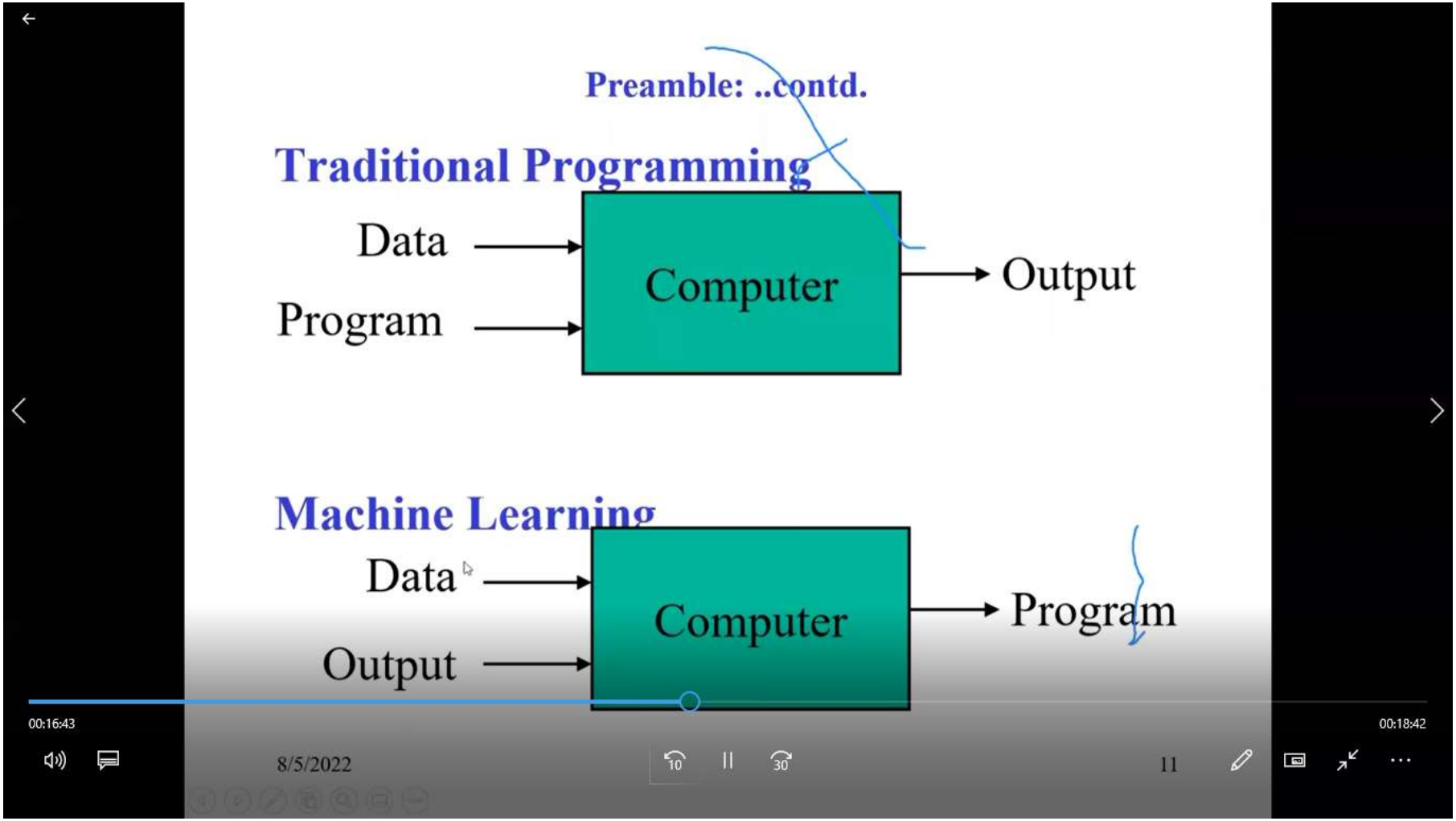
Preamble: ..contd.
Traditional Programming
Data
Program
Computer
Output
Machine Learning
Data
Output
Computer
Program
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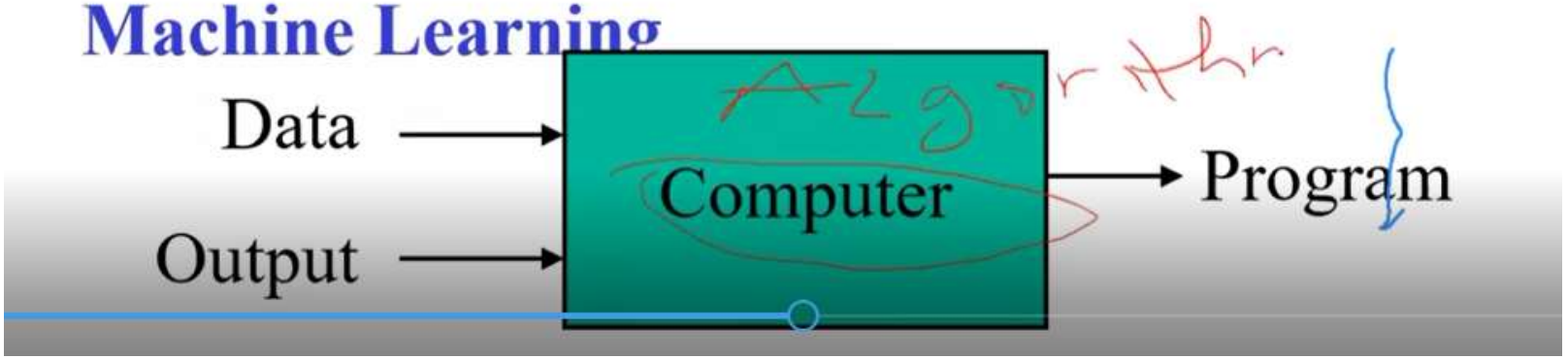
11

