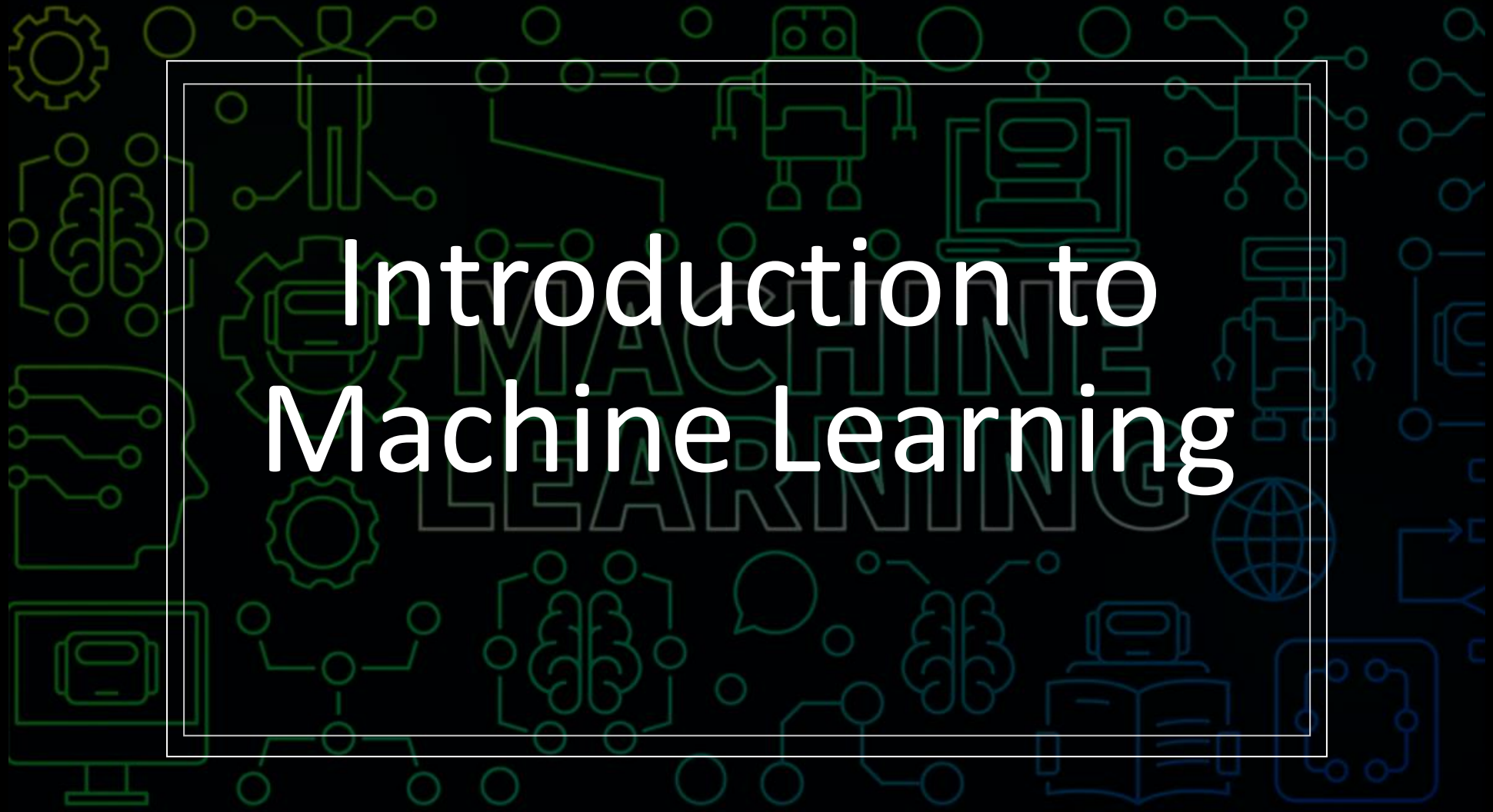


Introduction to Machine Learning

நன்றி தலைவா!

CS 4641/7641

Machine Learning

Instructor: Byron Boots

These slides are partially based on slides assembled by Eric Eaton, with grateful acknowledgement of the many others who made their course materials freely available online.

