Logistic Regression – Detailed Q&A;

1. What is Logistic Regression, and how does it differ from Linear Regression?
Logistic Regression is a classification algorithm used when the dependent variable is categorical (binary or multiclass). Linear Regression predicts continuous values, while Logistic Regression predicts probabilities between 0 and 1 using the sigmoid function.

2. What is the mathematical equation of Logistic Regression?
$h\theta(x) = 1 / (1 + e^{(-\theta^T x)})$

3. Why do we use the Sigmoid function in Logistic Regression?
Because it maps any real number to the range (0, 1), making it interpretable as a probability.

4. What is the cost function of Logistic Regression?
Log Loss (Binary Cross-Entropy):
$J(\theta) = - (1/m) \Sigma [y \log(h\theta(x)) + (1 - y) \log(1 - h\theta(x))]$

5. What is Regularization in Logistic Regression? Why is it needed?
Regularization adds a penalty to the cost function to avoid overfitting. It controls model complexity.

6. Explain the difference between Lasso, Ridge, and Elastic Net regression.
- Lasso (L1): Encourages sparsity, some coefficients become 0.
- Ridge (L2): Shrinks coefficients but keeps all features.
- Elastic Net: Combination of L1 and L2.

7. When should we use Elastic Net instead of Lasso or Ridge?
When we expect correlated features and want both sparsity and stability.

8. What is the impact of the regularization parameter (λ) in Logistic Regression?
- Large $\lambda \rightarrow$ Strong regularization, smaller coefficients, underfitting risk.
- Small $\lambda \rightarrow$ Weak regularization, risk of overfitting.

9. What are the key assumptions of Logistic Regression?
- Linear relationship between features and log-odds.
- Independent observations.
- No extreme multicollinearity.
- Large sample size for stable estimates.

10. What are some alternatives to Logistic Regression for classification tasks?
- Decision Trees, Random Forest, XGBoost, SVM, Neural Networks, Naive Bayes, KNN.

11. What are Classification Evaluation Metrics?
Accuracy, Precision, Recall, F1-score, ROC-AUC, Cohen's Kappa, MCC, PR Curve.

12. How does class imbalance affect Logistic Regression?
It biases the model toward the majority class, leading to misleading accuracy.

13. What is Hyperparameter Tuning in Logistic Regression?
Adjusting parameters like C (regularization strength), penalty type, solver.

14. What are different solvers in Logistic Regression? Which one should be used?
- liblinear: Small datasets, binary/multiclass OvR.
- lbfgs: Large datasets, multinomial.
- saga: Large, sparse data, supports Elastic Net.
Choice depends on data size, type, and penalty.

15. How is Logistic Regression extended for multiclass classification?
- One-vs-Rest (OvR)
- Multinomial (Softmax)

16. What are the advantages and disadvantages of Logistic Regression?
■ Simple, interpretable, fast.
■ Struggles with non-linear relationships, sensitive to outliers.

17. What are some use cases of Logistic Regression?
Credit scoring, spam detection, medical diagnosis, churn prediction.

18. What is the difference between Softmax Regression and Logistic Regression?
Logistic Regression $\rightarrow$ Binary classification.
Softmax Regression $\rightarrow$ Multiclass classification (probabilities sum to 1).

19. How do we choose between One-vs-Rest (OvR) and Softmax for multiclass classification?
- OvR: Simple, works well for unbalanced classes.
- Softmax: Better for truly multinomial relationships.

20. How do we interpret coefficients in Logistic Regression?
Each coefficient represents the change in log-odds for a one-unit change in the predictor, holding others constant.