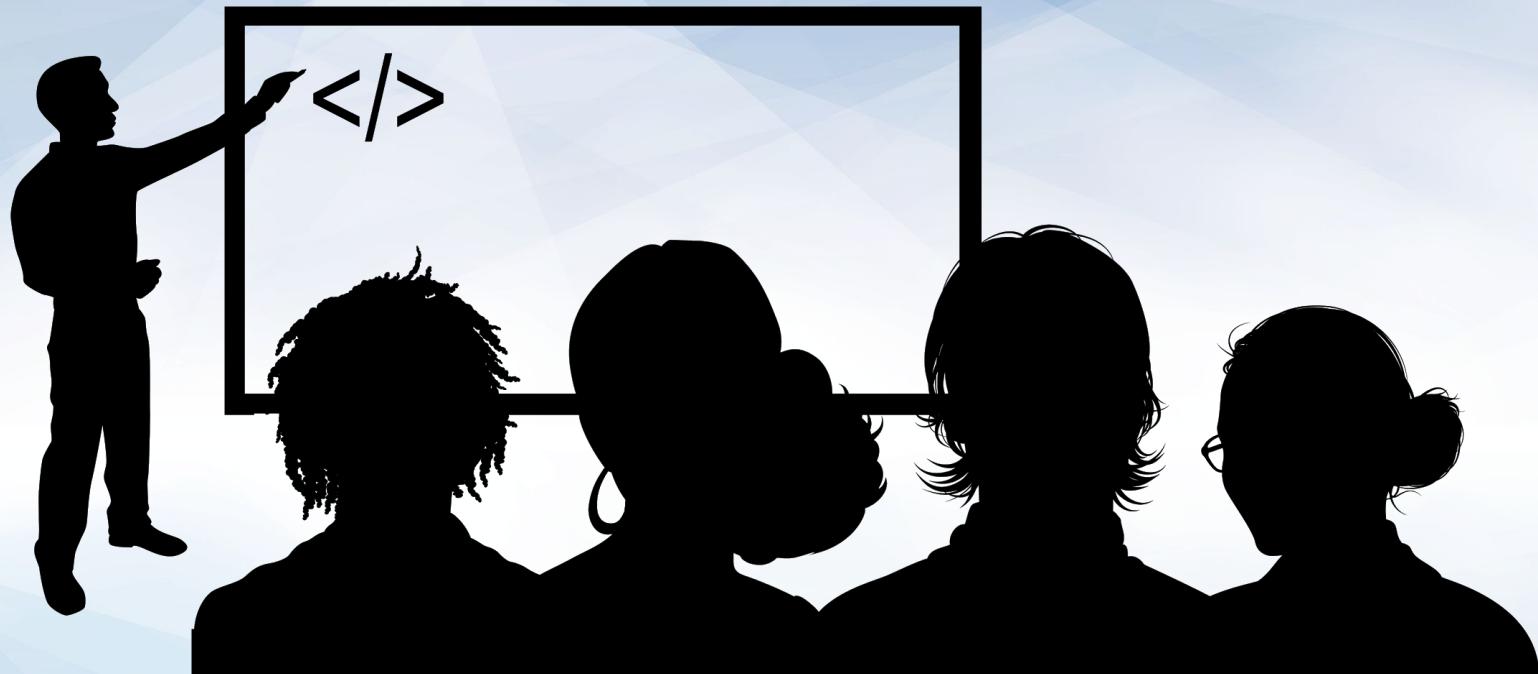




# Introduction to Machine Learning

Data Boot Camp  
Lesson 21.1



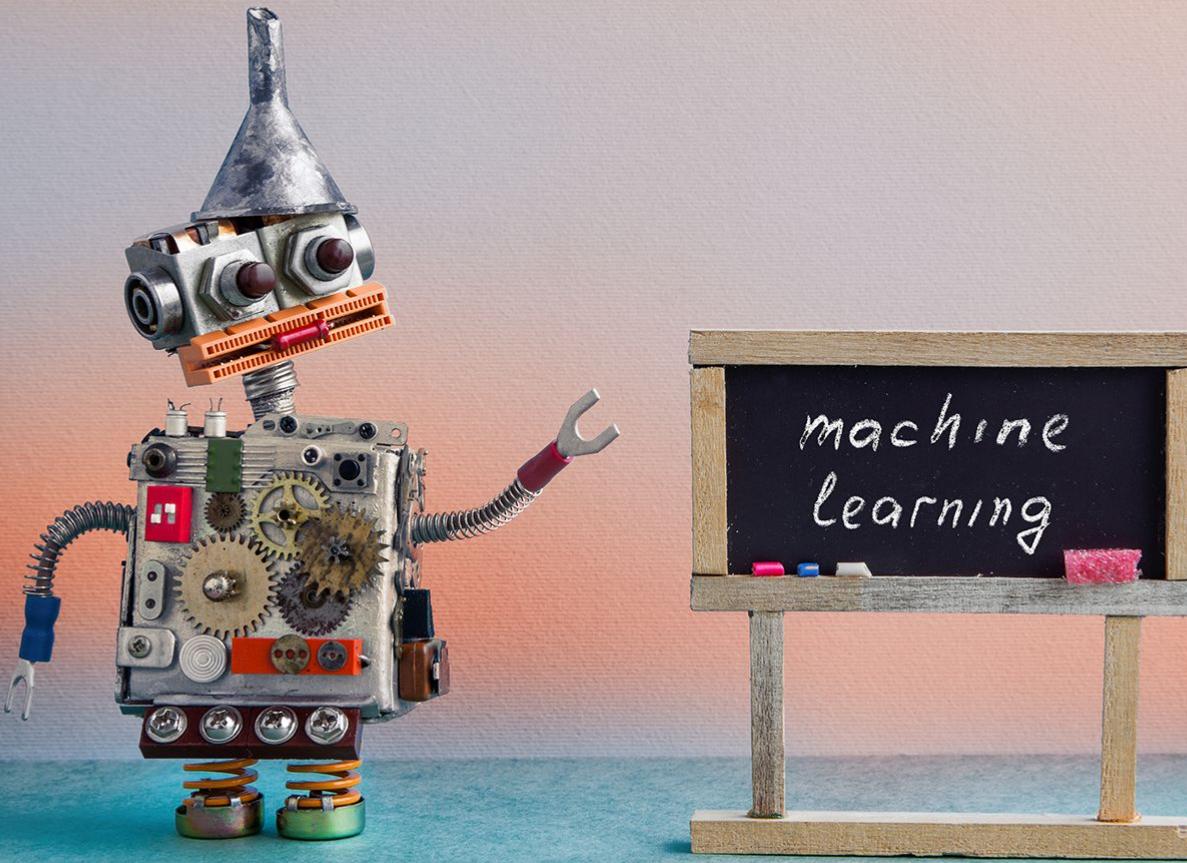


# Instructor Demonstration

## Introduction to Machine Learning

# So It Begins...

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# **Basic Definitions**

# Intelligent Algorithms (Definition)

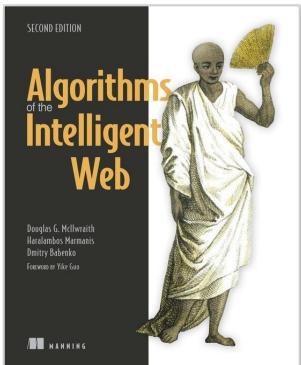
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Intelligent algorithms are ones that use data to modify its behavior. Intelligent algorithms differ in that they can change their behavior as they run, often resulting in a user experience that many would say is intelligent.



