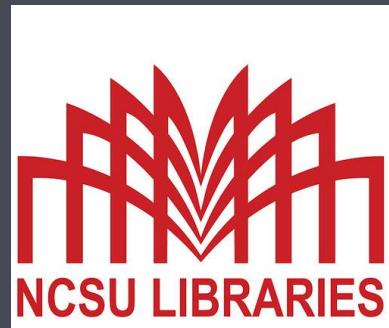


# An Introduction to Machine Learning

---

Ruth Okoilu





# Goals

- Understand the idea of Machine Learning (ML)
- Understand the processes behind creating a real world ML system
- Understand how the choice of ML algorithm affects the accuracy of created model



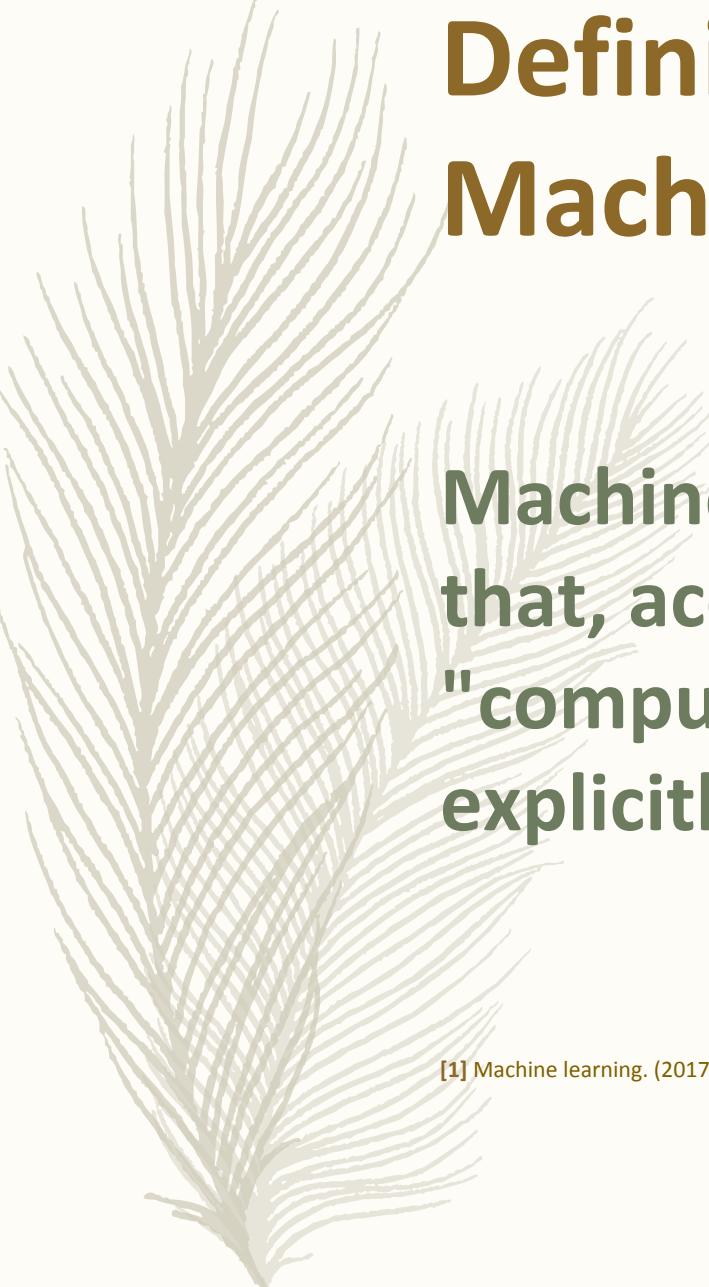
# Target Audience

**Anyone interested in building smart applications/software using ML but does not have any previous exposure to the field.**

**Prior experience with R or Python is helpful.**

**Links to resources:**

[go.ncsu.edu/ex\\_1](http://go.ncsu.edu/ex_1)  
[go.ncsu.edu/ex\\_2](http://go.ncsu.edu/ex_2)  
[go.ncsu.edu/ml\\_s](http://go.ncsu.edu/ml_s)  
[go.ncsu.edu/ml\\_w](http://go.ncsu.edu/ml_w)



# Definition and Overview of Machine Learning

Machine Learning is the subfield of computer science that, according to Arthur Samuel in 1959, gives "computers the ability to learn without being explicitly programmed."<sup>1</sup>

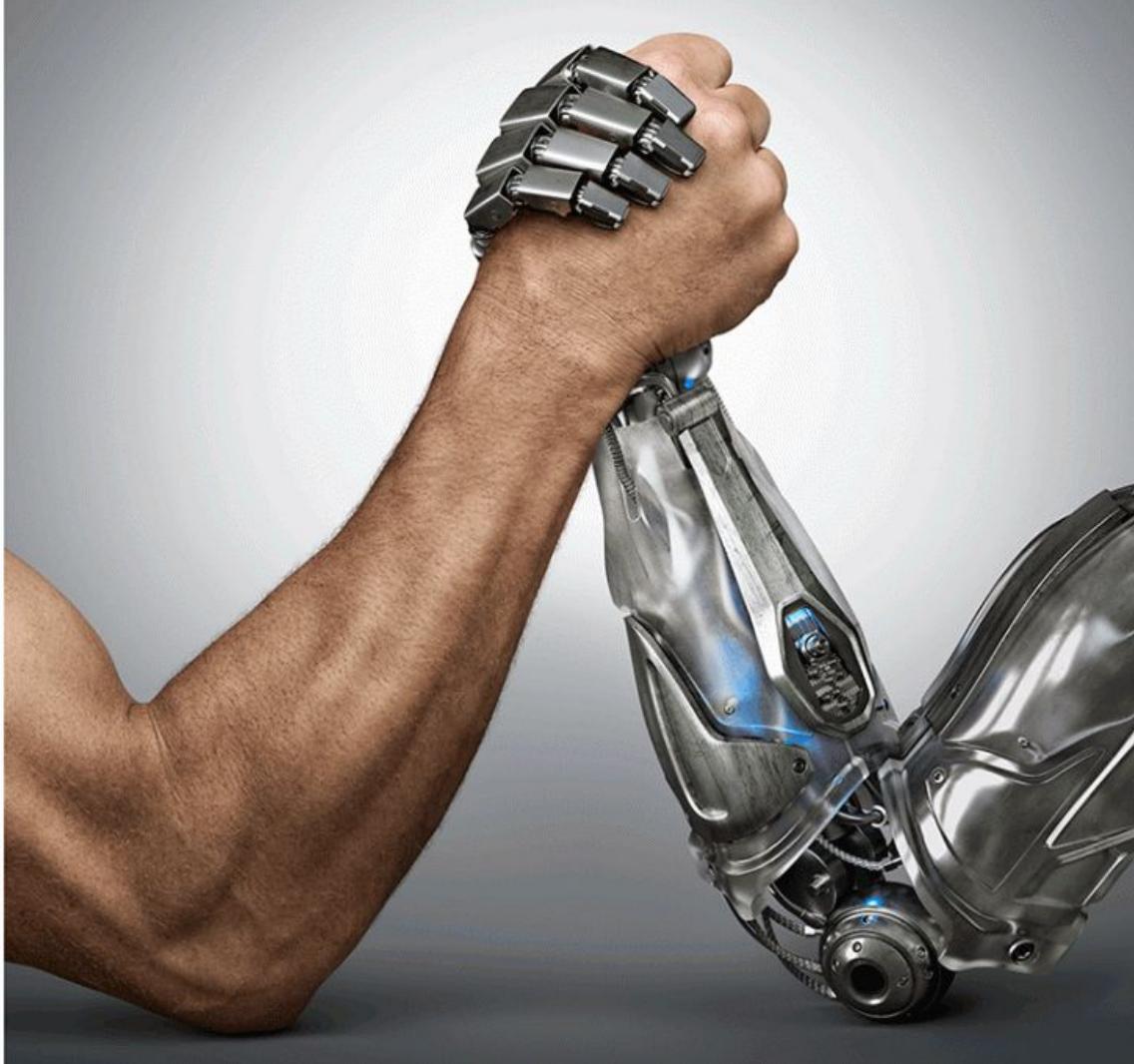
[1] Machine learning. (2017, July 18). Retrieved July 18, 2017, from [https://en.wikipedia.org/wiki/Machine\\_learning](https://en.wikipedia.org/wiki/Machine_learning)

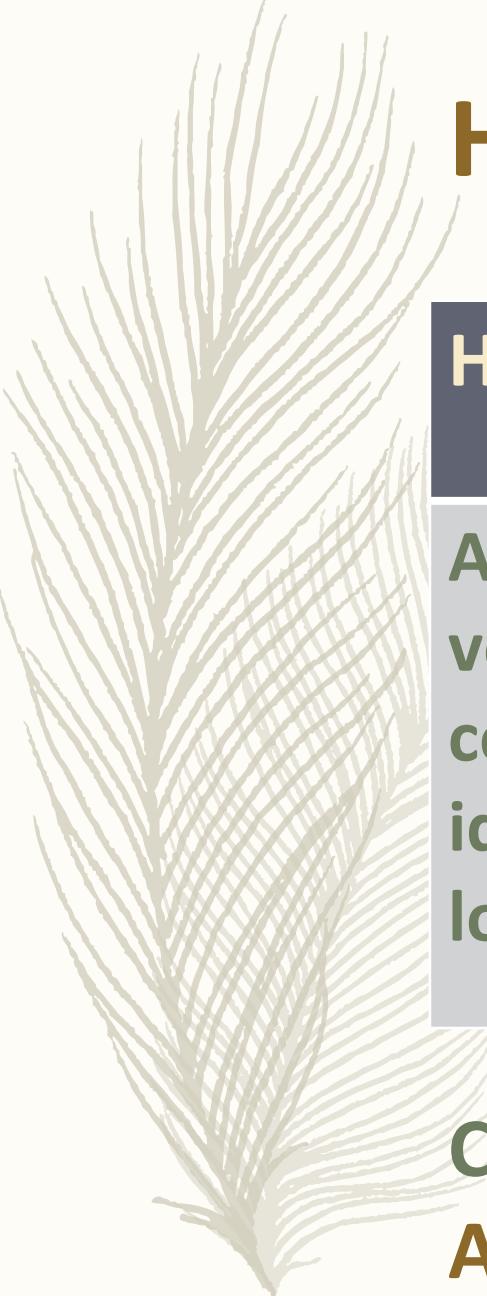
# Basically, ML is...



