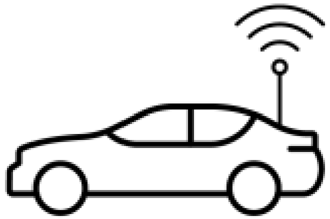
Data Science

for the automotive industry



Algeciras

2011
Aerospace
Engineering

Internship
Image Processing

2013
M. Sc. in
Electronics, signal
Treatment and
Communications

Internship
Mechanical
testing

2018
PhD in Structural
Health Monitoring

R&D Engineer in
Material and
Processes

Reverse Engineering
Consultant

Data Scientist

2018
Telemetry systems
specialist

What about you?

Name , Google e-mail and brief description of background.

Groups creation

Course roadmap

1) **Data Science (1d)**

What

Who

Why

When

How

2) Practical sessions with Python (3d)

Machine Learning

Deep Learning

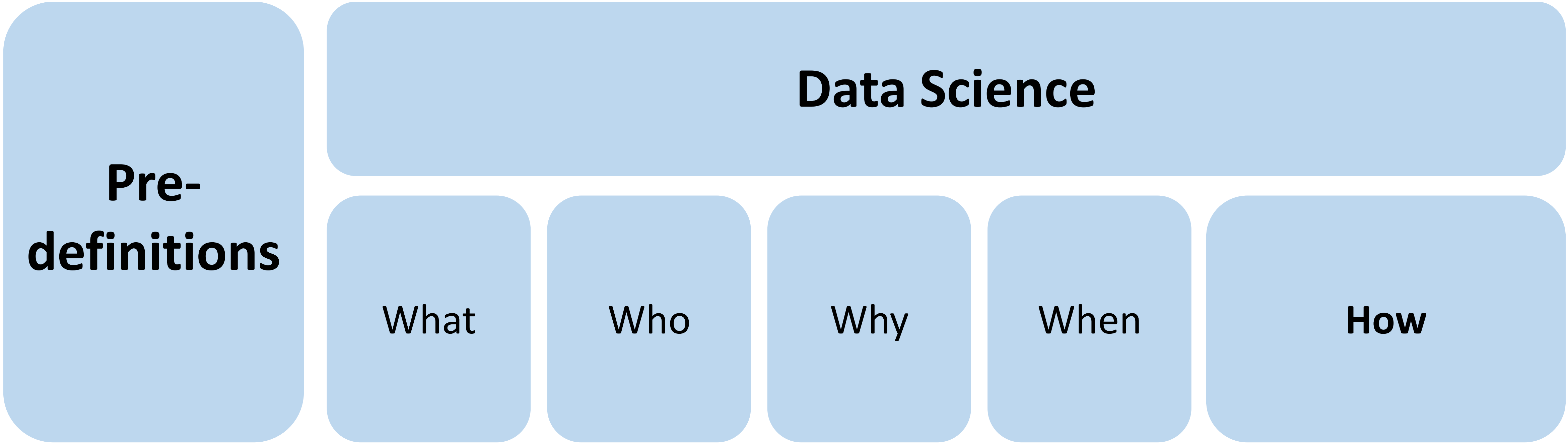
Reinforcement Learning

3) Hackhaton Python (1d)

