Data Mining

Prof. Mauricio Araya
mauricio.araya@usm.cl
Of. B339 +56 32 2654207

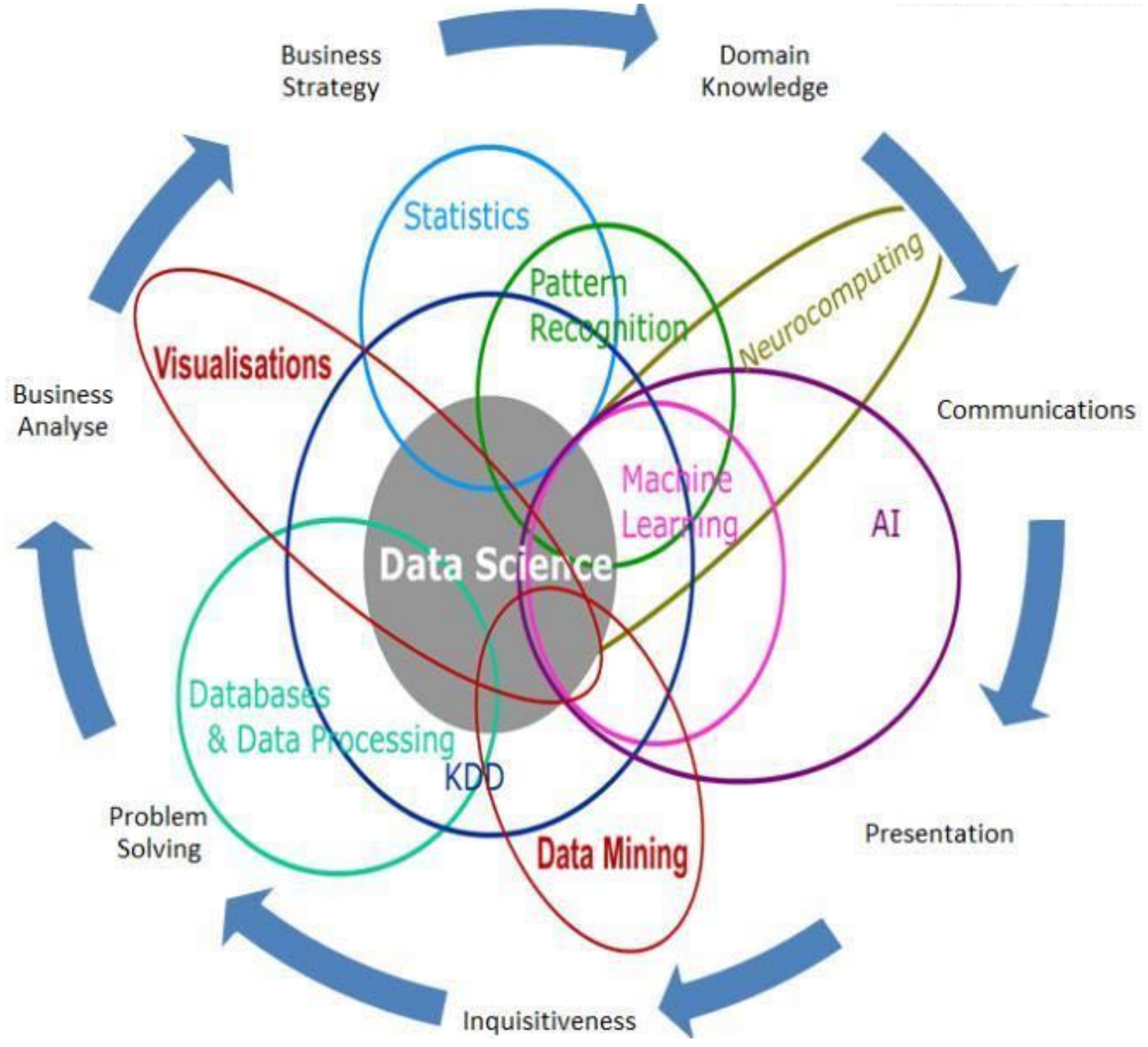
Un par de preguntas

https://www.menti.com/

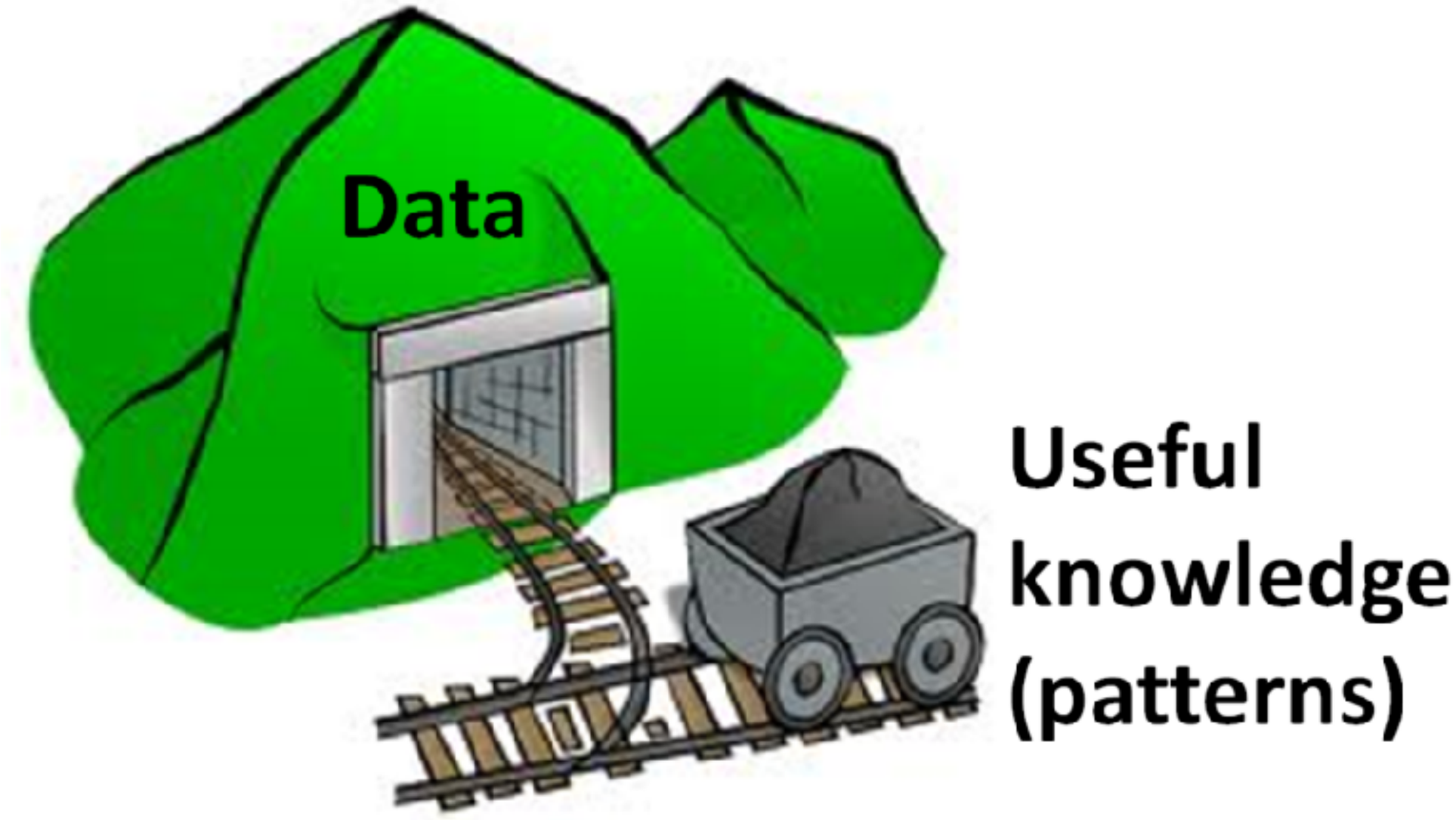
38 08 31

https://www.menti.com/ep1guqopvx

Data Science

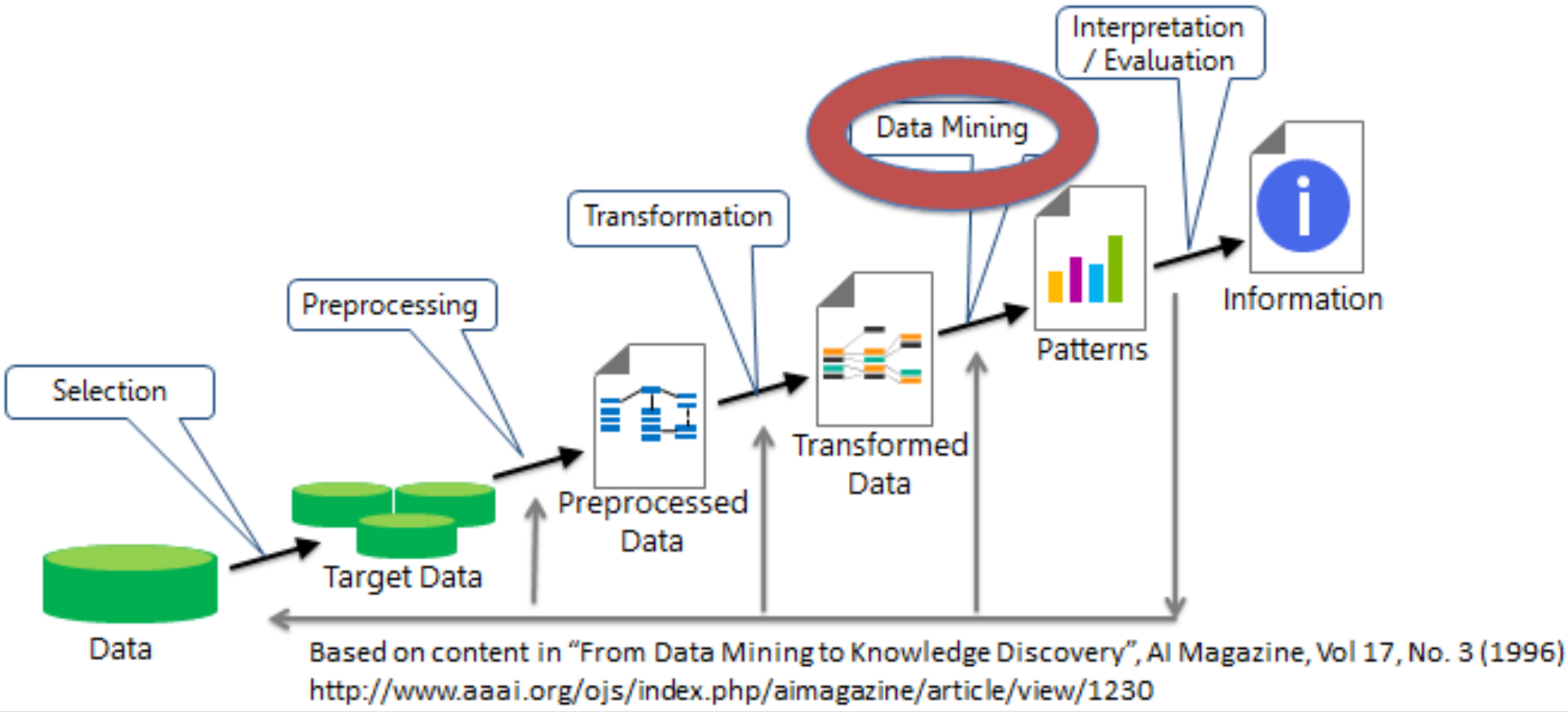


Data Mining (DM)




```
X = np.array([10.9, 5.34, 8.32, 12.43, 20.32, 7.24])
y = np.array([True, False, False, True, True, False])
```