What is Machine Learning?

“Machine learning is the next Internet”
-Tony Tether, Director, DARPA

“Machine learning is the hot new thing”
-John Hennessy, President, Stanford

“Machine learning is today’s discontinuity”
-Jerry Yang, CEO, Yahoo

“Machine learning is the new electricity”
-Andrew Ng, Chief Scientist Baidu

What is Machine Learning?

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

- Herbert Simon

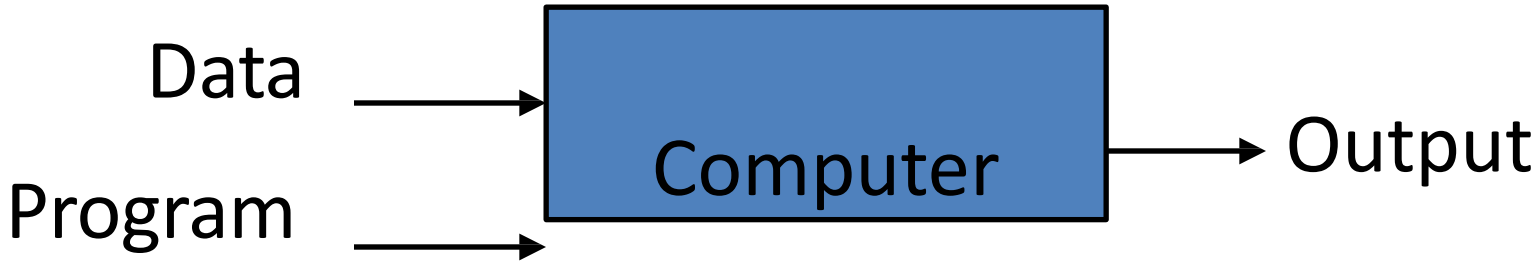
Definition by Tom Mitchell (1998):

Machine Learning is the study of algorithms that

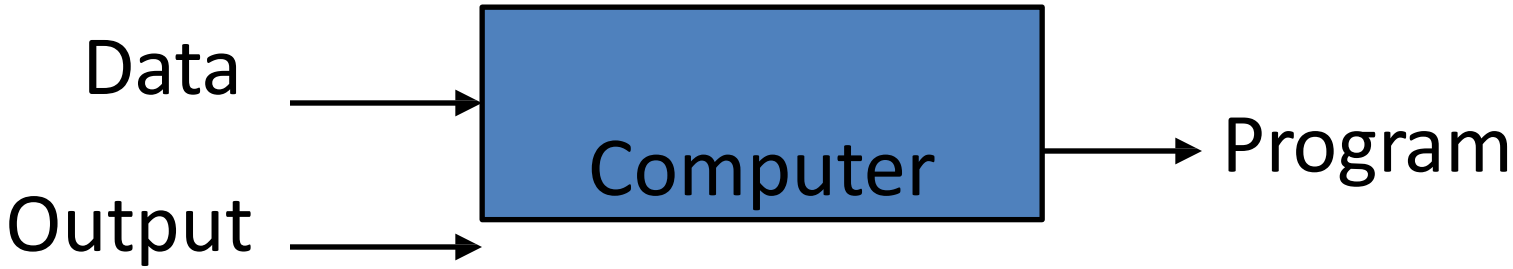
- improve their performance P
- at some task T
- with experience E.

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

Traditional Programming



Machine Learning



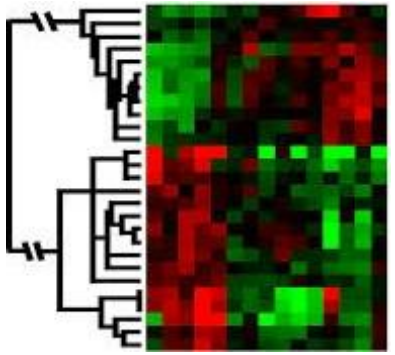
Slide credit: Pedro Domingos

When Do We Use Machine Learning?

