SUPERVISED LEARNING - TEST 1 (20 to 30 mins)

15-Question Test on Linear Regression, Gradient Descent, Bias & Variance

Topics:

 Linear Regression:

 Gradient Descent:

 Bias & Variance:



Section 1: Linear Regression

Q1. What is Linear Regression?   
Answer: **Linear Regression is a statistical method used to model the realationship between a dependent variable and one or more independent variables by fitting a linear equation to the observed data**

Q2. Write the formula for simple linear regression. Answer: **The formula for simple linear regression is:**

**y=β0​+β1​x+ε**

Q3. What is the purpose of the cost function in linear regression? Answer: **MSE=n1​i=1∑n​(yi​−y^​i​)2**

Q4. How do you interpret the coefficients in a multiple linear regression model?

Answer: **In a multiple linear regression model:**

**y=β0+β1x1+β2x2+⋯+βnxn+εy = \beta\_0 + \beta\_1 x\_1 + \beta\_2 x\_2 + \cdots + \beta\_n x\_n + \varepsilony=β0​+β1​x1​+β2​x2​+⋯+βn​xn​+ε**

Q5. What are the assumptions of Linear Regression? Answer**: Linear Regression relies on several key assumptions to ensure that the model produces valid and reliable results. These are:**

1. **Linearity:  
   The relationship between the independent variables and the dependent variable is linear.**
2. **Independence:  
   The residuals (errors) are independent of each other. This means there is no correlation between the residuals.**
3. **Homoscedasticity (Constant Variance):  
   The residuals have constant variance at every level of the independent variables.**
4. **Normality of Errors:  
   The residuals of the model are normally distributed, especially important for inference (e.g., confidence intervals, hypothesis testing).**
5. **No Multicollinearity (for multiple linear regression):  
   The independent variables should not be highly correlated with each other.**
6. **No Autocorrelation (mainly in time series data):  
   The residuals should not show patterns over time (i.e., no serial correlation).**



Section 2: Gradient Descent

Q6. What is Gradient Descent?

Answer:

Q7. Write the formula for parameter update in Gradient Descent. Answer:  **Gradient Descent is an optimization algorithm used to minimize the cost function in machine learning models, including linear regression.**

Q8. What is the role of the learning rate in Gradient Descent? Answer: **The learning rate (denoted as α\alphaα) in Gradient Descent controls the size of the steps taken towards minimizing the cost function.**

**Role of the Learning Rate:**

* **It determines how much the model's parameters are updated during each iteration.**
* **It's a crucial hyperparameter that affects the speed and success of convergence**



Q9. What is the primary purpose of regularization in machine learning models?

A) To increase the complexity of the model to fit the training data better.

B) To minimize the training error without regard to generalization.

C) To prevent overfitting by penalizing large coefficients in the model.

D) To ensure that all features are included in the final model regardless of their importance.

Answer: **C) To prevent overfitting by penalizing large coefficients in the model.**

Q10. What happens if the learning rate is too small or too large? Answer**: If the learning rate is too small:**

* **The model learns very slowly.**
* **Takes many iterations to converge to the minimum.**
* **Training time increases significantly.**
* **It may get stuck in local minima or plateaus.**

**🔹 If the learning rate is too large:**

* **The model can overshoot the minimum of the cost function.**
* **It may fail to converge or diverge entirely.**
* **The cost function may fluctuate or oscillate instead of decreasing**.



Section 3: Bias & Variance

Q11. Define Bias and Variance in the context of machine learning models. Answer: **In the context of machine learning, bias and variance are two sources of error that affect a model's ability to generalize to new data. They are key components of the bias-variance tradeoff.**

Q12. What is the Bias-Variance tradeoff?

Answer: **The Bias-Variance Tradeoff is a fundamental concept in machine learning that describes the balance between two sources of error that affect a model’s**

Q13. How does increasing the complexity of a model affect bias and variance?

Answer: **Increasing the complexity of a model generally has the following effects on**

Q14. What is underfitting and overfitting in machine learning? Answer: **Underfitting:**

* **Occurs when a model is too simple to capture the underlying patterns in the data.**
* **The model performs poorly on both training and test data.**
* **It has high bias and low variance.**
* **Example: Using a linear model to fit data with a complex nonlinear relationship.**

**Overfitting:**

* **Happens when a model is too complex and fits not only the true patterns but also the noise in the training data.**
* **The model performs very well on training data but poorly on unseen test data.**
* **It has low bias but high variance.**
* **Example: A very deep decision tree that memorizes the training data.**

Q15. How can you reduce overfitting in a model? Answer:

**Here are several common techniques to reduce overfitting in a machine learning model:**

**1. Use More Training Data**

* **More data helps the model learn the true patterns better and reduces the chance of fitting noise.**

**2. Feature Selection / Dimensionality Reduction**

* **Remove irrelevant or noisy features that may cause the model to overfit.**

**3. Regularization**

* **Add penalties to large coefficients to discourage complexity.**
* **Examples:**
  + **L1 regularization (Lasso)**
  + **L2 regularization (Ridge)**

**4. Simplify the Model**

* **Choose a less complex model or reduce model parameters (e.g., fewer layers in neural networks, shallower trees).**

**5. Early Stopping**

* **Stop training when performance on a validation set starts to degrade, preventing the model from fitting noise.**

**6. Cross-Validation**

* **Use techniques like k-fold cross-validation to ensure the model generalizes well.**

**7. Ensemble Methods**

* **Combine predictions from multiple models (e.g., Random Forest, Boosting) to reduce variance.**

**8. Data Augmentation (mainly for images, text)**

* **Increase training data diversity by transforming data (rotations, flips, noise).**