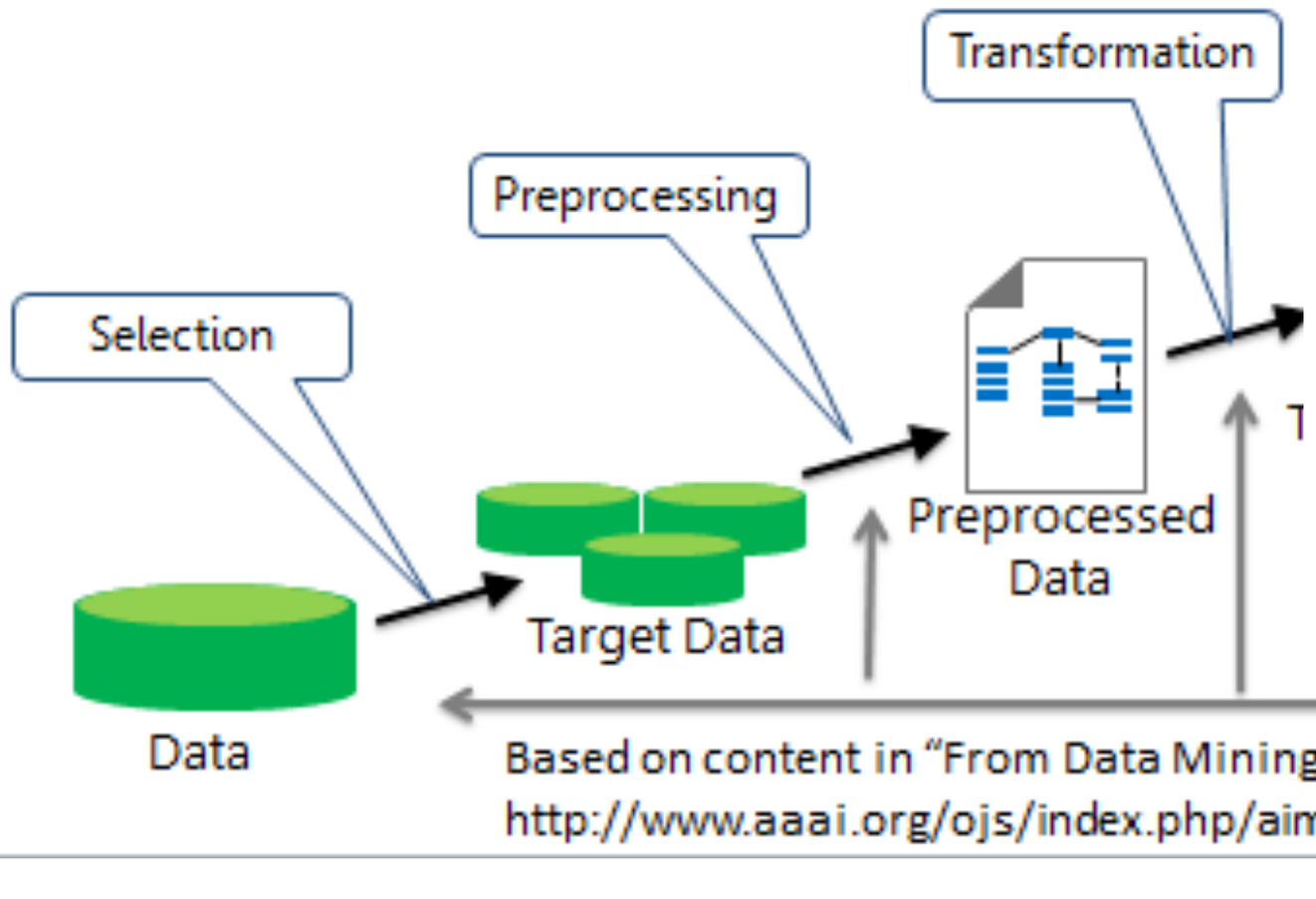
Data Mining & Data Science



Data Mining & Big Data

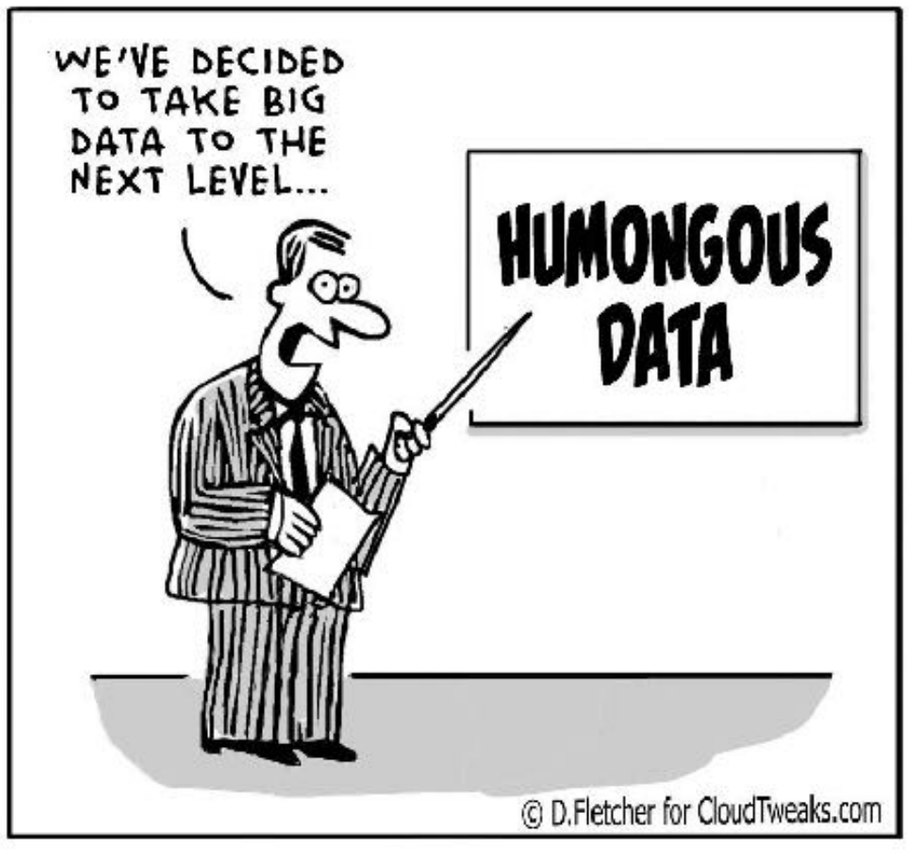
BIG DATA IS LIKE TEENAGE SEX: EVERYONE TALKS ABOUT IT, NOBODY REALLY KNOWS HOW TO DO IT, EVERYONE THINKS EVERYONE ELSE IS DOING IT, SO EVERYONE CLAIMS THEY ARE DOING IT...

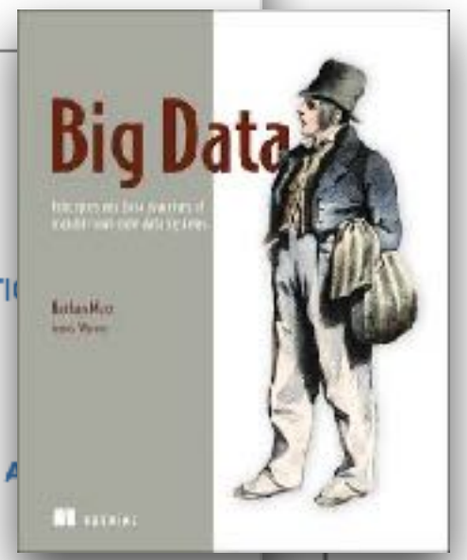
DAN ARIELY



Based on content in "From Data Mining to Knowledge Discovery", AI Magazine, Vol 17, No. 3 (19
http://www.aaai.org/ojs/index.php/aimagazine/article/view/1230

Data Mining & Big Data





Transforma

ation

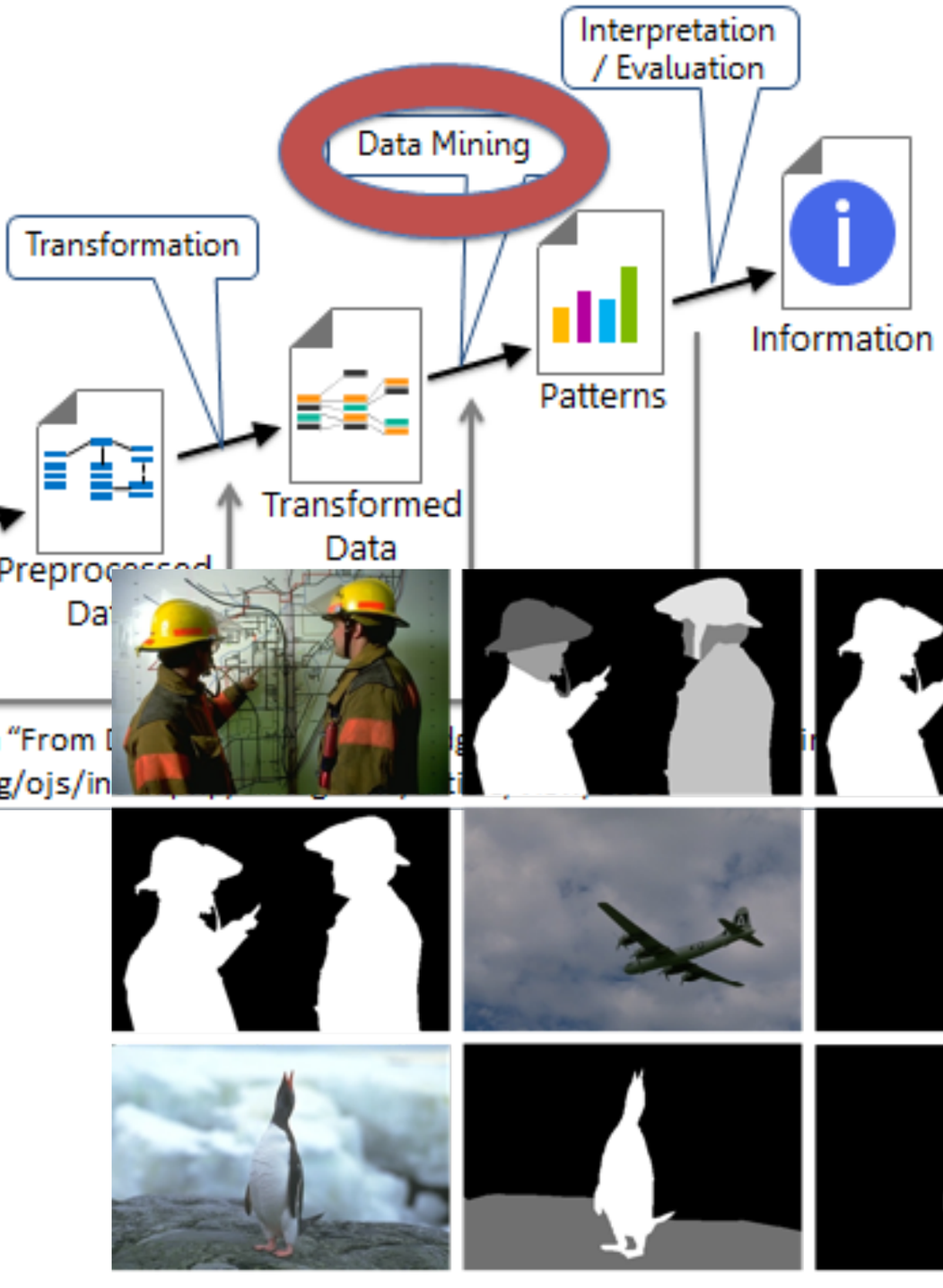
eprocesse
Data

rom Data

ol 17, No. 3 (19

ojs/index.php/aimagazine/article/view/1230

Pattern Recognition (PR)



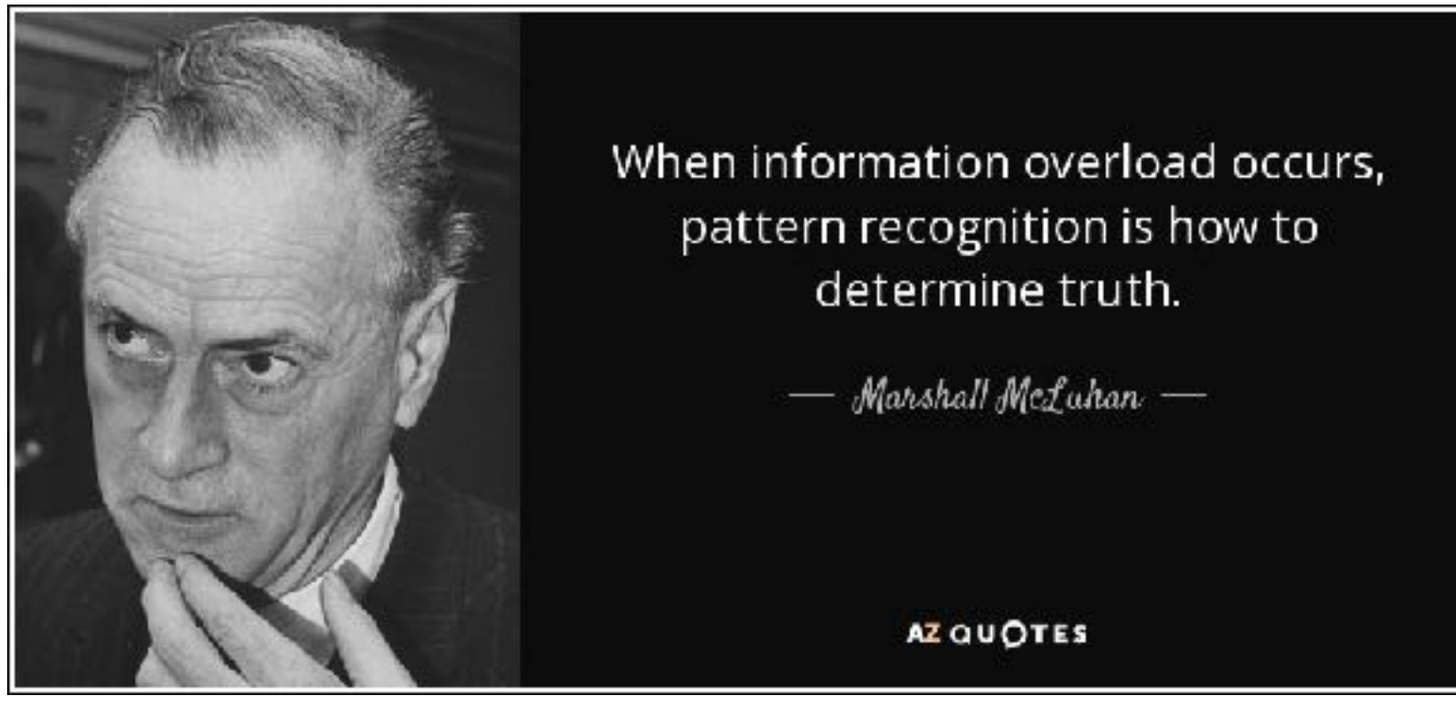
$$f(x) = \begin{cases} True & \text{if } x > 10 \\ False & \text{else} \end{cases}$$

PR + DM

$$f(x) = \begin{cases} True & \text{if } x > 10 \\ False & \text{else} \end{cases}$$

```
def reactive_agent(x):
    if x > 10.0:
        return True
    else:
        return False
```

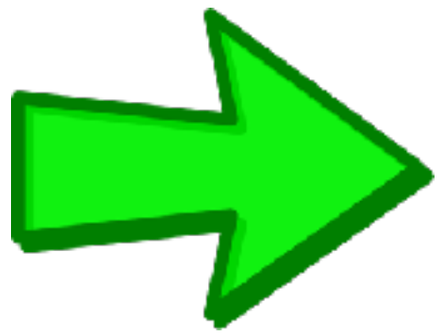
```
X = np.array([10.9, 5.34, 8.32, 12.43, 20.32, 7.24])
y = np.array([True, False, False, True, True, False])
```

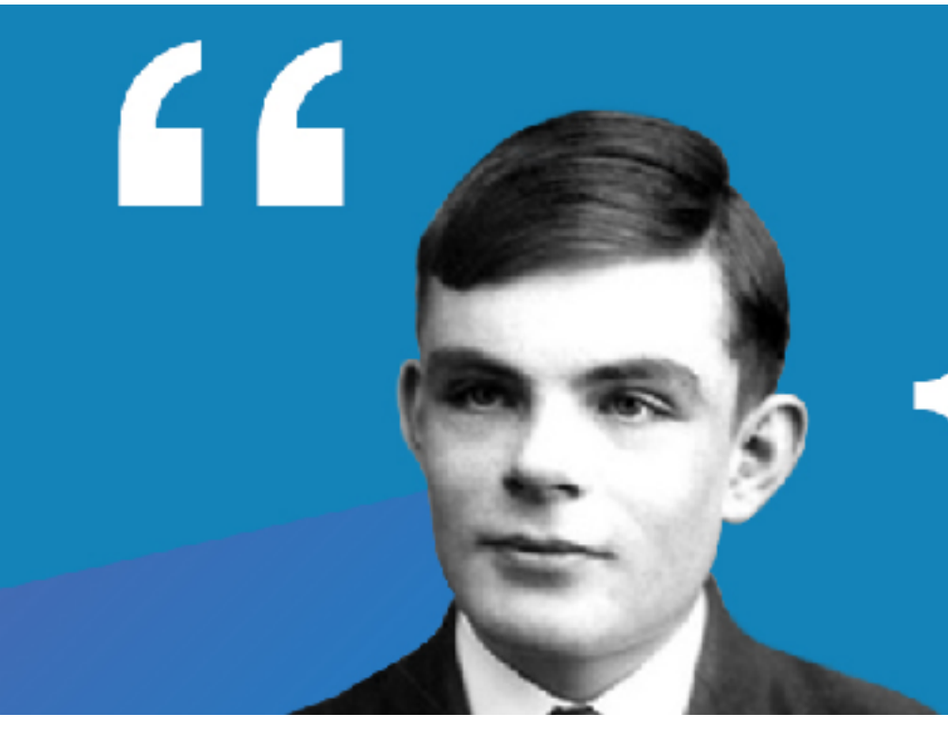


Machine Learning (ML)

```
X = np.array([10.9, 5.34, 8.32, 12.43, 20.32, 7.24])
y = np.array([True, False, False, True, True, False])
```

```
def reactive_agent(...):
    ... 10 ...
        ... True
    ...
        return False
```

