer_neuron2a)
  output_layer_neurona = a(output_layer_neuronz)
  #print(locals())
  return output_layer_neurona


print("ANSWER#6 %4.2f" % y(1,0))


first = y(inputs[0][0], inputs[0][1])
second = y(inputs[1][0], inputs[1][1])
third = y(inputs[2][0], inputs[2][1])
fourth = y(inputs[3][0], inputs[3][1])
print("ANSWER#7 A: 1st and 2nd equal : ", "YES" if first==second else "NO")
print("ANSWER#7 B: 2nd and 3rd equal : ", "YES" if second==third else "NO")
print("ANSWER#7 C: 3rd and 4th equal : ", "YES" if third==fourth else "NO")
print("ANSWER#7 D: 4th and 1st equal : ", "YES" if fourth==first else "NO")
```

Accepted answer for **Question 6 is 0.99**. I don't know what is the issue with my solution!

Based on data, Answer questions 8-10:

Dear Students,

There is a mistake in multiple choice options of Questions 8, 9, 10 in Assignment 5. Kindly make a random choice, marks will be given to any option selected.

Regards, NPTEL. Feb 27