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Intro to Machine Learning

But first, **what is Machine Learning?**

> Machine learning is a subfield of computer science that focuses on building algorithms that rely on a collection of examples of some phenomenon. These examples may come from nature, be handcrafted by humans, or generated by another algorithm.

The Hundred-Page Machine Learning Book

Types of Learning

Supervised Learning

The dataset is a collection of labeled examples.

Unsupervised Learning

The dataset is a collection of unlabeled examples.

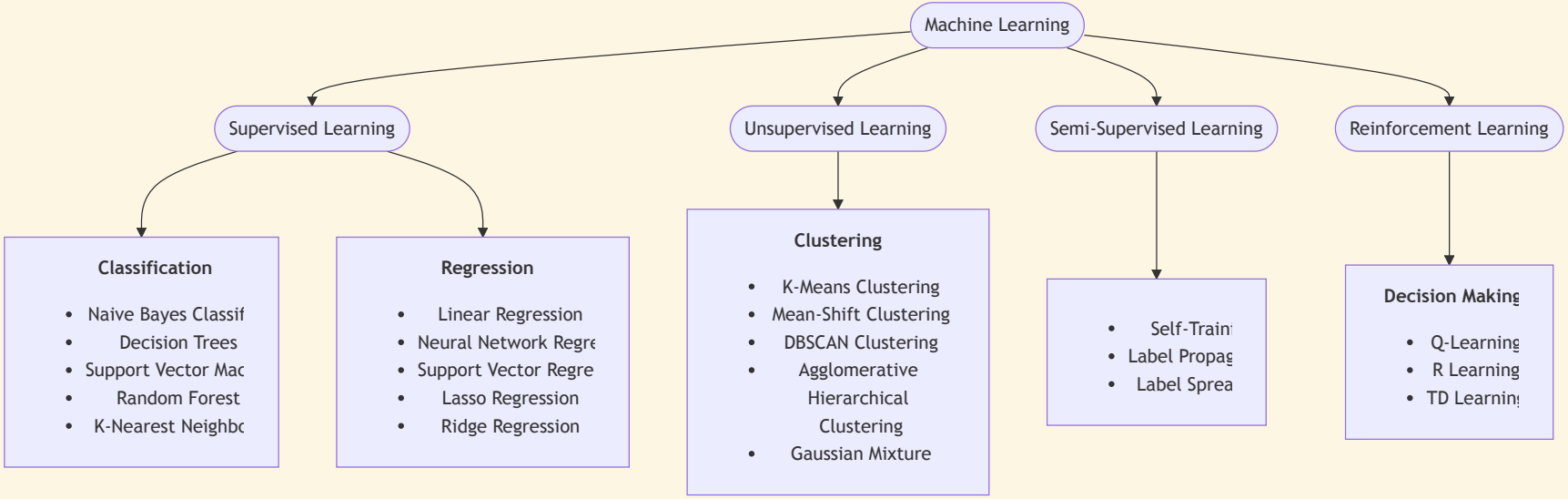
Semi-Supervised Learning

The dataset includes both labeled and unlabeled examples.

Reinforcement Learning

The machine interacts with an environment to maximize rewards.

Types of Learning



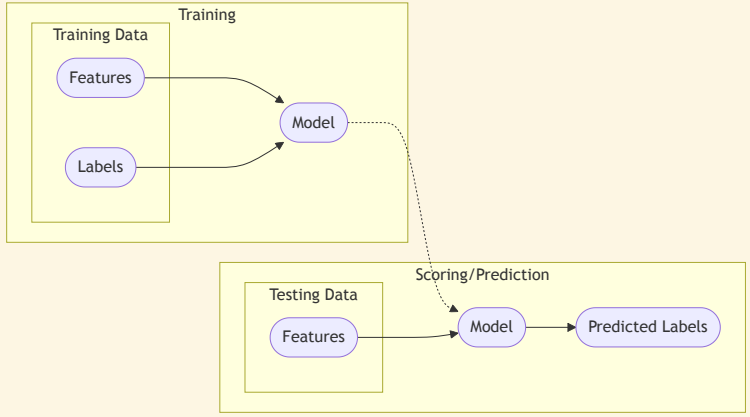
*This class will focus on **Supervised Learning** and **Unsupervised Learning** as those are the most common.*

