

# 2024-03-26 Final Exam

5072DASC6Y Data Science 23/24 (2.1) · 7 exercises · 25.0 points

## Multimodal Data Processing Questions

1.0 point · 1 question

1 Which of the following statements about multimodal data processing is **TRUE**?

1.0 point · Multiple choice · 4 alternatives

- Transformers use multi-head attention to look at different aspects of the inputs.
- Self-attention layers use fixed weights to filter information.
- Contrastive Learning brings negative pairs closer and pushes positive pairs far apart.
- Late fusion means that we concatenate the representations of modalities A and B before making the predictions.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

## Structured Data Processing Questions

2.0 points · 2 questions

2 Suppose we flipped a coin 100 times, and we got 0 heads and 100 tails. What is the entropy of the result in this coin-flipping experiment?

1.0 point · Multiple choice · 4 alternatives

- 0
- 1
- 0.25
- 0.5

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

3 Which of the following statements about the Decision Tree model is **FALSE**? Notice that we refer to the general Decision Tree, not a specific implementation.

1.0 point · Multiple choice · 4 alternatives

- Decision Tree can be trained very well without problems using the misclassification error as the node-splitting strategy.
- When splitting nodes, Decision Tree can use the same feature multiple times.
- Decision Tree can be used for classification and regression tasks.
- Decision Tree can handle continuous features.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

## Text Data Processing Questions

6.0 points · 6 questions

4 Given two word embedding vectors for "cat" (0.9, -0.2) and "dog" (0.3, 0.8), what is the cosine similarity between these two word embedding vectors (round to two decimal places)?

Hint: To calculate the cosine similarity between two vectors, you first need to compute the dot product of the vectors (i.e., sum of element-wise multiplication), and then divide it by the product (i.e., multiplication) of their magnitudes. The magnitude of a vector  $v = (x, y)$  is  $\text{sqrt}(x^2 + y^2)$ , where *sqrt* means taking the square root. Use the `numpy.sqrt` function if you need to compute the square root.

1.0 point · Multiple choice · 4 alternatives

0.14

0.08

0.05

0.55

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

5 Which of the following best describes the output of topic modeling using Latent Dirichlet Allocation?

1.0 point · Multiple choice · 4 alternatives

- A set of vectors, where each vector is represented as weights over the words in the text corpus.
- A set of vectors, where each vector is represented as counts over the words in the text corpus.
- A set of clusters, where each cluster represents a group of similar documents.
- A set of vectors, where each vector is represented as a word in a high-dimensional space.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

6 Which of the following about text processing is **FALSE**?

1.0 point · Multiple choice · 4 alternatives

- Lemmatization simply chops word tails to obtain the word's base form.
- POS tagging labels the role of each word in a particular part of speech, such as verb.
- Stemming cannot always correctly identify the original form of each word.
- Word embedding represents each word as a data point in a high-dimensional space.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

7 Which of the following is the order that best describes the attention mechanism?

- A: Compute the attention distribution using softmax
- B: Compute attention-weighted sum of encoder output
- C: Get the encoder output values (from the RNN)
- D: Compute attention scores (dot product similarity)
- E: Randomly shuffle the output from the previous step to increase robustness against noise
- F: Transform encoder outputs (dimension reduction)

1.0 point · Multiple choice · 4 alternatives

- CFDAB
- CABDEF
- CFDBA
- CBDEAF

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

8 Given the following term frequency (TF) table for four words (“apple”, “bike”, “spaceship”, “tea”) in four documents, which word is the most representative for the first document (with ID 1) according to TF-IDF?

Document ID	TF for “apple”	TF for “bike”	TF for “spaceship”	TF for “tea”
1	2	0	4	8
2	3	2	3	0
3	2	3	0	1
4	4	0	0	0

1.0 point · Multiple choice · 4 alternatives

- tea
- apple
- spaceship
- bike

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

9 Given an array [3, 1, 0.1], what is the output (round to two decimal places) if we give the array to a softmax layer in the neural network? Notice that the integer or float numbers in the array are separated by commas.

Hint: Use the `numpy.exp` function if you need to compute the result of an exponential function.

1.0 point · Multiple choice · 4 alternatives

[0.84, 0.11, 0.05]

[20.09, 2.72, 1.11]

23.91

[0.73, 0.24, 0.02]

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

## Image Data Processing Questions

5.0 points · 5 questions

10 Given an image, which of the following kernels will blur the image after performing the typical convolution operation (no padding, stride 1) using the kernel? Assume that Python numpy is imported.