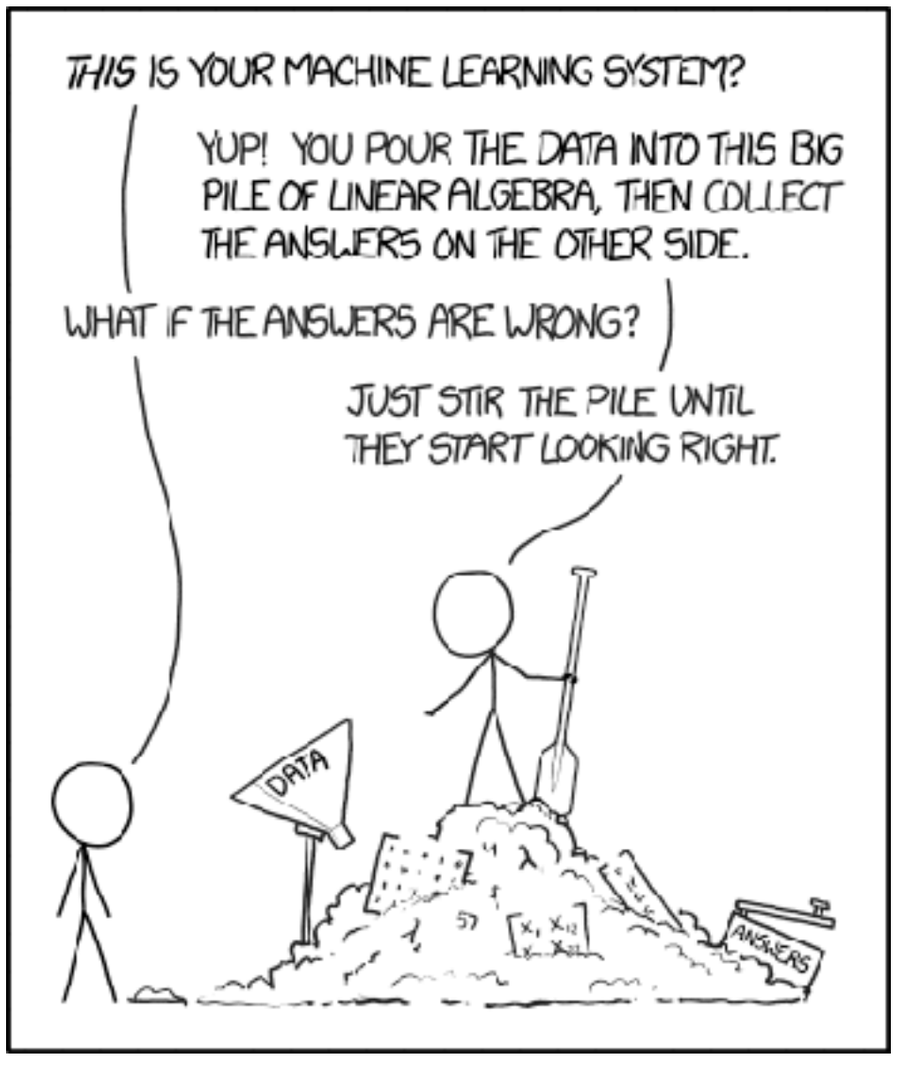


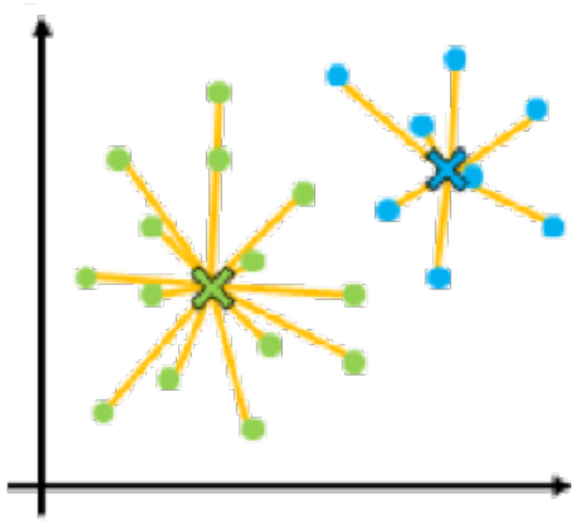


> ...what we want is a machine that can learn from experience.
>
> Alan Turing, 1947

Machine Learning (ML)

```
X = np.array([10.9, 5.34, 8.32, 12.43, 20.32, 7.24])
y = np.array([True, False, False, True, True, False])
```





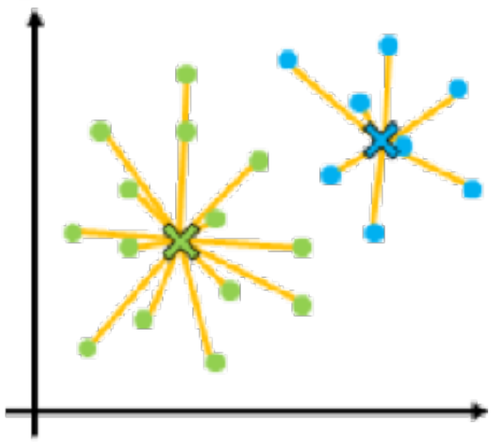
$$\mu_T = \sum_{x \in T} \frac{x}{|T|}$$

$$\mu_F = \sum_{x \in F} \frac{x}{|F|}$$

$$f(x) = \begin{cases} T & \text{if } |\mu_T - x| < |\mu_F - x| \\ F & \text{else} \end{cases}$$

Machine Learning (ML)

```
X = np.array([10.9, 5.34, 8.32, 12.43, 20.32, 7.24])
y = np.array([True, False, False, True, True, False])
```



$$\mu_T = \sum_{x \in T} \frac{x}{|T|}$$

$$\mu_F = \sum_{x \in F} \frac{x}{|F|}$$

$$f(x) = \begin{cases} T & \text{if } |\mu_T - x| < |\mu_F - x| \\ F & \text{else} \end{cases}$$

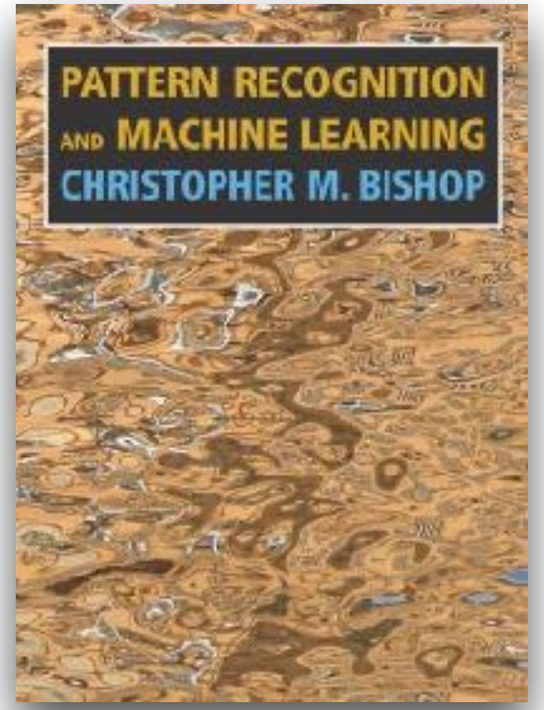
$$S = \frac{\mu_T + \mu_F}{2}$$

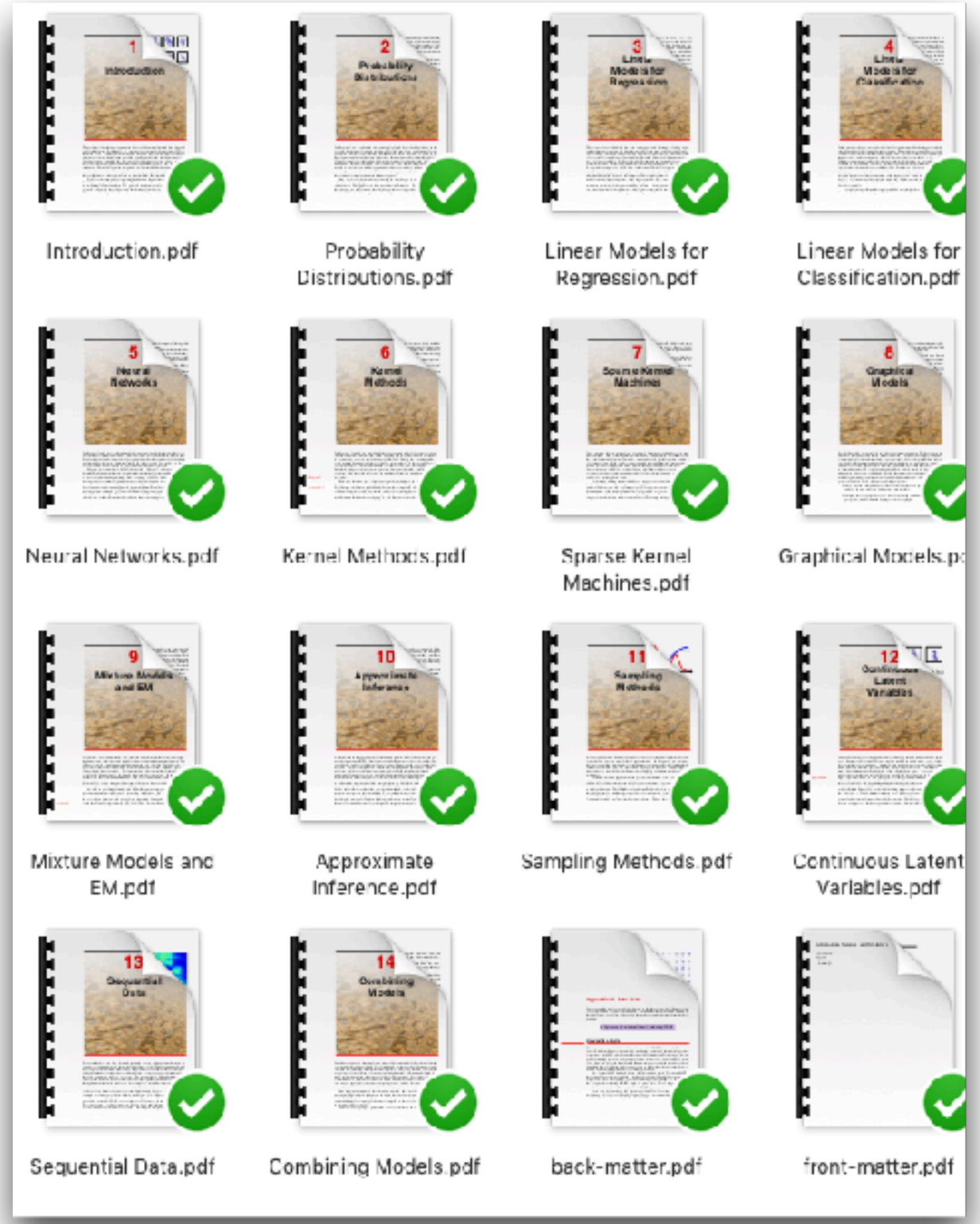
```
def learning_agent(x,Data,labels):
    v_true  = np.mean(Data[labels==True])
    v_false = np.mean(Data[labels==False])
    d_true  = np.abs(x - v_true)
    d_false  = np.abs(x - v_false)
    if d_true < d_false:
        return True
    else:
        return False
```

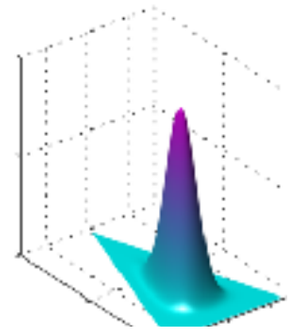
```
(v_true + v_false)/2
```

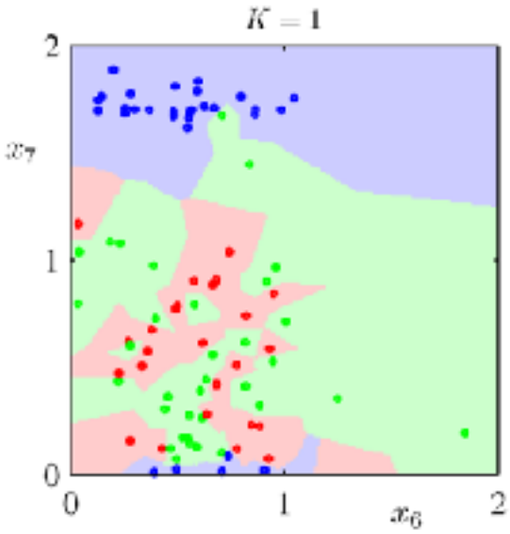
```
10.758333333333333
```

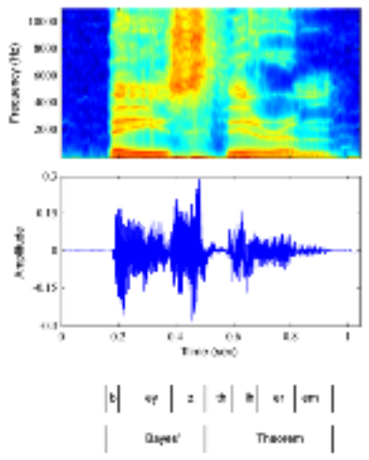
Machine Learning (ML)