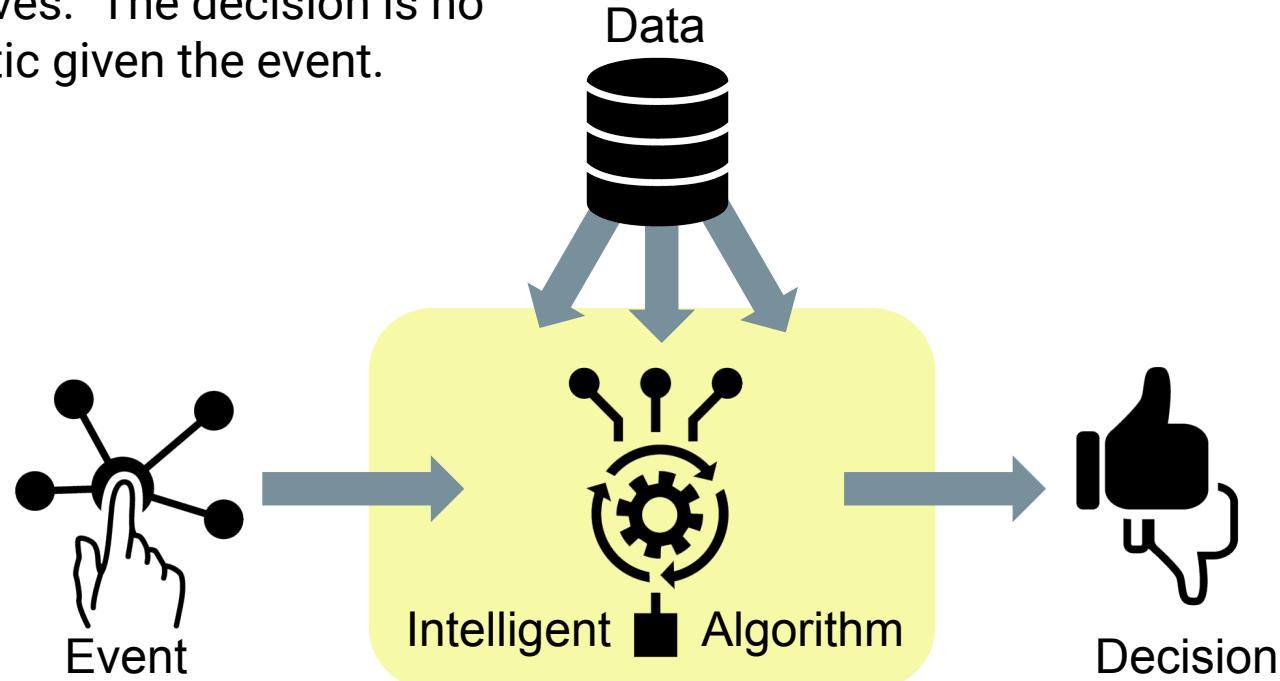
*—Algorithms of the Intelligent Web, Second Edition*



**Algorithms of the Intelligent Web, Second Edition**  
by Douglas G. McIlwraith Haralambos Marmanis Dmitry Babenko  
Publisher: Manning Publications  
Release Date: August 2016

# Intelligent Algorithms (Diagram)

Intelligent algorithms are ones that respond to data such that the algorithm gets better. It effectively “evolves.” The decision is no longer deterministic given the event.



# Intelligent Algorithms (Triad)

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## Machine Learning

Capability of software to generalize phenomena (past or future) based on past experience

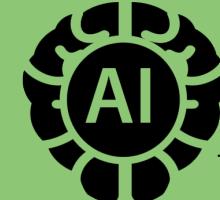
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## Predictive Analytics

Capability of software to predict future outcomes based on historical data

---



## Artificial Intelligence

Software (and machines) that have a series of options (rules) to achieve a particular goal

---

# Artificial Intelligence (Example)

---



# Predictive Analytics (Example)

## How retargeting ads work:



Your potential customer



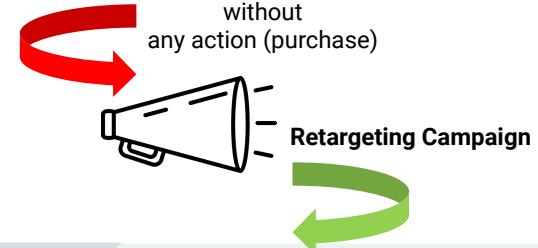
Customer sees your ad



Customer visits your website



Customer leaves your website without any action (purchase)