ML is used when:

- Human expertise does not exist (navigating on Mars)
- Humans can't explain their expertise (speech recognition, vision)
- Models must be customized (personalized medicine)
- Models are based on huge amounts of data (genomics)



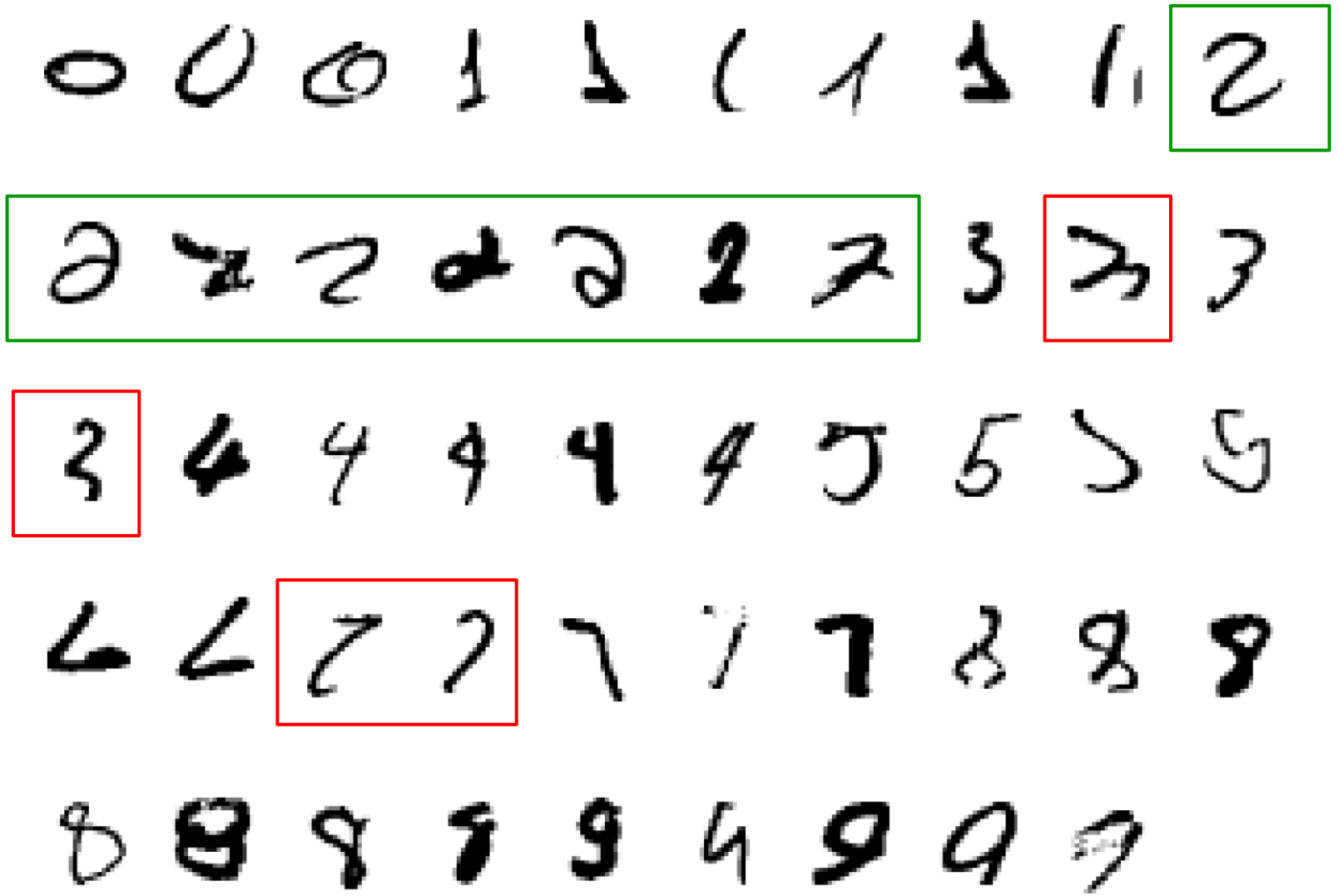
Learning isn't always useful:

- There is no need to "learn" to calculate payroll

Based on slide by E. Alpaydin

A classic example of a task that requires machine learning:

It is very hard to say what makes a 2



Slide credit: Geoffrey Hinton

Some more examples of tasks that are best solved by using a learning algorithm

- Recognizing patterns:
  - Facial identities or facial expressions
  - Handwritten or spoken words
  - Image classification (this is a cat)
- Generating patterns:
  - Generating images or motion sequences
- Recognizing anomalies:
  - Unusual credit card transactions
  - Unusual patterns of sensor readings in a nuclear power plant
- Prediction:
  - Future stock prices or currency exchange rates
  - Applying this steering angle will crash the car

Slide credit: Geoffrey Hinton

Sample Applications

- Web search
- Computational biology
- Finance
- E-commerce
- Space exploration
- Robotics
- Information extraction
- Social networks
- Etc.

