BT 3041 - Analysis and Interpretation of Biological Data
End-semester Examination

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Answers

Question Number	Answer	Question Number	Answer
1	B	21	A
2	C	22	C
3	B	23	C
4	C	24	D
5	D	25	B
6	B	26	C
7	A	27	C
8	C	28	D
9	B	29	D
10	C	30	D
11	D	Part B - 1	B
12	B	Part B - 2	C
13	B	Part B - 3	C
14	C	Part B - 4	D
15	A	Part B - 5	B
16	A	Part B - 6	C
17	D	Part B - 7	D
18	B	Part B - 8	B
19	C	Part B - 9	A
20	B	Part B - 10	A

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AIBD end semester — Rough

Part B

1)

Point	#edges	neighbours	AD	BD	CD	ED
A	4 edges	BC DE	ABD			
			ACD			
			AED			
B	3 edges	ACD		BAD		
				BCD		
C	4 edges	ABDE			CAD	
					CBD	
					CED	
E	3 edges	ACD				EAD
						ECD

3, 2, 3, 2
(B)

2)

	(0,0)	(0,1)	(3,0)	(3,2)	(7,0)	(7,5)
(0,0)	0	1	3	$\sqrt{13}$	7	$\sqrt{74}$
(0,1)		0	$\sqrt{10}$	$\sqrt{10}$	$\sqrt{50}$	$\sqrt{65}$
(3,0)			0	2	4	$\sqrt{41}$
(3,2)				0	$\sqrt{20}$	5
(7,0)					0	5
(7,5)						0

	C1	(3,0)	(3,2)	(7,0)	(7,5)
(0,0;0,1) C1	0	3 $\sqrt{10}$	$\sqrt{10}$ $\sqrt{13}$	7 $\sqrt{50}$	$\sqrt{65}$ $\sqrt{74}$
(3,0)		0	2	4	$\sqrt{41}$
(3,2)			0	$\sqrt{20}$	5
(7,0)				0	5
(7,5)					0

min → blue
max → green

(3,0) and (3,2)
for both min & max

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2) ans: (3,0) and (3,2)

(c)

3) same as above: (3,0) and (3,2)

(c)

4) $y_1 > y_2 \rightarrow$ class 1 ; $y_1 < y_2 \rightarrow$ class 2 } $y_1 = y_2$ decision surface

$y_1 = g(x_1 - x_2 - 1/2)$

$y_2 = g(x_1 + x_2 - 1/2)$

$y_1 = y_2$

$g(x_1 - x_2 - 1/2) = g(x_1 + x_2 - 1/2)$

sigmoid is a monotonically increasing function.

Hence,

$x_1 - x_2 - 1/2 = x_1 + x_2 - 1/2$

$\Rightarrow \underline{\underline{2x_2 = 0}}$

$\Rightarrow \underline{\underline{x_2 = 0}}$

otherwise

$$\frac{1}{1+e^{-(x_1 - x_2 - 1/2)}} = \frac{1}{1+e^{-(x_1 + x_2 - 1/2)}}$$

$\Rightarrow$ Inverse on both sides

$$1 + e^{-(x_1 + x_2 - 1/2)} = 1 + e^{-(x_1 - x_2 - 1/2)}$$

$\Rightarrow$ log on both sides (ln)

$\Rightarrow -(x_1 - x_2 - 1/2) = -(x_1 + x_2 - 1/2)$

$\Rightarrow \underline{\underline{x_2 = 0}}$

(a)

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5) $y_1 = g(x_1)$ $\quad y = g(y_1 + y_2 - 1.3)$

$y_2 = g(x_2)$

$g \to$ step function

$$g(x) = \begin{cases} 0 & x<0 \\ 1/2 & x=0 \\ 1 & x>0 \end{cases}$$

Q1

$x_1 > 0 \quad x_2 > 0$

$y_1 = 1 \quad y_2 = 1$

$y = g(0.7)$

$\Rightarrow y = 1$ ✓

Q2

$x_1 < 0 \quad x_2 > 0$

$y_1 = 0 \quad y_2 = 1$

$y = g(-0.3)$

$\Rightarrow y = 0$

Q3

$x_1 < 0 \quad x_2 < 0$

$y_1 = 0 \quad y_2 = 0$

$y = g(-1.3)$

$\Rightarrow y = 0$

Q4

$x_1 > 0 \quad x_2 < 0$

$y_1 = 1 \quad y_2 = 0$

$y = g(-0.3)$

$\Rightarrow y = 0$

(B)

6) σ is step

	$v_1 = \sigma(x_1 + x_2 - 1.5)$	$v_2 = \sigma(x_1 + x_2 - 0.5)$	$y = \sigma(v_1 - v_2 - 1/2)$
(0,0)	$\sigma(-1.5) = 0$	$\sigma(-0.5) = 0$	$\sigma(0 - 0 - 1/2) = 0$
(0,1)	$\sigma(-0.5) = 0$	$\sigma(0.5) = 1$	$\sigma(0 - 1 - 0.5) = 0$
(1,0)	$\sigma(-0.5) = 0$	$\sigma(0.5) = 1$	$\sigma(0 - 1 - 0.5) = 0$
(1,1)	$\sigma(0.5) = 1$	$\sigma(1.5) = 1$	$\sigma(1 - 1 - 0.5) = 0$

Based on the correction

$y = \sigma(v_2 - v_1 - 1/2)$

(0,0) $\sigma(0 - 0.5) = 0$

(0,1) $\sigma(1 - 0.5) = 1$

(1,0) $\sigma(1 - 0.5) = 1$

(1,1) $\sigma(0 - 0.5) = 0$

Hence XOR

(C)

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7) $C = x^2+y^2$ and $3x+4y=10$

max (x^2+y^2)
st $(3x+4y=10)$
using Lagrangian.