1st day -> Creation of groups

3rd day -> Unveiling the topic

4th-5th -> Hackhaton


Pre-
definitions
Data Science
What
Who
Why
When
How

Pre-definitions

Data Science

What

Who

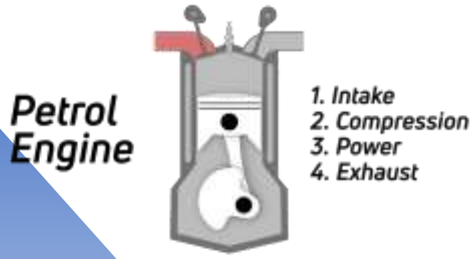
Why

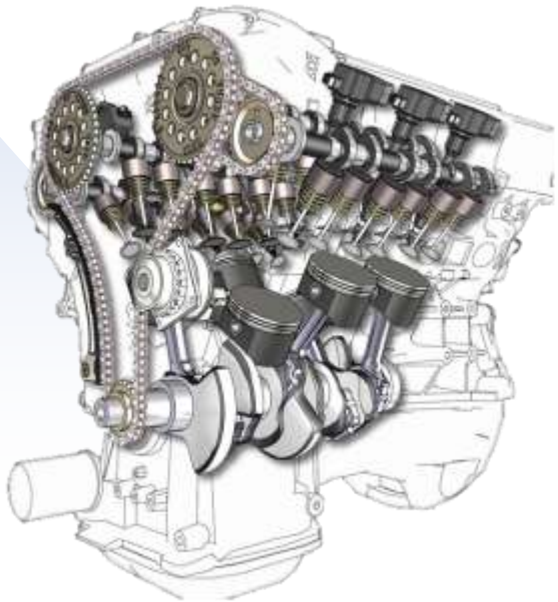
When

How

Low vs High level

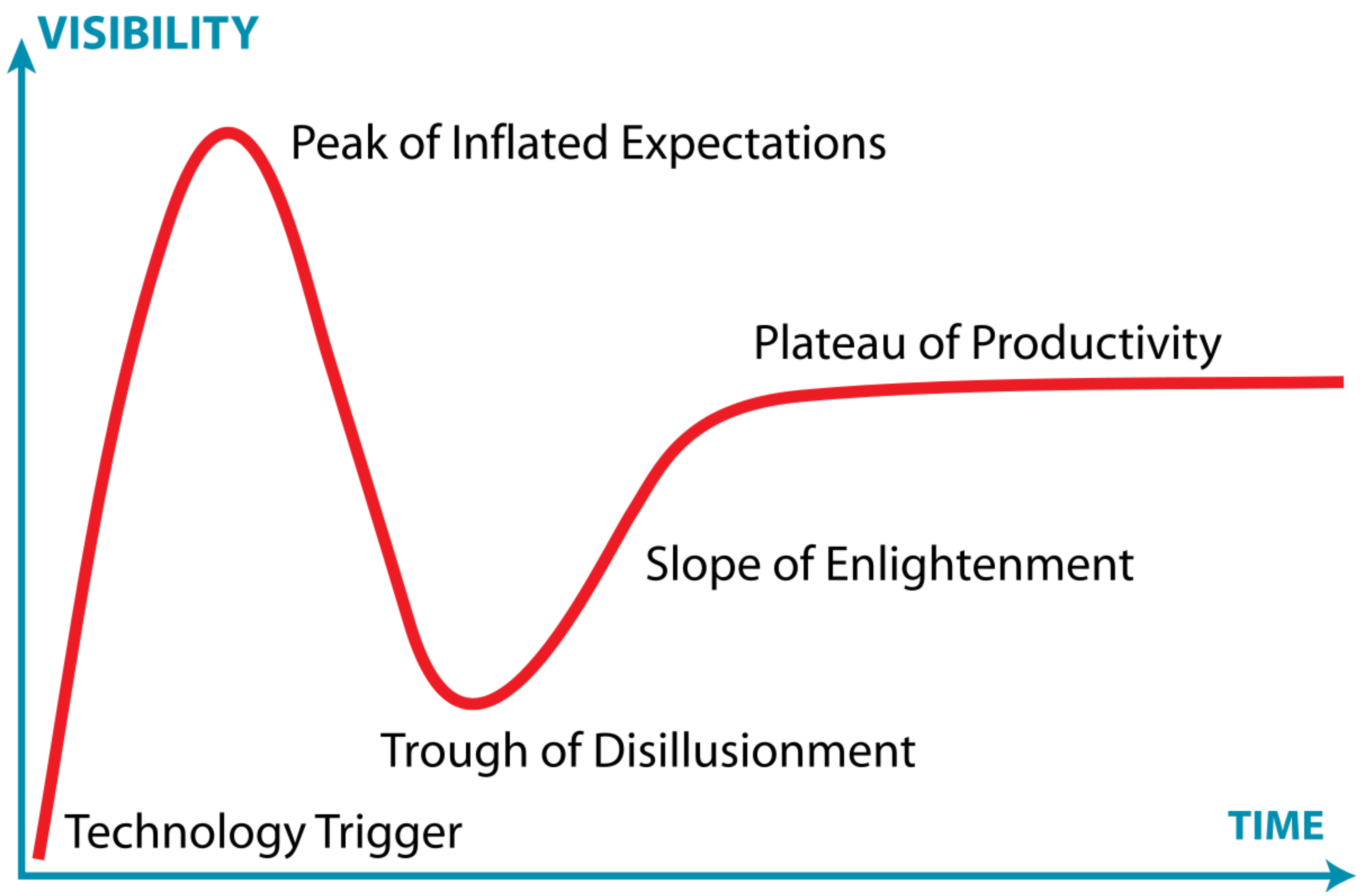
High Level





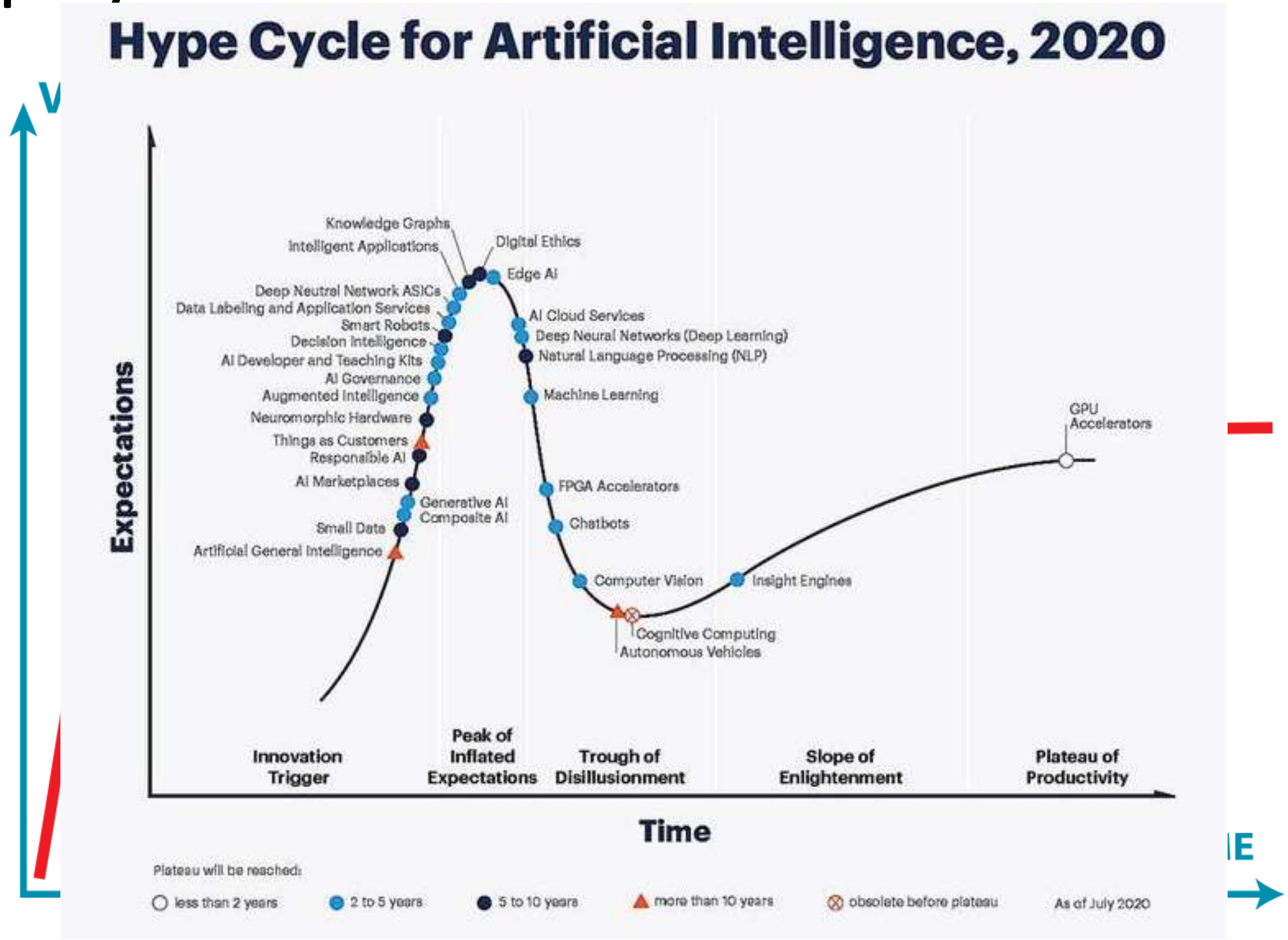
Low Level

Gartner Hype Cycle



* https://fr.wikipedia.org/wiki/Cycle_du_hype#/media/Fichier:Gartner_Hype_Cycle.svg