- teaching a machine how to perform learning tasks
- science of teaching the machine to identify trends in data
- make predictions on data
- recognize patterns that cannot easily be detected by humans

# Human Brain vs Computer



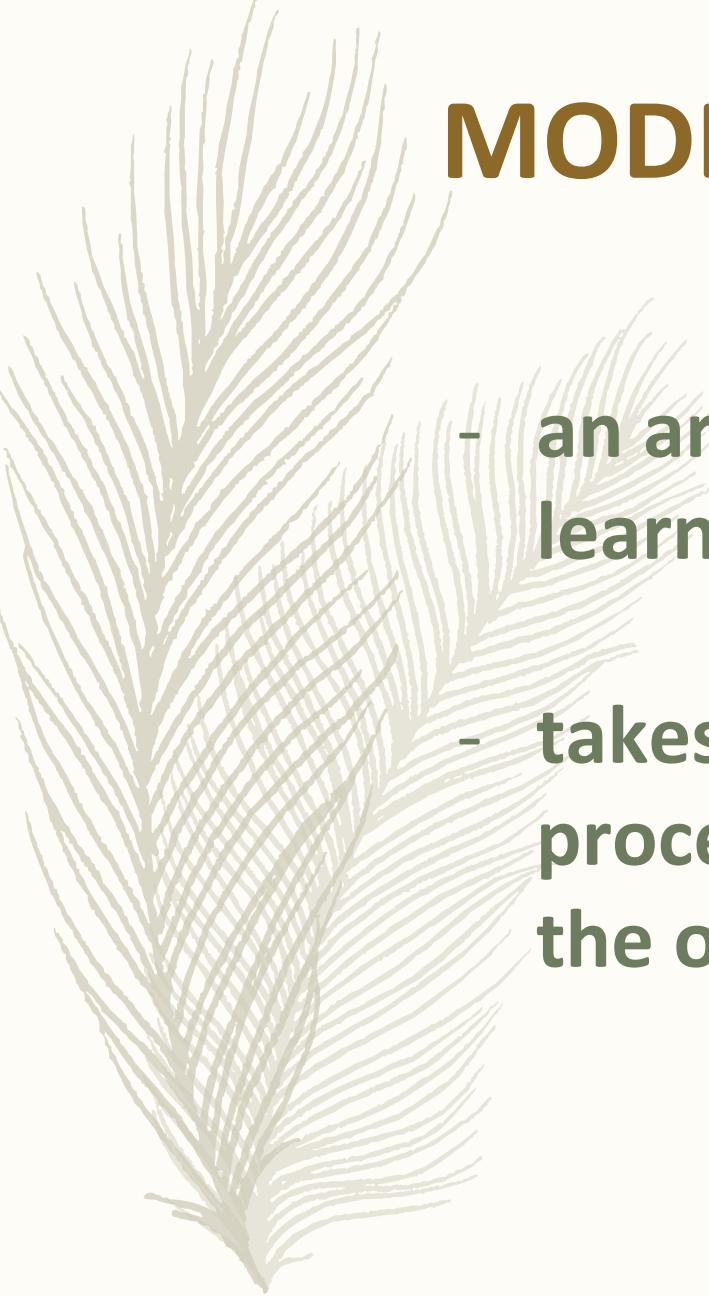


# Human Brain vs Computer

Human Brain	Computer
A human can learn the voices of 10 (maybe 100) co-workers and be able to identify them without looking	A machine can learn the voices of over 10,000 people and be able to predict whose voice it is.

Computer wins, How?

Answer = Machine Learning!!!



# MODEL

- **an artifact or a formula created by the process of learning from previous data.**
- **takes in an input (a person's voice), does some processing and predicts the name of the person as the output.**

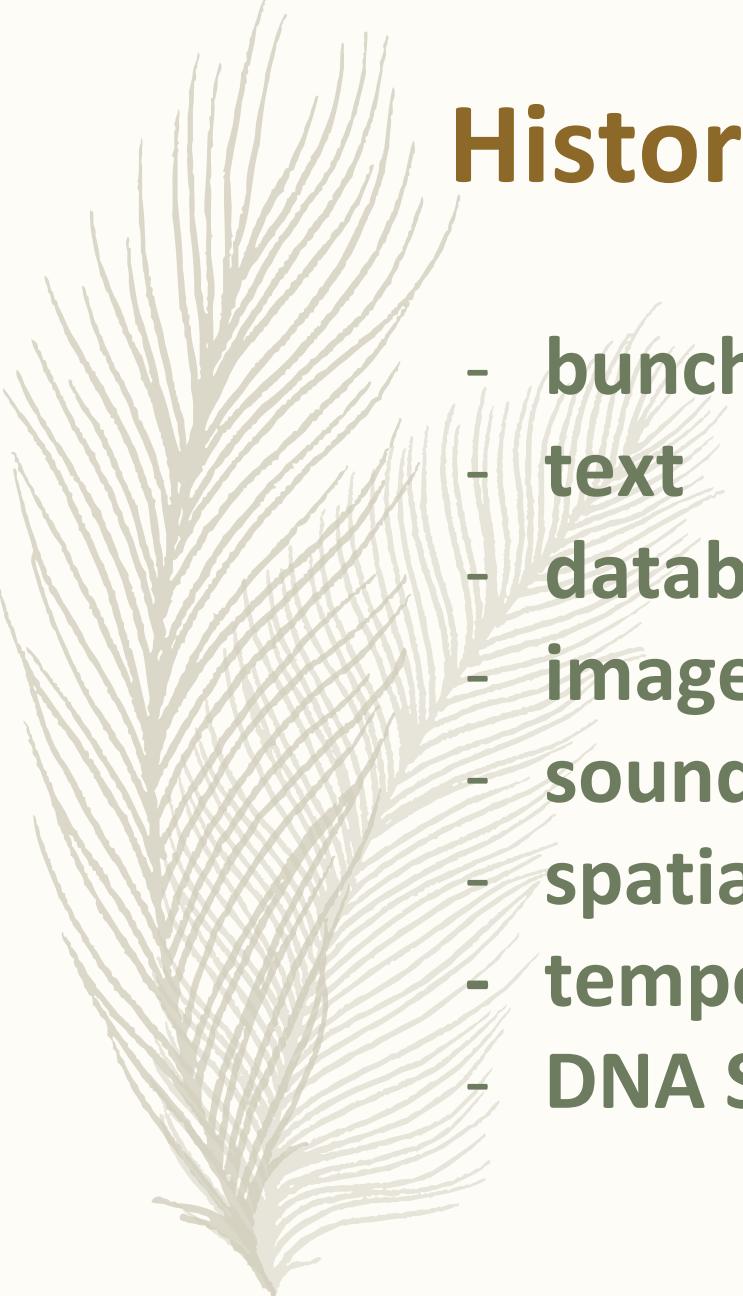


# MODEL

Model

=





# **Historical Data**

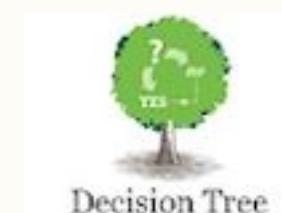
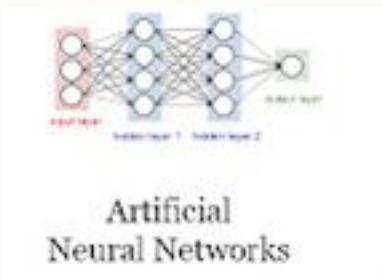
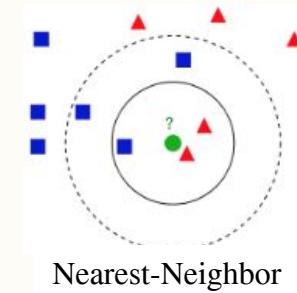
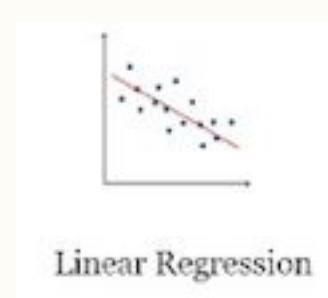
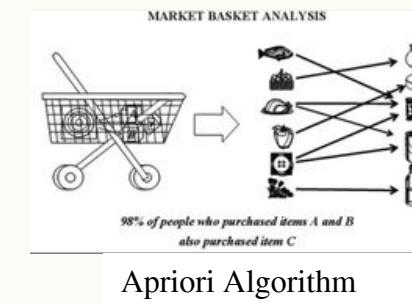
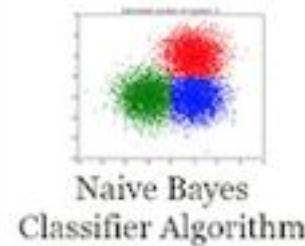
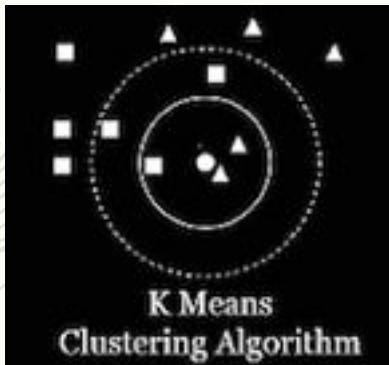
- **bunch of audio records of each person's voice**
- **text**
- **database records**
- **images**
- **sounds**
- **spatial information**
- **temporal**
- **DNA Sequences etc.**

# Computer Never Misses



- teaching a machine how to score a goal at every attempt
- learns from historical records of goal angles, kick intensity etc.