Slide credit: Pedro Domingos

Why Is Machine Learning Important?

"Web rankings today are mostly a matter of machine learning"

-Prabhakar Raghavan, Dir. Research, Yahoo

"Machine learning is going to result in a real revolution"

-Greg Papadopoulos, CTO, Sun

"A breakthrough in machine learning would be worth ten Microsofts"

-Bill Gates, Chairman, Microsoft

Deep Learning in the Headlines

BUSINESS NEWS

MIT Technology Review

Is Google Cornering the Market on Deep Learning?

A cutting-edge corner of science is being wooed by Silicon Valley, to the dismay of some academics.

By Antonio Regalado on January 29, 2014

How much are a dozen deep-learning researchers worth? Apparently, more than $400 million.

This week, Google reportedly paid that much to acquire DeepMind Technologies, a startup based in

BloombergBusinessweek Technology

Acquisitions

The Race to Buy the Human Brains Behind Deep Learning Machines

By Ashlee Vance | January 27, 2014

intelligence projects. "DeepMind is bona fide in terms of its research capabilities and depth," says Peter Lee, who heads Microsoft Research.

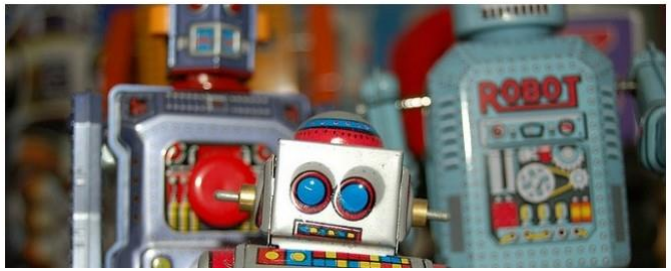
According to Lee, Microsoft, Facebook (FB), and Google find themselves in a battle for deep learning talent. Microsoft has gone from four full-time deep learning experts to 70 in the past three years. "We would have more if the talent was there to

WIRED GEAR SCIENCE ENTERTAINMENT BUSINESS SECURITY DESIG

INNOVATION INSIGHTS | community content | featured

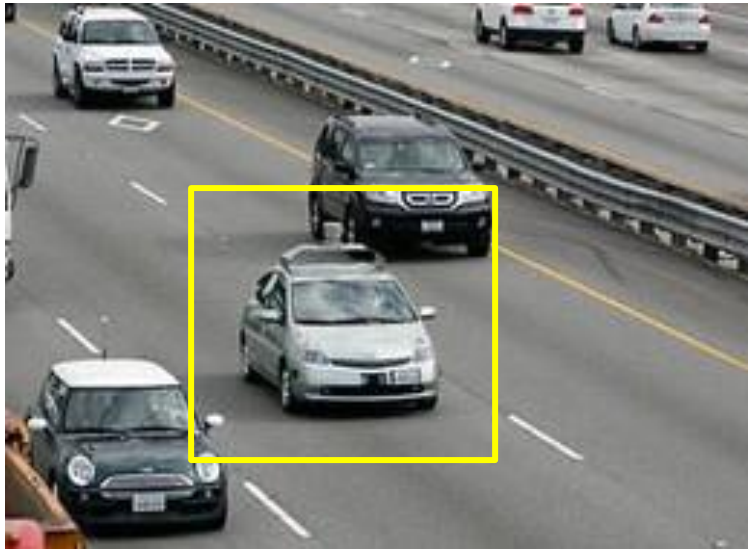
Deep Learning's Role in the Age of Robots

BY JULIAN GREEN, JETPAC 05.02.14 2:56 PM



State of the Art Applications of Machine Learning

Autonomous Cars



- Nevada made it legal for autonomous cars to drive on roads in June 2011
- Four states (Nevada, Florida, California, and Michigan) have legalized autonomous cars.