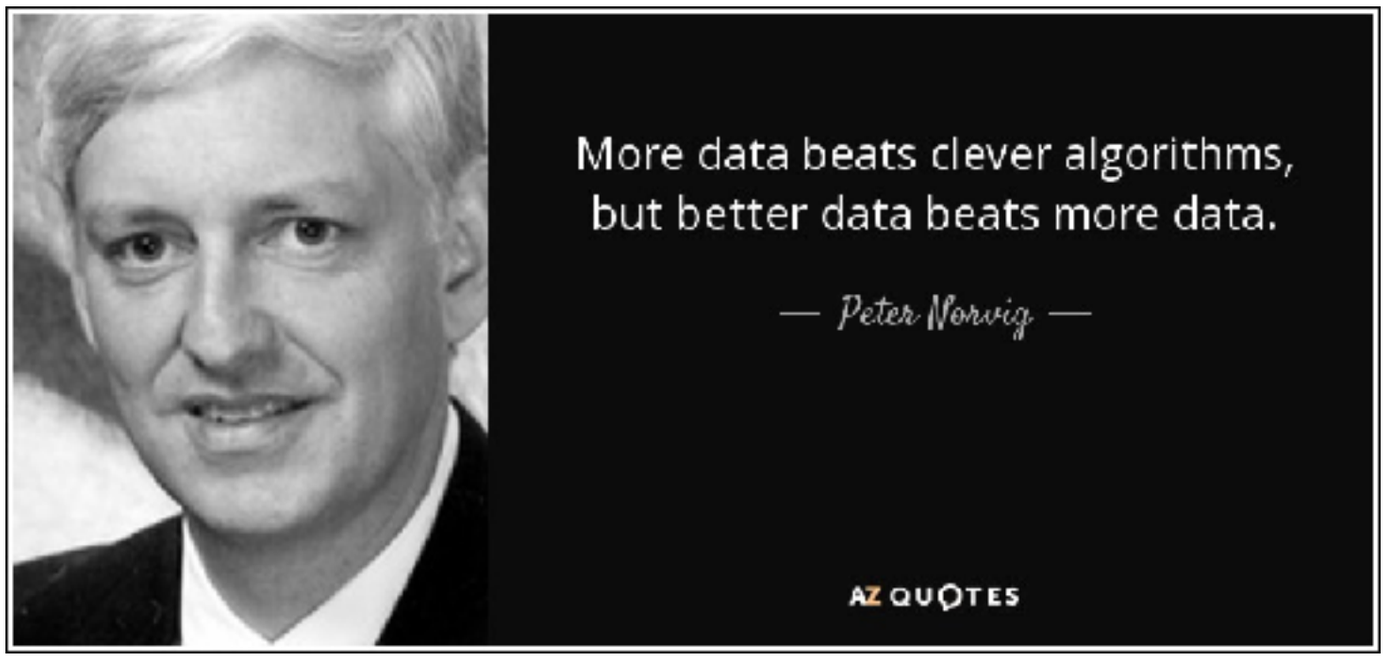


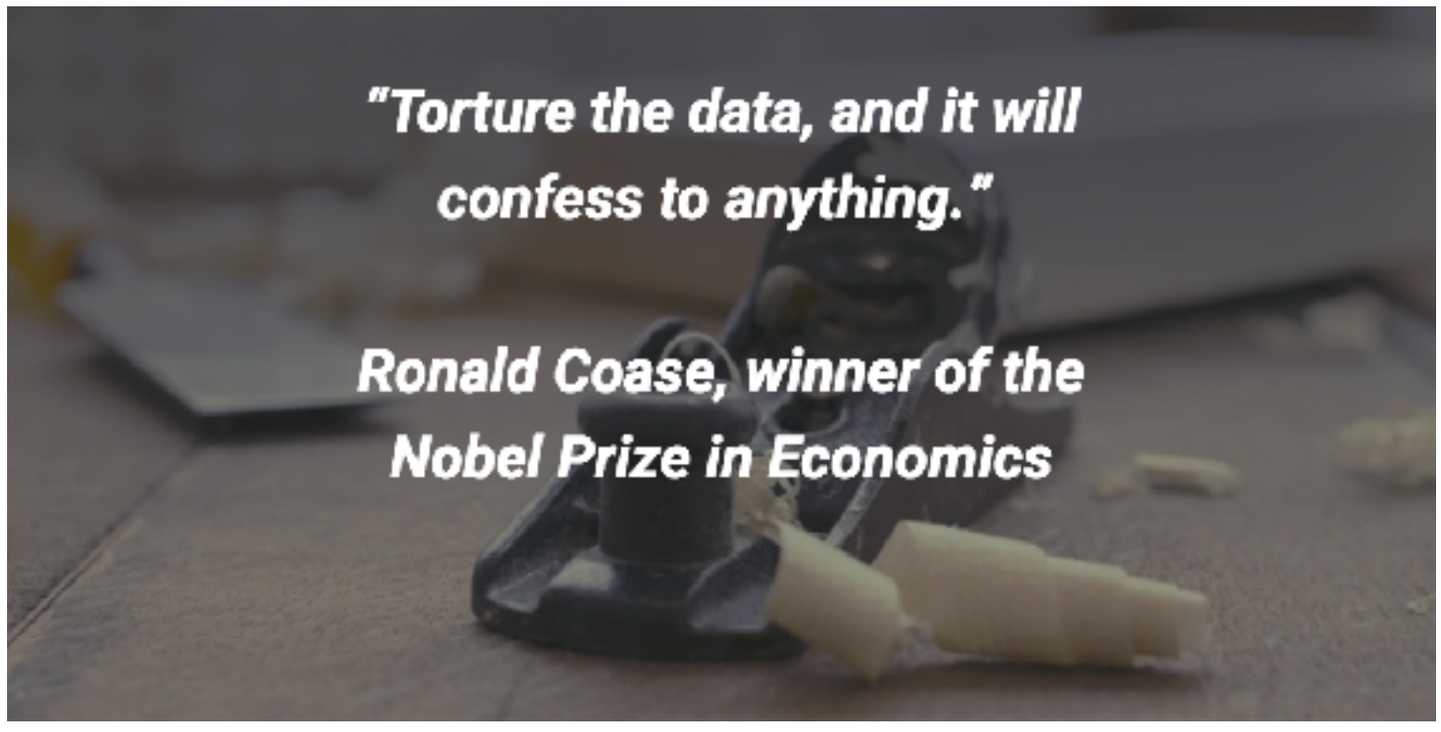




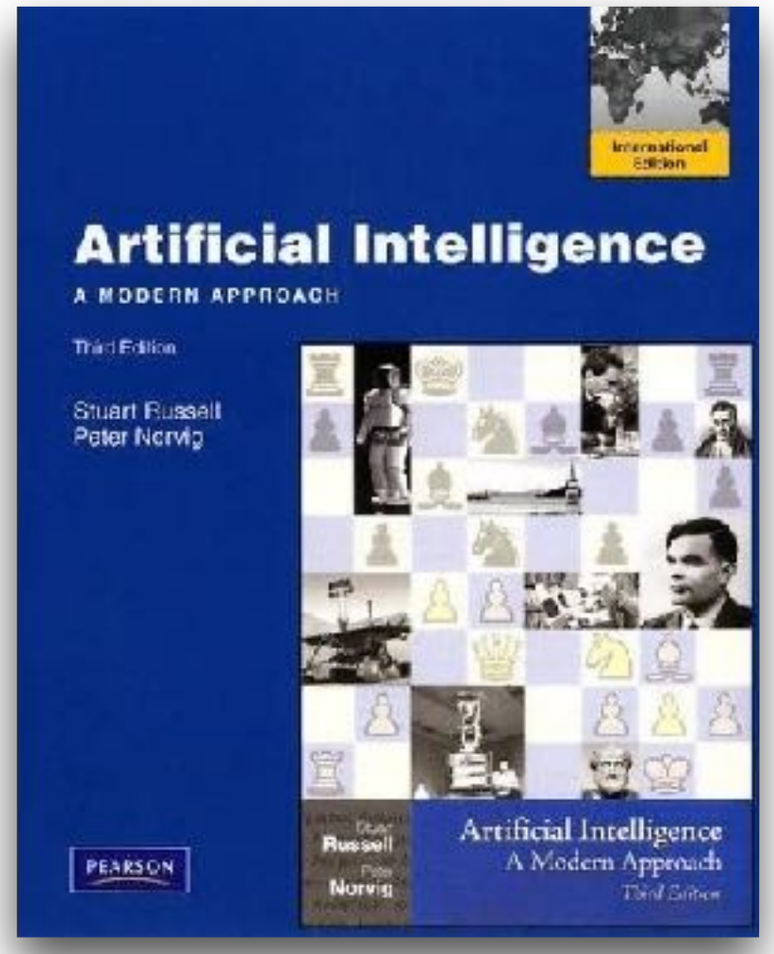


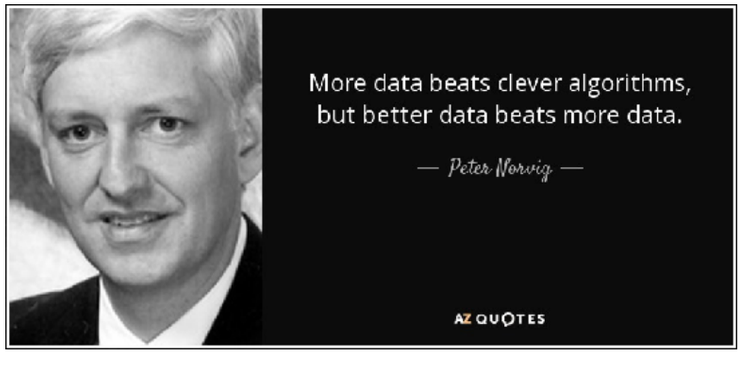
ML + PR + DM


More data beats clever algorithms,
but better data beats more data.
— Peter Norvig —
AZ QUOTES


"Torture the data, and it will
confess to anything."
Ronald Coase, winner of the
Nobel Prize in Economics

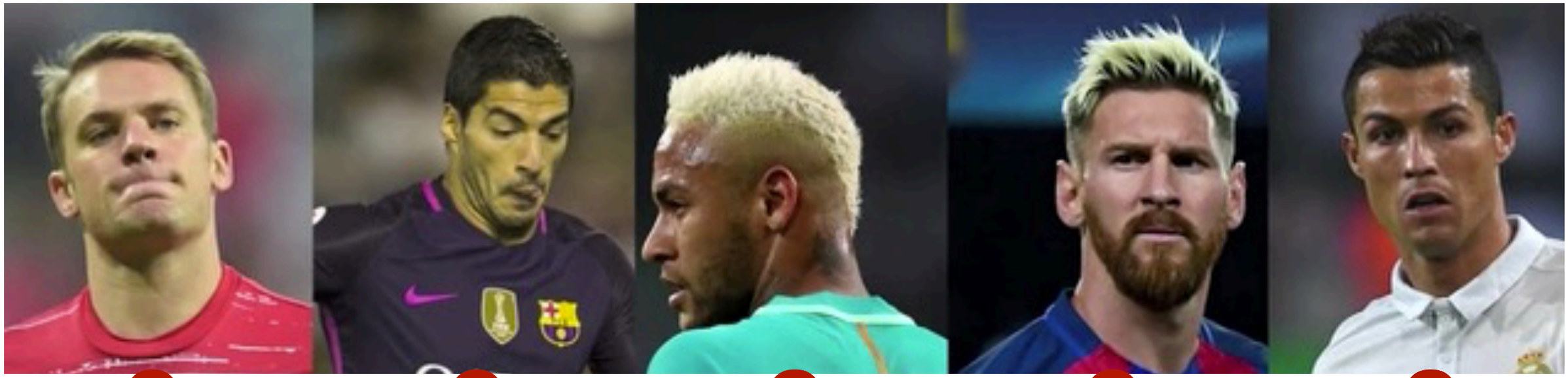
What About AI?





Data

Data



M. Nauer

Age: 31
Nat: Germany
Value: €61M
Overall: 92

L. Suárez

Age: 30
Nat: Uruguay
Value: €97M
Overall: 92

Neymar Jr.

Age: 25
Nat: Brazil
Value: €123M
Overall: 92

L. Messi

Age: 30
Nat: Argentina
Value: €105M
Overall: 93

C. Ronaldo

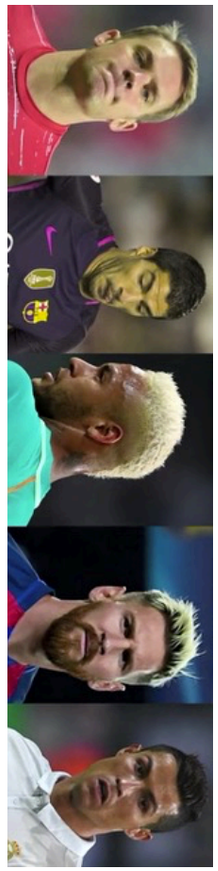
Age: 32
Nat: Portugal
Value: €95.5M
Overall: 94

Data: Features and Samples

Features

Samples

	Name	Age	Nationality	Overall	Potential	Value	Photo
0	Cristiano Ronaldo	32	Portugal	94	94	€95.5M	https://cdn.sofifa.org/48/18/players/20801.png
1	L. Messi	30	Argentina	93	93	€105M	https://cdn.sofifa.org/48/18/players/158023.png
2	Neymar	25	Brazil	92	94	€123M	https://cdn.sofifa.org/48/18/players/190871.png
3	L. Suárez	30	Uruguay	92	92	€97M	https://cdn.sofifa.org/48/18/players/176580.png
4	M. Neuer	31	Germany	92	92	€61M	https://cdn.sofifa.org/48/18/players/167495.png
5	R. Lewandowski	28	Poland	91	91	€92M	https://cdn.sofifa.org/48/18/players/188545.png
6	De Gea	26	Spain	90	92	€64.5M	https://cdn.sofifa.org/48/18/players/193080.png
7	E. Hazard	26	Belgium	90	91	€90.5M	https://cdn.sofifa.org/48/18/players/183277.png
8	T. Kroos	27	Germany	90	90	€79M	https://cdn.sofifa.org/48/18/players/182521.png
9	G. Higuaín	29	Argentina	90	90	€77M	https://cdn.sofifa.org/48/18/players/167664.png
10	Sergio Ramos	31	Spain	90	90	€52M	https://cdn.sofifa.org/48/18/players/155862.png
11	K. De Bruyne	26	Belgium	89	92	€83M	https://cdn.sofifa.org/48/18/players/192985.png
12	T. Courtois	25	Belgium	89	92	€59M	https://cdn.sofifa.org/48/18/players/192119.png
13	A. Sánchez	28	Chile	89	89	€67.5M	https://cdn.sofifa.org/48/18/players/184941.png
14	L. Modrić	31	Croatia	89	89	€57M	https://cdn.sofifa.org/48/18/players/177003.png
15	G. Bale	27	Wales	89	89	€69.5M	https://cdn.sofifa.org/48/18/players/173731.png



Text Int Cat Per Float Complex

TYPES

Potential vs Age

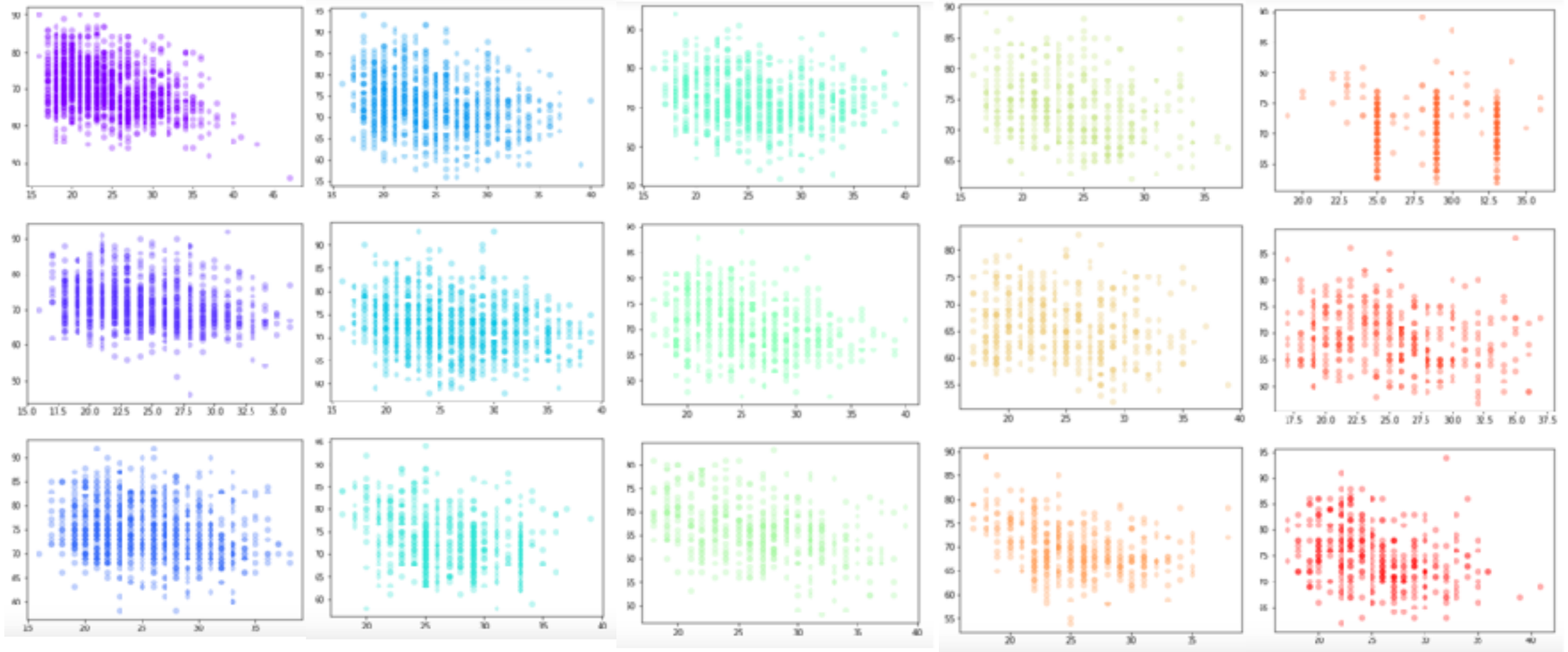
Features

Samples

	Name	Age	Nationality	Overall	Potential	Value	Photo
0	Cristiano Ronaldo	32	Portugal	94	94	€95.5M	https://cdn.sofifa.org/48/18/players/20801.png
1	L. Messi	30	Argentina	93	93	€105M	https://cdn.sofifa.org/48/18/players/158023.png
2	Neymar	25	Brazil	92	94	€123M	https://cdn.sofifa.org/48/18/players/190871.png
3	L. Suárez	30	Uruguay	92	92	€97M	https://cdn.sofifa.org/48/18/players/176580.png
4	M. Neuer	31	Germany	92	92	€61M	https://cdn.sofifa.org/48/18/players/167495.png
5	R. Lewandowski	28	Poland	91	91	€92M	https://cdn.sofifa.org/48/18/players/188545.png
6	De Gea	26	Spain	90	92	€64.5M	https://cdn.sofifa.org/48/18/players/193080.png
7	E. Hazard	26	Belgium	90	91	€90.5M	https://cdn.sofifa.org/48/18/players/183277.png
8	T. Kroos	27	Germany	90	90	€79M	https://cdn.sofifa.org/48/18/players/182521.png
9	G. Higuaín	29	Argentina	90	90	€77M	https://cdn.sofifa.org/48/18/players/167664.png
10	Sergio Ramos	31	Spain	90	90	€52M	https://cdn.sofifa.org/48/18/players/155862.png
11	K. De Bruyne	26	Belgium	89	92	€83M	https://cdn.sofifa.org/48/18/players/192985.png
12	T. Courtois	25	Belgium	89	92	€59M	https://cdn.sofifa.org/48/18/players/192119.png
13	A. Sánchez	28	Chile	89	89	€67.5M	https://cdn.sofifa.org/48/18/players/184941.png
14	L. Modrić	31	Croatia	89	89	€57M	https://cdn.sofifa.org/48/18/players/177003.png
15	G. Bale	27	Wales	89	89	€69.5M	https://cdn.sofifa.org/48/18/players/173731.png