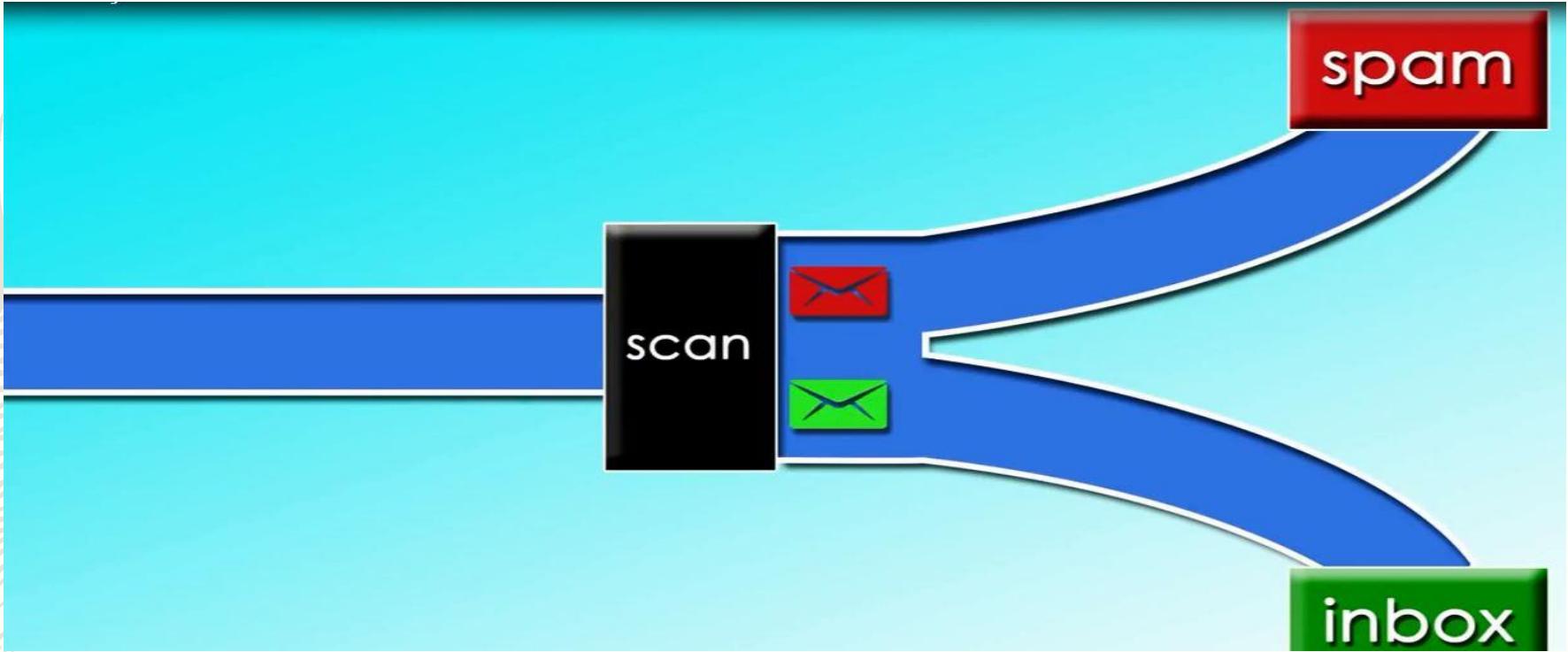
# ML Algorithms





# **How to Use ML as a Creative Tool**

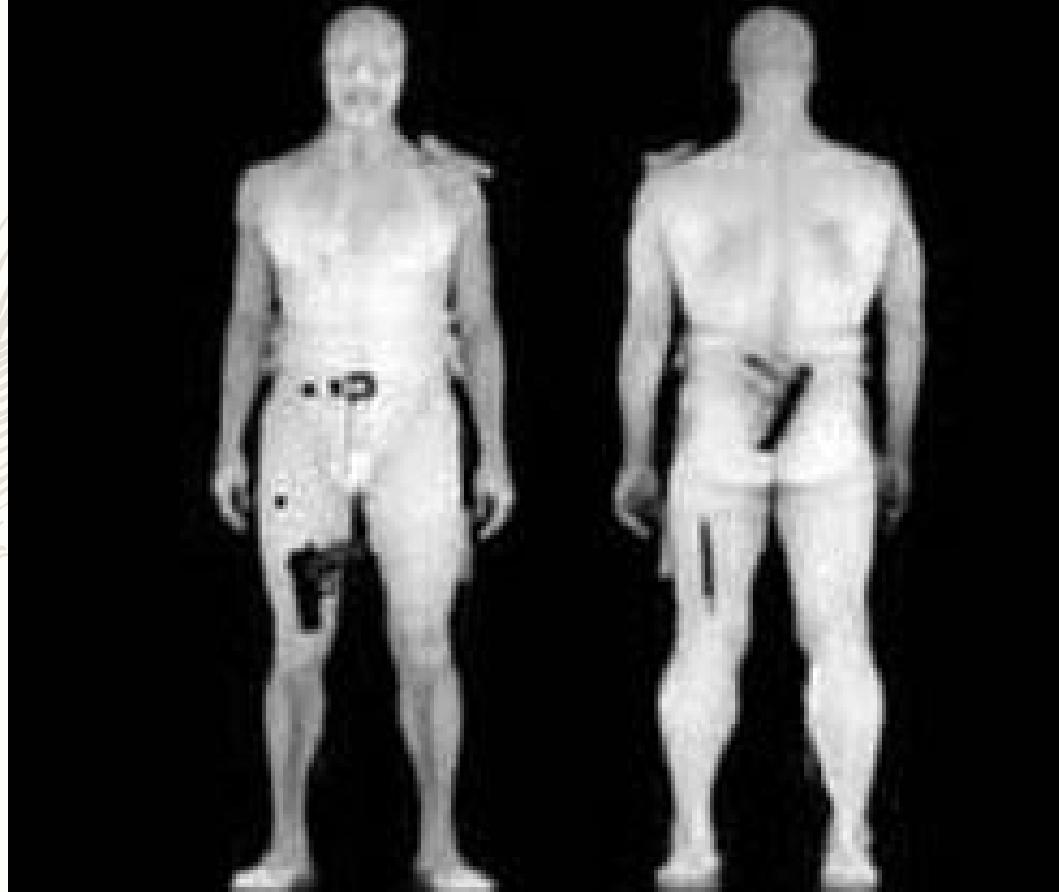
**Building functions from experience is useful for the following:**



SPAM DETECTION



**SECURITY AND CRIME DETECTION**





Self-driving cars



## Credit Card Fraud Detection



Speech Understanding



Watson Wins Jeopardy Quiz Show



FACE RECOGNITION ON PHONE CAMERAS



# BRAIN MACHINE INTERFACES



[www.imdb.com/title/tt1632701/](http://www.imdb.com/title/tt1632701/) ▾

★★★★★ Rating: 8.8/10 - 179,137 votes

Suits – When SEC investigator Sean Cahill fails to link Eric Woodall and Charles Forstman · Suits -- When Evan Smith brings new evidence nullifying the firm's ...  
61 Episodes - Full Cast & Crew - Gabriel Macht - Patrick J. Adams

### Suits | USA Network

[www.usanetwork.com/suits](http://www.usanetwork.com/suits) ▾

USA Network Original Series - Suits stars Patrick J. Adams as Michael Mike Ross and Gabriel Macht as Harvey Specter working at a law firm in NYC.

### Suits - TV.com

[www.tv.com/shows/suits-2011/](http://www.tv.com/shows/suits-2011/) ▾

★★★★★ Rating: 8.6/10 - 2,733 votes

Suits: Watch full length episodes & video clips. Read the latest Suits episode guides & recaps, fan reviews, news, and much more.

### Suits | Facebook

<https://www.facebook.com/SUITsonUSA> ▾

Suits. 2648045 likes · 69238 talking about this. Official Suits page. New episodes this summer. Watch full episodes online at...

### Suits - Suits & Clothing | Men's Wearhouse

[www.menswearhouse.com/mens-suits](http://www.menswearhouse.com/mens-suits) ▾

Shop for suits and other suits & clothing. Get the latest styles, brands and selection in men's clothing from Men's Wearhouse.

### Watch Suits Online - Streaming at Hulu

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Stream clips of Suits instantly. ... In Suits, one of Manhattan's top corporate lawyers (Gabriel Macht) sets out to recruit a new hotshot associate and hires the only ...

### Suits for women | Floral, Separates & Smart Suits | ASOS

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Shop for Women's Suit Jackets, Suit Skirts & Suit Trousers at next.co.uk. Next day delivery and free returns available. 1000s of products online now.

### Men's Suits - Jos. A. Bank

[www.josbank.com/menswear/shop/suits](http://www.josbank.com/menswear/shop/suits) ▾

Select refined men's suits from JoS. A. Bank - the experts in men's apparel. Our business suits are crafted with renowned quality and attention to detail.

# SUITS



[More images](#)

## Suits

TV series

★★★★★ 8.8/10 · IMDb

★★★★★ 8.6/10 · TV.com

In need of an associate, big-time Manhattan corporate lawyer Harvey Specter hires the only guy who impresses him – college dropout Mike Ross. The fact that Ross isn't actually a lawyer isn't lost on Specter, who believes his new right-hand man is a legal prodigy with the book smarts of a Harvard la... [More](#)

First episode date: June 23, 2011

Theme song: Greenback Boogie

Network: USA Network

Program creator: Aaron Korsh

Nominations: Screen Actors Guild Award for Outstanding Performance by a Male Actor in a Drama Series, more

### Cast

[View 10+ more](#)



Gabriel Macht  
Harvey Specter



Patrick J. Adams  
Michael Ross



Meghan Markle  
Rachel Zane



Sarah Rafferty  
Donna Paulsen



Rick Hoffman  
Louis Litt

### People also search for

### Machine Learning

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Fairly Legal  
2011 – 2012



The Whole Truth  
2010



Made in Jersey  
2012



Royal Pains  
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Harry's Law  
2011 – 2012

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About 133,000,000 results (0.37 seconds)

### In the news



#### Kerry Washington's GLAAD Speech and the Problem of Black Homophobia

Daily Beast - 16 hours ago

Kerry Washington gave a rousing speech at the GLAAD Media Awards addressing the issue ...

Scandal star Kerry Washington calls for equal rights at Glaad awards  
BBC News - 1 day ago

KERRY WASHINGTON OVER KIM KARDASHIAN ANY DAY!  
YouTube - 19 hours ago

[More news for kerry washington](#)

### Kerry Washington - Wikipedia, the free encyclopedia

[en.wikipedia.org/wiki/Kerry\\_Washington](https://en.wikipedia.org/wiki/Kerry_Washington) ▾

Kerry Marisa Washington (born January 31, 1977) is an American actress. Since 2012, Washington has gained wide public recognition for starring in the ABC ...  
Nnamdi Asomugha - David Moscow - List of awards and ... - Alicia Masters

### kerry washington (@kerrywashington) | Twitter

<https://twitter.com/kerrywashington> ▾

18.4K tweets • 1264 photos/videos • 2.07M followers. "Me & my homie @lenadunham hung out & chatted w/ @marieclaire and there's a mag to prove it!

### Kerry Washington - IMDb

[www.imdb.com/name/nm0913488/](https://www.imdb.com/name/nm0913488/) ▾

Kerry Washington was born on January 31, 1977 in The Bronx, New York City, New York, USA as Kerry Marisa Washington. She is an actress, known for Django ...

### Kerry Washington (@kerrywashington) • Instagram photos ...

<https://instagram.com/kerrywashington/> ▾

See Instagram photos and videos from Kerry Washington (@kerrywashington)

### Kerry Washington | Facebook

<https://www.facebook.com/thekerrywashington> ▾

Kerry Washington. 3722680 likes · 123144 talking about this. www. kerrywashington.com https://twitter.com/#!/kerrywashington



[More images](#)

## Kerry Washington

Actress

Kerry Marisa Washington is an American actress. Since 2012, Washington has gained wide public recognition for starring in the ABC drama Scandal, a Shonda Rhimes series in which she plays Olivia Pope. ... [Wikipedia](#)

**Born:** January 31, 1977 (age 38), The Bronx, New York City, New York, United States

**Height:** 1.63 m

**Spouse:** Nnamdi Asomugha (m. 2013)

**Parents:** Valerie Washington, Earl Washington

**Children:** Isabelle Amarachi Asomugha

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Denzel Washington &gt; Children &gt; Olivia Washington

John David Washington  
SonKatia Washington  
DaughterOlivia Washington  
DaughterMalcolm Washington  
Son**Kerry Washington - Wikipedia, the free encyclopedia**[en.wikipedia.org/wiki/Kerry\\_Washington](http://en.wikipedia.org/wiki/Kerry_Washington) ▾

Since 2012, Washington has gained wide public recognition for starring in the ABC ....

In addition to Washington's acting, her costumes as Olivia Pope have ...

Nnamdi Asomugha - David Moscow - List of awards and ... - Alicia Masters

**Olivia Washington - IMDb**[www.imdb.com/name/nm3463325/](http://www.imdb.com/name/nm3463325/) ▾

Olivia Washington was born on April 10, 1991 in Los Angeles, California, USA as Olivia ... Younger sister of John David Washington and Katia Washington.

[Biography](#) - [Photo Gallery](#) - [Other works](#) - [Publicity](#)**Kerry Washington - IMDb**[www.imdb.com/name/nm0913488/](http://www.imdb.com/name/nm0913488/) ▾

Kerry Washington, Actress: Django Unchained. Kerry Washington was born on January 31, 1977 in The Bronx, New York City, New York, USA as ... Olivia Pope.

**In the news****'Scandal' Season 4 Episode 17 SPOILERS: Olivia Pope Plans Cyrus, Michael's White House Wedding; B613 In Great ...**

Design &amp; Trend - 8 hours ago

... and how Olivia Pope (Kerry Washington) will convince him to move up his wedding date.

'Scandal' Season 4 Spoilers: Olivia Pope Fixes A Gay Republican White House Wedding In Episode 17 [VIDEO]

International Business Times AU - 23 hours ago

[More news for olivia washington](#)

Gave more weight to Kerry Washington's picture when the search was for Olivia Washington



## Olivia Washington

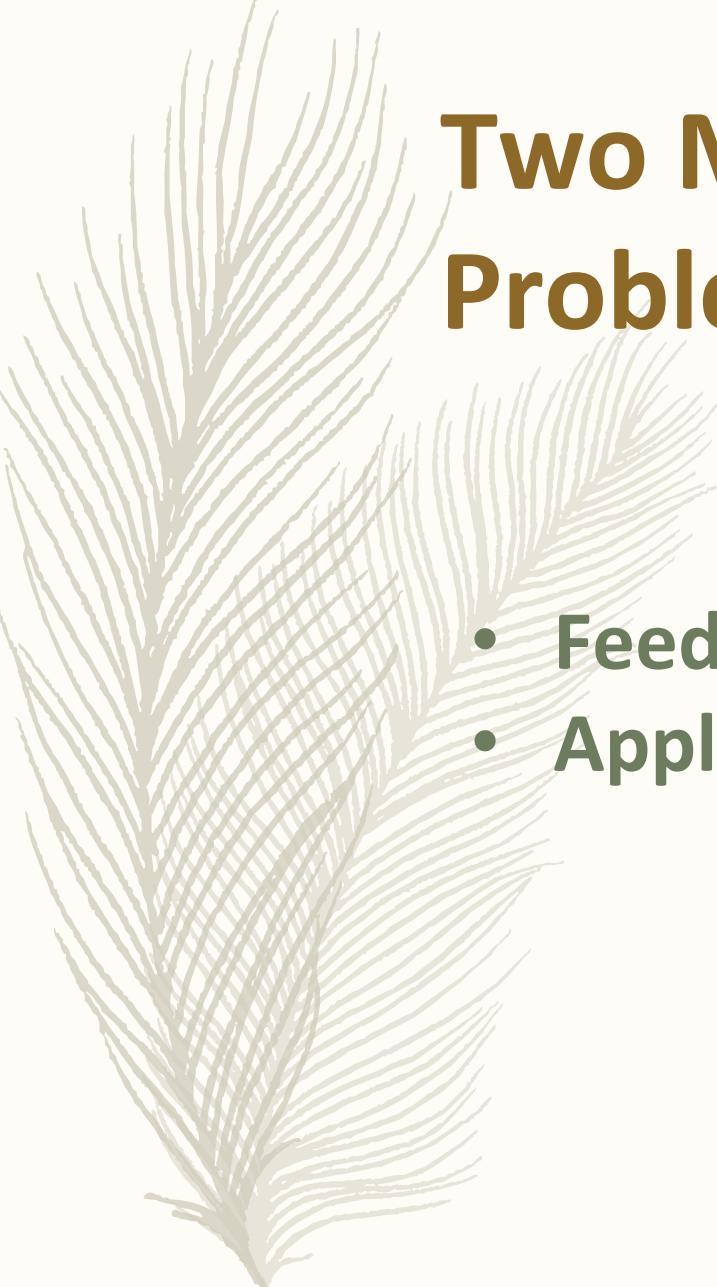
Actress

**Born:** April 10, 1991 (age 23), Los Angeles, California, United States**Education:** New York University**Siblings:** John David Washington, Malcolm Washington, Katia Washington**Parents:** Paulette Pearson Washington, Denzel Washington**Movies:** [The Butler](#)[View 10+ more](#)Denzel Washington  
FatherJohn David Washington  
BrotherPaulette Pearson Washington  
Mother