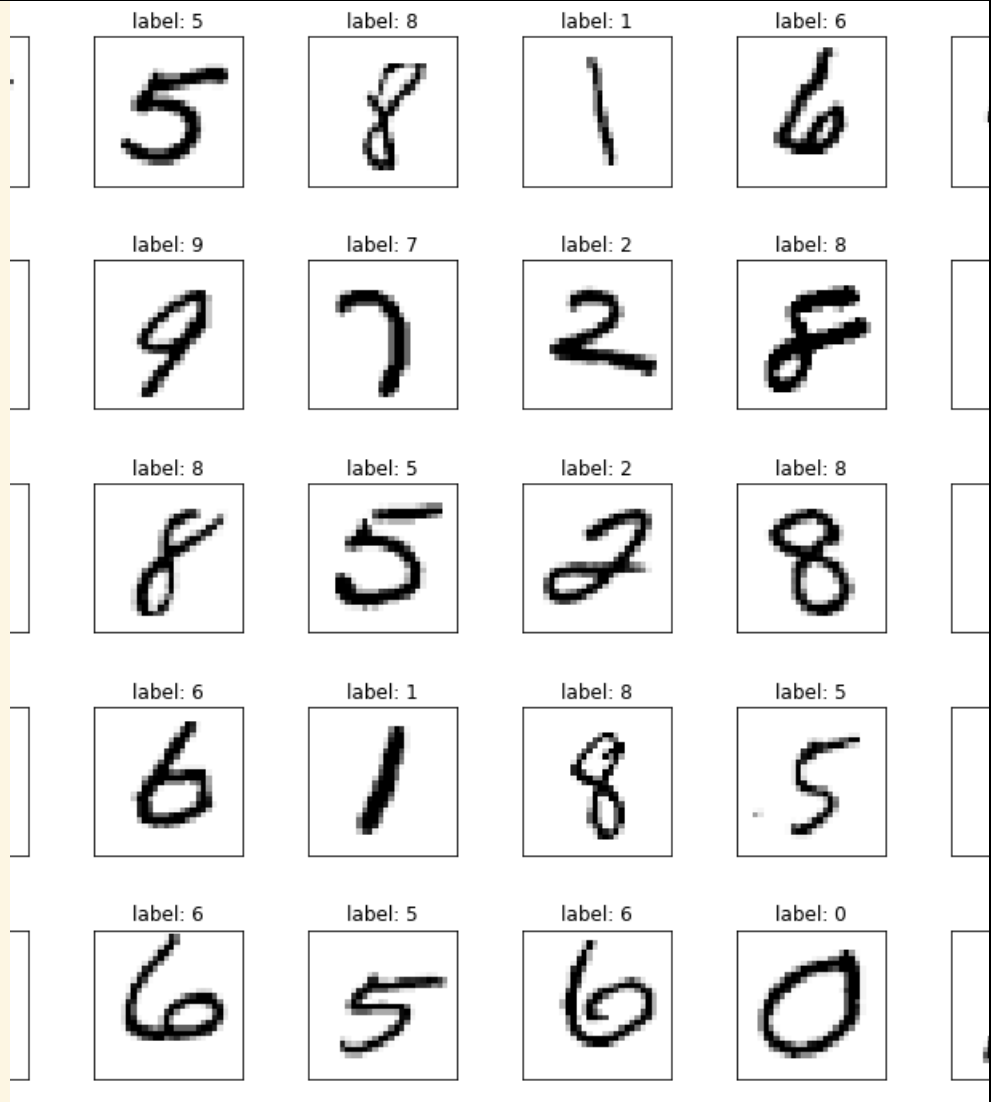
Supervised Learning

Your "training" dataset is composed of examples of labeled examples:

- X - features
- Y - labels

A supervised learning model learns to predict the label Y from the features X.

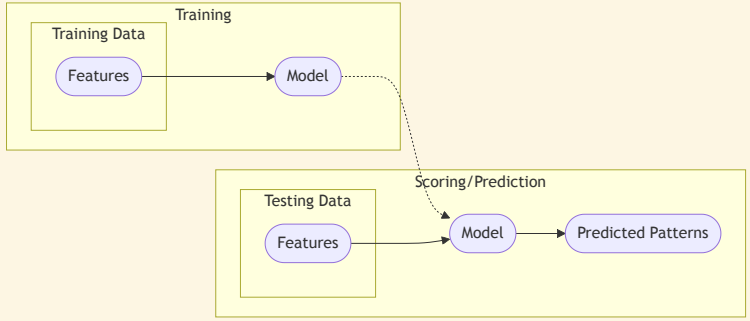


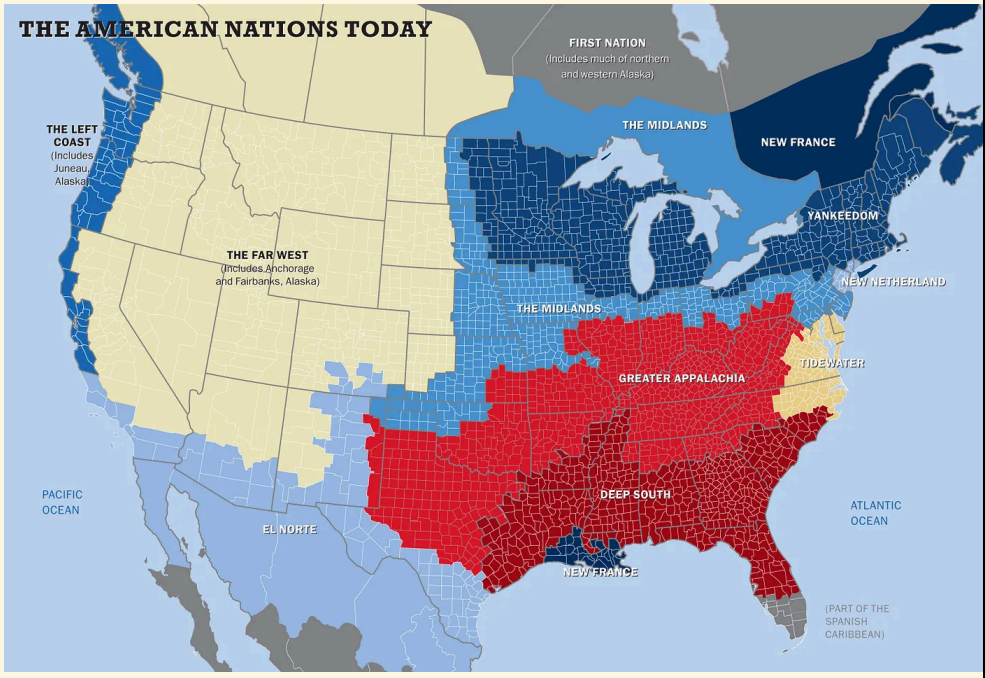


Unsupervised Learning

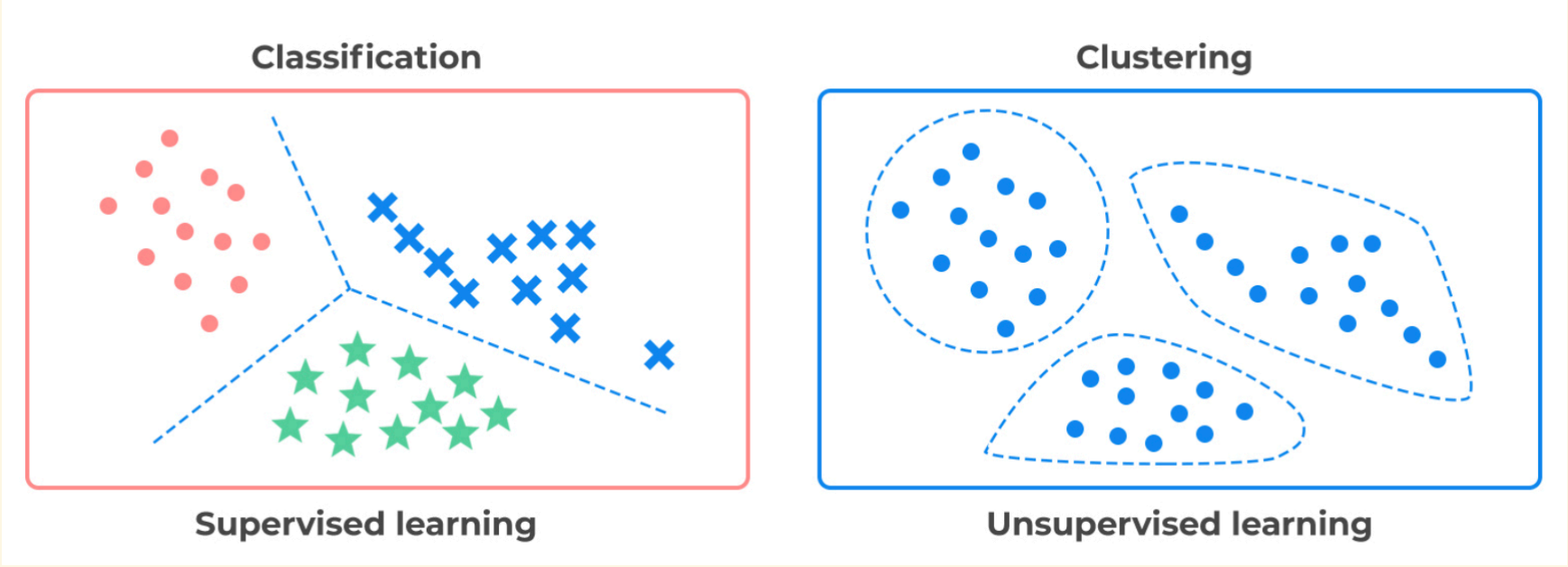
Your "training" dataset is composed of examples of unlabeled examples:

- X - features An unsupervised learning model learns to find patterns in the features X.





Supervised vs Unsupervised Learning

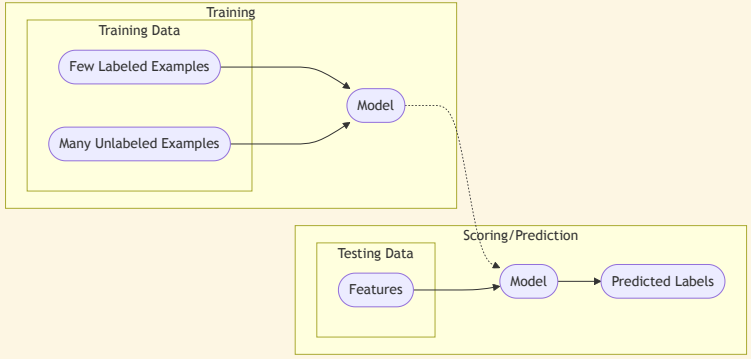


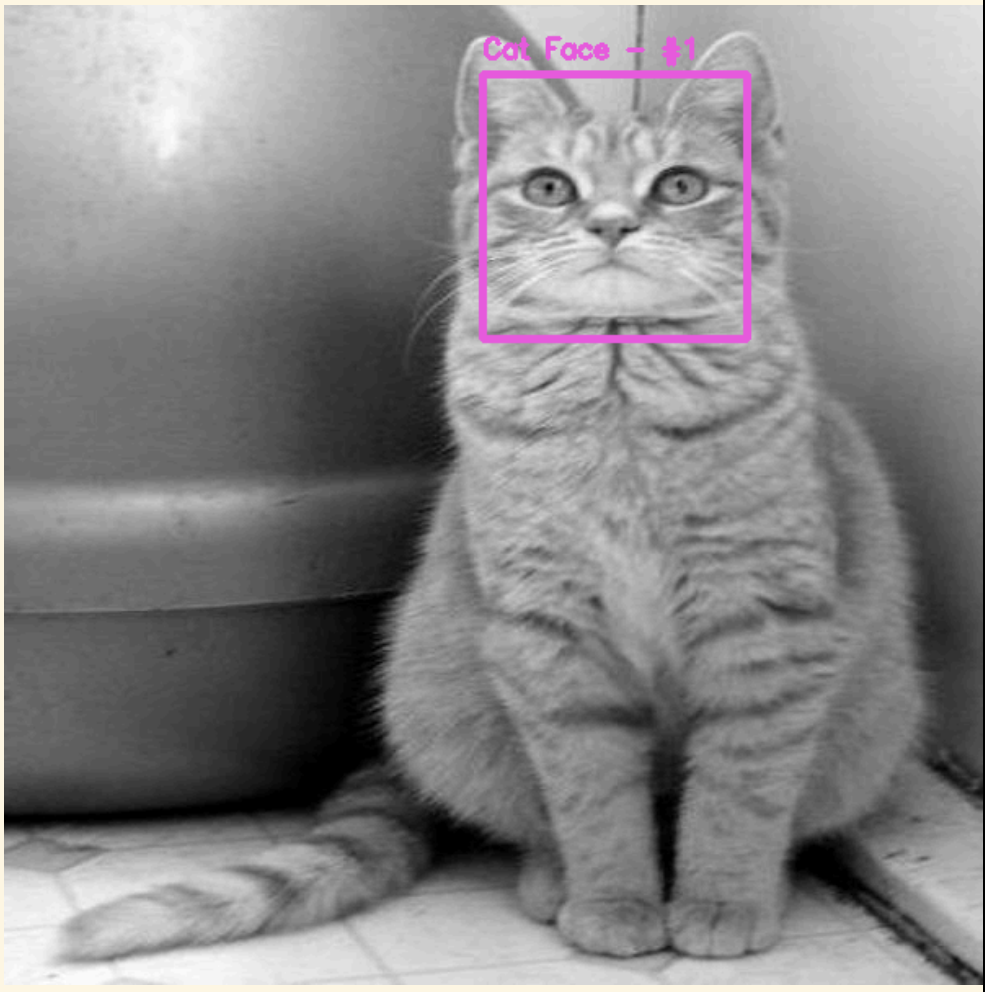
Semi-Supervised Learning

Your "training" dataset contains:

- A **small** set of labeled examples: (X_L, Y_L)
- A **large** set of unlabeled examples: X_U

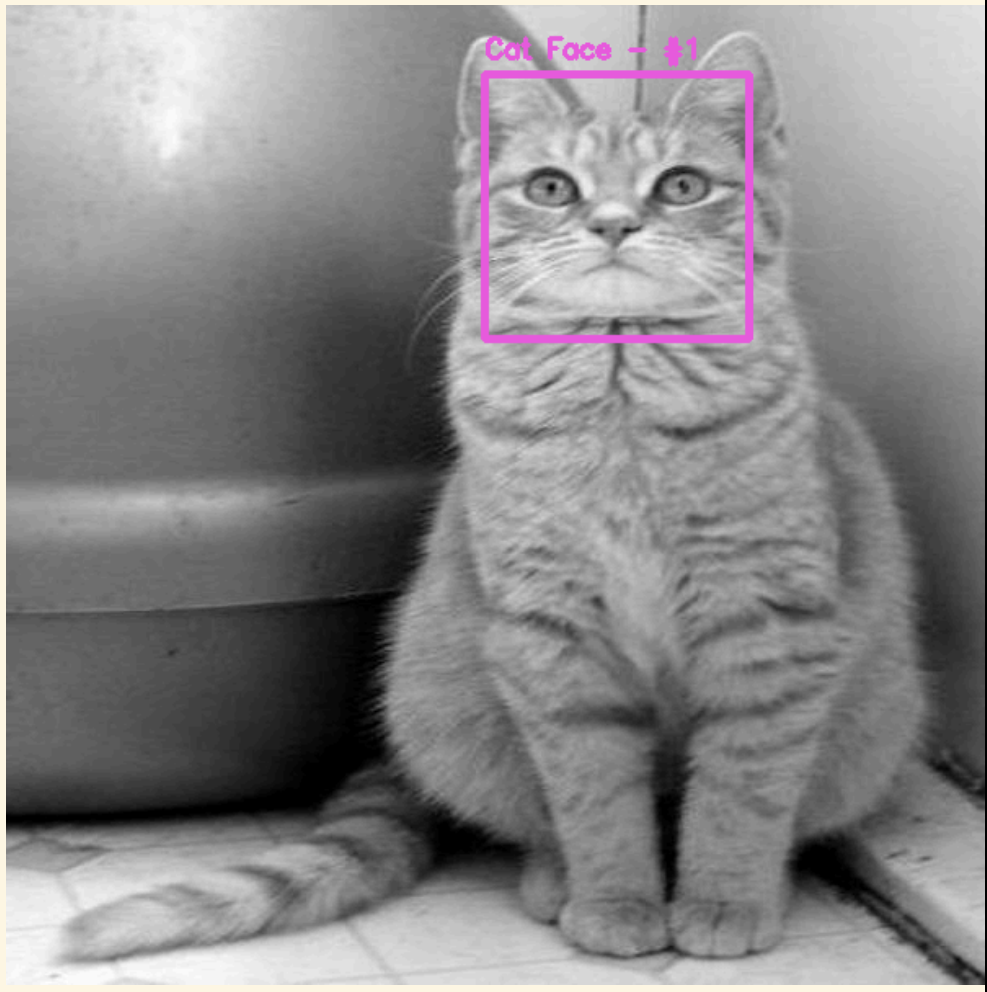
The model learns from both labeled and unlabeled data to improve predictions.





Semi-Supervised in Action

- **Google Photos**
  - **Initial Setup**: You label a few faces
  - **After**: Automatically groups all photos of that person
  - Combines your labels with facial clustering
- **YouTube Auto-Captions**
  - **Some videos**: Human-transcribed (labeled)
  - **Most videos**: Auto-generated using both labeled and unlabeled audio

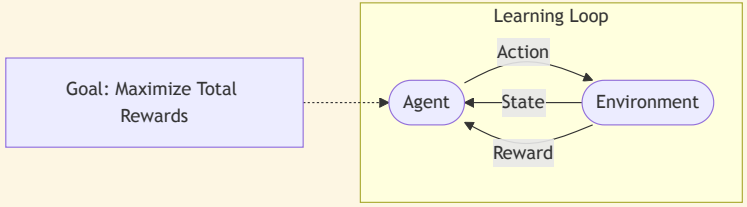


Reinforcement Learning

The model (agent) learns through **trial and error** by:

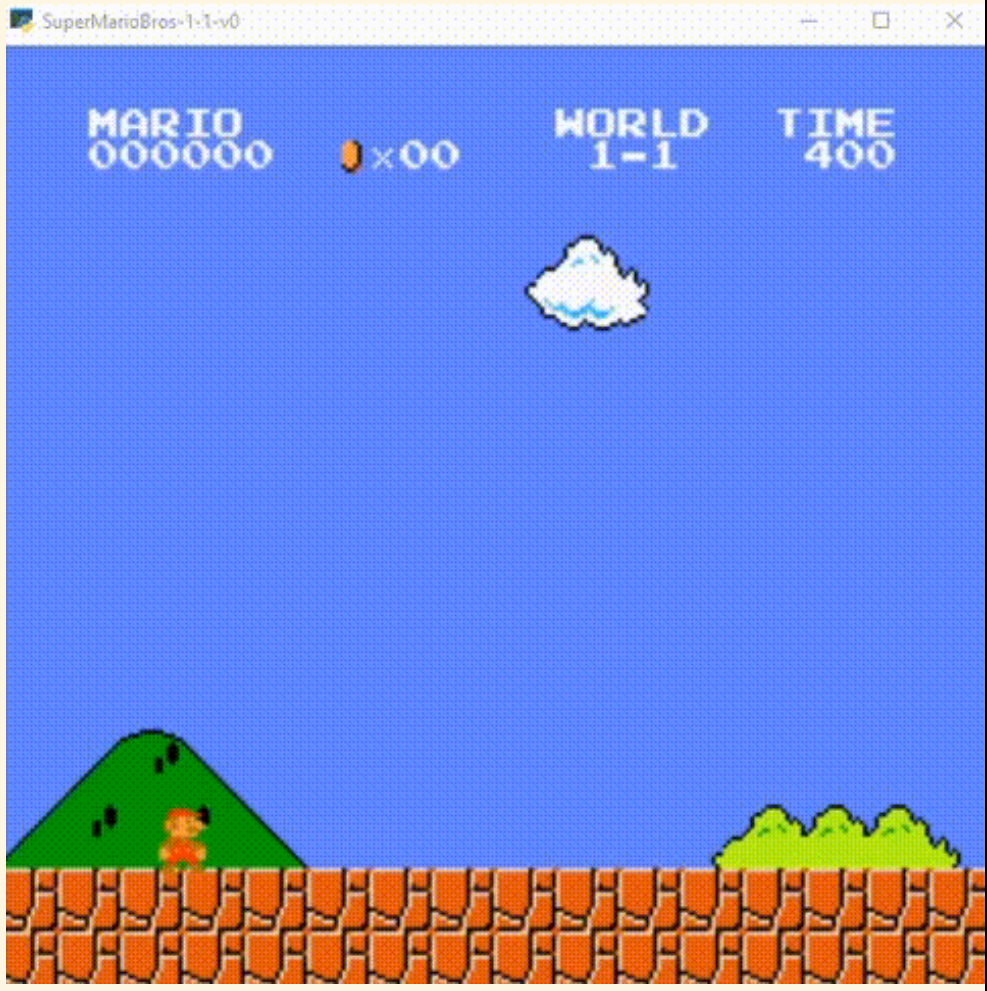
- **State** (S): What the agent observes
- **Action** (A): What the agent can do
- **Reward** (R): Feedback for actions taken

The agent learns a policy $\pi(S) \rightarrow A$ to maximize cumulative rewards.



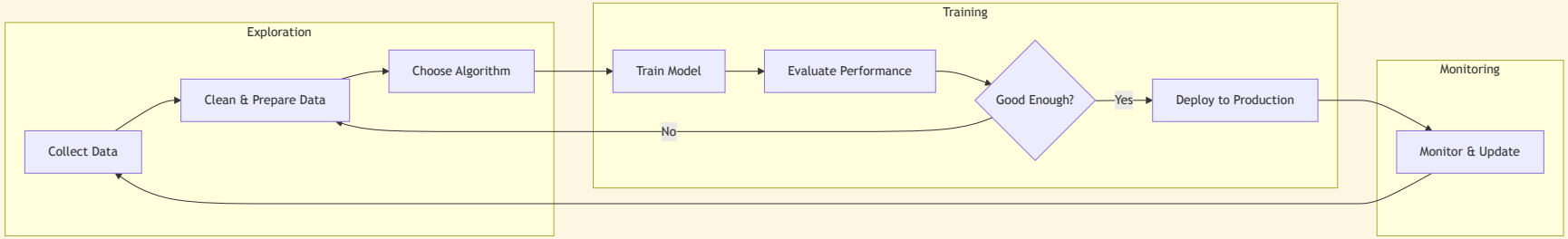
Reinforcement Learning in Action

- **Google Maps Route Suggestions**
  - **Action:** Suggest route
  - **Reward:** User selects route
  - **Learns:** Traffic patterns and user choices
- **TikTok's "For You" Page**
  - **Action:** Show video
  - **Reward:** Watch time, likes, shares
  - **Learns:** What keeps you scrolling



The ML Pipeline

Most real-world ML systems follow this workflow:



Before We Dive Into Algorithms...

Key Questions to Ask:

1. **What type of problem is it?**
   - Classification, Regression, Clustering, etc.
2. **What data do we have?**
   - Labeled? Unlabeled? How much?
3. **What's our goal?**
   - Accuracy? Speed? Interpretability?
4. **What are the constraints?**
   - Computing power? Real-time requirements?

These questions determine which algorithm to use!