Your happy customer



Customer completes the purchase

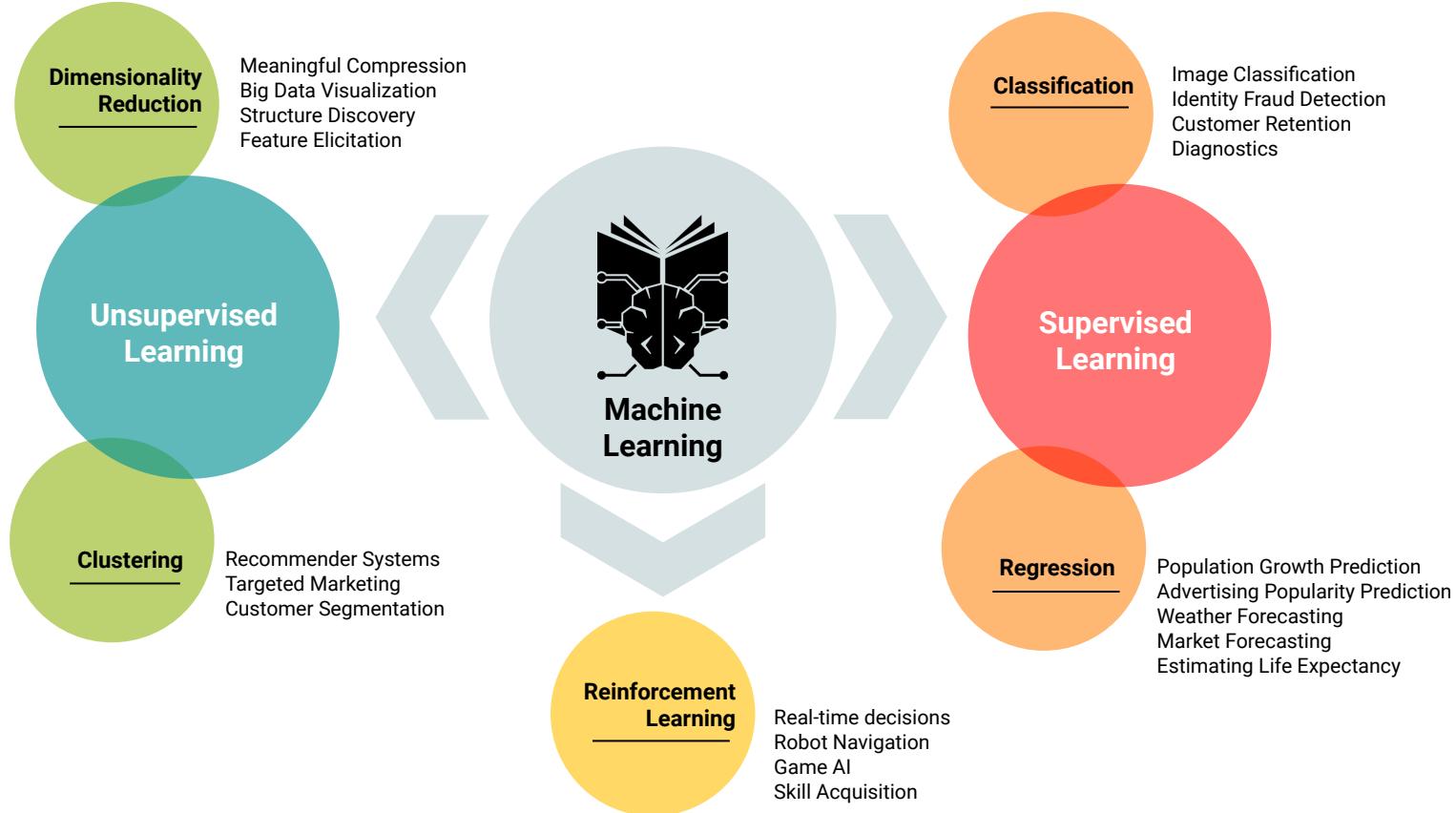


Customer visits your website again

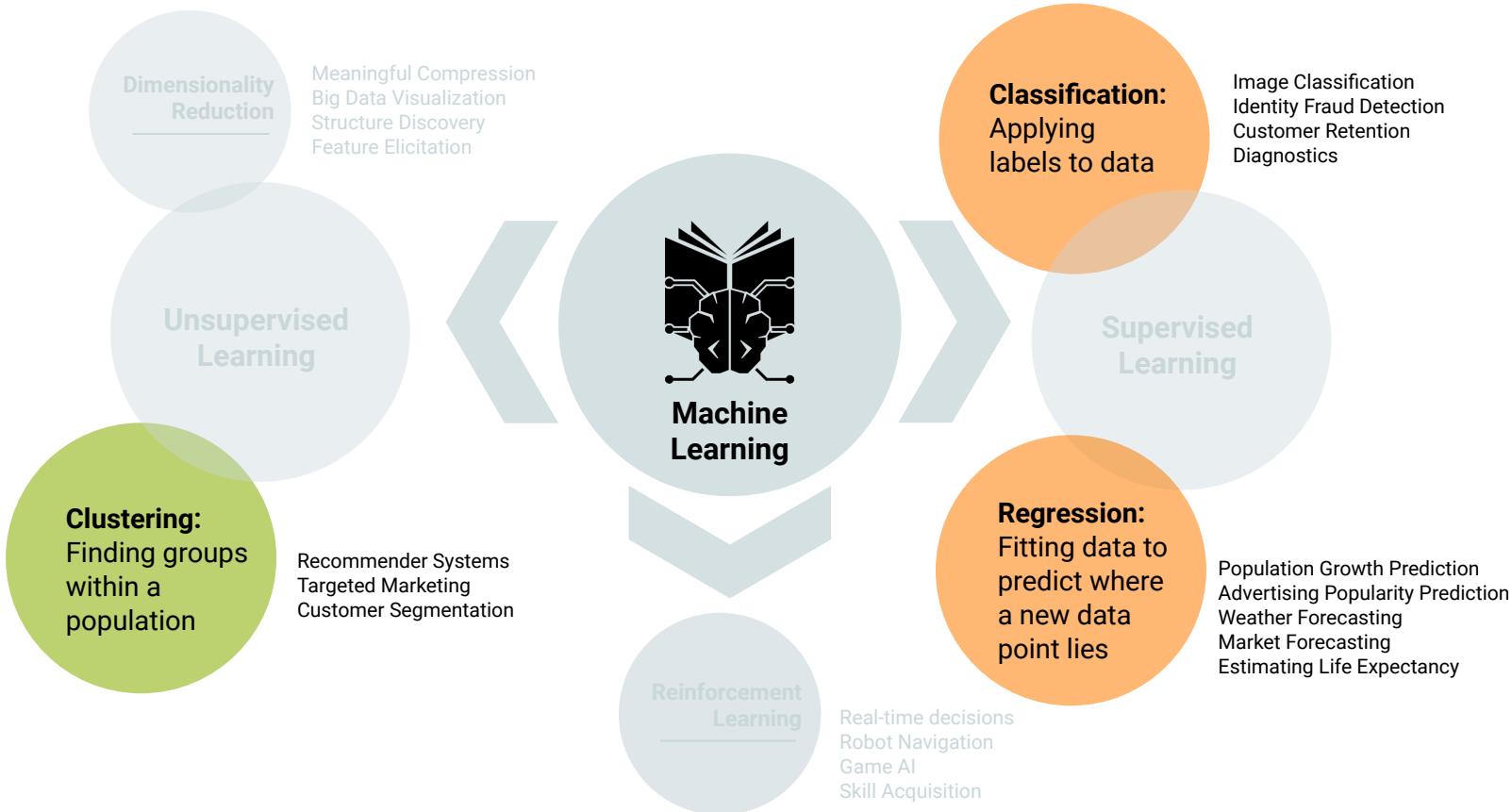


Customer sees your ad on their Facebook feed and partner sites

# Machine Learning (Categories)



# Machine Learning (Categories)



# Machine Learning (Supervised)

**Supervised Learning:** Algorithms for which the potential outcomes are knowable in advance (i.e., category or numeric range) and can be used to correct the model's predictions.

01

Example

Using data such as credit score, credit history, income, etc., we are trying to predict whether an individual is a credit risk or not.

**Known Category:**

“Credit Risk” vs. “Not Credit Risk”

02

Example

Using features such as number of bedrooms, square feet, etc., we are trying to predict the market value of a house.