England
Germany
Spain
France
Argentina
Brazil
Italy
Colombia
Japan

Netherlands
Republic of Ireland
United States
Chile
Sweden
Portugal



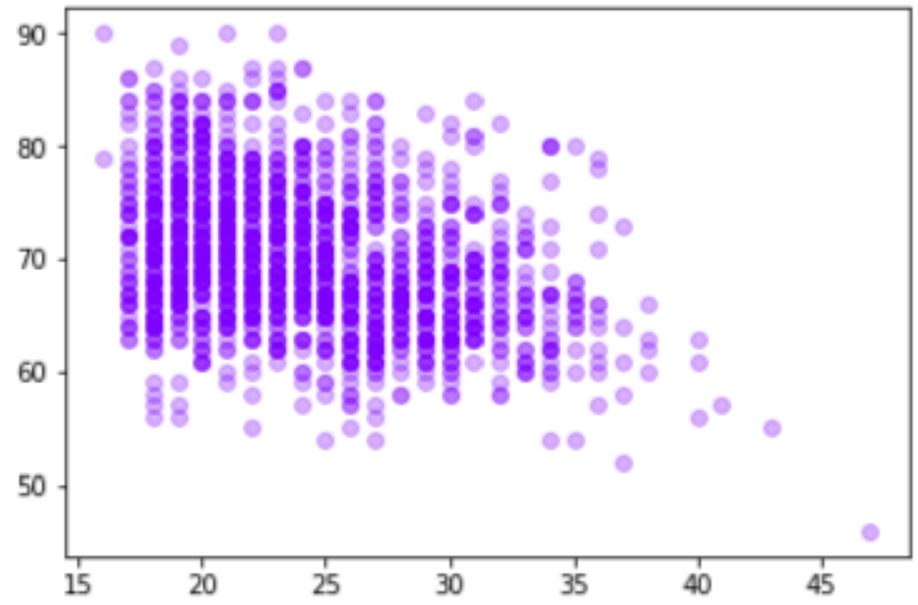
Potential vs Age

Features

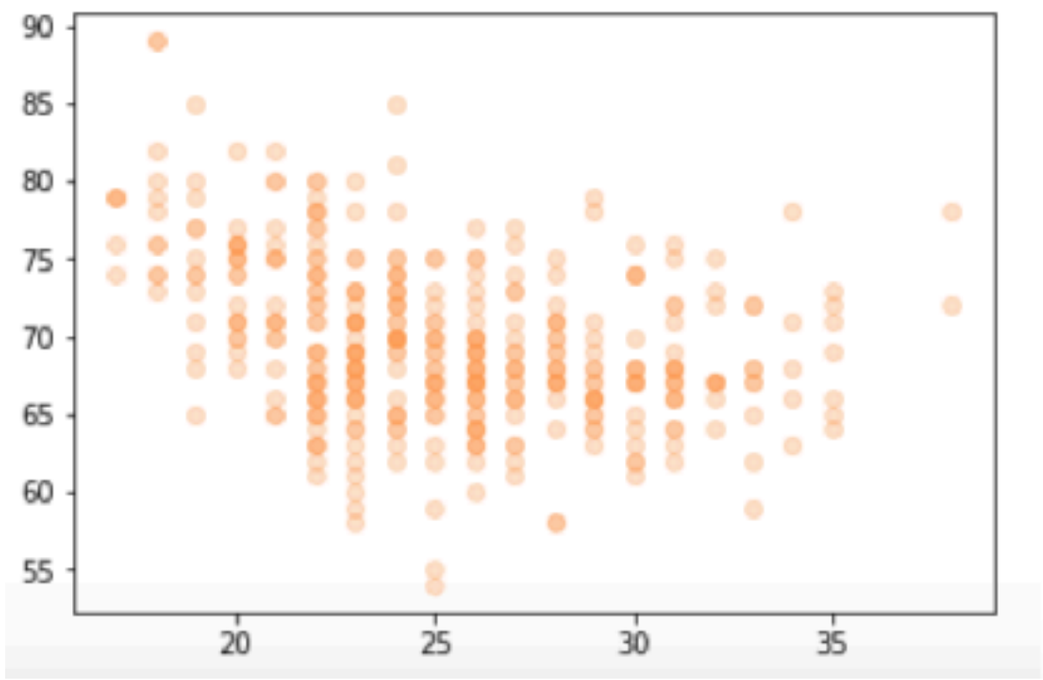
Samples

	Name	Age	Nationality	Overall	Potential	Value	Photo
0	Cristiano Ronaldo	32	Portugal	94	94	€95.5M	https://cdn.sofifa.org/48/18/players/20801.png
1	L. Messi	30	Argentina	93	93	€105M	https://cdn.sofifa.org/48/18/players/158023.png
2	Neymar	25	Brazil	92	94	€123M	https://cdn.sofifa.org/48/18/players/190871.png
3	L. Suárez	30	Uruguay	92	92	€97M	https://cdn.sofifa.org/48/18/players/176580.png
4	M. Neuer	31	Germany	92	92	€61M	https://cdn.sofifa.org/48/18/players/167495.png
5	R. Lewandowski	28	Poland	91	91	€92M	https://cdn.sofifa.org/48/18/players/188545.png
6	De Gea	26	Spain	90	92	€64.5M	https://cdn.sofifa.org/48/18/players/193080.png
7	E. Hazard	26	Belgium	90	91	€90.5M	https://cdn.sofifa.org/48/18/players/183277.png
8	T. Kroos	27	Germany	90	90	€79M	https://cdn.sofifa.org/48/18/players/182521.png
9	G. Higuaín	29	Argentina	90	90	€77M	https://cdn.sofifa.org/48/18/players/167664.png
10	Sergio Ramos	31	Spain	90	90	€52M	https://cdn.sofifa.org/48/18/players/155862.png
11	K. De Bruyne	26	Belgium	89	92	€83M	https://cdn.sofifa.org/48/18/players/192985.png
12	T. Courtois	25	Belgium	89	92	€59M	https://cdn.sofifa.org/48/18/players/192119.png
13	A. Sánchez	28	Chile	89	89	€67.5M	https://cdn.sofifa.org/48/18/players/184941.png
14	L. Modrić	31	Croatia	89	89	€57M	https://cdn.sofifa.org/48/18/players/177003.png
15	G. Bale	27	Wales	89	89	€69.5M	https://cdn.sofifa.org/48/18/players/173731.png

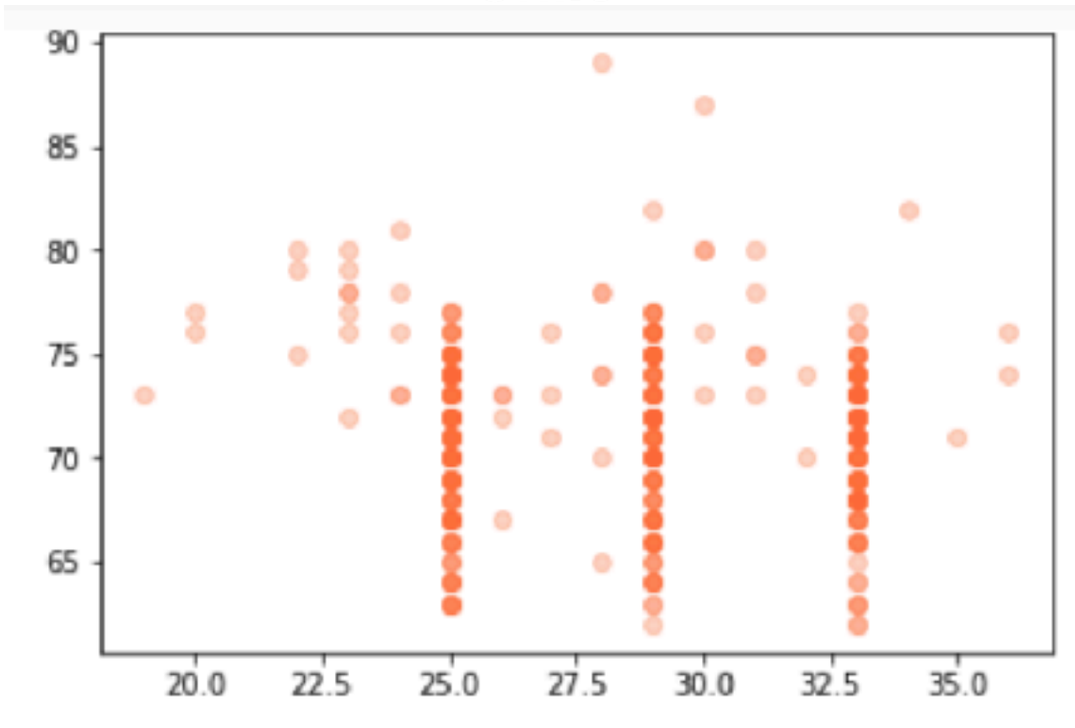
England



United States



Chile

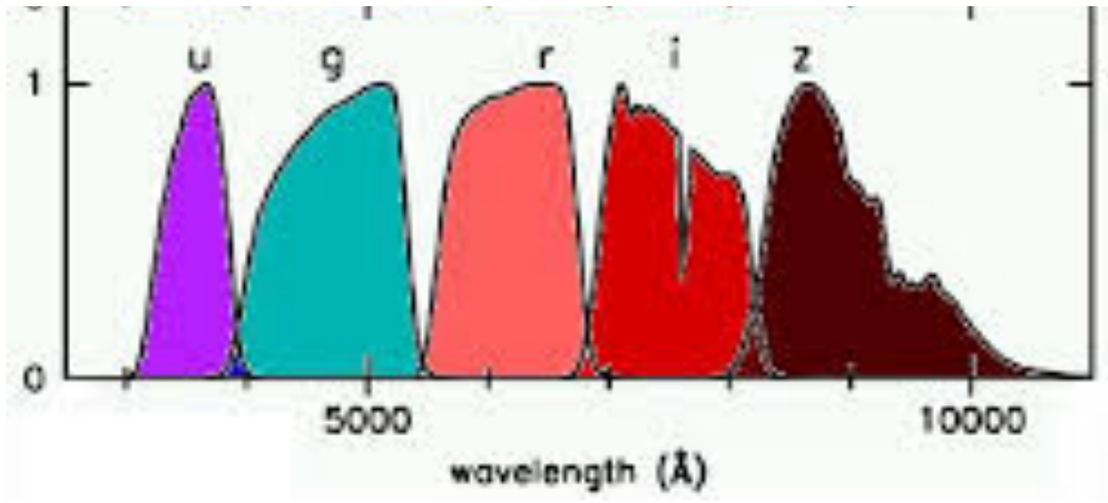


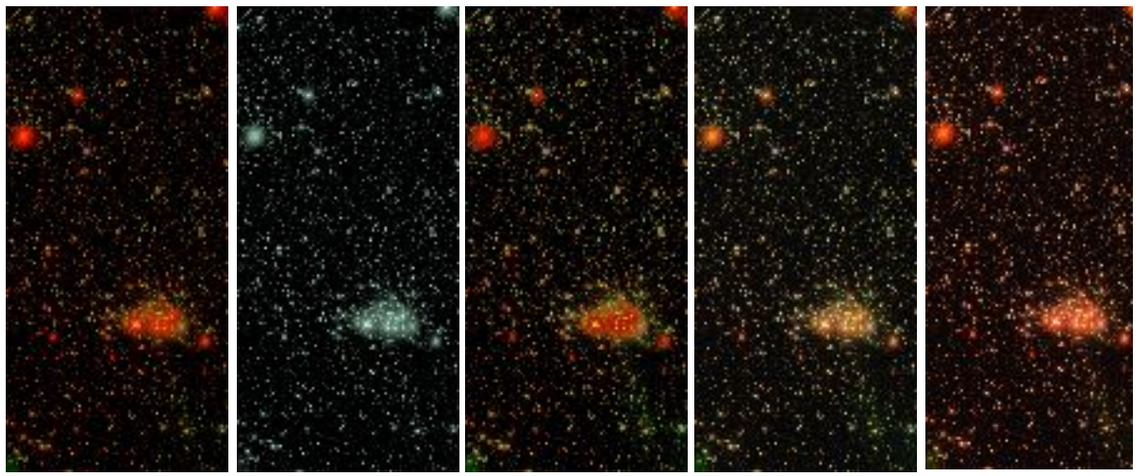
Real Stars

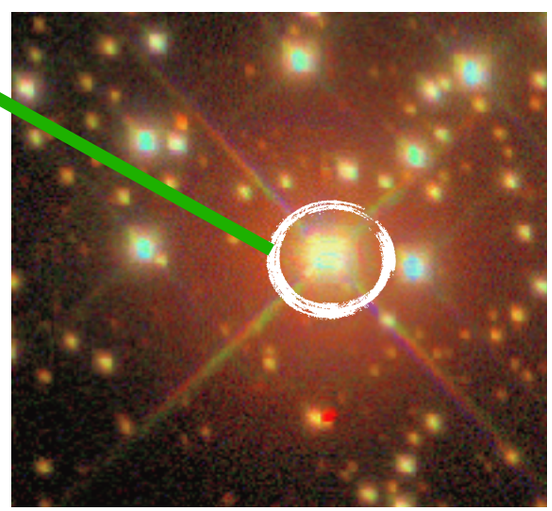
Samples

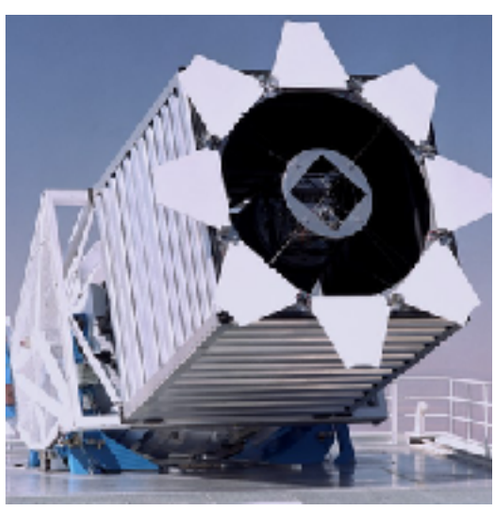
Features

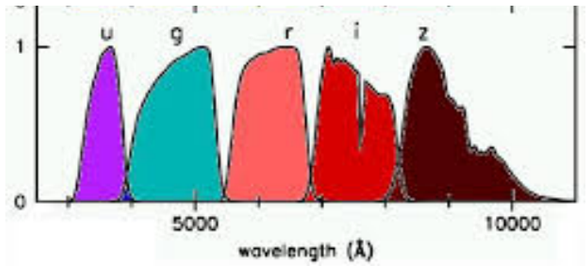
	u-g	g-r	r-i	i-z
0	1.250999	0.394000	0.137000	0.061999
1	1.048000	0.339001	0.151999	0.023001
2	1.008001	0.341999	0.129000	0.203001
3	0.965000	0.392000	0.149000	0.150000
4	1.040001	0.333000	0.125999	0.101999
5	1.154001	0.373999	0.145000	0.121000
6	0.965000	0.384001	0.118999	0.011000
7	1.015001	0.370998	0.158001	0.091999
8	1.003000	0.391001	0.145000	0.074999
9	0.948000	0.330000	0.164000	0.021000
10	1.020000	0.389999	0.168001	0.070999