Georgia Tech's Autonomous Car →
(Sting Racing Team)

Impact of Deep Learning in Speech Technology

Slide credit: Li Deng, MS Research

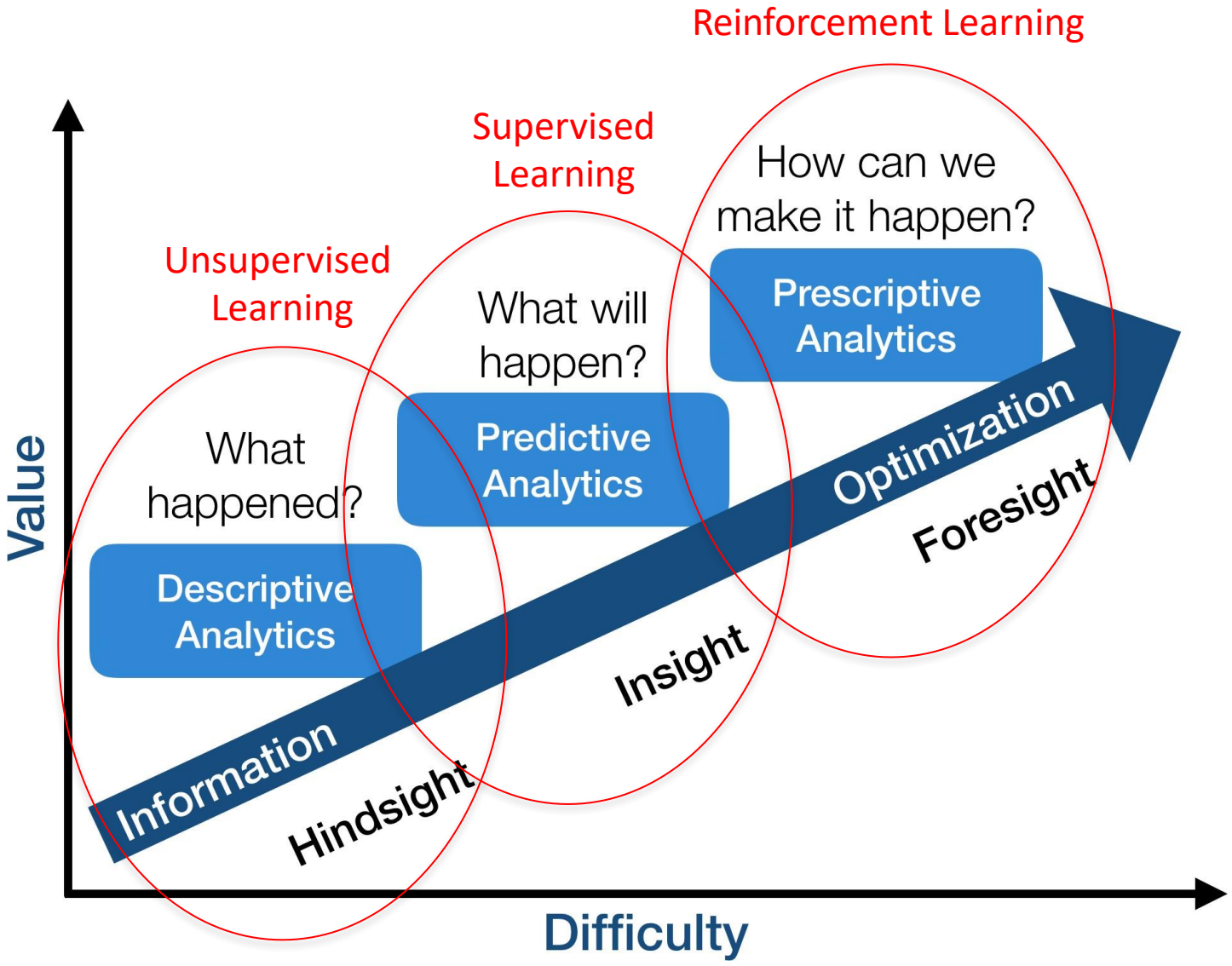
ML vs DL

Types of Learning

	from input ***x***, output:
unsupervised	summary ***z***
supervised	prediction ***y***
reinforcement	action ***a*** to maximize reward ***r***