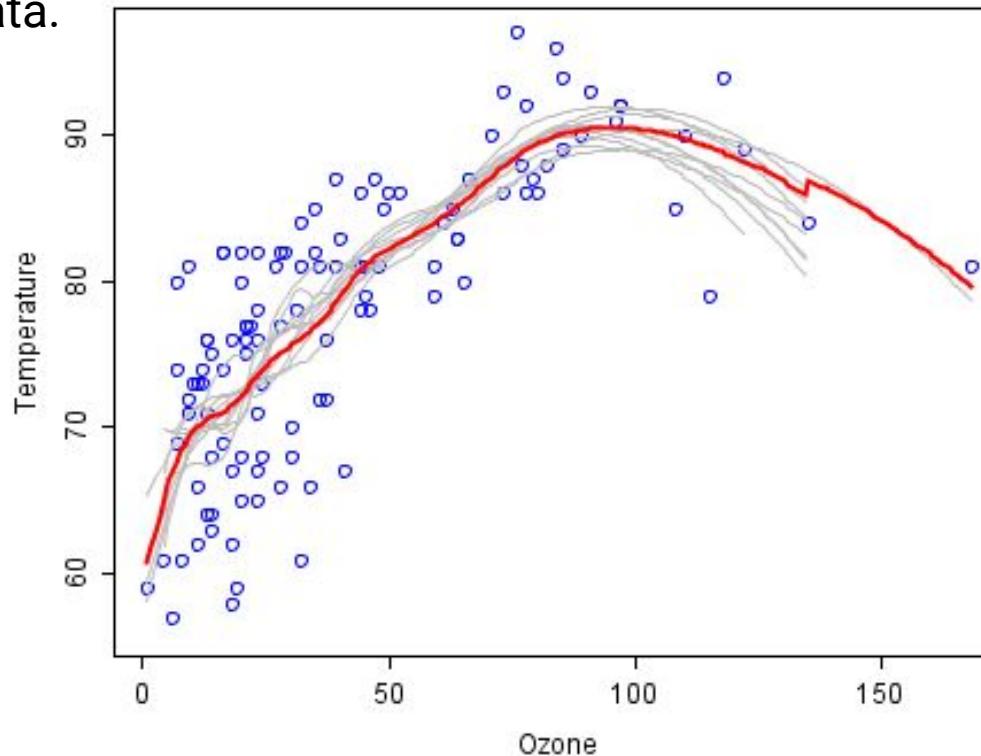
**Numeric Range:**

50,000–500,000

# Machine Learning (Regression)

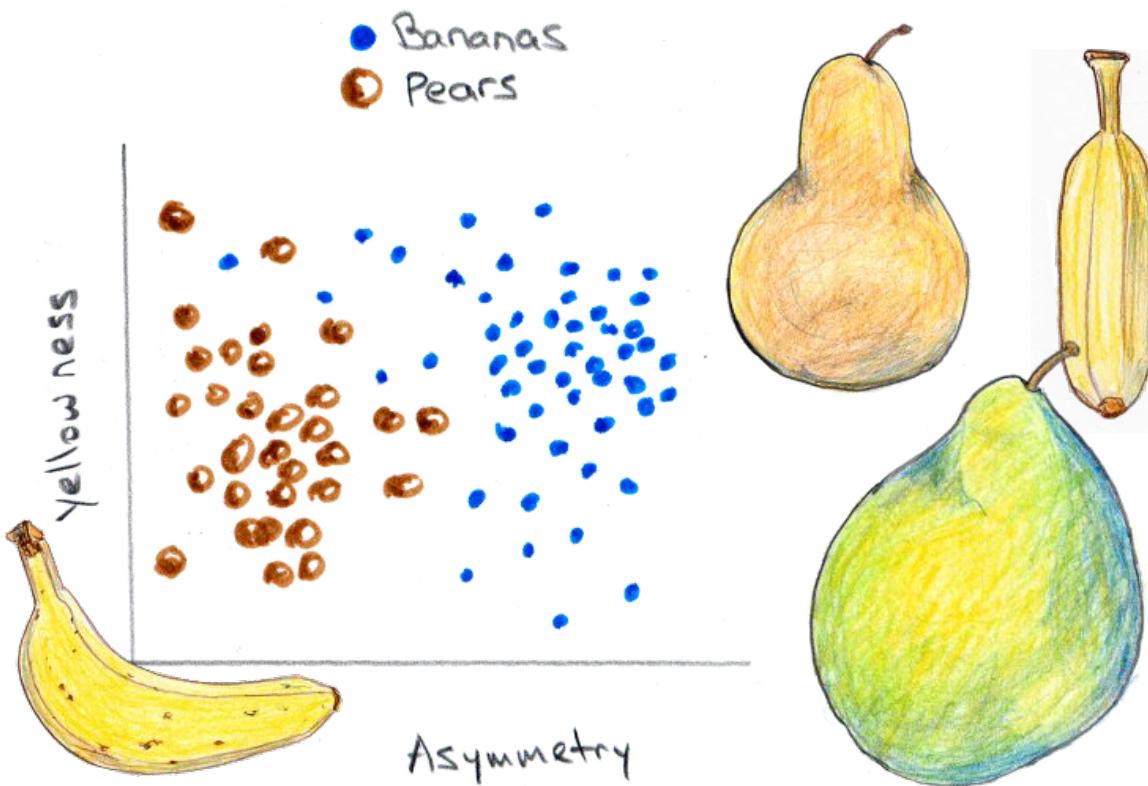
---

We'll be revisiting regression to predict the location of data points based on old data.



# Machine Learning (Classification)

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# Machine Learning (Classification)

In classification problems, our focus is identifying which predefined label our data falls into, based on the **features** we have.

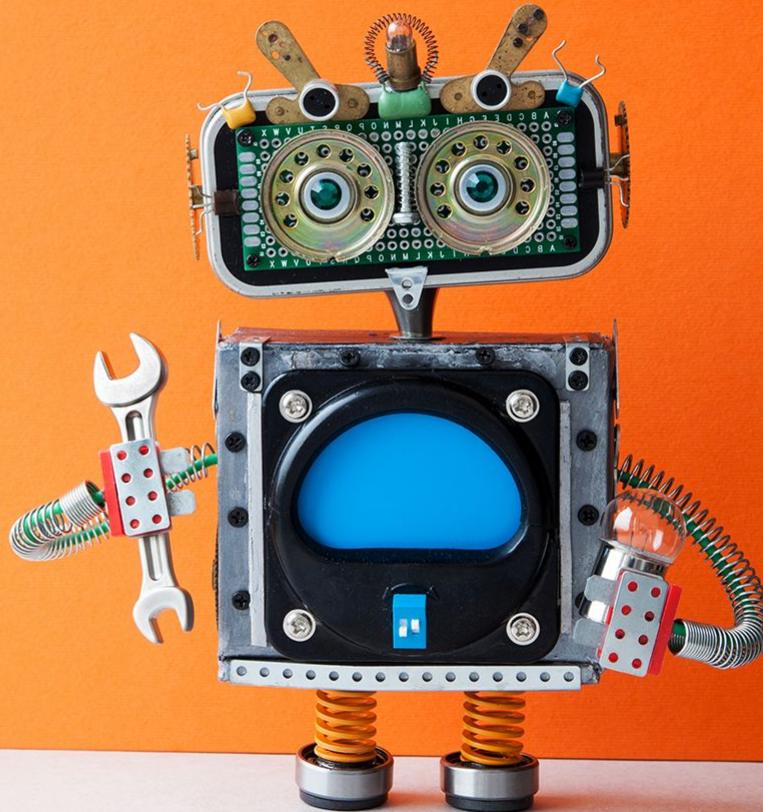
From: cheapsales@buystufffromme.com To: ang@cs.stanford.edu Subject: Buy now!	From: Alfred Ng To: ang@cs.stanford.edu Subject: Christmas dates?
Deal of the week! Buy now! Rolex w4tchs - \$100 Med1cine (any kind) - \$50 Also low cost M0rgages available.	Hey Andrew, Was talking to Mom about plans for Xmas. When do you get off work? Meet Dec 22? -Alf
Spam	Non-Spam