Preamble: ..contd.

Traditional Programming

Machine Learning



Preamble: Magic?

No, more like gardening

- **Seeds** = Algorithms
- **Nutrients** = Data
- **Gardener** = You
- **Plants** = Programs

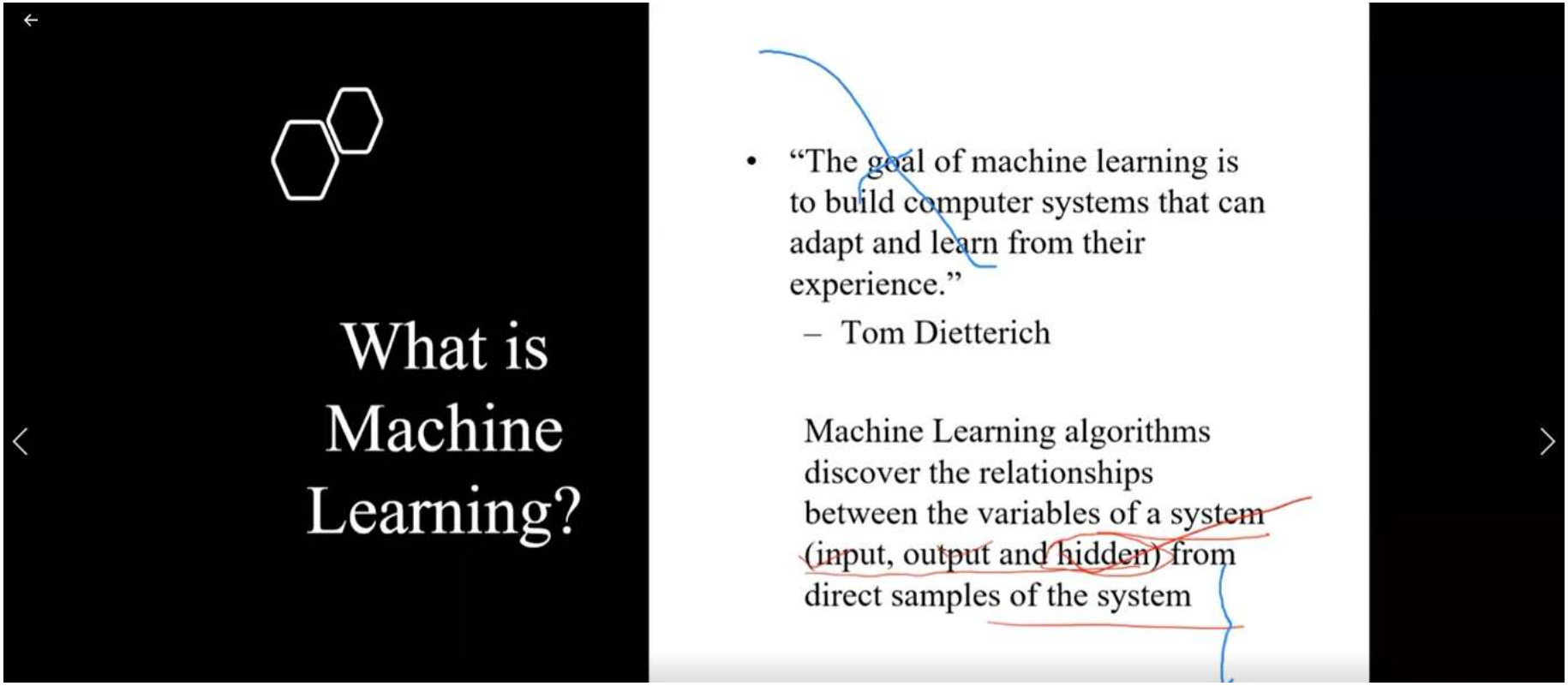
What is Machine Learning?

