Linear Classification Models

Linear Models for Classification----------explain in the format of writtern in exam

Sure! Here's a concise and well-structured **exam-style explanation** of **Linear Models for Classification**:

Linear Models for Classification

A **Linear Model for Classification** is a statistical method used to classify data into different categories based on a linear combination of input features.

Definition:

A **Linear Classification Model** predicts the class label of an input vector $\mathbf{x} = (x_1, x_2, ..., x_n)$ using a linear function:

$$f(\mathbf{x}) = \mathbf{w}^T\mathbf{x} + b$$

Where:

- $\mathbf{w} = (w_1, w_2, ..., w_n)$ are the weights,
- b is the bias (intercept),
- $f(\mathbf{x})$ is the decision function.

Working Principle:

- If $f(\mathbf{x}) \geq 0$, classify $\mathbf{x}$ as **Class 1**
- If $f(\mathbf{x}) < 0$, classify $\mathbf{x}$ as **Class 0**

The decision boundary is the hyperplane defined by $\mathbf{w}^T\mathbf{x} + b = 0$.

Common Linear Classification Models:

1. **Logistic Regression** – Uses sigmoid function to output probabilities.
2. **Perceptron** – Basic linear classifier; updates weights based on classification error.
3. **Support Vector Machine (SVM)** – Finds maximum margin hyperplane.

Advantages:

- Simple and fast.

- Works well when classes are linearly separable.
- Easy to interpret.

Limitations:

- Not suitable for non-linearly separable data.
- May underperform on complex datasets.

Example:

For a 2D feature space:

$$f(x_1, x_2) = 2x_1 + 3x_2 - 5$$

Classify based on sign of $f(x_1, x_2)$.

Would you like a short diagram or graph to go along with this for visual clarity?