# Machine Learning (Unsupervised)

---

## Unsupervised Learning:

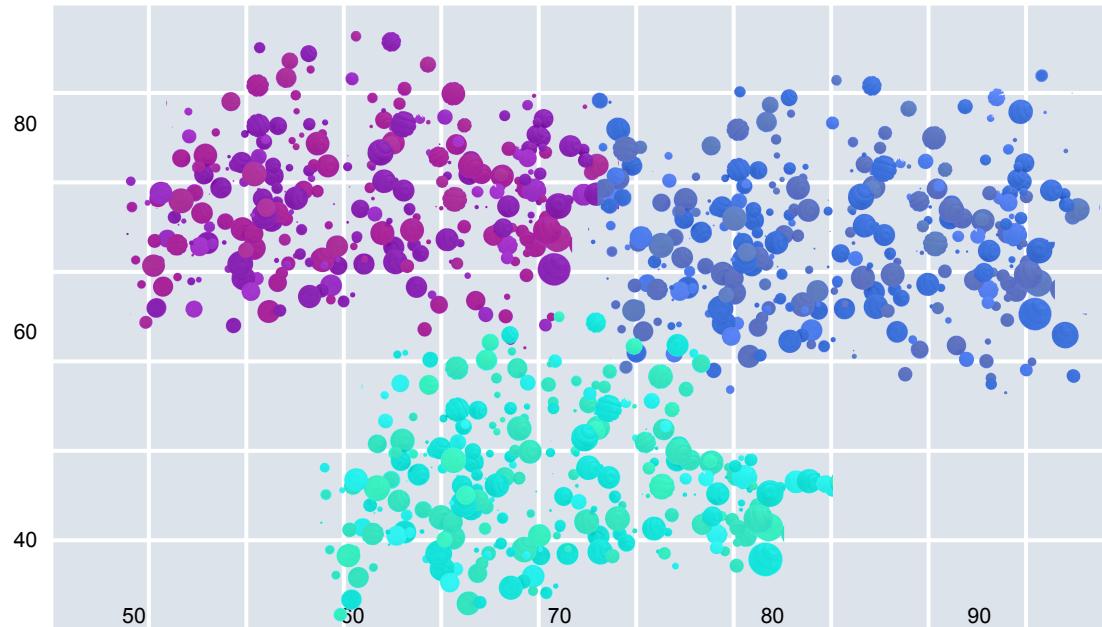
Algorithms for which the potential outcomes are unlabeled. Inferences are made directly from the data without feedback from known outcomes or labels.



# Machine Learning (Clustering)

---

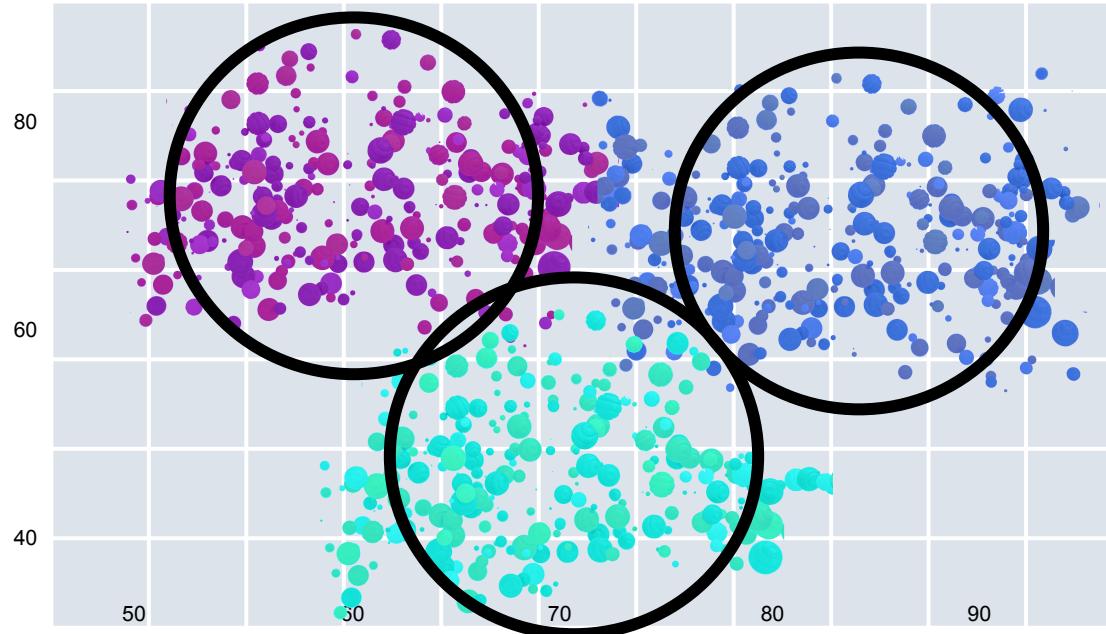
In this clustering problem, we expect our algorithm to find the groupings of data points based on location.



# Machine Learning (Clustering)

In this clustering problem, we expect our algorithm to find the groupings of data points based on location.

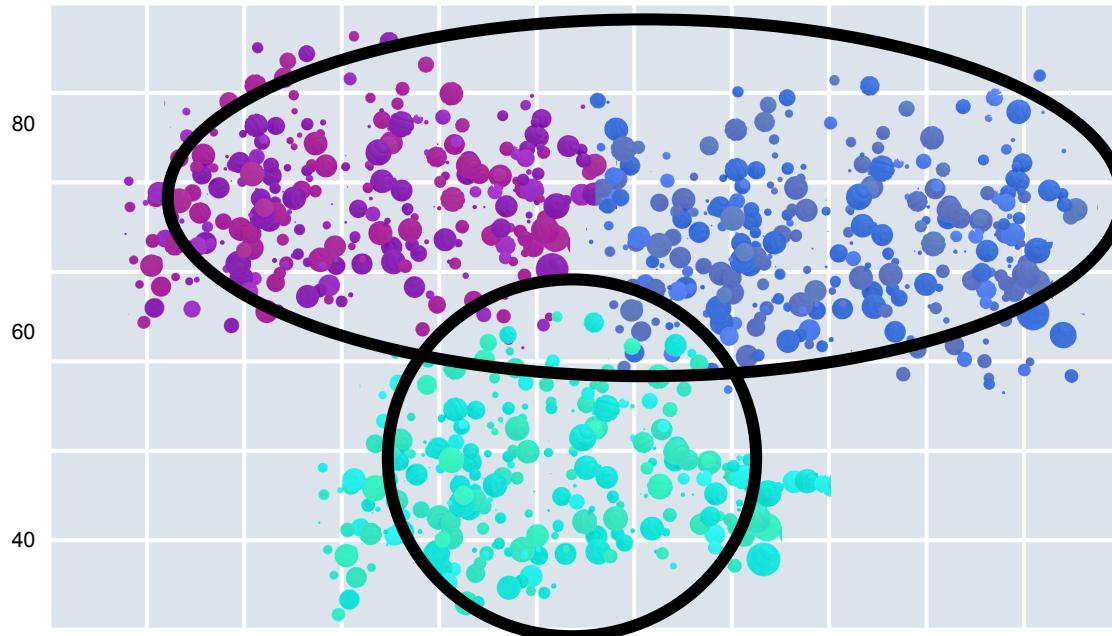
K=3



# Machine Learning (Clustering)

But the problem is more complex:

