Machine Learning models overview

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1. Supervised Learning

In supervised learning, the model learns from labeled data (input-output pairs) to make predictions or classify new data. The main tasks are **classification** and **regression**.

Key Tasks:

- **Classification**: Predicting discrete classes or labels (e.g., spam or not spam).
- **Regression**: Predicting continuous values (e.g., housing prices).

Example Models:

1. **Linear Regression** (Regression Task):
    - Predicts a continuous output based on the linear relationship between input features and the target variable.
    - Example: Predicting aircraft fuel consumption based on altitude, speed, and weather conditions.
2. **Logistic Regression** (Classification Task):
    - A binary classification model that estimates the probability of a class label.
    - Example: Classifying whether a satellite signal indicates a fault (yes/no).
3. **Support Vector Machines (SVM)**:
    - Used for both classification and regression by finding a hyperplane that best separates different classes.
    - Example: Classifying images from satellite data (e.g., land vs. water).
4. **Decision Trees**:
    - A tree-based model that makes decisions by splitting the data based on features.
    - Example: Diagnosing aircraft component failures based on sensor readings.
5. **Random Forest** (Ensemble Learning):
    - A collection of decision trees used for more robust predictions through bagging.
    - Example: Predicting aircraft engine maintenance needs by combining multiple decision trees trained on historical data.
6. **Neural Networks**:
    - Feedforward neural networks are flexible models for both classification and regression.

- Example: Predicting aircraft flight delays based on complex factors like weather, route, and air traffic.

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2. Unsupervised Learning

Unsupervised learning models learn patterns in data without explicit labels. The model attempts to find structure in the data, often used for **clustering** and **dimensionality reduction** tasks.

Key Tasks:

- **Clustering**: Grouping similar data points together (e.g., customer segmentation).
- **Dimensionality Reduction**: Reducing the number of features in the data.

Example Models:

1. **K-Means Clustering**:
    - Groups data points into K clusters based on feature similarity.
    - Example: Grouping different regions in satellite imagery based on terrain type (forest, desert, water).
2. **Hierarchical Clustering**:
    - Builds a hierarchy of clusters based on distance between data points.
    - Example: Grouping different flight routes based on patterns in flight data.
3. **Principal Component Analysis (PCA)**:
    - Reduces the dimensionality of the data by finding principal components that capture the most variance.
    - Example: Reducing the complexity of aircraft sensor data to extract the most important features.
4. **Autoencoders** (Neural Network for Dimensionality Reduction):
    - An unsupervised neural network that compresses data and reconstructs it, often used for anomaly detection.
    - Example: Detecting anomalies in satellite communication systems by learning a normal pattern of behavior.