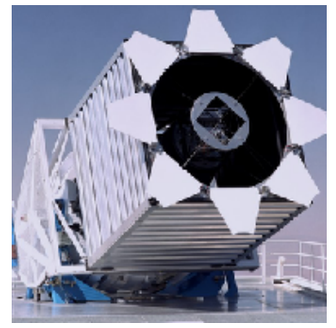








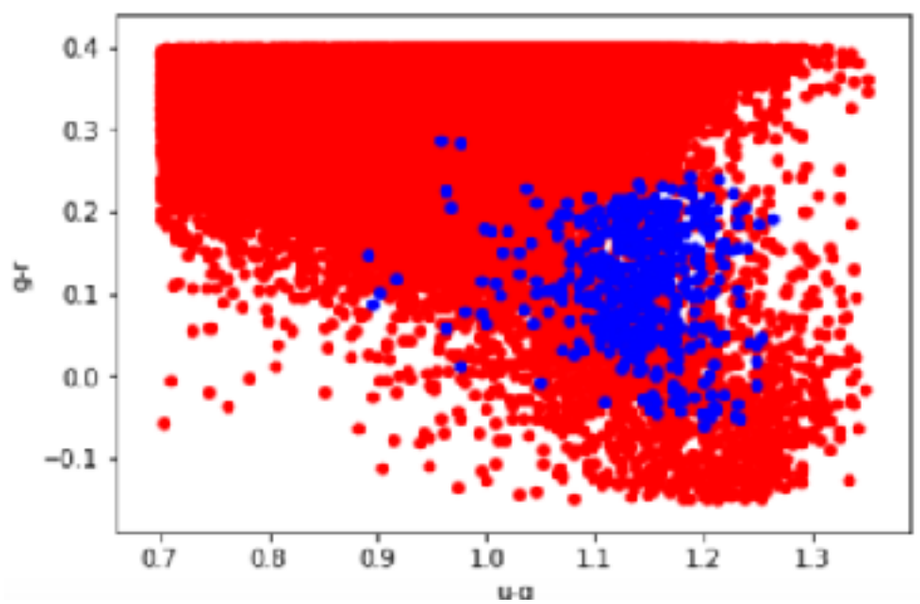
Real Stars

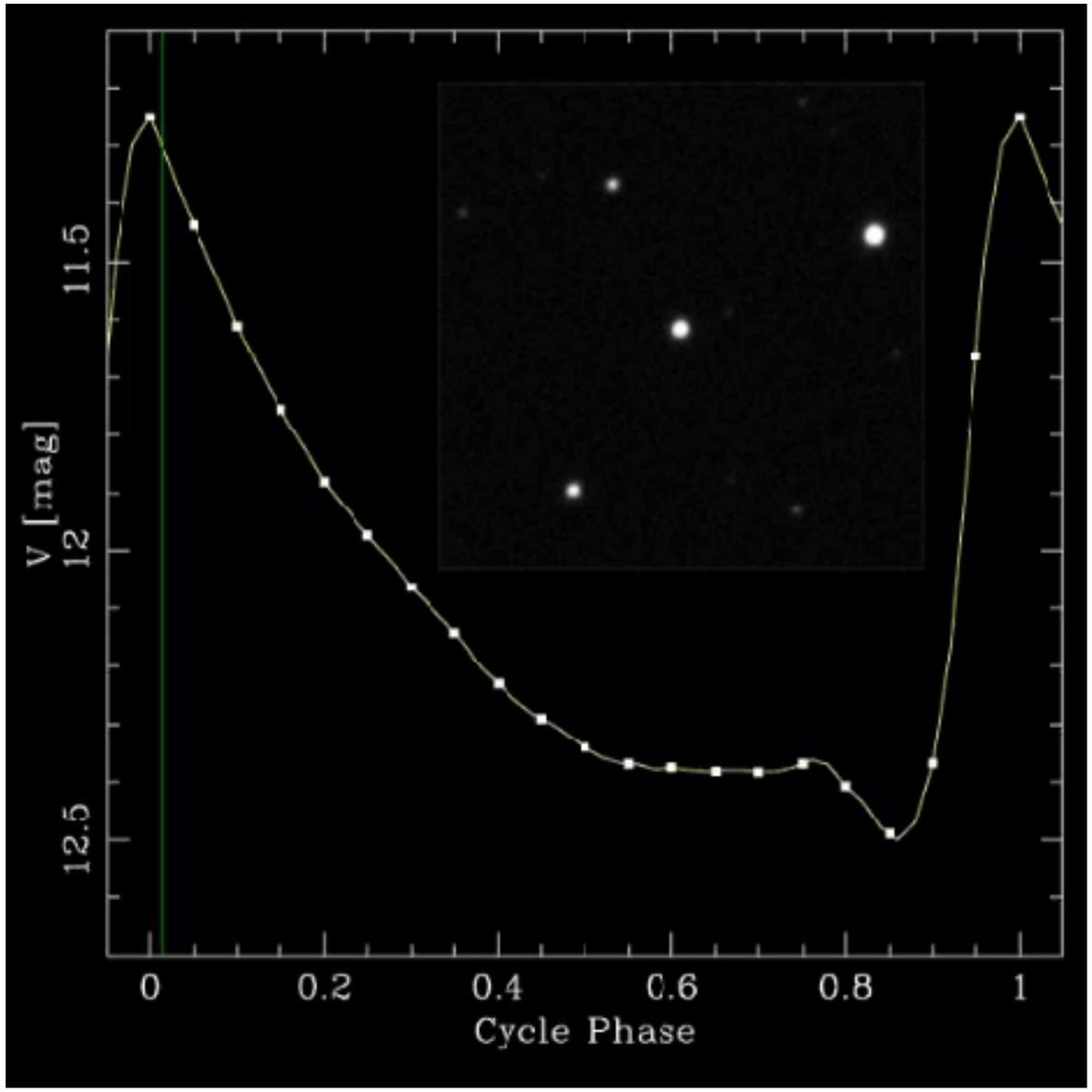


Features

	u-g	g-r	r-i	i-z
0	1.250999	0.394000	0.137000	0.061999
1	1.048000	0.339001	0.151999	0.023001
2	1.008001	0.341999	0.129000	0.203001
3	0.965000	0.392000	0.149000	0.150000
4	1.040001	0.333000	0.125999	0.101999
5	1.154001	0.373999	0.145000	0.121000
6	0.965000	0.384001	0.118999	0.011000
7	1.015001	0.370998	0.158001	0.091999
8	1.003000	0.391001	0.145000	0.074999
9	0.948000	0.330000	0.164000	0.021000
10	1.020000	0.389999	0.168001	0.070999

Samples

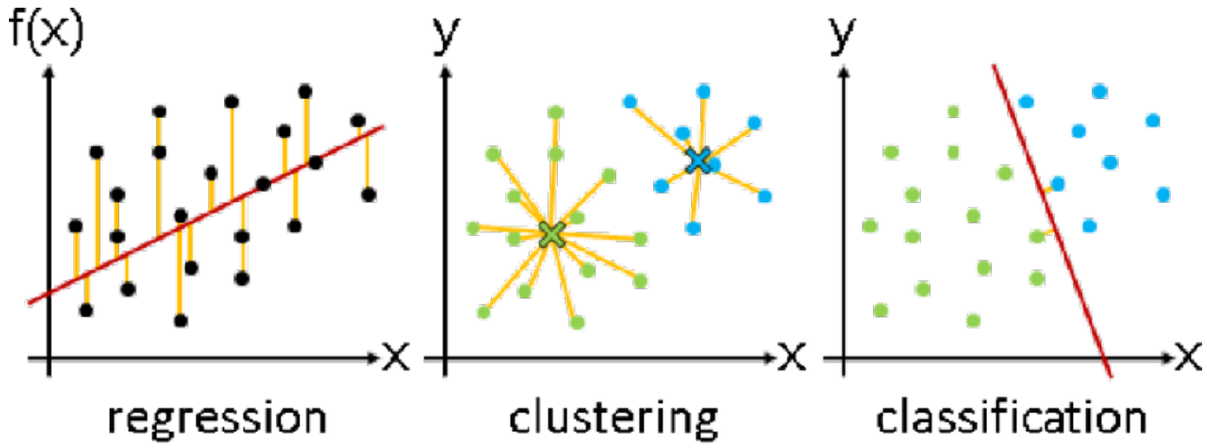


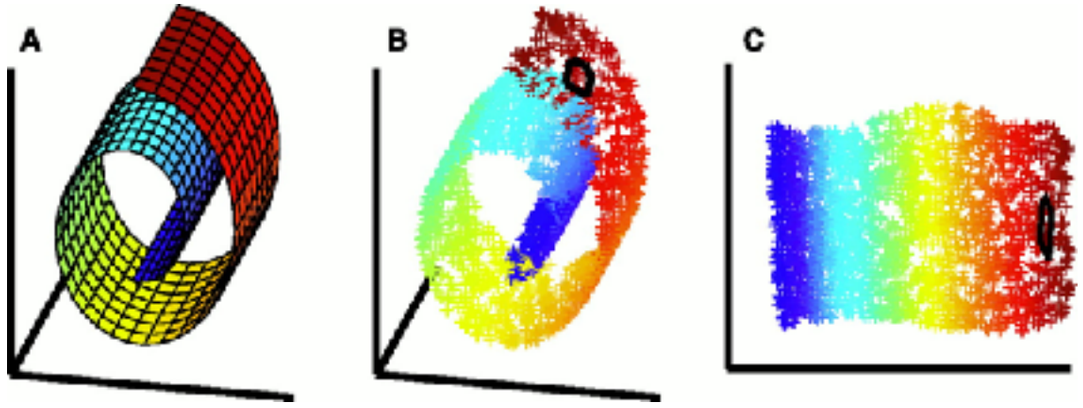


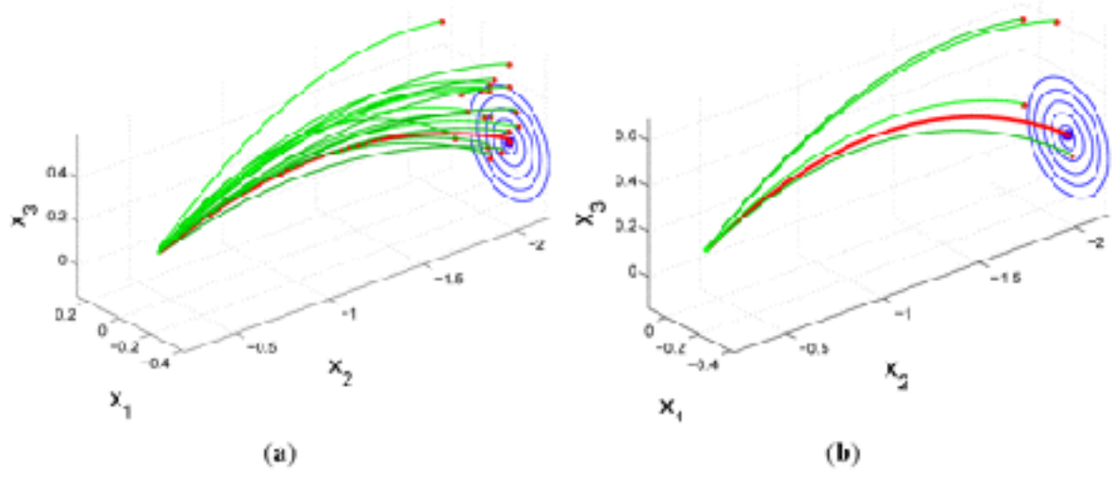
Models and Methods

Machine Learning Tasks

- **Decisions** based on data
  - **Predicting**
    - regression, extrapolation, etc.
  - **Labelling**
    - classification, clustering, etc.
- **Characterizing**
  - density estimation, model selection, dimensionality reduction, etc.
- **Acting**
  - active learning, reinforcement learning, etc.