K=2

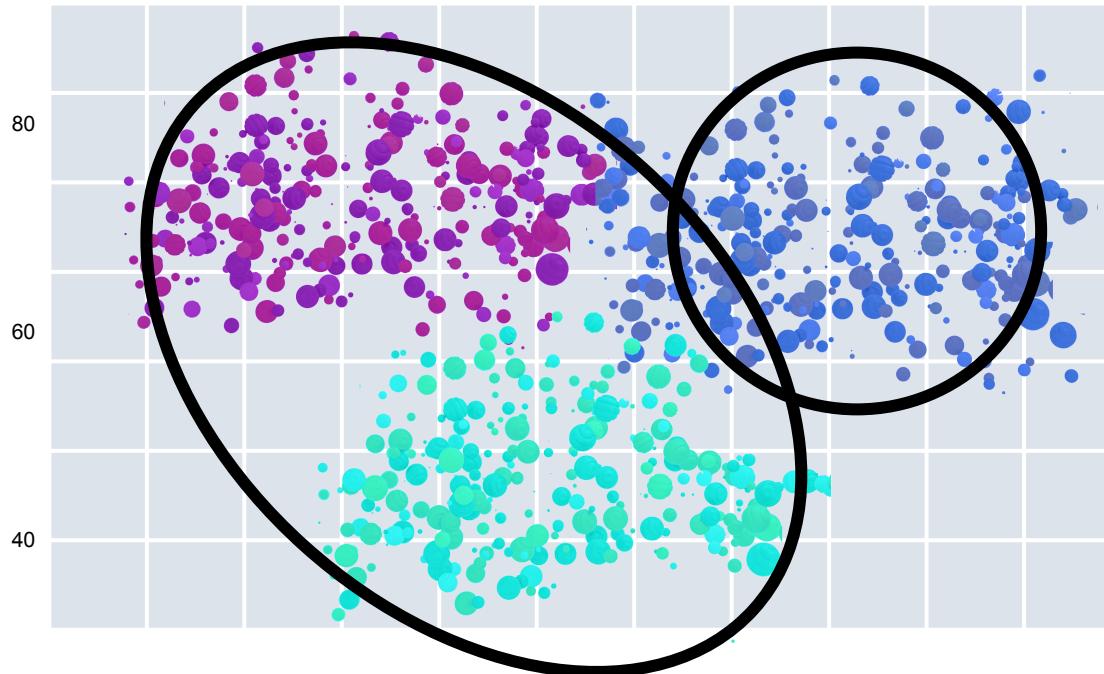


# Machine Learning (Clustering)

---

Perhaps the clusters are not where we think they are.

K=2

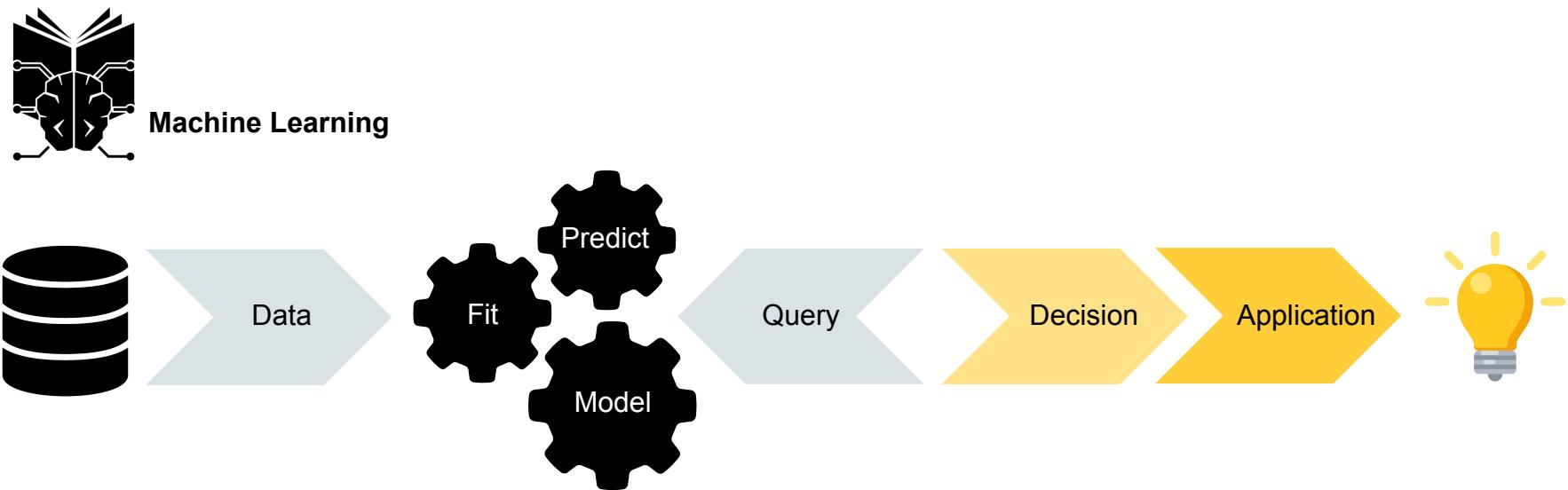


# Training and Predicting

---

Regardless of the problem type, in Machine Learning we follow a familiar paradigm.

**Model → Fit (Train) → Predict**

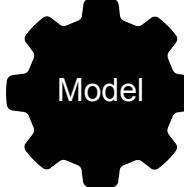


# Training and Predicting

Regardless of the problem type, in Machine Learning we follow a familiar paradigm.

Model → Fit (Train) → Predict

A	B	C	Class
11	16	22	1
10	8	4	2
...	...	...	...