Gartner Hype Cycle



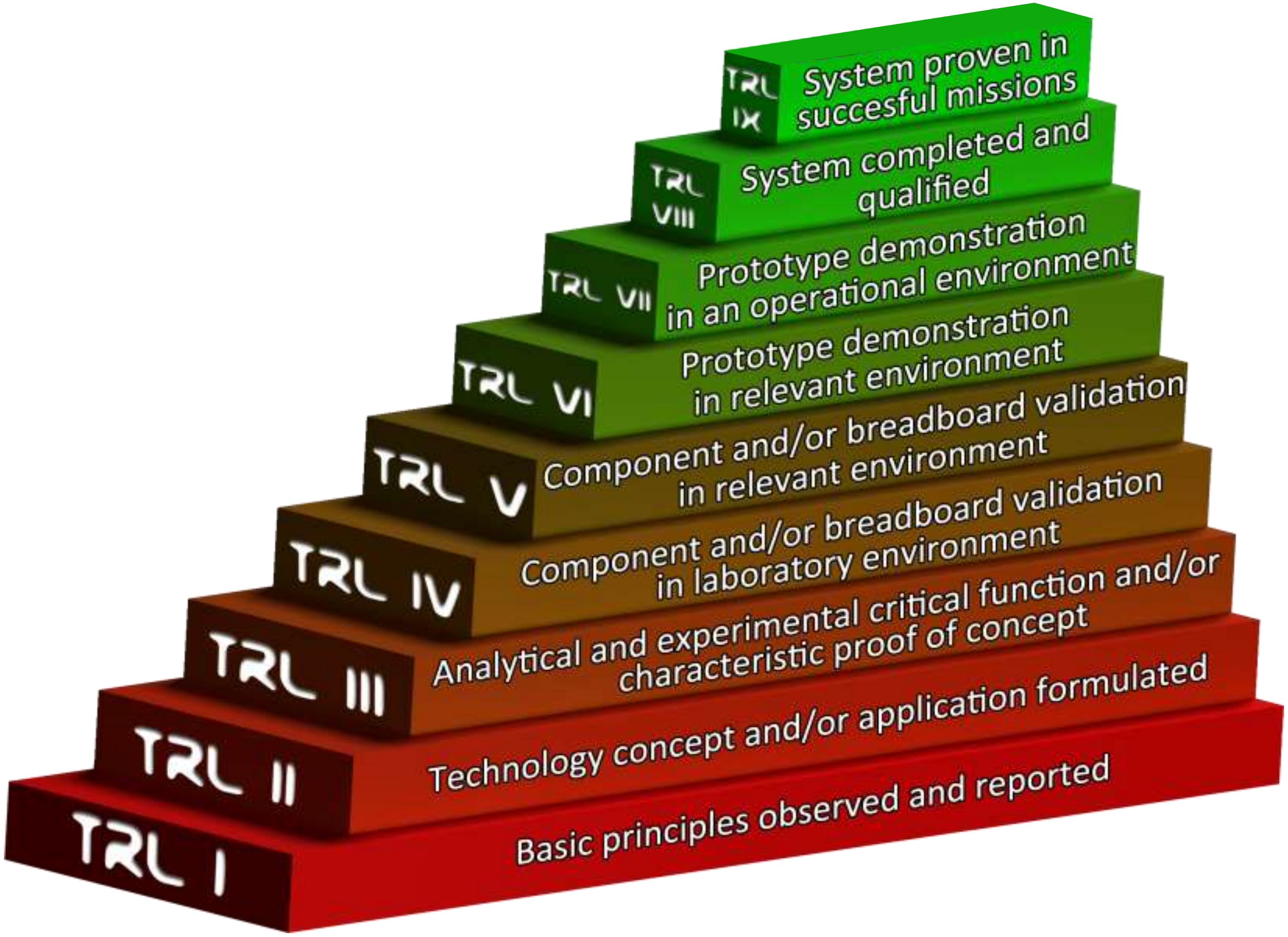
* https://www.forbes.com/sites/louiscolumbus/2020/10/04/whats-new-in-gartners-hype-cycle-for-ai-2020/