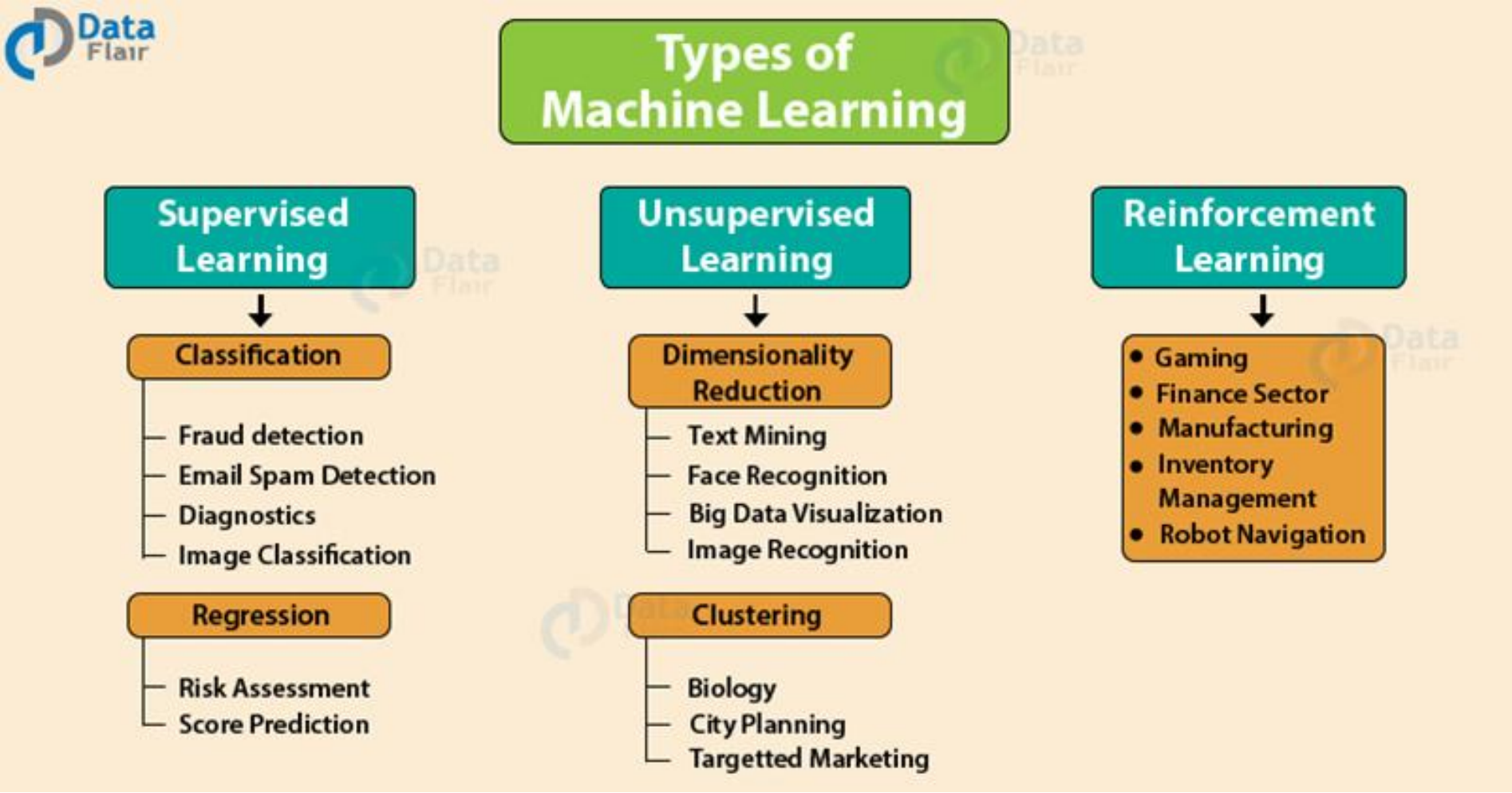
From Wiggins, Recht

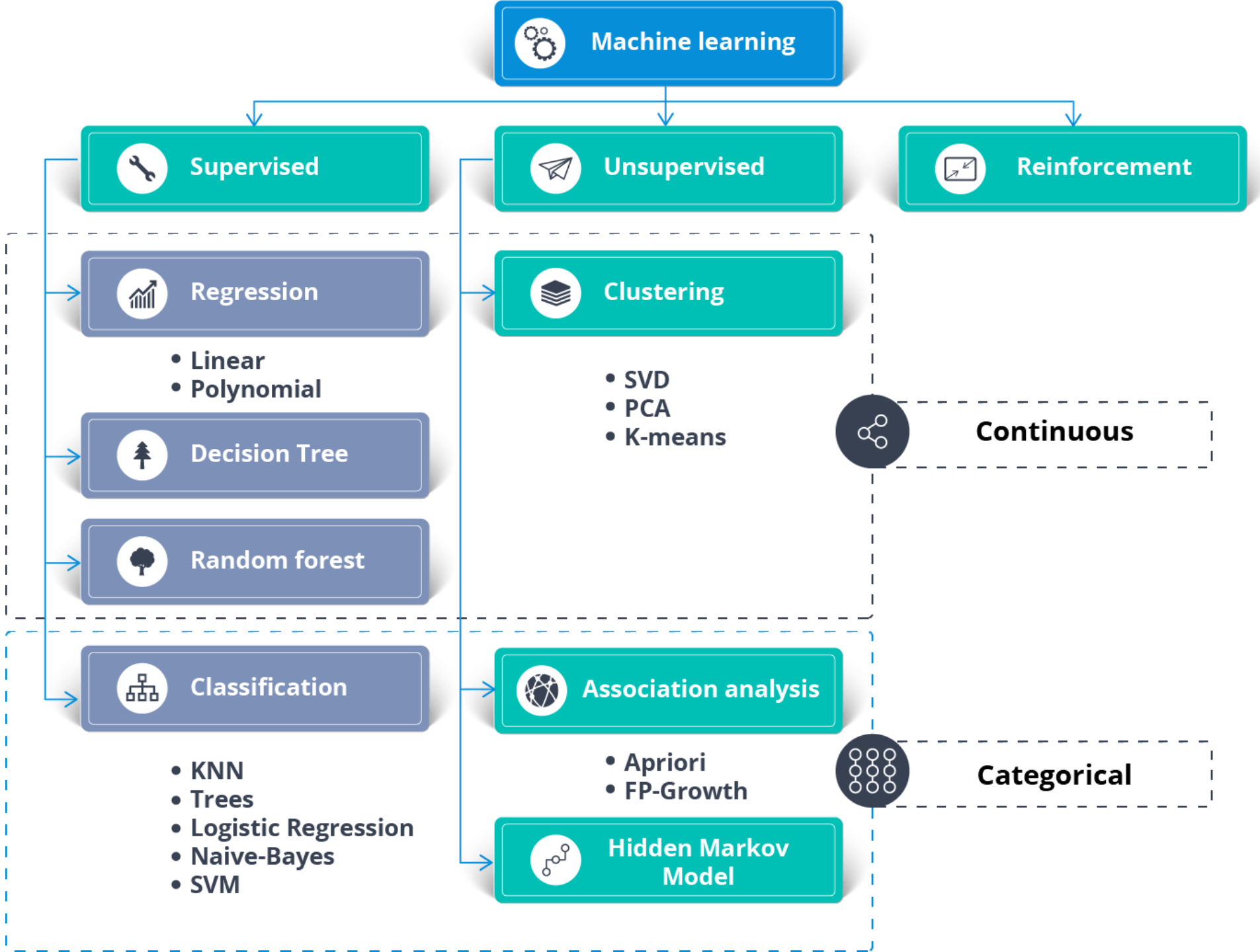
Types of Learning



From Gartner, Recht

ML Applications




Machine learning
Supervised
Unsupervised
Reinforcement
Regression
Linear
Polynomial
Decision Tree
Random forest
Clustering
SVD
PCA
K-means
Continuous
Classification
KNN
Trees
Logistic Regression
Naive-Bayes
SVM
Association analysis
Apriori
FP-Growth
Hidden Markov Model
Categorical