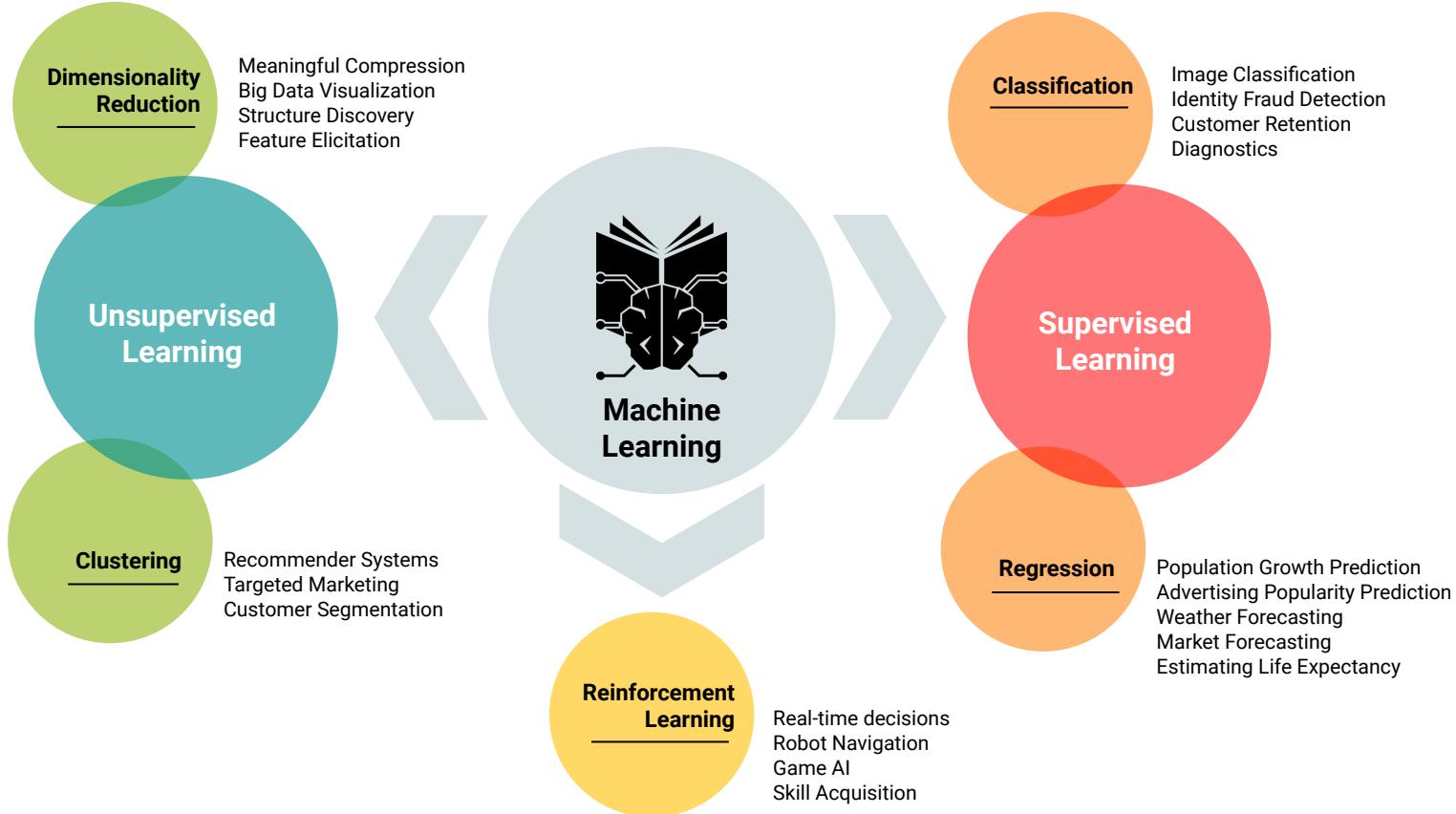
Class
1

A	B	C	Class
10	15	23	?



Apply

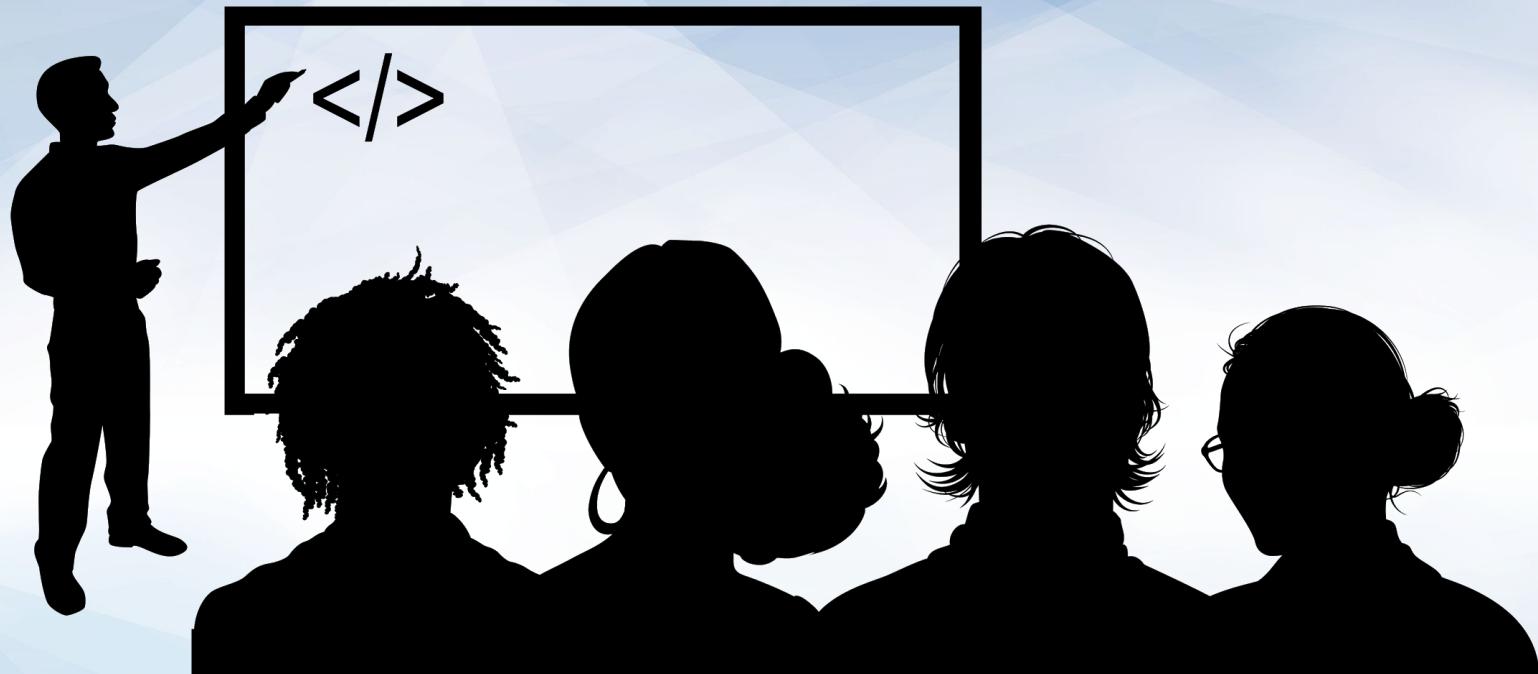
# Many Models: Which Do We Choose?



Machine Learning will one day likely be relegated to a world of the off-the-shelf formulas readily available by the masses. We're already nearly there.