$L = (x^2+y^2) - \lambda(3x+4y-10)$

$\nabla_{(x,y)} L = \begin{pmatrix} 2x - 3\lambda \\ 2y - 4\lambda \end{pmatrix} = 0$

$\Rightarrow \underline{\underline{x = 3\lambda/2}}$ and $\underline{\underline{y = 2\lambda}}$

$\nabla_\lambda L = 0 \Rightarrow \underline{\underline{3x+4y=10}}$

$\frac{3(3\lambda)}{2} + 4(2\lambda) = 10$

$\frac{9\lambda+16\lambda}{2} = 10$

$\underline{\underline{\lambda = \frac{20}{25}}}$

$\Rightarrow \underline{\underline{\lambda = \frac{4}{5}}}$

maximum value
$= x^2+y^2$
$= \frac{9}{}\left(\frac{4}{5}\right)^2 + (2\lambda)^2$

$= \left(\frac{3\lambda}{2}\right)^2 + (2\lambda)^2$

$= \frac{9\lambda^2}{4} + 4\lambda^2$

$= \frac{9\lambda^2+16\lambda^2}{4} = \underline{\underline{\frac{25\lambda^2}{4}}}$ $\Rightarrow$ maximum $= \frac{25}{4}\left(\frac{16}{25}\right) = \underline{\underline{4}}$

(D)

8) $S = \{-2, -1, 0, 1, 2\}$ $\quad n = 1$ (univariate)

$\Rightarrow \mu =$ mean of samples $\quad K = 1$ (single gaussian)

$\Rightarrow \mu = \frac{\Sigma x_j}{N}$

and $\sigma =$ std of samples

$\Rightarrow \sigma^2 = \frac{\Sigma (x_j - \mu)^2}{N}$

$N = 5$

and $\underline{\mu = 0}$

$\sigma^2 = \frac{(4) + (1) + 0 + 1 + 4}{5} = \frac{10}{5} = \underline{2}$ $\quad \Rightarrow \sigma = \sqrt{2} = 1.414$

considering $\underline{\alpha = 1}$

(B)

9) $y = w^T x - w_0$

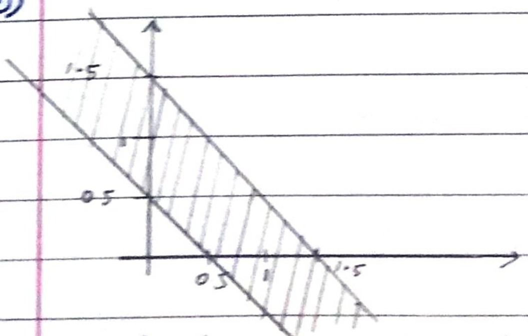
maximize: $\underline{d_i (w^T x_i - w_0)} = C$

$\frac{\partial (C)}{\partial w} = d_i x_i \qquad \frac{\partial (C)}{\partial w_0} = -d_i$

$\Rightarrow \Delta w = \eta d_i x_i \; ; \quad \Delta w_0 = -\eta d_i$

(A)

10)



$y_1 = g(x_1 + x_2 - 1.5)$

$y_2 = g(x_1 + x_2 - 0.5)$

$y = g(y_2 - y_1 - 0.5)$

considering g as sigmoidal wave (infinite)

considering g as step function a rectangular strip

(A)

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Part A

1) SNN is graph based clustering
(B)

2) $A = \begin{pmatrix} 1 & 1 \\ 0 & -1 \end{pmatrix}$

$\lambda = 1$ / $\lambda = -1$

indefinite
(C)

3) [minimum, Q1, median, Q3, maximum]
(B)

4) $x^T A x + a^T x = f(x)$

$\nabla f(x) = \underline{2Ax + a}$
(C)

5) Most imp. factor among a large set
(D)

6) (B) vector field plot

7) (A) circle segment display

8) (C) circos

9) (B) parallel coordinates plot

10) (C) Jaccard distance

11) (A) offers a way of finding "right" # of clusters
- The global minima of k-means is unique
- Objective function we try to minimize : SSE

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12) (B) Hierarchial clustering

13) (B) SOM

- finds correlation among input
- Removes them all

14) (C)

$N_{C_2} = \frac{N(N-1)}{2}$

15) (A)

- globular clusters
- well seperated

16) (A) scale based clustering

17) (D) SNN

18) (B) Improves testing accuracy

19) (C) Differentiability

20) (B) $(1+(W^T x)^2)$

- should only be dependent on $\|x-w\|$
- a radial distance measure only

21) (A) all distinct data points

22) (C) kmeans. & ~~eg~~ pseudoinverse

23) (C) margin (Δ)

24) (D)

$\min \|w\|^2$ subject to $y_i(w \cdot x_j + b) \geq 1, j = 1, \ldots, N$

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25) (B)

$O(N^3)$ for time

$O(N^2)$ for space

26) (C) Heiracial data comprehension takes place

27) (C)

$$\text{specificity} = \frac{TN}{TN+FP}$$

28) (A)

- Require ~~an bell like~~ ~~exponential~~ decay in eigen values
- sharper the decay, better

29) (A) cone trees

30) (A) cone trees