- "Learning is any process by which a system improves performance from experience." - Herbert Simon

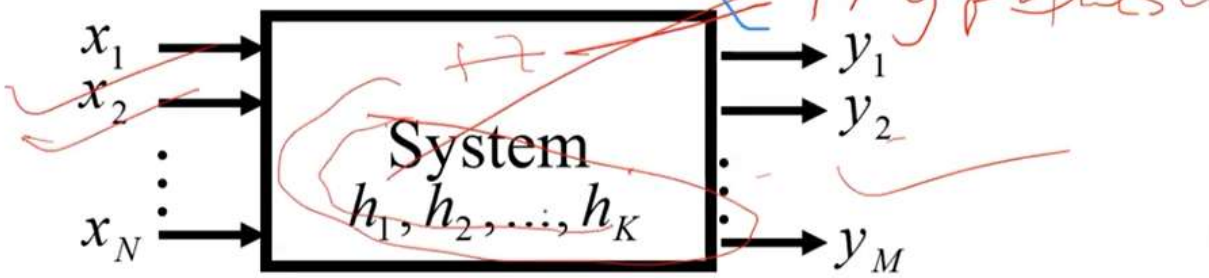
Definition by Tom Mitchell (1998):

- Machine Learning is the study of algorithms that
  - improve their performance P
  - at some task T
  - with experience E.

A well-defined learning task is given by <P, T, E>.


What is Machine Learning?
• "The goal of machine learning is to build computer systems that can adapt and learn from their experience."
– Tom Dietterich
Machine Learning algorithms discover the relationships between the variables of a system (input, output and hidden) from direct samples of the system

A Generic System



Input Variables: $\mathbf{x} = (x_1, x_2, \ldots, x_N)$

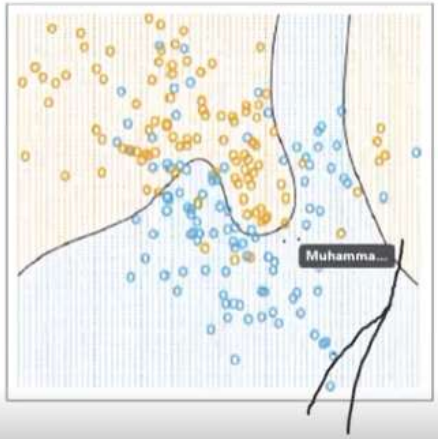
Hidden Variables: $\mathbf{h} = (h_1, h_2, \ldots, h_K)$

Output Variables: $\mathbf{y} = (y_1, y_2, \ldots, y_K)$

Machine Learning Paradigms/or The Sub-Fields of ML

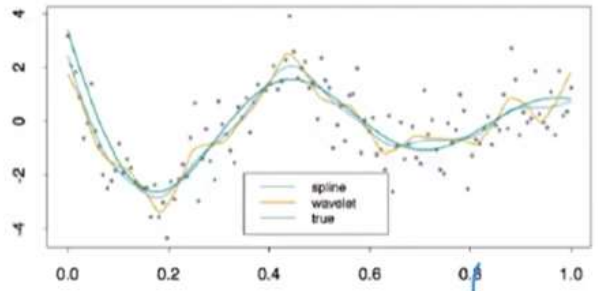
Association	Basket analysis: •$P(Y \mid X)$ probability that somebody who buys X also buys Y where X and Y are products/services. •Example: $P(\text{chips} \mid \text{biscuit}) = 0.7$
Supervised Learning	Classification Regression
Unsupervised Learning	Clustering/dimensionality reduction
Semi-supervised Learning	Co-training (mix small labeled data with Large unlabeled data) Active learning (Interactive supervised learning)
Reinforcement Learning	Learning a policy: A sequence of outputs •Policy could be: positive, negative, punishment, and extinction. •(Learns from mistakes-Algorithm learns to react to environment)

Supervised Learning categories



Classification

Predict categorical value:
loan or not? spam or not?

