Indian Institute of Technology, Madras - BS in Data Science and Applications

Notations :

1.Options shown in green color and with ✔ icon are correct.

2.Options shown in red color and with ✖ icon are incorrect.

Question Paper Name :	IIT M FOUNDATION AN4 EXAM QPF4 16 JULY 2023
Subject Name :	2023 July: IIT M FOUNDATION AN4 EXAM QPF4
Creation Date :	2023-07-10 18:54:05
Duration :	240
Total Marks :	705
Display Marks:	Yes
Share Answer Key With Delivery Engine :	Yes
Actual Answer Key :	Yes
Calculator :	Scientific
Magnifying Glass Required? :	No
Ruler Required? :	No
Eraser Required? :	No
Scratch Pad Required? :	No
Rough Sketch/Notepad Required? :	No
Protractor Required? :	No
Show Watermark on Console? :	Yes
Highlighter :	No
Auto Save on Console?	Yes
Change Font Color :	No

If the application is run locally on http://127.0.0.1:5000 using the command `python app.py stable`, what will be rendered by the browser for URL http://127.0.0.1:5000/home?

Options :

6406531929089. ✖ **static url path: /static**
static folder: C:\home\mad_1\static

6406531929090. ✖ **static url path: /stable**
static folder: C:\home\mad_1\stable

6406531929091. ✖ **static url path: C:\home\mad_1\stable**
static folder: /stable

6406531929092. ✔ **static url path: /stable**
static folder: C:\home\mad_1\static

MLF

Section Id :	64065339062
Section Number :	12
Section type :	Online
Mandatory or Optional :	Mandatory
Number of Questions :	15
Number of Questions to be attempted :	15
Section Marks :	50
Display Number Panel :	Yes
Group All Questions :	No

Enable Mark as Answered Mark for Review and Clear Response :	Yes
Maximum Instruction Time :	0
Sub-Section Number :	1
Sub-Section Id :	64065382525
Question Shuffling Allowed :	No
Is Section Default? :	null

Question Number : 233 Question Id : 640653577678 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 0

Question Label : Multiple Choice Question

THIS IS QUESTION PAPER FOR THE SUBJECT "DIPLOMA LEVEL : MACHINE LEARNING FOUNDATIONS (COMPUTER BASED EXAM)"

ARE YOU SURE YOU HAVE TO WRITE EXAM FOR THIS SUBJECT?

CROSS CHECK YOUR HALL TICKET TO CONFIRM THE SUBJECTS TO BE WRITTEN.

(IF IT IS NOT THE CORRECT SUBJECT, PLS CHECK THE SECTION AT THE TOP FOR THE SUBJECTS REGISTERED BY YOU)

Options :

6406531929129. ✔ YES

6406531929130. ✖ NO

Sub-Section Number :	2
Sub-Section Id :	64065382526
Question Shuffling Allowed :	Yes
Is Section Default? :	null

Question Number : 234 Question Id : 640653577679 Question Type : MSQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction

Time : 0

Correct Marks : 3 Max. Selectable Options : 0

Question Label : Multiple Select Question

Which of the following statements are correct?

Options :

6406531929131. ✔ $\mathbf{I}(444\%3 = 0 \text{ and } \pi \in \mathbb{R}) = 1.$

6406531929132. ✖ Mean Squared Error (MSE) is a suitable loss function for classification problems.

6406531929133. ✖ The loss obtained after applying encoder and decoder functions to a given data can be negative.

6406531929134. ✔ Gaussian mixture model is a family of distributions for modeling multimodal data.

Question Number : 235 Question Id : 640653577691 Question Type : MSQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3 Max. Selectable Options : 0

Question Label : Multiple Select Question

Which of the following statements is/are true?

Options :

6406531929155. ✔ Row space of a matrix is orthogonal to the null space of the matrix.

6406531929156. ✖ Row space of a matrix is orthogonal to the null space of transpose of the matrix.

6406531929157. ✔ Dimension of row space of a matrix is always equal to the dimension of column space of the matrix.

6406531929158. ✖ Dimension of row space of a matrix need not be equal to the dimension of column space of the matrix.

Question Number : 236 Question Id : 640653577693 Question Type : MSQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3 Max. Selectable Options : 0

Question Label : Multiple Select Question

Which of the following matrices have eigenvectors as $\begin{bmatrix}2\\1\\2\end{bmatrix}$, $\begin{bmatrix}1\\-2\\0\end{bmatrix}$ and $\begin{bmatrix}1\\0\\-1\end{bmatrix}$?