Jascha Washington



Olivia A. Davidson

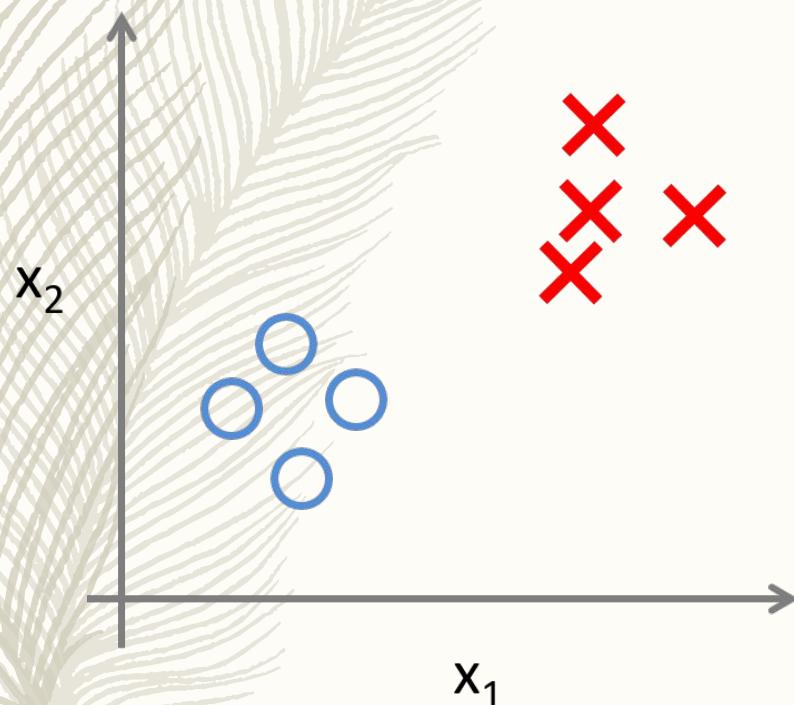


# **Two Major Ways to Classify ML Problems/Tasks**

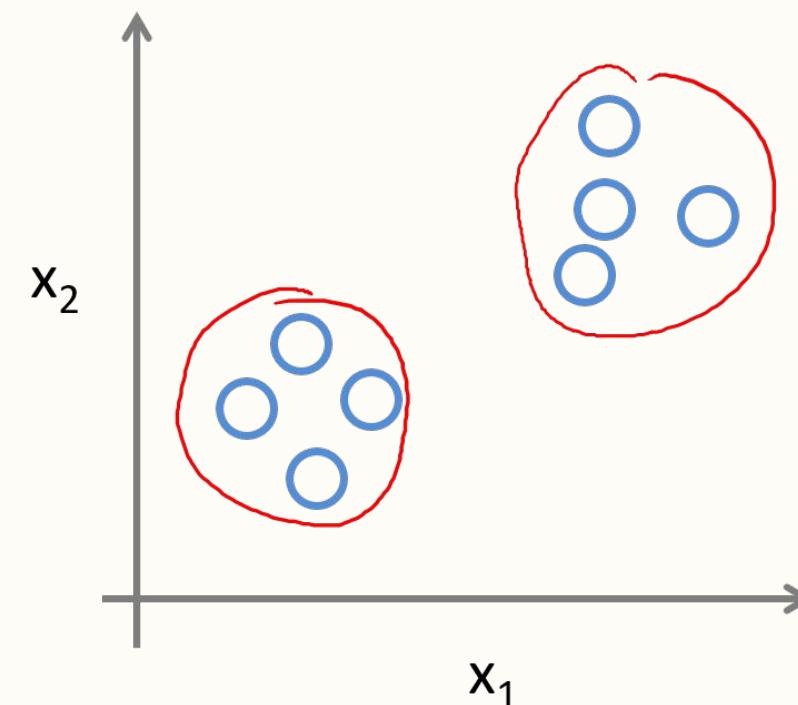
- **Feedback available to the learning system**
- **Application of the desired system**

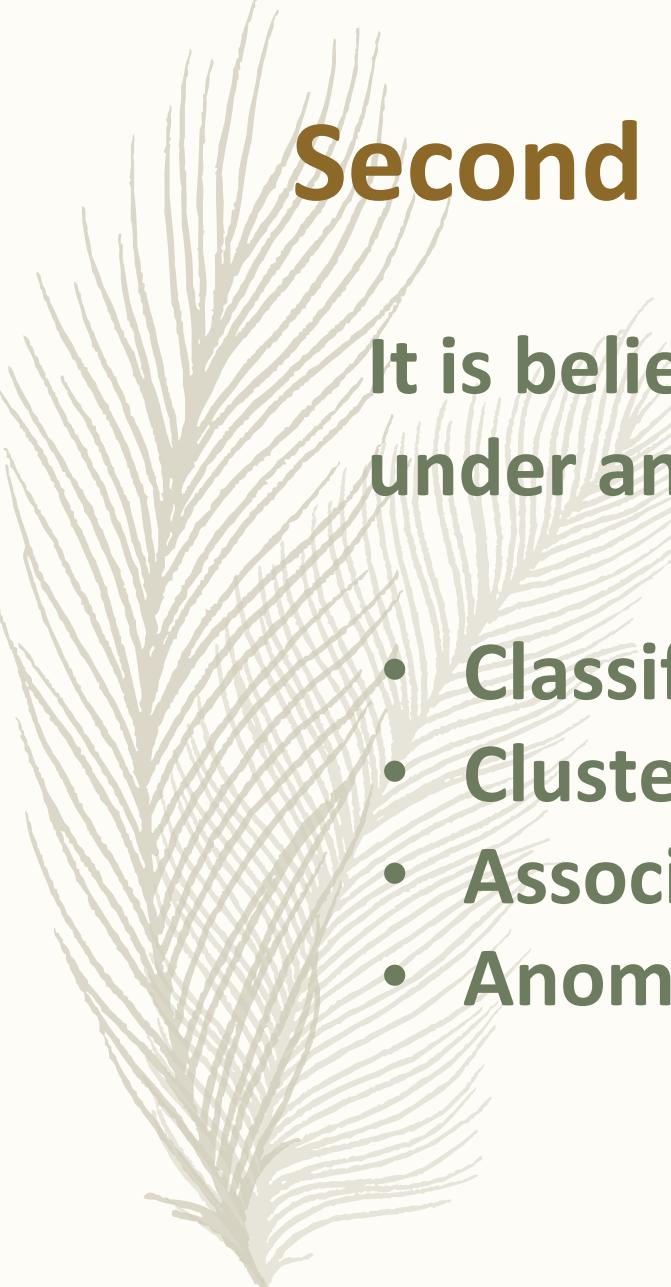
# ML Tasks classified Based on Feedback Available

Supervised Learning



Unsupervised Learning





# **Second Classification**

**It is believed that all machine learning tasks fall under any of the following:**

- **Classification**
- **Clustering**
- **Association Rule Discovery**
- **Anomaly Detection**

