

UNSUPERVISED LEARNING

What Is Unsupervised Learning?

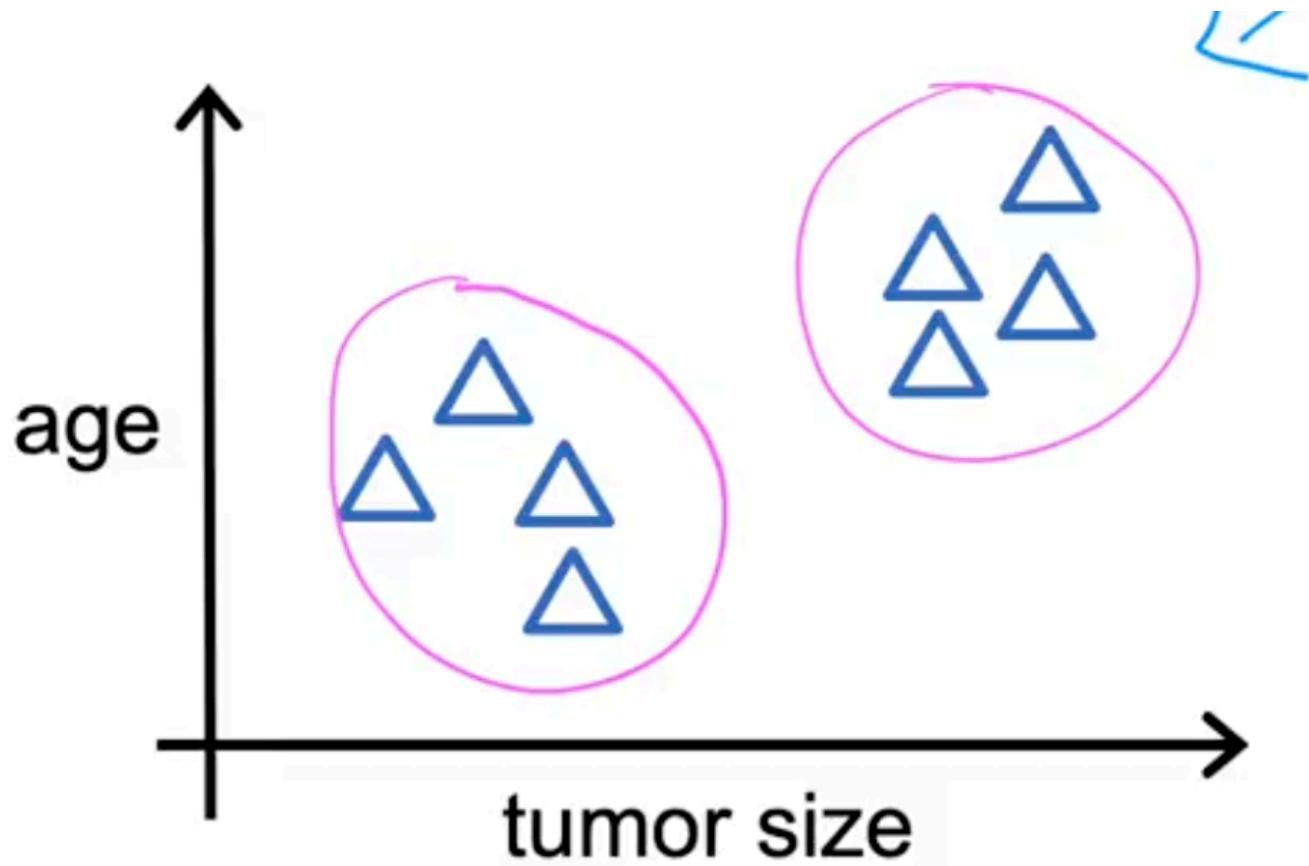
- **Definition:**
 - Unsupervised learning discovers patterns or structure from **unlabeled data**.
 - **Training data:**
 - Contains inputs (x) only (no output labels (y)).
 - **Goal:**
 - Find interesting structure, patterns, or regularities in the data.
 - **Key idea:**
 - The algorithm is **not given “right answers”**.
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Clustering

- **Type:** Unsupervised learning
- **Goal:**
 - Group similar data points into **clusters**.
- **What the algorithm decides:**
 - How many clusters exist
 - Which examples belong to each cluster

Example: Patient Data (No Diagnosis)

- **Inputs:**
 - Tumor size
 - Patient age
- **No labels:**
 - Unknown whether tumors are benign or malignant
- **Algorithm behavior:**
 - Finds natural groupings in the data
 - Assigns patients to clusters based on similarity



Main Types of Unsupervised Learning

- **Clustering**
- **Anomaly detection**
- **Dimensionality reduction**

Anomaly Detection

- **Goal:** Identify unusual, rare, or abnormal data points
- **How it works:**
 - Learns what “normal” data looks like
 - Flags deviations from normal patterns
- **Common applications:**
 - Fraud detection in financial transactions
 - Monitoring systems for abnormal behavior
 - Security breaches and fault detection

Dimensionality Reduction

- **Goal:** Reduce the number of features while preserving important information
- **What it does:** Compresses high-dimensional data into a lower-dimensional representation
- **Benefits:**
 - Faster computation
 - Easier visualization
 - Reduced storage requirements
- **Intuition:**
 - Keep the most important structure in the data
 - Discard redundant or low-importance information