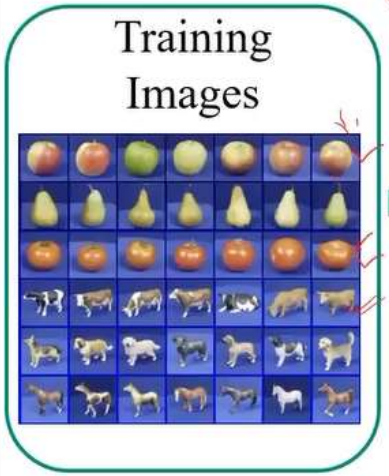


Regression

Predict continuous value:
ex: stock market, credit score, temperature, Netflix rating

Steps

Training



Training Labels

Image Features

Training

Learned model

Testing

Test Image

Image Features

Learned model

Prediction

19

Slide credit: D. Hoiem and L. Lazebnik

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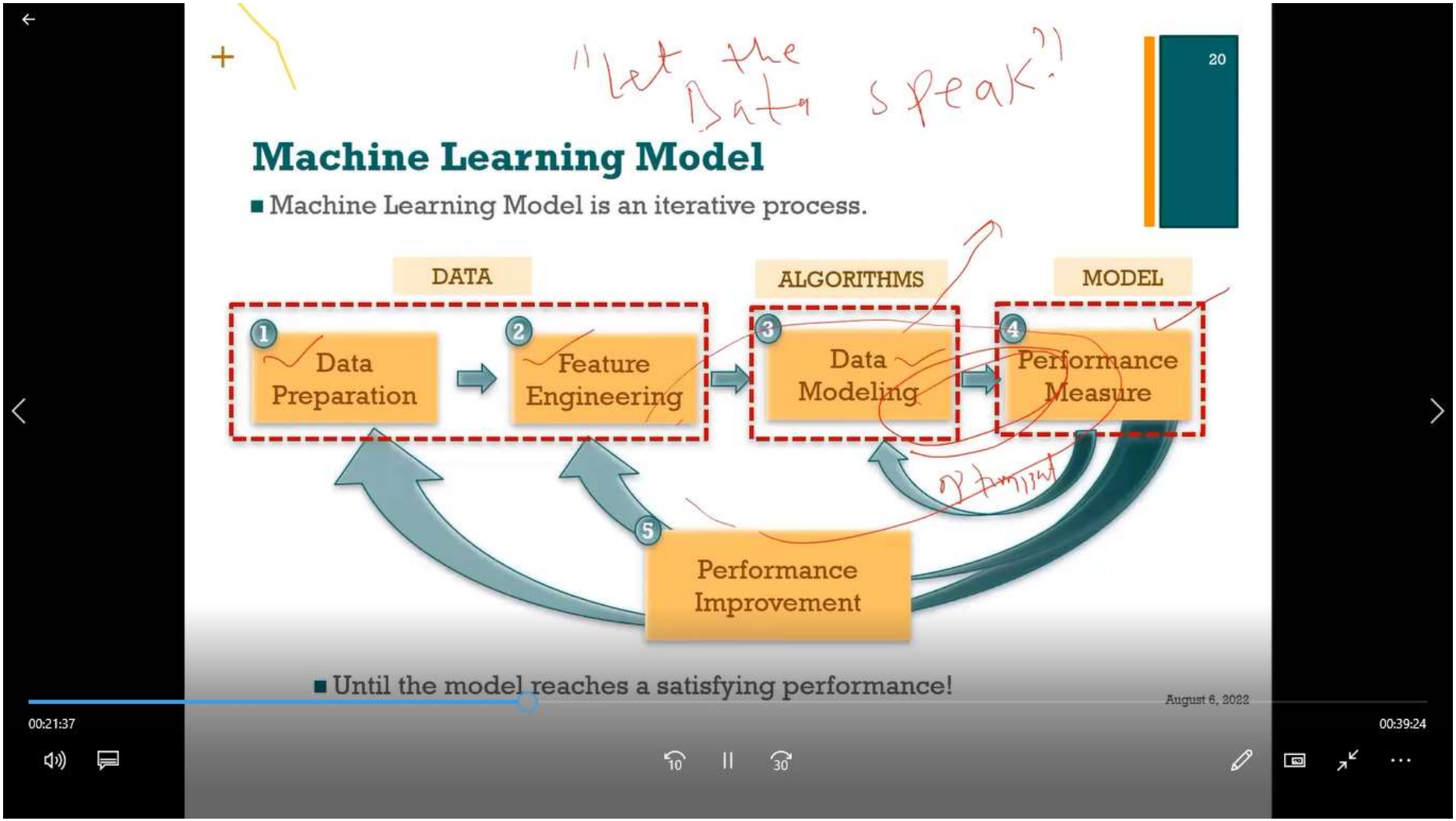
"Let the Data speak"
20
Machine Learning Model
Machine Learning Model is an iterative process.
DATA
ALGORITHMS
MODEL
1 Data Preparation
2 Feature Engineering
3 Data Modeling
4 Performance Measure
5 Performance Improvement
Until the model reaches a satisfying performance!
August 6, 2022
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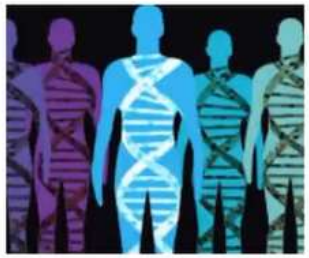
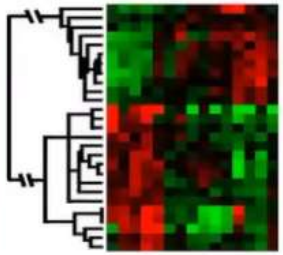



