Manarat International University (MIU)

Department of Computer Science and Engineering
Mid-term Examination (Summer 2019)
Artificial Intelligence (CSE-411)

Full Marks: 20 Time: 1.5 Hour

Answer any 5 (Five) questions. All questions are of equal value.

1 Show the derivative of log likelihood for logistic regression is 4

$$\frac{\partial LL(\theta)}{\partial \theta_j} = \sum_{i=1}^{n} \left[y^{(i)} - \sigma(\theta^T \mathbf{x}^{(i)}) \right] x_j^{(i)}$$

Where the symbols have their usual meanings.

2 What is Gradient Ascent Optimization. Write the Gradient Ascent Optimization algorithm for logistic regression in pseudo-code. 4

3 Show that the maximum likelihood estimation (MLE) of a Bernoulli distribution is the sample mean. 4

4 Adult heights can be considered to be normally distributed, 2 + 2

a. Adult women have a mean height of 65 inches and a standard deviation of 3.5 inches. What is the probability that a randomly selected adult woman is over 72 inches?

b. What is the probability that a randomly selected woman is between 63 and 65 inches?

5 Following statistics shows preference (like or not) data of 40 student of CSE-40th batch for the tv sitcoms *Friends*, *Big Bang Theory* and *How I Met Your Mother*. Each training example has x_1 , x_2 and y where 4
x_1 is whether or not the student liked *Friends*,
x_2 is whether or not the student liked *Big Bang Theory* and
y is whether or not the student liked *How I Met Your Mother*.

For the 40 training examples the MLE estimates are as follows:

Y	X_1	*Friends* 0	*Friends* 1
How I Met Your Mother	0	10	6
	1	4	20

Y	X_2	*Big Bang Theory* 0	*Big Bang Theory* 1
How I Met Your Mother	0	8	8
	1	18	6

Md Ibrahim, a new student, likes *Friends* ($x_1 = 1$) but not *Big Bang Theory* ($x_2 = 0$). What do you predict that he will like *How I Met Your Mother ?*

6 Shazam is an application developed by Apple Inc. which can identify music based on a short sample played on the device. Based on the frequency of requests it's been getting these days, Shazam has found that: 4

80% of songs are *Hello* by Lionel Richie
20% of songs are *Can't Get Used to Losing You* by Andy Williams

When a request is made, Shazam receives an audio sample that it uses to update its belief. From one particular audio sample (S), Shazam estimates that:

- S would have a 50% chance of appearing if *Hello* were playing.
- S would have a 90% chance of appearing if *Can't Get Used to Losing You* were playing

What is the updated probability that the song is *Hello* given the audio sample heard?

Hint: $P(X_1) = 0.8$, $P(X_2) = 0.2$, $P(S \mid X_1) = 0.5$, $P(S \mid X_2) = 0.9$
Find $P(X_1 \mid S)$ using Bayes Theorem and Law of Total Probability

Standard Normal Table

Note: An entry in the table is the area under the curve to the left of z, $P(Z \leq z) = \Phi(z)$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7703	0.7734	0.7764	0.7793	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8906	0.8925	0.8943	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952