

**Style guide and expectations:** Please answer all the question. We expect you to cite all sources you used outside of the course material.

**Deadlines:** Week 12 Tutorial.

## 1 Long Question:: Answer any 1

**(5 pt.)** You are a Data Scientist at eSewa, Nepal's leading digital payment platform.

- Identify two high - impact areas where unsupervised learning could add significant business value.
- For each area:
  - Define the problem clearly (e.g., customer behavior clustering, fraud pattern detection).
  - Propose a specific unsupervised learning approach (e.g., clustering, anomaly detection, dimensionality reduction) and recommend one or more algorithms (e.g., K-Means, DBSCAN, Autoencoders).
  - Briefly explain how the outputs from these models can be integrated into eSewa's products or services to drive business decisions.

**(5 pt.)** You are a Machine Learning Engineer at a growing e-commerce company preparing to implement and scale machine learning systems.

- List and explain at least three real-world challenges you expect during ML model development, deployment, or maintenance (e.g., data drift, imbalanced data, system latency).
- For each challenge:
  - Discuss potential consequences if not properly addressed.
  - Propose technical or organizational solutions you would implement (e.g., retraining pipelines, feature monitoring, distributed serving, MLOps practices).
- Finally, reflect on how cross-functional collaboration (between data scientists, engineers, product teams) can help mitigate these challenges more effectively.

**[We are expecting:** For the case presented above, write a brief answer limited to 300 words.]

## 2 Short Question:: Pick one from each category.

### 2.1 Overfitting:: Answer any 1.

(2.5 pt.) In the context of machine learning:

- Define and differentiate between overfitting and underfitting.
- Explain why both are problematic for model performance.
- Illustrate your explanation with simple examples (e.g., overfitting a training dataset, underfitting a complex pattern).

(2.5 pt.) Overfitting is a common challenge in deep learning models.

- Describe at least two techniques commonly used to prevent or reduce overfitting (e.g., dropout, early stopping, data augmentation).
- For each method:
  - Briefly explain how it works.
  - Provide a practical example of how it would be applied in a real-world deep learning project (e.g., image classification, sentiment analysis).

**[We are expecting:** For the question presented above, write a brief answer limited to 200 words.]

### 2.2 Neural Network Architecture:: Answer any 1.

(2.5 pt.) Difference between CNN and RNN:

- Explain the fundamental differences between a Convolutional Neural Network (CNN) and a Recurrent Neural Network (RNN).
  - Provide examples of scenarios where one would be more suitable than the other (e.g., image recognition vs. time-series prediction).
- Briefly discuss common challenges faced during the training of deep learning models (e.g., vanishing gradients, overfitting).
  - Provide possible solutions or techniques to address these challenges (e.g., batch normalization, early stopping).

(2.5 pt.) What are the main differences between normal Neural Network architectures and autoencoders? Explain in brief with example, How autoencoders can be applied in various contexts (problems at least one)? Explain how they help addressing these problems.

**[We are expecting:** For the question presented above, write a brief answer limited to 200 words.]

### **3 Final Submission:**

Final Submission must be as follows: