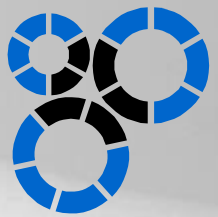
Machine Learning
CSE - 465

Lecture - 01

Outline

- What is Machine Learning?
- Example of Machine Learning problems
- Types of learning
  - Supervised
  - Unsupervised
  - Semi-supervised
  - Reinforcement



What is Machine Learning?

- Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

- The goal of machine learning is to develop methods that can automatically detect patterns in data, and then to use the uncovered patterns to predict future data or other outcomes of interest.

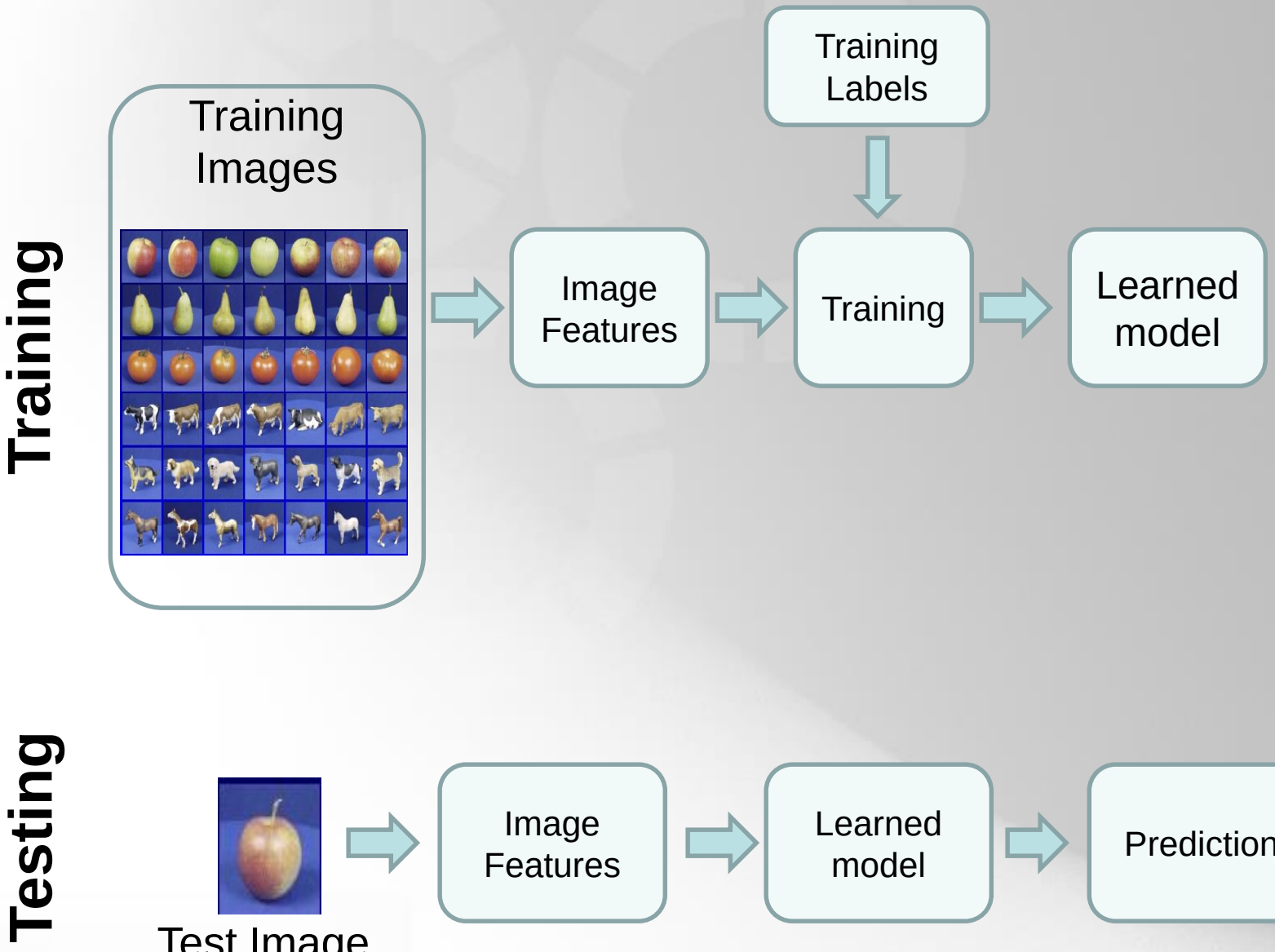
Example of Machine Learning problems

- Pattern Recognition
  - Facial identities or facial expressions
  - OCR or speech recognition (Alexa, Siri, Cortana)
  - Medical images
  - Sensor Data/IoT
- Optimization
  - Many parameters have “hidden” relationships that can be the basis of optimization
- Pattern Generation
  - Generating images or motion sequences

Example of Machine Learning problems

- Anomaly Detection
  - Unusual patterns in the telemetry from physical and/or virtual plants (e.g., data centers)
  - Unusual sequences of credit card transactions
  - Unusual patterns of sensor data from a nuclear power plant
- Prediction
  - Future stock prices or currency exchange rates

Generic Method of Machine Learning



Slide credit: D. Hoiem and L. Lazebnik

Types of Learning

- **Supervised (inductive) learning**
  - Labeled training data
- **Unsupervised learning**
  - Unlabeled training data
- **Semi-supervised learning**
  - A small portion of the training data is labeled
- **Reinforcement learning**
  - Rewards from sequence of actions

Supervised Learning (1/4)

- Supervised machine learning algorithms can apply what has been learned in the past to new data using labeled examples to predict future events.
- Starting from the analysis of a known training dataset, the learning algorithm produces an inferred function to make predictions about the output values.
- The system is able to provide targets for any new input after sufficient training.
- The learning algorithm can also compare its output with the correct, intended output and find errors in order to modify the model accordingly.

Supervised Learning (2/4)

examples

label

$label_1$

$label_2$

$label_3$

$label_4$

labeled examples

Supervised Learning (3/4)

label

$label_1$

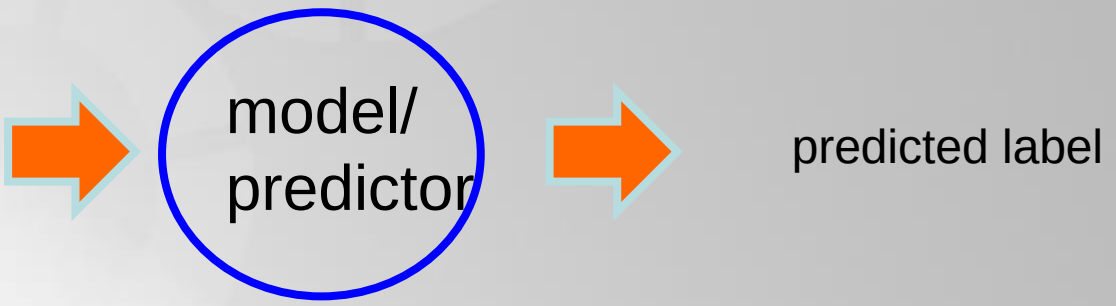
$label_2$

$label_3$

$label_4$

model/
predictor

Supervised Learning (4/4)



Unsupervised Learning (1/2)

- Unsupervised machine learning algorithms are used when the information used to train is neither classified nor labeled.
- Unsupervised learning studies how systems can infer a function to describe a hidden structure from unlabeled data.
- The system doesn’t figure out the right output, but it explores the data and can draw inferences from datasets to describe hidden structures from unlabeled data.

Unsupervised Learning (2/2)





Unlabeled Training Data

Semi-supervised Learning

- Semi-supervised machine learning algorithms fall somewhere in between supervised and unsupervised learning, since they use both labeled and unlabeled data for training – typically a small amount of labeled data and a large amount of unlabeled data.
- The systems that use this method are able to considerably improve learning accuracy.
- Semi-supervised learning is chosen when the acquired labeled data requires skilled and relevant resources in order to train it / learn from it. Otherwise, acquiring unlabeled data generally doesn’t require additional resources.

Reinforcement Learning (1/2)

- Reinforcement machine learning algorithm is a learning method that interacts with its environment by producing actions and discovers errors or rewards.
- Trial and error search and delayed reward are the most relevant characteristics of reinforcement learning.
- This method allows machines and software agents to automatically determine the ideal behavior within a specific context in order to maximize its performance.
- Simple reward feedback is required for the agent to learn which action is best; this is known as the reinforcement signal.

Reinforcement Learning (2/2)

left, right, straight, left, left, left, straight	**GOOD**
left, straight, straight, left, right, straight, straight	**BAD**

left, right, straight, left, left, left, straight	**18.5**
left, straight, straight, left, right, straight, straight	**-3**

Given a sequence of examples/states and a ***reward*** after completing that sequence, learn to predict the action to take in for an individual example/state

Thank You