

Artificial Intelligence and Machine Learning (6CS012)

Question and Answer

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1. Long Question:

Machine Learning Engineer Challenges:

There are three critical challenges to the development, deployment, and maintenance of ML models I expect within the sphere of work as a Machine learning engineer in an e-commerce company, including:

1. Data Drift:

- **Challenge:** Model performance degradation occurs because of the changes in data distribution (e.g., changing customer preferences).
- **Consequences:** This has resulted in a deterioration of the quality of recommendations with fewer sales to follow and customer dissatisfaction as a conclusion.
- **Solutions:** Apply feature monitoring for identifying drift; applying following statistical test such as KS test. Set up automatic retraining pipelines that are triggered by drift thresholds to make sure that the models adjust to new patterns. Use MLOps tools, like ML flow, for pipeline orchestration.

2. Imbalanced Data:

- **Challenge:** Biased distributions of classes (e.g., scarce fraudulent transactions) favor the majority of classes.
- **Consequences:** Inadequate detection of the minority classes with the risk of financial loss or losses of opportunities.
- **Solutions:** Perform oversampling (e.g., SMOTE), or class weighting during training. Continuously assess the models using such metrics as F1-score or AUC-ROC, so as to prioritize minority class performance. Active learning can be used to curate a wide range of datasets.

3. System Latency:

- **Challenge:** Large inference times of real-time applications (Product recommendations) worsen the user's experience.
- **Consequences:** Slow responses lead to an increase of cart abandonment rates, affecting revenue.
- **Solutions:** Optimize models for LSP by quantization or pruning to increase the speed of inferencing. For scalability; use distributed serving with tools such as TensorFlow Serving on Kubernetes. Store common predictions to eliminate latency.

Cross-Functional Collaboration: Data scientists will be able to study drift patterns; engineers will be able to establish stable pipelines for MLOps; product teams will be able to set metrics of performance that correspond to business goals. Frequent syncs guarantee model, data, and infrastructure update in time, thus increasing the reliability of the system and user satisfaction.

2. Short Questions: Overfitting

2.1 Overfitting: Define and Differentiate

Definition: Overfitting is a phenomenon that occurs when a model learns noise or specific patterns on the training samples thus doing well on the training data but failing in unseen data. Underfitting occurs when the model is too simple, whereby it is not able to capture the patterns, causing poor performance on both training and test data.

Why Problematic: Overfitting produces models that do not generalize well and the model will misclassify new data (e.g., an overfitted spam email classifier mislabels good emails). An underfitting does not learn significant relationship patterns with an output of faulty predictions (an underfitted sales forecaster ignores seasonal patterns).

Examples: Overfitting occurs in images classification where the model learns the pixel noise, which is present in the train images and tries to recognize new images. It is not possible to detect complex trends with an underfitted linear model on a nonlinear dataset (e.g., customer purchase patterns), and it produces low accuracy.

2.2 Overfitting: Techniques to Prevent

Dropout:

- **How It Works:** Randomly drops out neurons during training so that a neural network is not depending on particular features.
- **Example:** In a deep learning framework where the task to be performed is classifying product images, using 50% for the dropout on dense layers should be used to enhance generalization.

Data Augmentation:

- **How It Works:** Creates synthetic training data via manipulation of inputs (e.g., rotation, flipping).
- **Example:** To improve both robustness of the model to different inputs and e commerce product recognition, enhance the images with rotation and zoom.