1.0 point · Multiple choice · 4 alternatives

- `numpy.array([[0.0625, 0.125, 0.0625],[0.125, 0.25, 0.125],[0.0625, 0.125, 0.0625]])`
- `numpy.array([[0, 0, 0],[0, 2, 0],[0, 0, 0]])`
- `numpy.array([[0, 0, 0],[2, 0, 0],[0, 0, 0]])`
- `numpy.array([[1, 2, 1],[0, 0, 0],[-1, -2, -1]])`

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

11 When performing image classification using deep neural networks, we usually randomly rotate input images, crop input images, and change the image colors before feeding the images to the neural network. Which of the following options best describes the purpose of doing this?

1.0 point · Multiple choice · 4 alternatives

- To combat overfitting by increasing dataset diversity
- To perform feature selection
- To reduce the model training time
- To reduce the size of input (e.g., images)

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly



12 Given the following image with size 4 (both width and height), what is the output after performing a max pooling operation with a 2x2 filter (i.e., width 2 and height 2) and stride 2?

2	7	1	6
4	8	5	1
0	4	3	2
1	3	1	2

1.0 point · Multiple choice · 4 alternatives

Output after max pooling:

8	6
4	3

Output after max pooling:

7
8
4
3

Output after max pooling:

8	8	6
8	8	5
4	4	3

Output after max pooling:

4	8	5	6
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Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

13 You are training a convolutional neural network using the stochastic gradient descent optimizer for an image classification task. During training the model, you observed that the loss and the model performance metrics did not converge (i.e., alternating between some high and low values). Which of the following is the best action to consider in this situation?

1.0 point · Multiple choice · 4 alternatives

- Decrease the learning rate after a certain number of epochs.
- Decrease the size of the neural network and use less data to train the model.
- Change the ReLU activation functions to the sigmoid activation functions instead.
- Decrease the batch size during the training process.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

14 Which of the following is the order that best describes the typical procedure for optimizing a model in PyTorch?

- A: Update the parameters of the model
- B: Backpropagate gradients for every parameter
- C: Accumulate the gradient from the previous steps
- D: Get a batch from the data loader object
- E: Obtain the predictions from the model
- F: Calculate the loss based on the difference between predictions and labels

1.0 point · Multiple choice · 4 alternatives

- DEFBA
- DBAFE
- DECBAF
- EDFACB

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

## Deep Learning Questions

8.0 points · 8 questions

15 Which of the following techniques is **NOT** effective in combating overfitting when training a deep neural network?

1.0 point · Multiple choice · 4 alternatives

- Increasing the number of layers in the neural network.
- Randomly dropping the neurons with a probability.
- Regularizing the model weights using some criterion.
- Augmenting the input data randomly on the fly.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

16 What is the difference between a feedforward neural network and a recurrent neural network regarding the model architecture?

1.0 point · Multiple choice · 4 alternatives

- In a recurrent network, the outputs from one layer are fed back as inputs, which forms feedback loops. But the computation of a feedforward network only goes forward, and the outputs are not re-used as inputs.
- Neurons in a feedforward network are organized in layers, and neurons in the same layer are not connected to each other. But a recurrent network has no such restriction and can have interconnectivity between neurons in the same layer.
- A feedforward network uses activation functions such as ReLU or sigmoid to introduce nonlinearity, while a recurrent network uses linear activation functions.
- Neurons in different layers in a feedforward network are fully connected. But a recurrent network only considers local connectivity, which means that neurons in different layers are partially connected.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

17 Which of the following is **NOT** a commonly used loss function for classification?

1.0 point · Multiple choice · 4 alternatives

- Squared error loss
- Cross-entropy loss
- Perceptron loss
- Logistic loss

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

18 Which of the following is the order that best describes the process of a typical gradient descent algorithm in machine learning?

1.0 point · Multiple choice · 4 alternatives

- A: Initialize model parameters with a starting point
- B: Make a step to update model parameters in the opposite direction to the gradient with a learning rate
- C: Compute the gradient of the error or cost function with respect to model parameters
- D: Repeat the previous two steps until convergence
- E: Make a step to update model parameters in the same direction to the gradient with a learning rate
- F: Repeat the previous two steps until the error or cost is zero

- ACBD
- ACBCED
- ACEF
- ACECBF

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

19 What is the main purpose of regularization when performing Gradient Descent?

1.0 point · Multiple choice · 4 alternatives

- To prevent the algorithm from overfitting the training data
- To speed up the algorithm and save computer memory
- To reduce the number of features in the dataset
- To schedule the learning rate appropriately

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

20 Given an input RGB image (3 channels) of size 32 by 32, a convolutional layer with 10 image filters (each filter has size 5 by 5), a stride of 3, and padding of 1. How many trainable parameters are in this convolutional layer, excluding the bias parameters? The “x” symbol in the following options indicates multiplication. For example, “5 x 5” means 25.

1.0 point · Multiple choice · 4 alternatives

- $5 \times 5 \times 10 \times 3$
- $32 \times 32 \times 10 \times 3$
- $5 \times 5 \times 10 \times 1$
- $5 \times 5 \times 1 \times 3$

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

21 Suppose we have a deep feedforward neural network with two layers. The first layer has four artificial neurons, and the second layer has one neuron. We want to use the network to perform binary classification (blue or orange colored dots) on the data that is shown below. The features are the values of the horizontal axis (X) and vertical axis (Y). Which of the following settings can help us achieve our task well?

1.0 point · Multiple choice · 4 alternatives

- Use the ReLU activation function for all neurons and use the cross-entropy loss.
- Use the identity activation function for all neurons and use the cross-entropy loss.
- Use the tanh activation function for all neurons and use the squared error loss.
- Use the identity activation function for all neurons and use the squared error loss.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

22 Suppose that we are performing a prediction task using artificial neurons. Which of the following statements about artificial neurons is **TRUE**?

1.0 point · Multiple choice · 4 alternatives

- Logistic regression uses the sigmoid activation function with the binary cross entropy loss function.
- Linear regression uses the identity activation function with the binary cross entropy loss function.
- Support Vector Machine uses the sigmoid activation function with the perceptron loss function.
- The perceptron classifier uses the identity activation function with the hinge loss function.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly



## Coding Questions

3.0 points · 3 questions

23 You are preprocessing text data for a document classification task. Given a pandas dataframe object D with two columns “class” and “tokens”. Each row means a document. The “class” column contains information about the class that the document belongs to, such as “Business”. The “tokens” column contains a list of tokens, such as ['Wall, St.', 'Bears', 'Claw', 'Back', 'Into']. Which of the options below best describes the function of the following code?

```
D.explode("tokens").groupby(["class",  
"tokens"]).size().reset_index(name="n").sort_values(["class", "n"], ascending=[False,  
True]).groupby("class").head(10)
```

1.0 point · Multiple choice · 4 alternatives

- Return a new dataframe with a new column that shows the 10 least used words per class, and their frequency.
- Return a new dataframe with a new column that shows the 10 most used words per class, and their frequency.
- Remove rows with duplicate tokens in the “tokens” column. Return a new dataframe with a new column that counts the frequency of each token among all documents per class.
- Compute the average frequency of each token in each document per class. Return a new dataframe with a new column that shows the 10 tokens with the highest average frequency.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

24 Given a pandas dataframe object D, where column “w” in each row contains a list of words, such as ['Wall, St.', 'of', 'Bear', 'claw', 'at', 'back', 'dog', 'into']. Which of the options below best describes the function of the following code?

```
S = ["bear", "cat", "dog", "koala", "rabbit"]  
D["w"].apply(lambda x: [word for word in x if word.lower() in S])
```

1.0 point · Multiple choice · 4 alternatives

- For each word list in each row in the “w” column of the dataframe, convert the words to lower cases, and only keep the words that are in list S.
- For each word list in each row in the “w” column of the dataframe, convert the words to lower cases, and remove words that are in list S.
- Select only the rows in the dataframe where the word list in the “w” column contains any word in list S.
- Count the frequency of each word in the “w” column of the dataframe, and then return the words that occur less frequently than a threshold defined in list S.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly

25 Given a 1-dimensional numpy array A with integers or floats. All values in the array are different. Assume that numpy is imported. What is the following code doing?

```
numpy.argsort(A)
```

1.0 point · Multiple choice · 4 alternatives

- Return the indices that would sort the array A in ascending order.
- Return the sorted array A in ascending order.
- Return the maximum value in the array A.
- Return the sum of all values in the array A.

Feedback

Feedback when the question is answered correctly

Feedback when the question is answered partially correctly

Feedback when the question is answered incorrectly