Options :

6406531929163. ✔ $\begin{bmatrix}3&2&4\\2&0&2\\4&2&3\end{bmatrix}$

6406531929164. ✔ $\begin{bmatrix}6&4&8\\4&0&4\\8&4&6\end{bmatrix}$

6406531929165. ✖ $\begin{bmatrix}2&1&4\\4&0&4\\8&4&6\end{bmatrix}$

6406531929166. ✖ $\begin{bmatrix}3&1&0\\2&0&2\\4&2&3\end{bmatrix}$

Question Number : 237 Question Id : 640653577694 Question Type : MSQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3 Max. Selectable Options : 0

Question Label : Multiple Select Question

Let the matrix $A \in \mathbb{R}^{d\times d}$ be diagonalizable, then which of the following statements is/are true for A?

Options :

6406531929167. ✖ A must be symmetric.

6406531929168. ✔ We can find a basis of eigenvectors for $\mathbb{R}^d$.

6406531929169. ✖ We can find an orthonormal basis of eigenvectors for $\mathbb{R}^d$.

6406531929170. ✔ A can have some repeated eigenvalues but must have distinct independent eigenvectors.

Sub-Section Number :	3
Sub-Section Id :	64065382527
Question Shuffling Allowed :	Yes
Is Section Default? :	null

Question Number : 238 Question Id : 640653577686 Question Type : MSQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4 Max. Selectable Options : 0

Question Label : Multiple Select Question

Let $A, B \in \mathbb{R}^{n \times n}$ be two matrices, then which among the following statements are correct?

Options :

6406531929147. ✔ $x \in \text{Nullspace}(A) \implies x \in \text{Nullspace}(BA)$.

6406531929148. ✔ $x \in \text{Columnspace}(A) \implies x \in \text{Columnspace}(B)$, where $A = BC, C \in \mathbb{R}^{n \times n}$.

6406531929149. ✔ $x \in \text{Nullspace}(AB) \implies Bx \in \text{Nullspace}(A)$.

6406531929150. ✖ $x \in \text{Nullspace}(AB) \implies x \in \text{Nullspace}(B)$.

Question Number : 239 Question Id : 640653577692 Question Type : MSQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4 Max. Selectable Options : 0

Question Label : Multiple Select Question

Consider the solution of the linear regression problem $(Ax = b)$ using least squares method, where $A = \begin{bmatrix} 1 & 5 & 5 \\ 2 & 3 & 5 \\ 0 & 7 & 1 \end{bmatrix}$ and $b = \begin{bmatrix} 7 \\ 8 \\ 4 \end{bmatrix}$.
Based on this data, which of the following statements is/are true?

Options :

6406531929159. ✔ The error value is zero as we can get an x such that Ax is exactly equal to b.

6406531929160. ✖ The error value is non-zero as we cannot get an x such that Ax is exactly equal to b.

6406531929161. ✔ Least squares solution for x is $\begin{bmatrix} 2 \\ 0.5 \\ 0.5 \end{bmatrix}$.

6406531929162. ✖ Least squares solution for x is $\begin{bmatrix} 1 \\ 0.6 \\ 0.4 \end{bmatrix}$.

Sub-Section Number :	4
Sub-Section Id :	64065382528
Question Shuffling Allowed :	Yes
Is Section Default? :	null

Question Number : 240 Question Id : 640653577684 Question Type : MCQ Is Question

Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4

Question Label : Multiple Choice Question

Find the linear approximation of the function $f(x,y) = ye^{xy}$ in the neighbourhood of (0,1).

Options :

6406531929139. ✔ $x + y$

6406531929140. ✖ $x + 2y$

6406531929141. ✖ $2x + y$

6406531929142. ✖ $2x + 3y$

Question Number : 241 Question Id : 640653577685 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4

Question Label : Multiple Choice Question

Let $f : \mathbb{R}^2 \to \mathbb{R}$, given by $f(x,y) = x^2 + y^2$. Consider the following algorithm:

$$X_{n+1} = X_n - h\nabla f(X_n), \quad X_i \in \mathbb{R}^2, i : 1, 2, \ldots \text{ and } h > 0,$$

where h is the step size and $\nabla f(X_n)$ is the gradient of f evaluated at X_n. Fix $h = 0.25$ and $X_0 = (1,3)$, which among the following points does the algorithm converge to?

Options :

6406531929143. ✖ (1, 3)

6406531929144. ✖ (1/2, 1/6)

6406531929145. ✔ (0, 0)

6406531929146. ✖ The algorithm does not converge

Sub-Section Number : 5

Sub-Section Id : 64065382529

Question Shuffling Allowed : Yes

Is Section Default? : null

Question Number : 242 Question Id : 640653577680 Question Type : SA Calculator : None

Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4

Question Label : Short Answer Question

Consider the following dataset with 5 data points:

X	y
$(2,3)$	5
$(-1,1)$	2
$(4,2)$	7
$(0,-2)$	1
$(-3,5)$	4

We want to fit a linear regression model of the form $f(X) = w^T x$ to this dataset, where $w = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$. Compute the value of the loss function L for this dataset which is defined as $L = \max_i |f(x^i) - y^i|$.