# Questions?

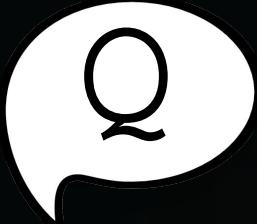


Instructor Demonstration  
Univariate Linear Regression

We start with  
something  
familiar...

...linear regression!





Q

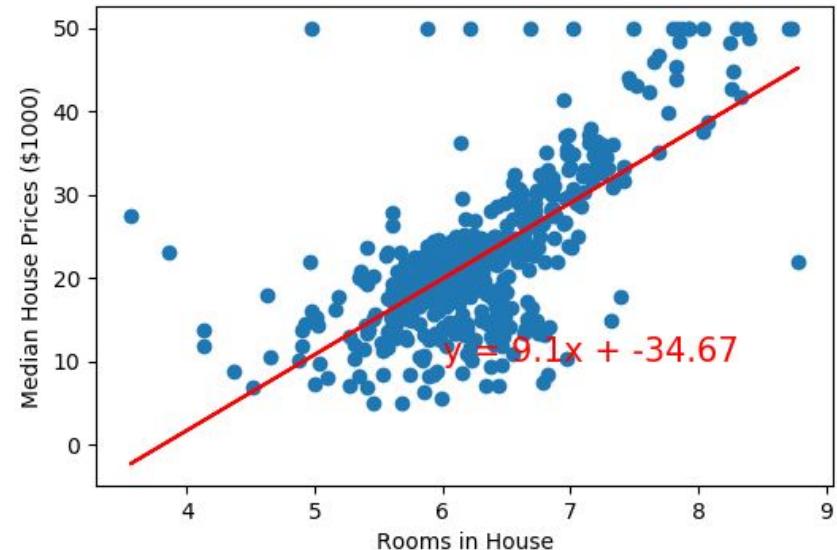
What is **linear regression**?

# Linear Regression is Used to Model and Predict A Relationship

---

Linear regression...

- Predicts a dependent variable, given values from an independent variable.
- There are two basic types
  - Simple linear regression
  - Multiple linear regression
- Both types predict an independent variable using the linear equation



# The Equation of a Line

---

$$y = mx + b$$

A diagram illustrating the components of the linear equation  $y = mx + b$ . The equation is written in a large, black, cursive-style font. Four red arrows point from labels below the equation to specific terms:

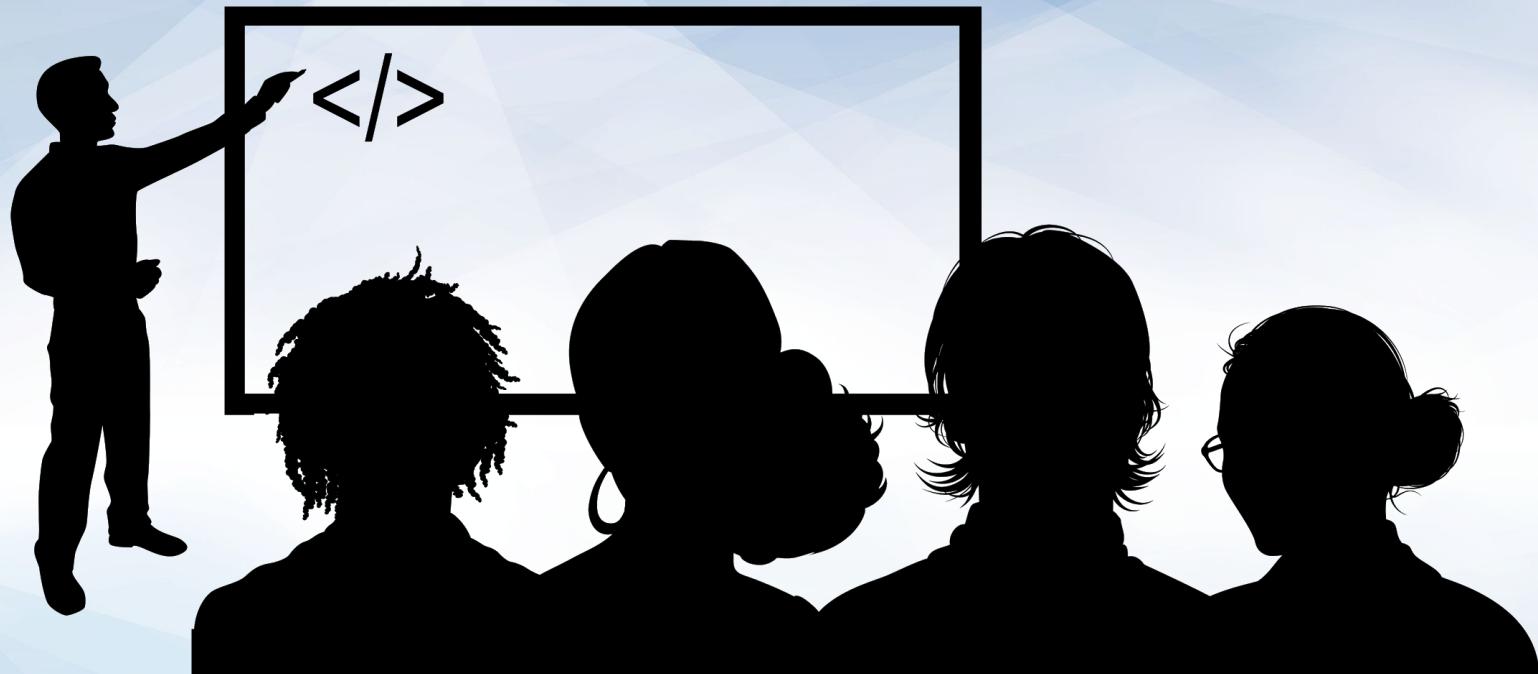
- An arrow points to the variable  $y$  with the label "Dependent variable".
- An arrow points to the term  $mx$  with the label "Slope".
- An arrow points to the variable  $x$  with the label "Independent variable".
- An arrow points to the term  $b$  with the label "y-intercept".



Linear regression is *FAST*

# <Time to Code>





## Instructor Demonstration Quantifying Regression

# Common Scoring Metrics

---

01

**R<sup>2</sup> (R-Squared):**

This is the baseline metric that many ML tools report on score. Higher R<sup>2</sup> values signify that the model is “highly predictive.” An R<sup>2</sup> value of >0.90 means that our model roughly accounts for 90% of the variability of the data.

02

**MSE (Mean Squared Error):**

This measures the average of the squares of the errors or deviations.

# Basic Premise of Validation Using Training/Testing Data

We will cut a slice of this data (80%) to build our model, and then use this slice to predict the values for the remaining 20%.

Full Data Set (Historic)			
N=1000			
# bedrooms	# baths	Sq. feet (k)	Price (k)
2	1	1	200
3	2	1.5	250
...	...	...	...

Training Data Set			
N=800			
# bedrooms	# baths	Sq. feet (k)	Price (k)
4	3.5	3.2	450
2	2	1.5	220
...	...	...	...

Testing Data Set			
N=200			
# bedrooms	# baths	Sq. feet (k)	Price (k)
1	1	.5	60
5	3.5	4.2	780
...	...	...	...