# Classification



701.jpg



702.jpg



703.jpg



704.jpg



705.jpg



706.jpg



707.jpg



708.jpg



709.jpg



710.jpg



711.jpg



712.jpg



713.jpg



714.jpg



715.jpg



716.jpg



717.jpg



718.jpg

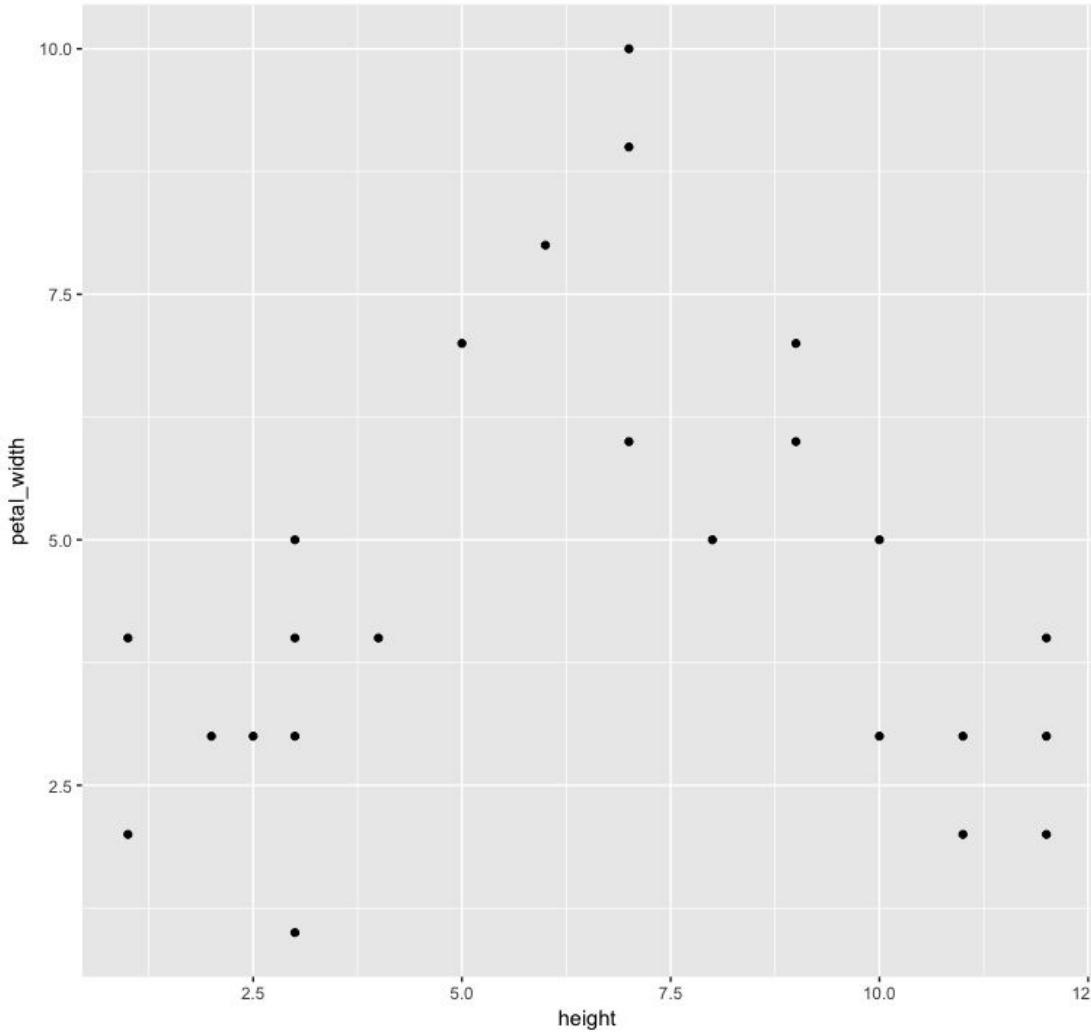


# Computer, what is this?

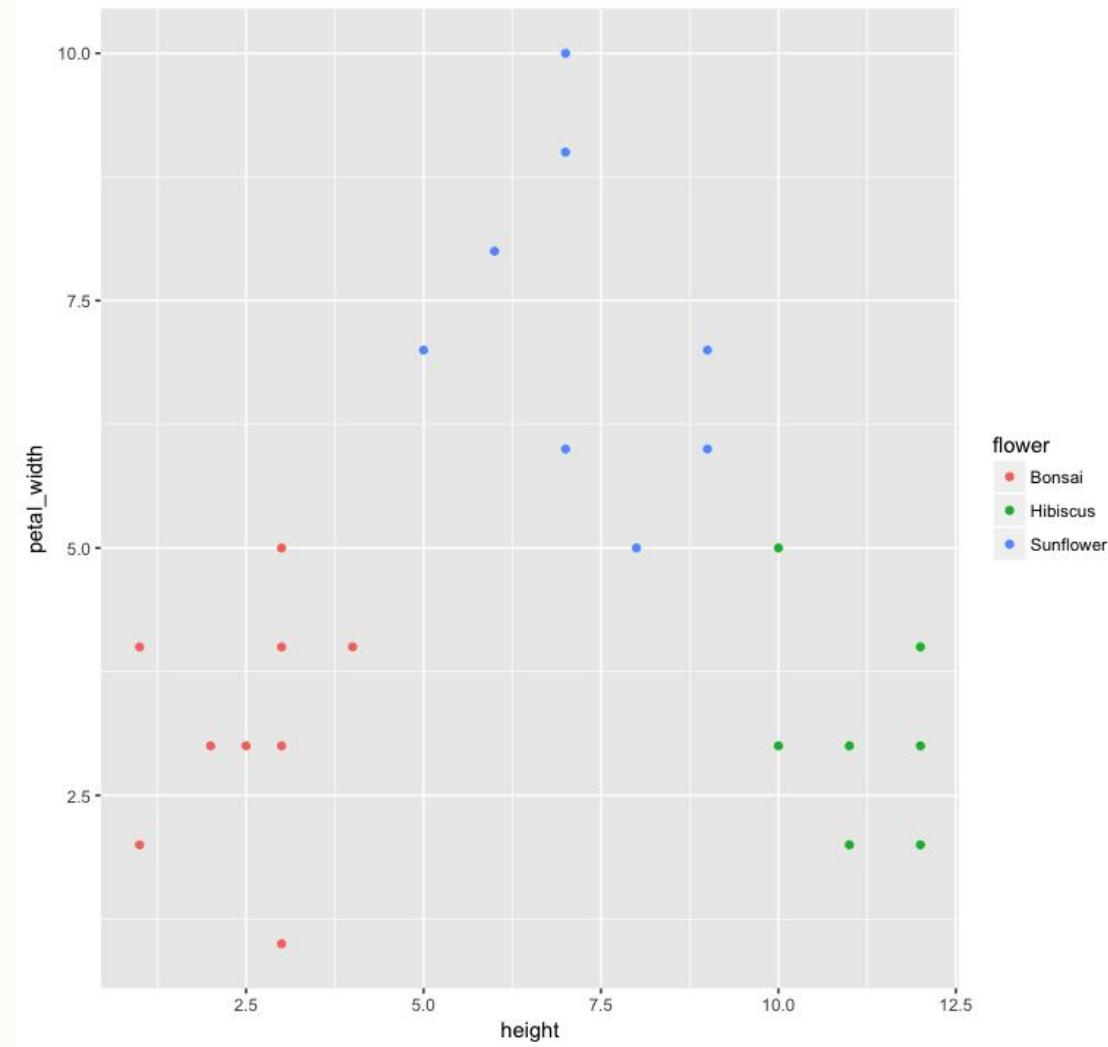
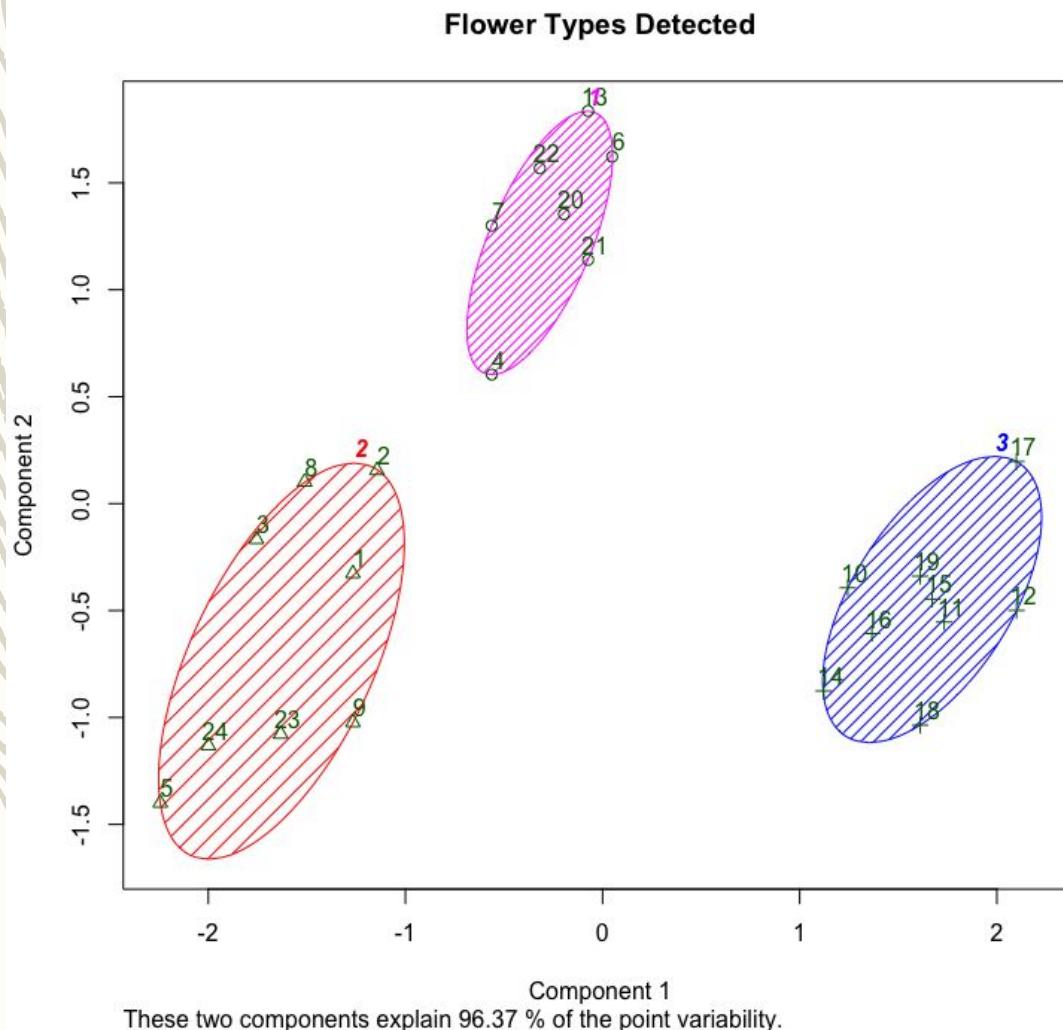