Response Type : Numeric

Evaluation Required For SA : Yes

Show Word Count : Yes

Answers Type : Equal

Text Areas : PlainText

Possible Answers :

5

Question Number : 243 Question Id : 640653577681 Question Type : SA Calculator : None

Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4

Question Label : Short Answer Question

Let $f(x_1, x_2, x_3) = \frac{x_1 + x_2 + x_3}{2}$ be used as an encoder function and $g(u) = [u, u, u]$ be used as a decoder function for dimensionality reduction of the dataset $X_1 = [1, 2, 3]$, $X_2 = [2, 4, 6], X_3 = [3, 6, 9], X_4 = [4, 8, 12]$. Calculate the reconstruction error $\left(R(f, g) = \frac{1}{n}\sum_{i=1}^{n} \|x_i - g(f(x_i))\|^2\right)$ for this encoder decoder pair. Enter the answer correct to one decimal place.

Response Type : Numeric

Evaluation Required For SA : Yes

Show Word Count : Yes

Answers Type : Range

Text Areas : PlainText

Possible Answers :

37 to 38

Question Number : 244 Question Id : 640653577690 Question Type : SA Calculator : None

Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 4

Question Label : Short Answer Question

Let P_1 be the projection matrix onto the line spanned by the vector $a = [1, 2, 3]^T$. Let P_2 be the projection matrix that projects vectors onto the plane perpendicular to span of a. Find the determinant of $P_1 + P_2$.

Response Type : Numeric

Evaluation Required For SA : Yes

Show Word Count : Yes

Answers Type : Equal

Text Areas : PlainText

Possible Answers :

1

Sub-Section Number :	6
Sub-Section Id :	64065382530
Question Shuffling Allowed :	Yes
Is Section Default? :	null

Question Number : 245 Question Id : 640653577682 Question Type : SA Calculator : None

Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3

Question Label : Short Answer Question

Find the directional derivative of $f(x, y, z) = x(x^2 - y^2) - z$ at a point D(1, -1, 0) in the direction of vector $\hat{h} = \frac{2}{7}i - \frac{3}{7}j + \frac{6}{7}k$. Enter the answer correct to two decimal places.

Response Type : Numeric

Evaluation Required For SA : Yes

Show Word Count : Yes

Answers Type : Range

Text Areas : PlainText

Possible Answers :

-1.16 to -1.12

Sub-Section Number :	7
Sub-Section Id :	64065382531
Question Shuffling Allowed :	Yes
Is Section Default? :	null

Question Number : 246 Question Id : 640653577683 Question Type : SA Calculator : None

Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 2

Question Label : Short Answer Question

Let the function $f(x) = \begin{cases} ax - 3, & x < 2 \\ 4, & x = 2 \\ 2x, & x > 2 \end{cases}$ be continuous for all $x \in \mathbb{R}$. Then, find the value of a.

Enter the answer correct to one decimal place.

Response Type : Numeric

Evaluation Required For SA : Yes

Show Word Count : Yes

Answers Type : Equal

Text Areas : PlainText

Possible Answers :

3.5

Sub-Section Number :	8
Sub-Section Id :	64065382532
Question Shuffling Allowed :	No
Is Section Default? :	null

Question Id : 640653577687 Question Type : COMPREHENSION Sub Question Shuffling Allowed : No Group Comprehension Questions : No Question Pattern Type : NonMatrix Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Question Numbers : (247 to 248)

Question Label : Comprehension

$$\text{Let } A = \begin{pmatrix} 1 & -1 \\ 1 & 1 \\ 1 & 2 \end{pmatrix} \text{ and } b = \begin{pmatrix} 1 \\ 1 \\ 3 \end{pmatrix}.$$

Based on the above data, answer the given subquestions.

Sub questions

Question Number : 247 Question Id : 640653577688 Question Type : MCQ Is Question Mandatory : No Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 2

Question Label : Multiple Choice Question

Is the system $Ax = b$ consistent?

Options :

6406531929151. ✖ Yes

6406531929152. ✔ No

Question Number : 248 Question Id : 640653577689 Question Type : SA Calculator : None Response Time : N.A Think Time : N.A Minimum Instruction Time : 0

Correct Marks : 3

Question Label : Short Answer Question

Using the least square approximation, find the length of the projection vector *p* of *b* onto the column space of *A*. Enter the answer correct to two decimal places.

Response Type : Numeric

Evaluation Required For SA : Yes

Show Word Count : Yes

Answers Type : Range

Text Areas : PlainText

Possible Answers :

3.12 to 3.16

Java

Section Id :	64065339063
Section Number :	13
Section type :	Online
Mandatory or Optional :	Mandatory
Number of Questions :	16
Number of Questions to be attempted :	16
Section Marks :	50
Display Number Panel :	Yes
Group All Questions :	No
Enable Mark as Answered Mark for Review and Clear Response :	Yes
Maximum Instruction Time :	0