**Question 1:**

**1. Linear Regression:**

Strengths:

1. Simple and easy to interpret.

2. Works well when the relationship between features and target is linear.

Limitations:

1. Assumes linearity, which may not hold for complex data.

2. Sensitive to outliers.

Application Scenario:

Best for predicting continuous variables in a linear relationship (e.g., predicting house prices based on size). Would not use for classification problems.

**2. Support Vector Machines (SVM):**

Strengths:

1. Effective in high-dimensional spaces.

2. Works well with both linear and non-linear data (with kernel trick).

Limitations:

1. Computationally expensive for large datasets.

2. Difficult to interpret results.

Application Scenario:

Ideal for image classification where data is complex and high-dimensional. Less suitable for simple, linear datasets.

**3. k-Nearest Neighbors (k-NN):**

Strengths:

1. Simple and intuitive.

2. No training phase; works well with small datasets.

Limitations:

1. Computationally expensive for large datasets (due to distance calculation).

2. Sensitive to noise and irrelevant features.

Application Scenario:

Suitable for recommendation systems or anomaly detection in small datasets. Would not use in large-scale or high-dimensional data.

**4. Decision Trees:**

Strengths:

1. Easy to visualize and interpret.

2. Can handle both categorical and numerical data.

Limitations:

1. Prone to overfitting, especially in complex trees.

2. Unstable, as small changes in data can result in different trees.

Application Scenario:

Ideal for medical diagnosis decision-making but not suitable for continuous output like regression without proper regularization.

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**Question 2:**

1. Bias and Variance Definitions:

Bias: Error due to overly simplistic assumptions in the model, leading to underfitting.

Variance: Error due to model sensitivity to small fluctuations in the training data, leading to overfitting.

2. Influence on Model Performance:

* High bias can cause the model to miss important patterns, resulting in underfitting.
* High variance means the model captures noise in the data, leading to overfitting.

3. Impact of Model Complexity:

* Simple models (like linear regression) tend to have high bias and low variance.
* Complex models (like deep decision trees) tend to have low bias but high variance.

4. Strategies to Balance Bias and Variance:

* Cross-validation helps in evaluating model performance across different subsets.
* Regularization (e.g., L1, L2 penalties) can help reduce variance in complex models.
* Ensemble methods like bagging and boosting reduce variance by averaging predictions across multiple models.