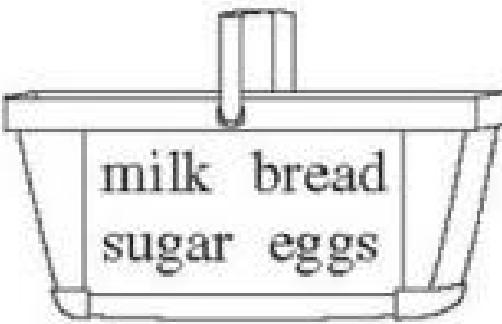
# Clustering



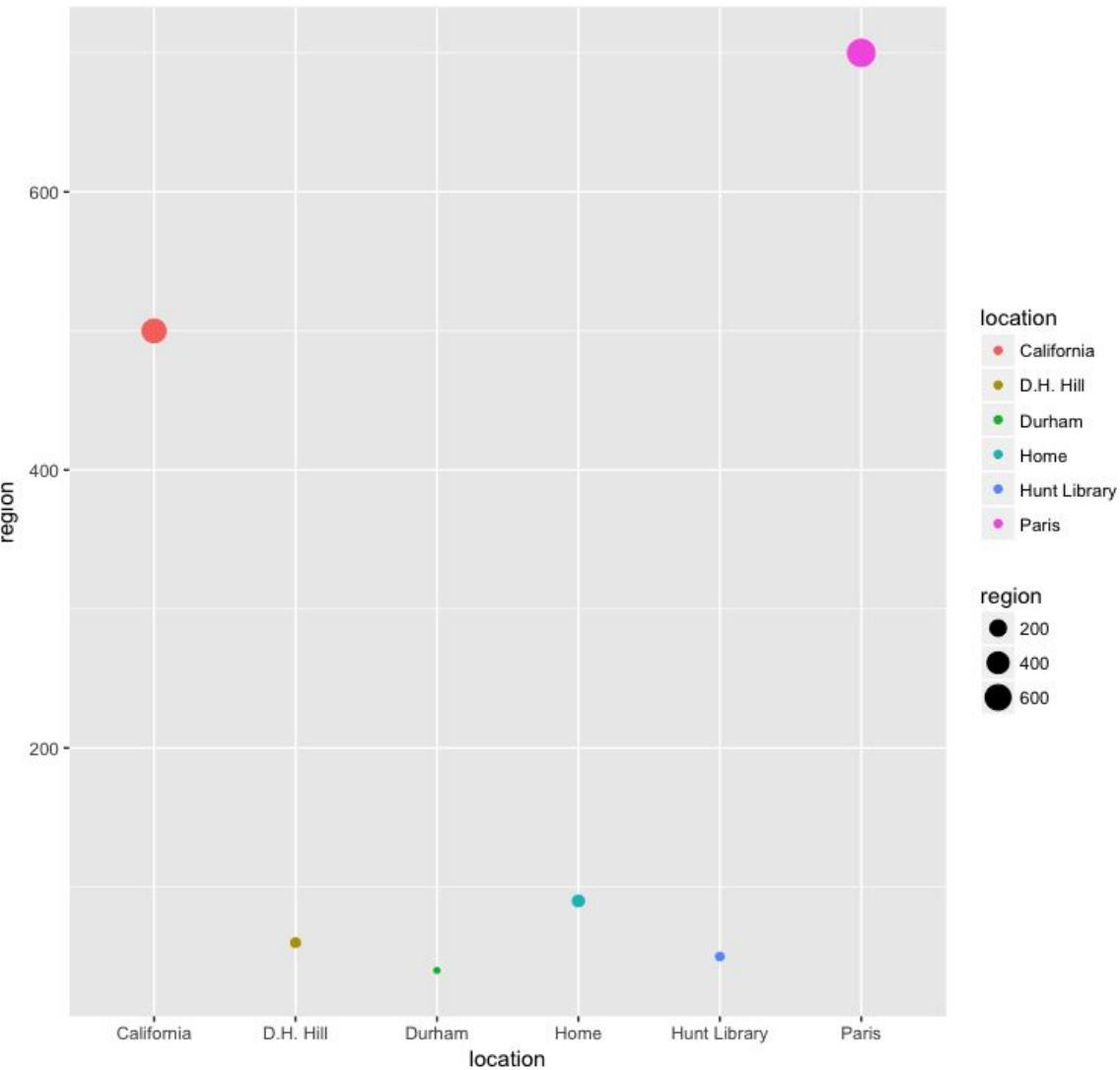
# Using KMeans Clustering Algorithm



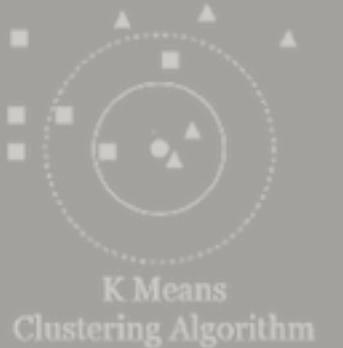
# Association Rule Mining



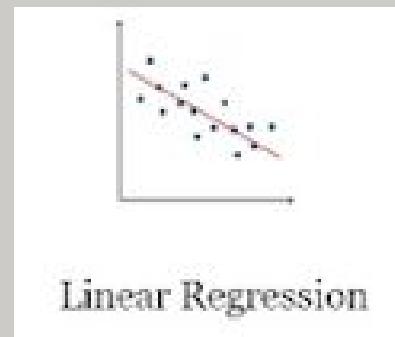
# Deviation Detection



# ML Algorithms



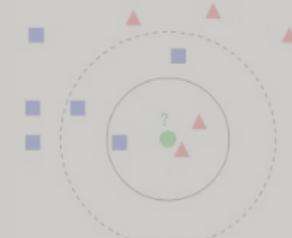
Artificial  
Neural Networks



MARKET BASKET ANALYSIS



Apriori Algorithm





# Main Processes Involved

- Get data
- Preprocess (Clean, Prepare, Manipulate Data & Exploratory Data Analysis)
- Train Model
- Test Model
- Post-Process (Visualize, Evaluate, Improve Model & Present)

# Get Data

- Flat Files



- Excel Files



- Statistical Software



- Databases



- Data from the Web



# Cleaning Data

Compare the following tables:

*Journal of Statistical Software*

	treatmenta	treatmentb
John Smith	—	2
Jane Doe	16	11
Mary Johnson	3	1

Table 1: Typical presentation dataset.

	John Smith	Jane Doe	Mary Johnson
treatmenta	—	16	3
treatmentb	2	11	1

Table 2: The same data as in Table 1 but structured differently.

person	treatment	result
John Smith	a	—
Jane Doe	a	16
Mary Johnson	a	3
John Smith	b	2
Jane Doe	b	11
Mary Johnson	b	1

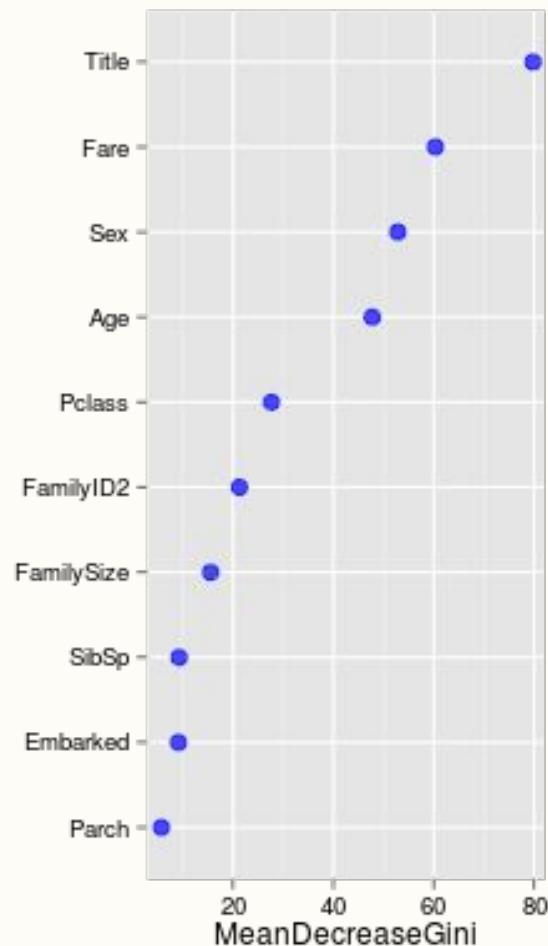
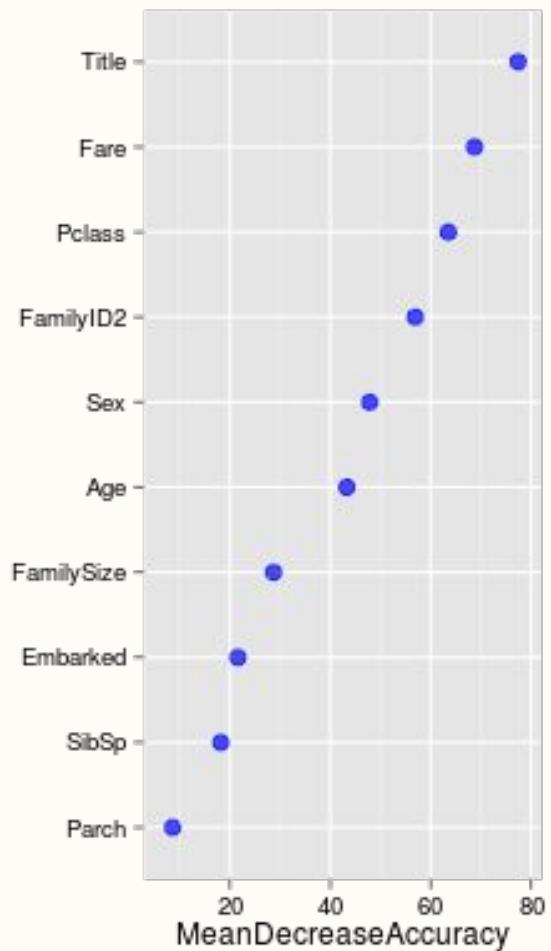
Table 3: The same data as in Table 1 but with variables in columns and observations in rows.