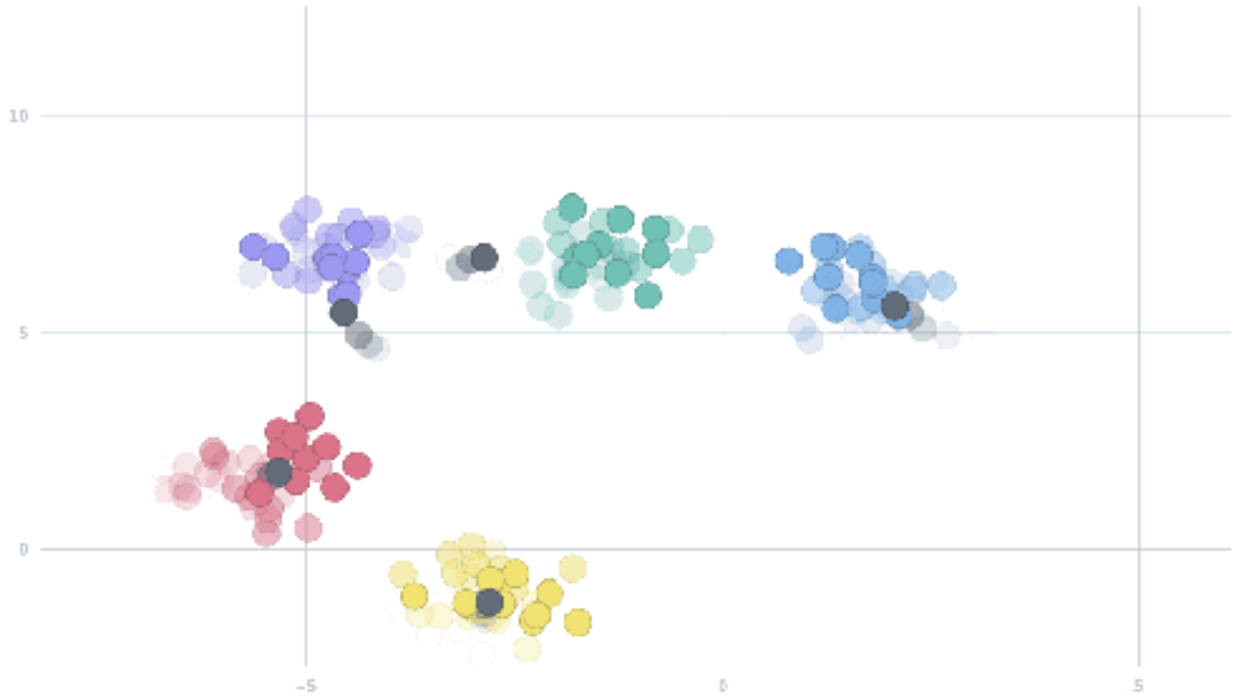




Machine Learning Paradigms

- **Task**
  - Supervised vs Unsupervised
  - Discrete vs Continuous
  - Batch vs Sequential
- **Models**
  - Parametric vs Non-Parametric
  - Linear vs Non-Linear
  - Discriminative vs Generative

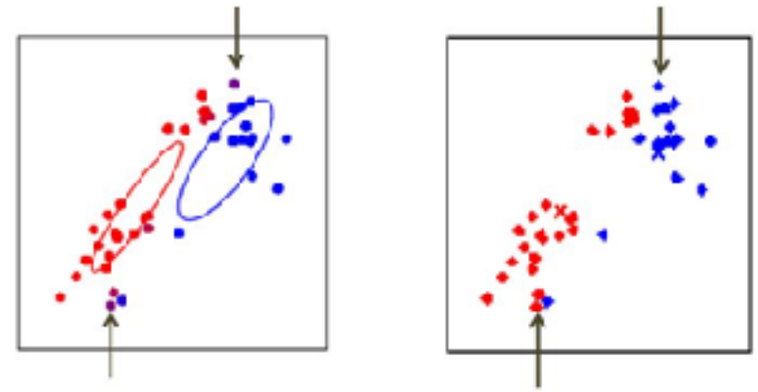
	Supervised Learning	*Unsupervised Learning*
Discrete	classification or categorization	clustering
Continuous	regression	dimensionality reduction

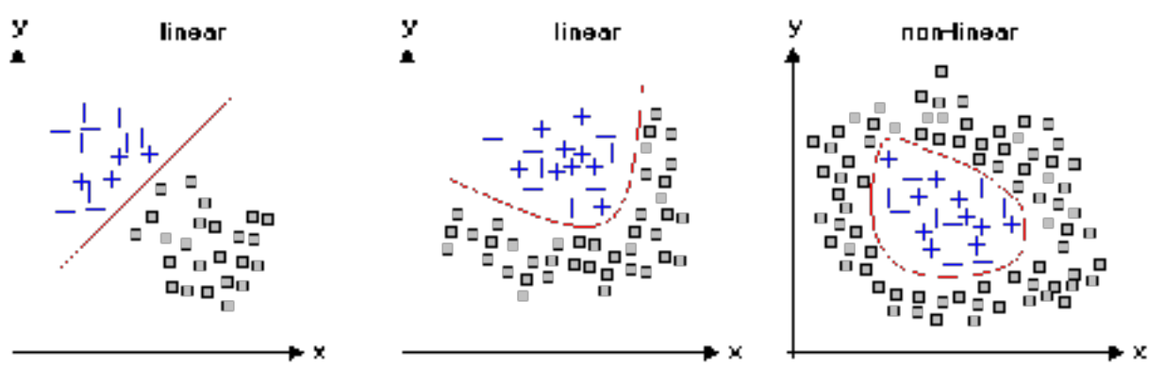


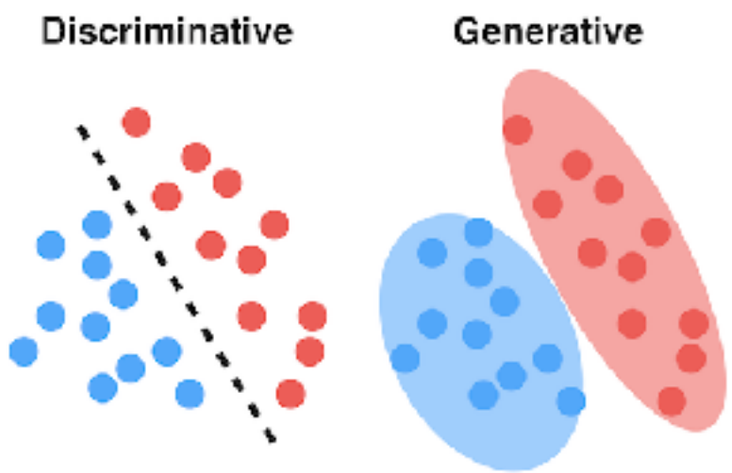
Machine Learning Paradigms

- **Task**
  - Supervised vs Unsupervised
  - Discrete vs Continuous
  - Batch vs Sequential

- **Models**
  - Parametric vs Non-Parametric
  - Linear vs Non-Linear
  - Discriminative vs Generative



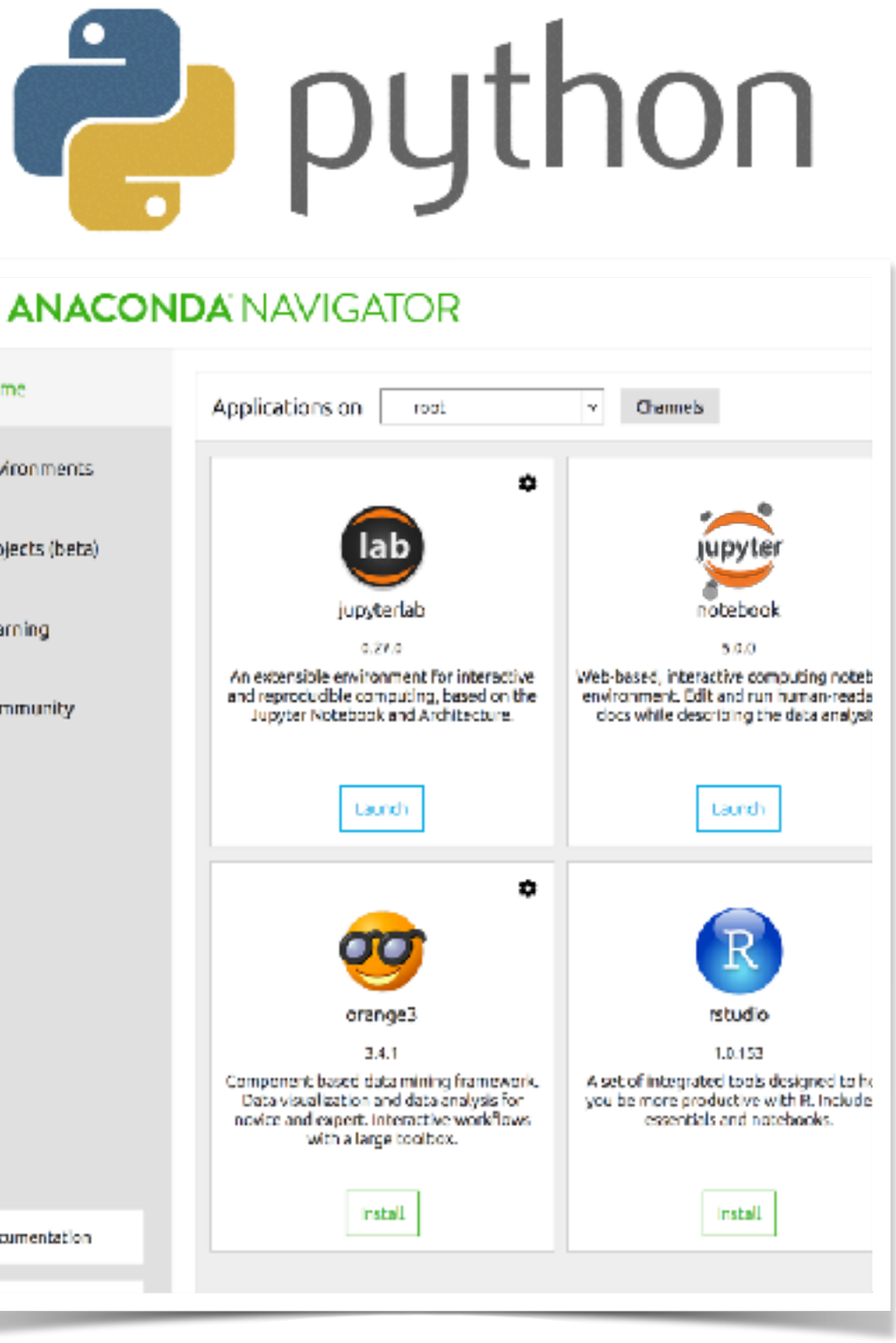




Jupyter

Installing Anaconda

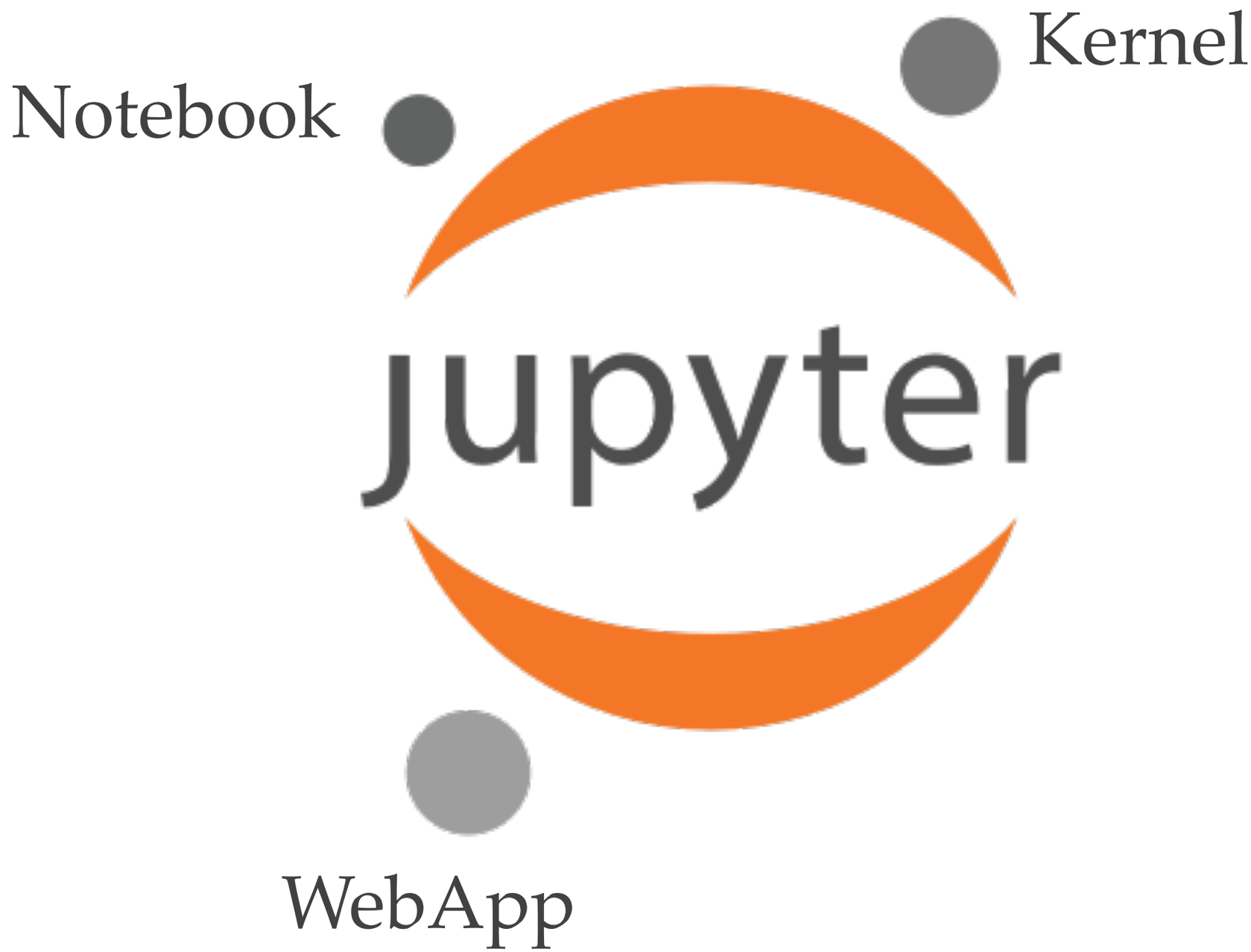
- Jupyter runs over Python
- Anaconda is a Python Distribution
  - We will use Python 3.7
  - Environments can do the trick
  - pip at your own risk
- Over 500 MB
  - Windows, Linux and MacOS



Setup an environment

- Fresh Installation:
  - `conda create --name` **`dm21`** `--clone root`
- Previous Installation:
  - `conda create -n` **`dm21`** `python=3.6 anaconda`
- Activate the environment
  - `source activate` **`dm21`**
- Move to a working directory
  - `mkdir directory`
  - `cd directory`
- Run Jupyter!
  - `jupyter notebook`