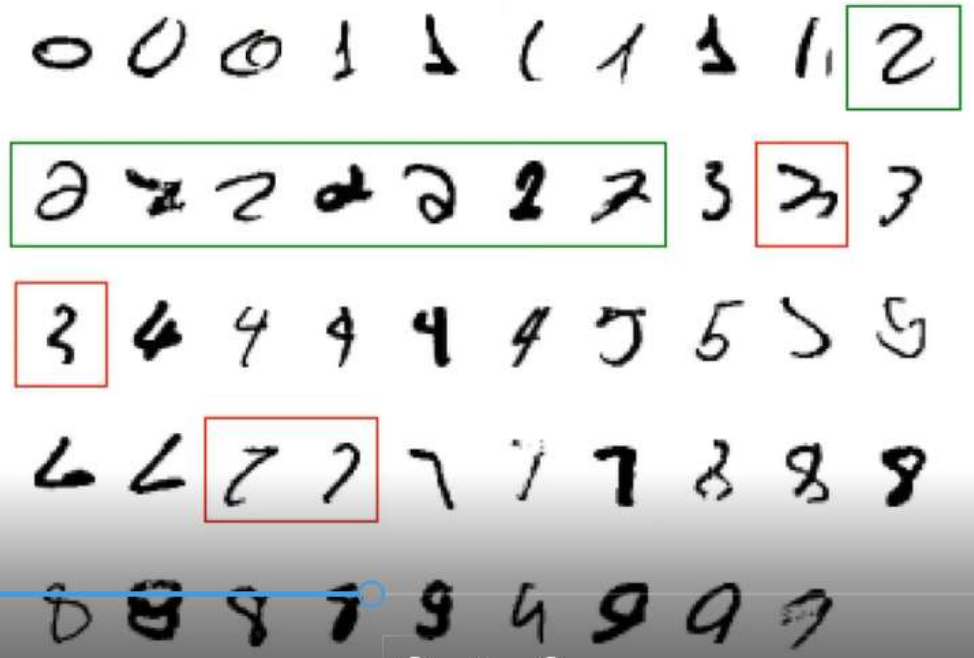
When is Machine Learning Used?

ML is used when:

- Human expertise does not exist (recently: Navigation on mas, protein folding)
- Humans can't explain their expertise (speech recognition, vision)
- Models must be customized (personalized medicine)
- Models are based on huge amounts of data (genomics), etc…

When is Machine Learning Used?

A classic example of a task that requires machine learning: it is very hard to say what makes a 2



You may also like...

personalized predictions are made by learning from past data

Successful Machine Learning Applications

- Speech recognition
  - Telephone menu navigation
- Computer vision
  - Mail sorting
- Bio-surveillance
  - Identifying disease outbreaks
- Robot control
  - Autonomous driving
- Empirical science
- Information extraction
- Social networks
- Debugging
- Predicting the next incidence at home
- [Your favorite areas]…

Applications ..Contd….

Speech and hand-writing recognition
Autonomous robot control
Data mining and bioinformatics: motifs, alignment, …
Playing games
Fault detection
Spam email detection
Retail: Market basket analysis, Customer relationship management (CRM)
Finance: Credit scoring, fraud detection
Manufacturing: Optimization, troubleshooting
Medicine: Medical diagnosis
Telecommunications: Quality of service optimization
Web mining: Search engines, etc…

Applications are diverse but methods are generic…