# Checking Data Quality





# Dimensionality reduction & Feature Engineering





# Dimensionality reduction & Feature Engineering

Name	Sex
Braund, Mr. Owen Harris	male
Cumings, Mrs. John Bradley (Florence Briggs Thayer)	female
Heikkinen, Miss. Laina	female
Futrelle, Mrs. Jacques Heath (Lily May Peel)	female
Allen, Mr. William Henry	male
Moran, Mr. James	male
McCarthy, Mr. Timothy J	male
Palsson, Master. Gosta Leonard	male
Johnson, Mrs. Oscar W (Elisabeth Vilhelmina Berg)	female
Nasser, Mrs. Nicholas (Adele Achem)	female
Sandstrom, Miss. Marguerite Rut	female
Bonnell, Miss. Elizabeth	female
Saundercock, Mr. William Henry	male
Andersson, Mr. Anders Johan	male



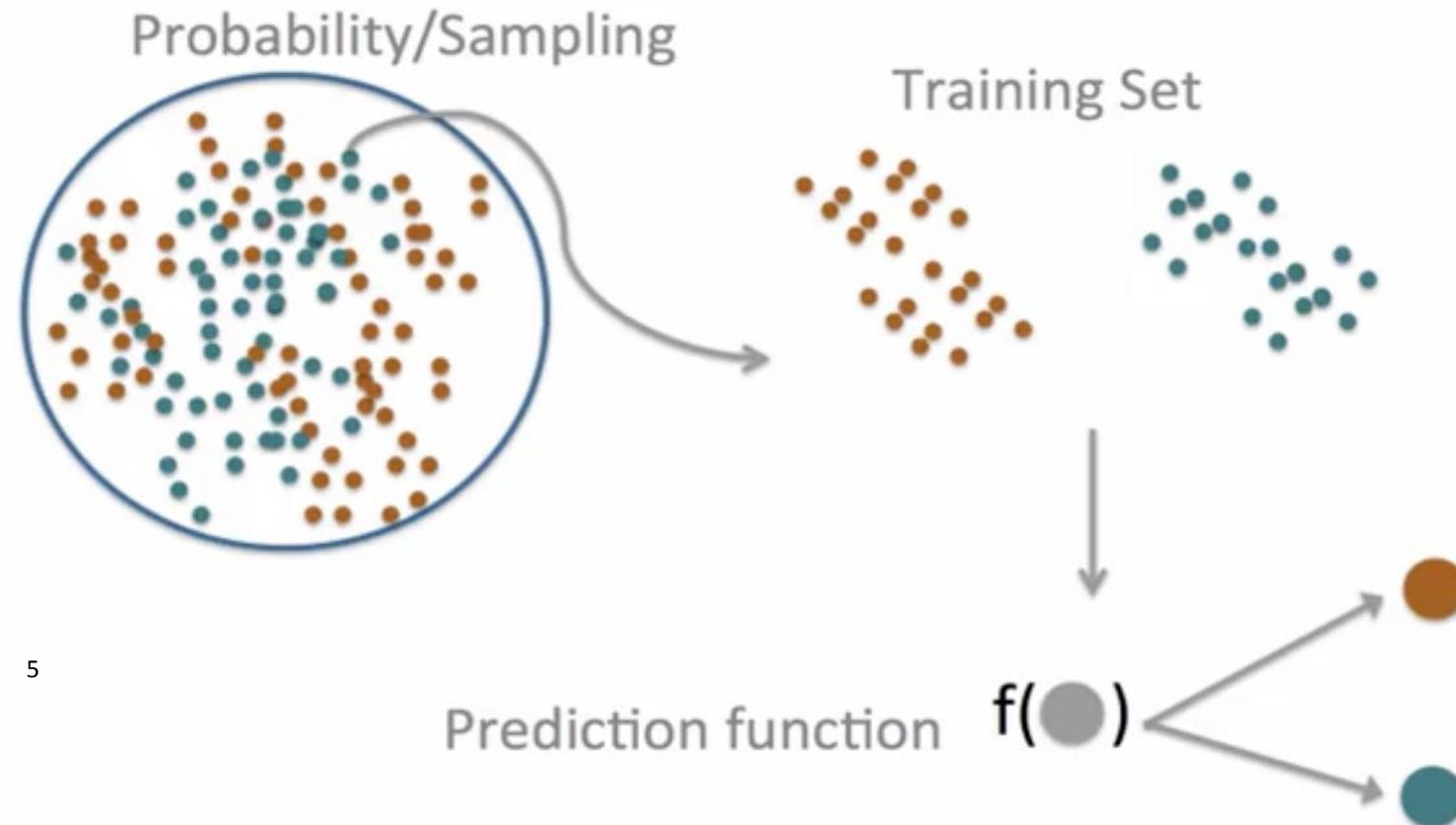
# Main Processes Involved

Get data diagram... excel DNA sequence audio into R

- Get data
- Preprocess (Clean, Prepare, Manipulate Data & Exploratory Data Analysis)
- Train Model
- Test Model
- Post-Process (Visualize, Evaluate, Improve Model & Present)



# Train Model



5

# Test Model





# Main Processes Involved

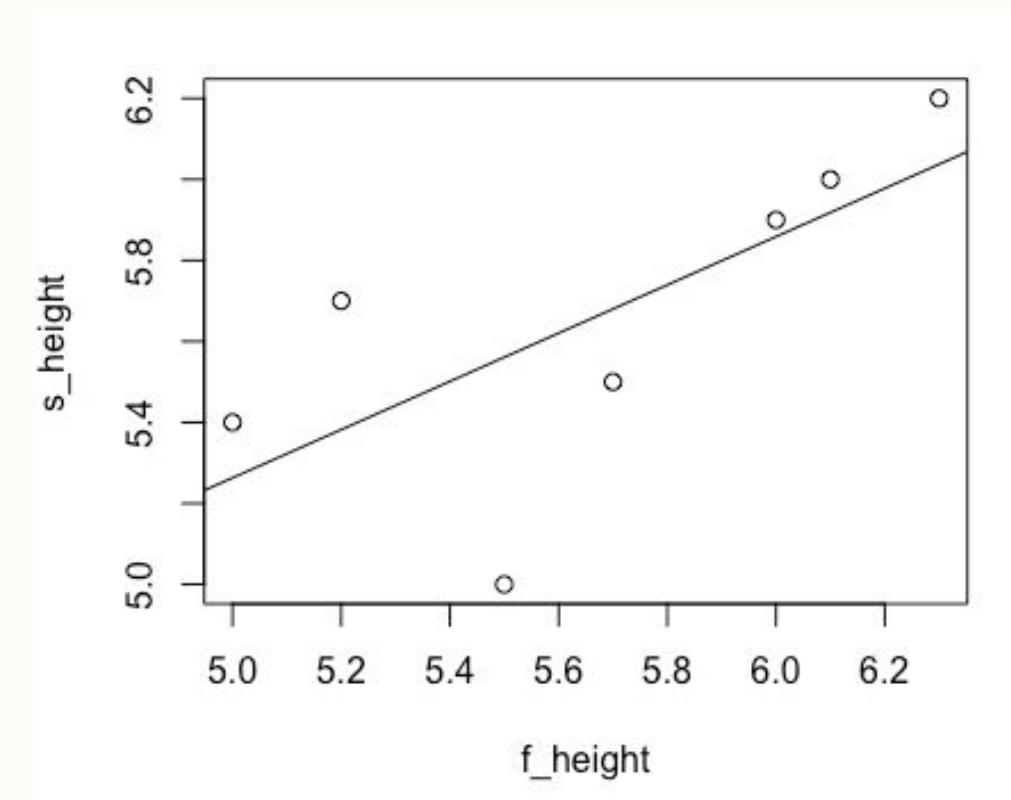
- Get data
- Preprocess (Clean, Prepare, Manipulate Data & Exploratory Data Analysis)
- Train Model
- Test Model
- Post-Process (Visualize, Evaluate, Improve Model & Present)

# Hands-on Exercises

## Exercise 1: Does Money Buy Happiness?

Correlation Between Salary and Employee Satisfaction

	f_height	s_height
1	5.5	5.0
2	5.7	5.5
3	5.0	5.4
4	5.2	5.7
5	6.0	5.9
6	6.1	6.0
7	6.3	6.2



Regression modelling is used to find equations that fit data

- $y = a + bx$

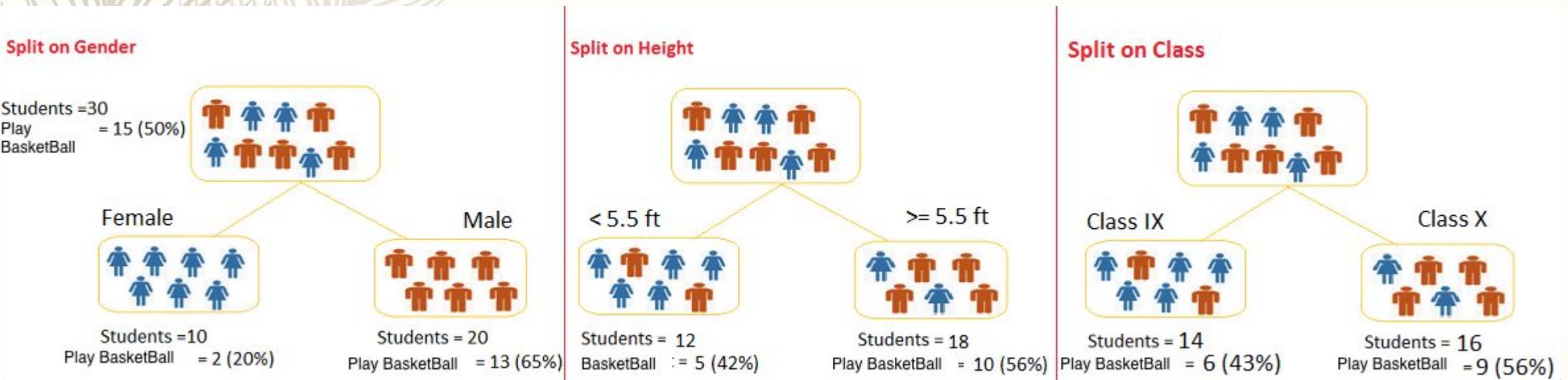
[Link to R and Python Code](#)

# Hands-on Exercises

## Exercise 2:

Predict Wage based on age, education, job class

### Random Forest Algorithm



[Link to R and Python Code](#)