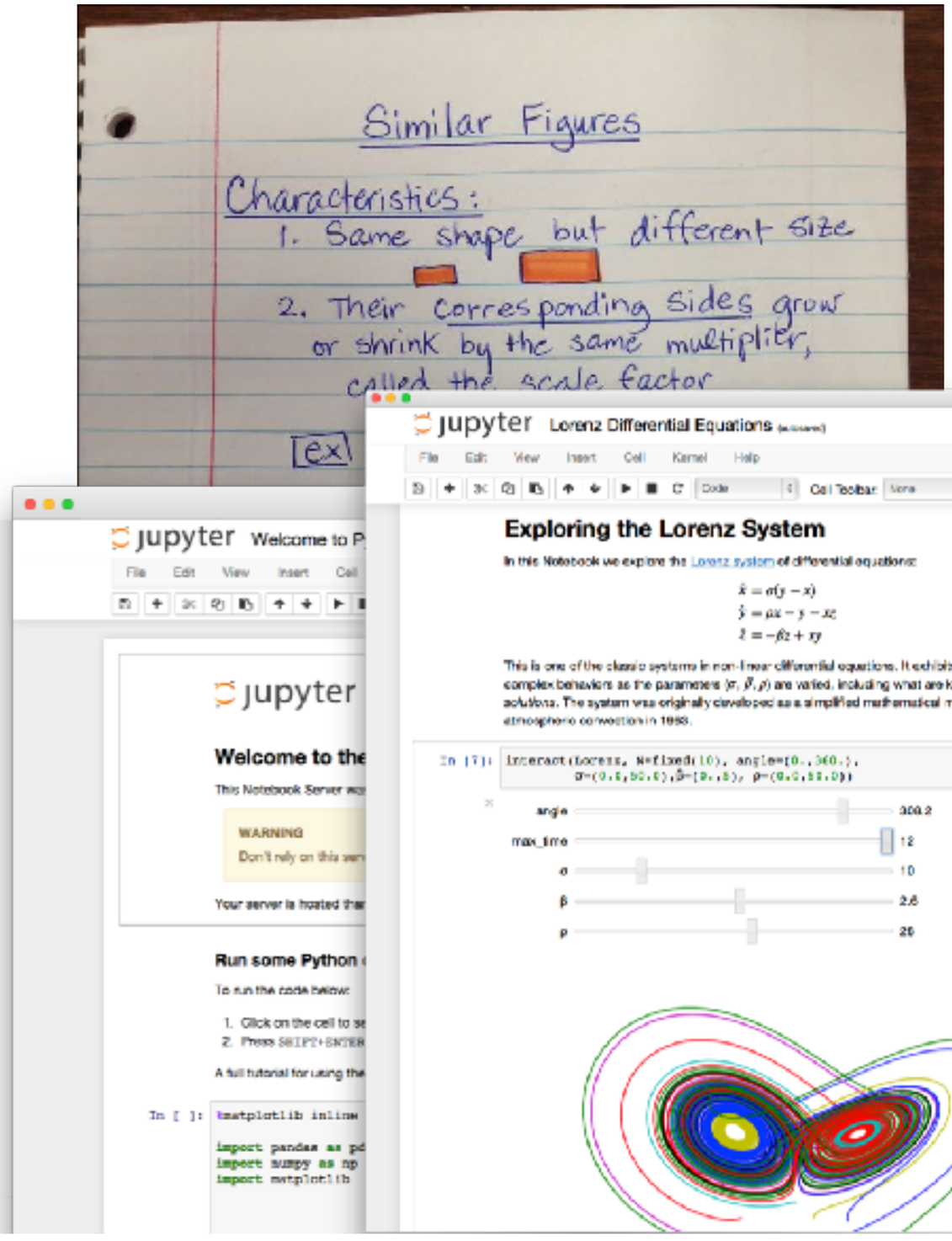
Basic Concepts of Jupyter



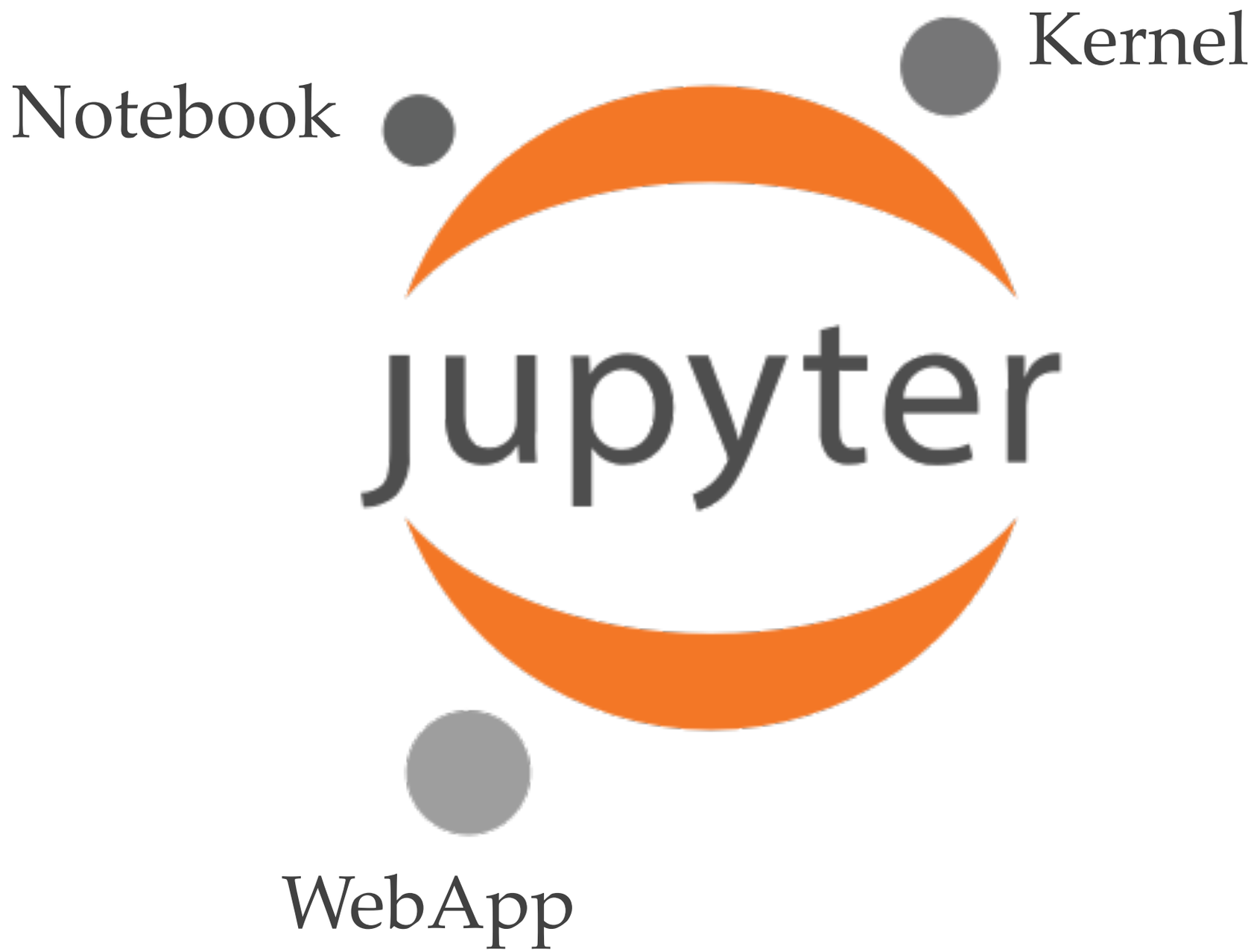
Basic Concepts of Jupyter

Notebook

- Data, text, documentation, figures in the same place
- Adds code to the same space
- Popularized by Mathematica
- Popular in data science
- Astronomy: self-documented pipelines
- Reproducible research



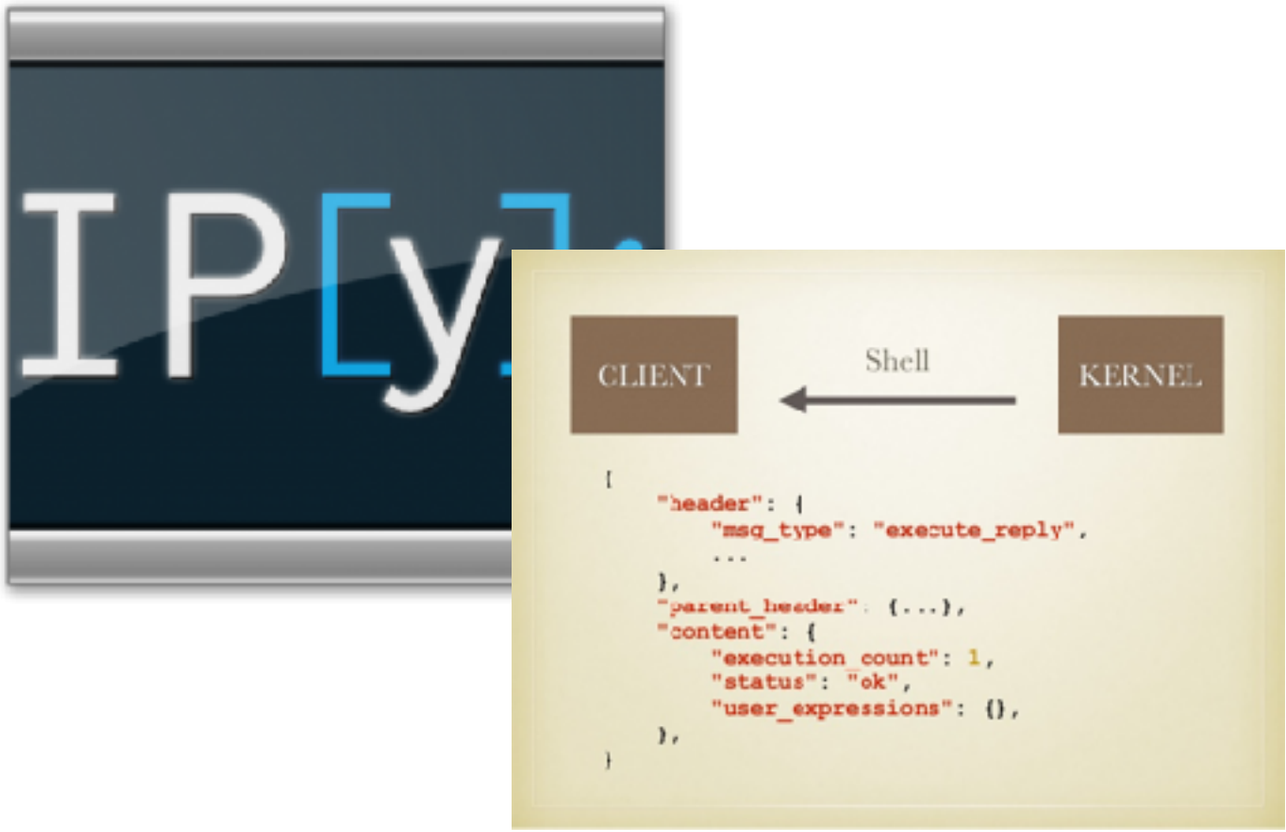
Basic Concepts of Jupyter

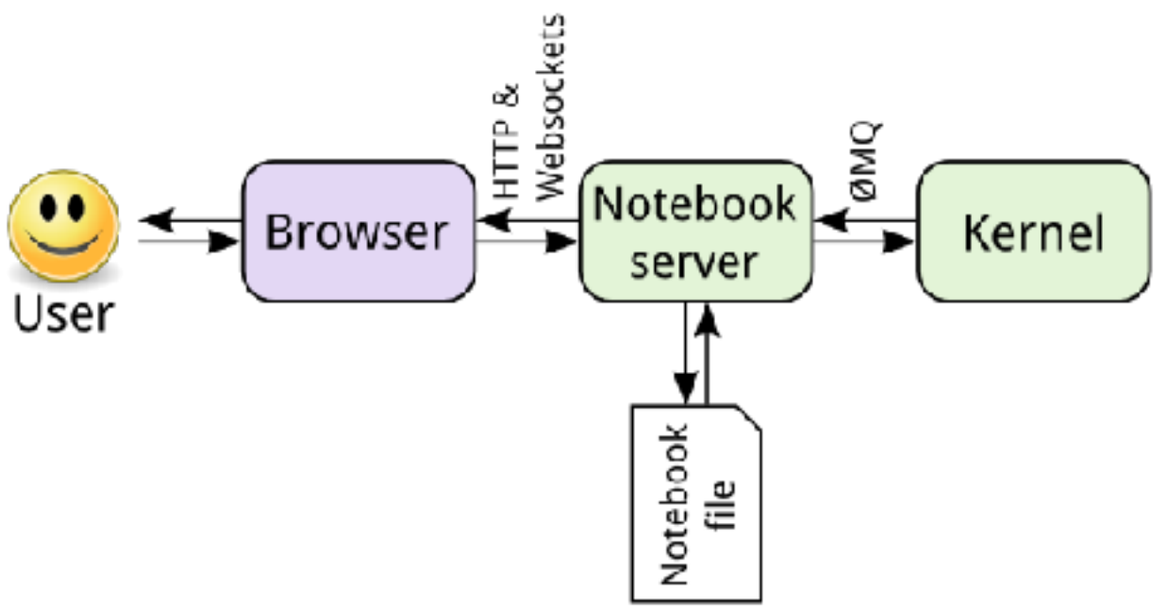


Basic Concepts of Jupyter

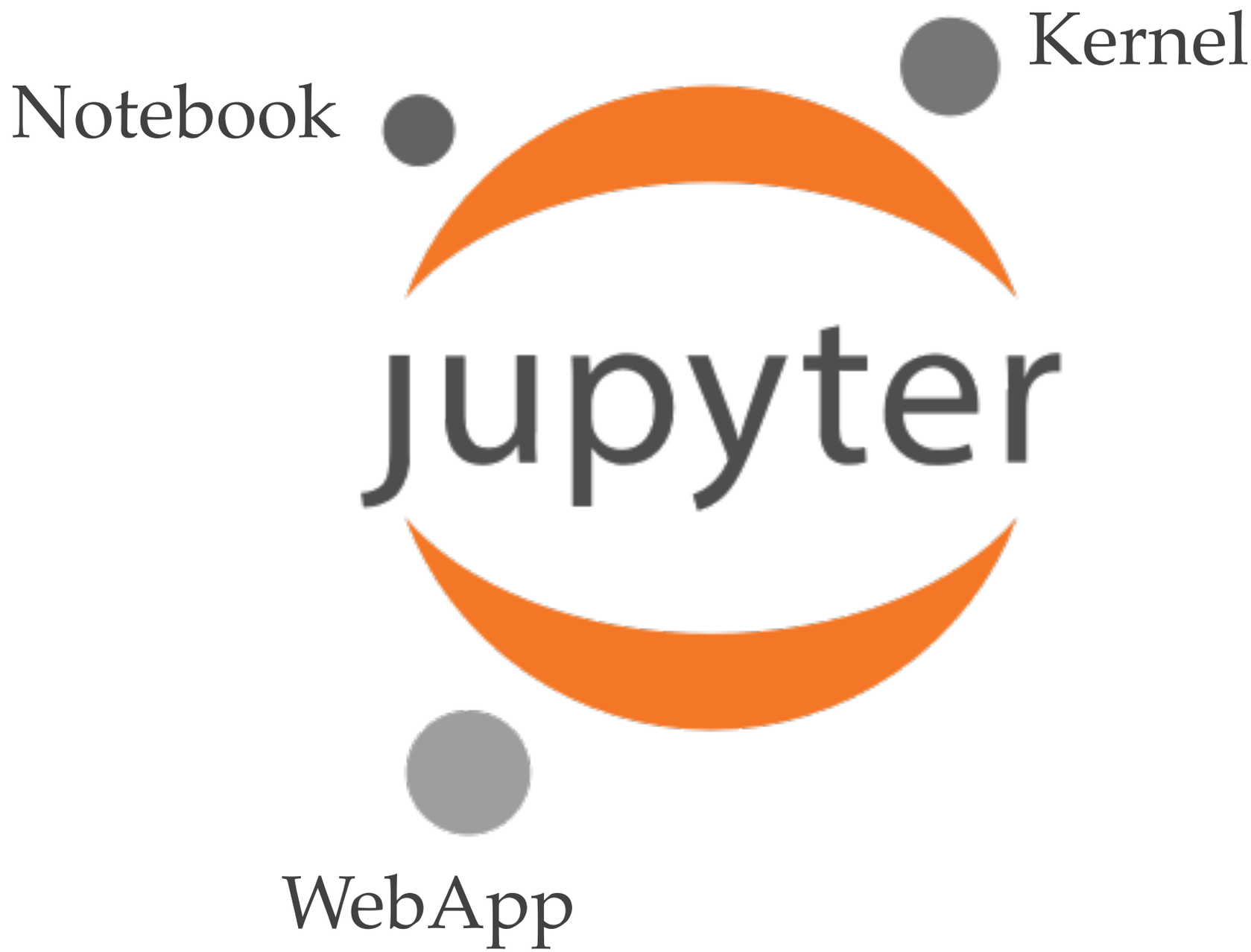
Kernel

- Interactive code executor
- Running in the “background” of the notebook
- Maintains the state (variables)
- Jupyter supports several
- We will use only **iPython** kernel





Basic Concepts of Jupyter



Basic Concepts of Jupyter

WebApp

- Jupyter is a **notebook server**

- Your browser is the **client**

- The state is in the server, not in the browser

- Is a Web Application, despite if you use it locally