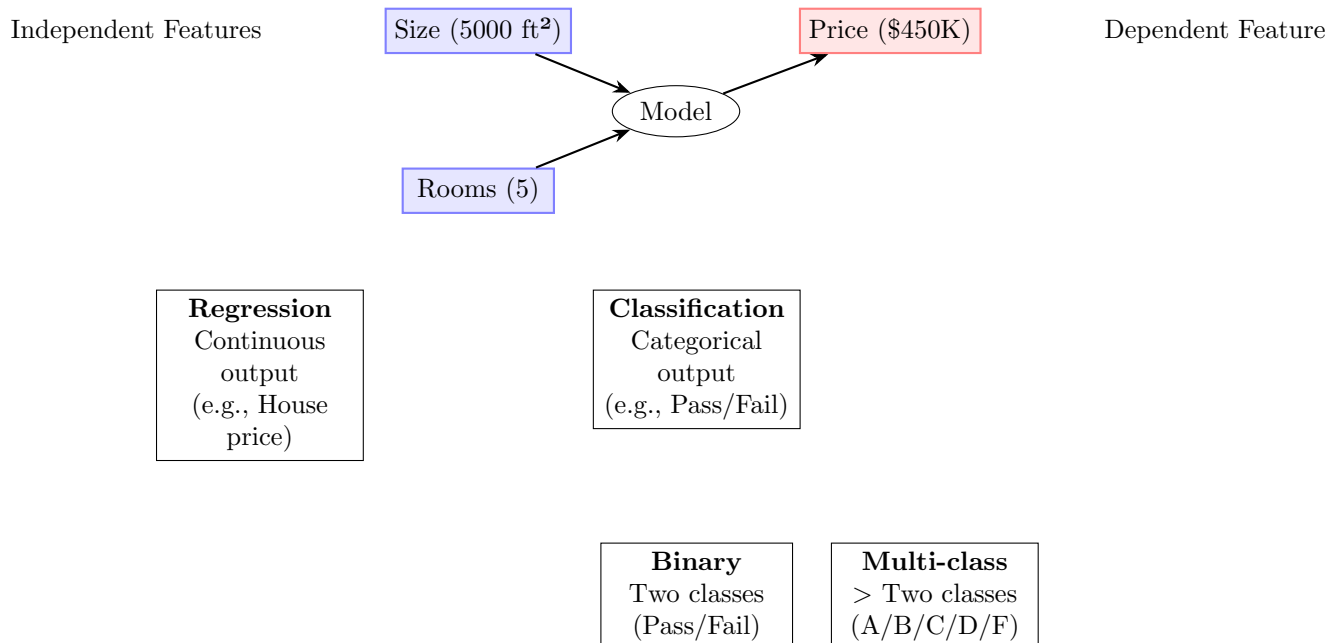# Types of Machine Learning

Course Notes

Three Fundamental Types

1. **Supervised Learning**: Uses labeled data with input-output pairs

2. **Unsupervised Learning**: Discovers patterns in unlabeled data

3. **Reinforcement Learning**: Learns through rewards/punishments

Supervised Machine Learning

Independent Features — Size (5000 ft^2) → Model → Price ($450K) — Dependent Feature

Rooms (5) → Model

Regression
Continuous output
(e.g., House price)

Classification
Categorical output
(e.g., Pass/Fail)

Binary
Two classes
(Pass/Fail)

Multi-class
> Two classes
(A/B/C/D/F)

Key Characteristics

- Requires **labeled dataset** with input-output pairs

- Contains **independent features** (input) and **dependent feature** (output)

- Output feature changes based on inputs

Problem Types

Regression	Binary Classification	Multi-class Classification
Continuous output	Two possible outcomes	Multiple categories
House price prediction	Student pass/fail	Letter grade prediction
$Y \in \mathbb{R}$	$Y \in \{0, 1\}$	$Y \in \{1, 2, \ldots, K\}$

Algorithms

- **Regression**: Linear, Ridge, Lasso, Elastic Net

- **Classification**: Logistic Regression, Decision Trees

- **Both**: Random Forest, AdaBoost, XGBoost

Unsupervised Machine Learning
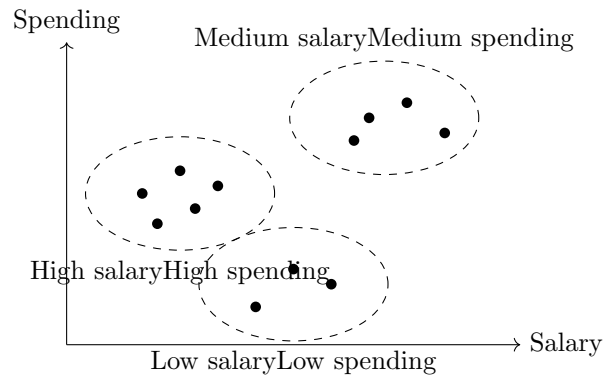
Key Characteristics

- **No output/label** in dataset

- Discovers hidden patterns and structures

- Groups similar data points into **clusters**

- Used for exploratory analysis

Example: Customer Segmentation

- **Features**: Salary, Spending score (1-10)

- **Goal**: Group customers for targeted marketing

- **Clusters**:

  - High salary + High spending (offer premium discounts)
  - Low salary + Low spending (minimal targeting)
  - Medium salary + High spending (growth opportunities)

Algorithms

- K-Means Clustering

- Hierarchical Clustering

- DBSCAN

Reinforcement Learning
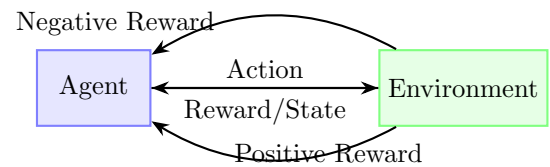
Analogy:
Baby learning
to walk

States: Standing,
Walking, Falling
Rewards: Praise,
Candy
Punishment: Pain

Key Characteristics

- Learns through **trial-and-error**

- Receives **rewards** for good actions

- Receives **penalties** for bad actions

- Goal: Maximize cumulative reward over time

Learning Process

$$\text{Policy} = \arg\max_{\pi} \mathbb{E}\left[\sum_{t=0}^{\infty} \gamma^t R_t\right]$$

Where:

- γ = Discount factor (0-1)

- R_t = Reward at time t

- Policy = Strategy for choosing actions

Summary Table

	Supervised	**Unsupervised**	**Reinforcement**
Data	Labeled	Unlabeled	Reward signals
Goal	Predict outputs	Discover patterns	Learn optimal actions
Training	Input-output pairs	Raw features only	Action-reward pairs
Output	Predictions	Clusters	Policy
Examples	Price prediction, Classification	Customer segmentation	Game AI, Robotics

Course Roadmap

1. Supervised Learning (Linear Regression → Tree-based methods)

2. Unsupervised Learning (Clustering algorithms)

3. Reinforcement Learning (Separate module)