Technology Readiness Level

Deployment - Innovation
(Private companies)

Development
(Technology centers)

Basic Science - Research
(Universities)



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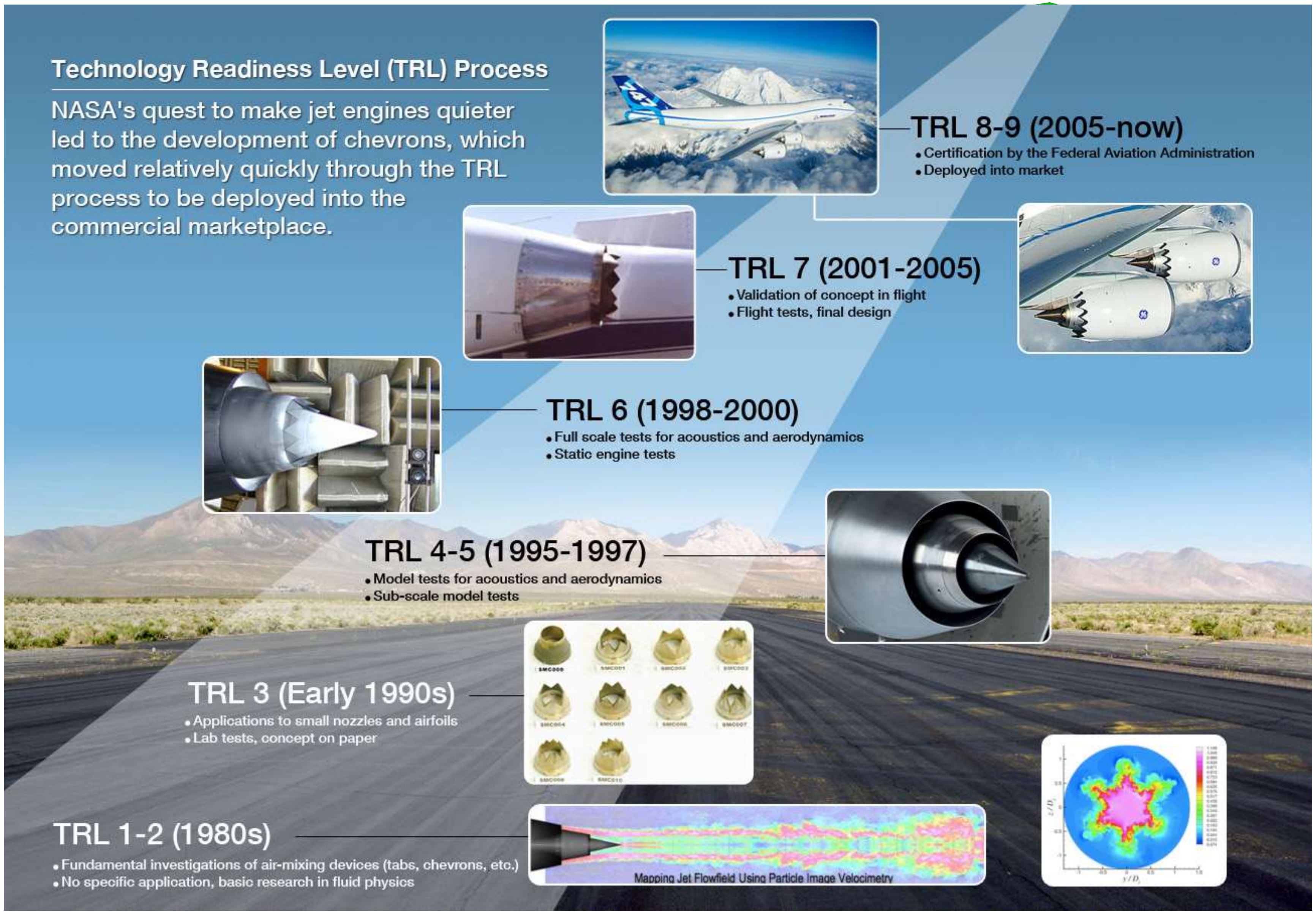


Pre-definitions

Data Science

What

Who

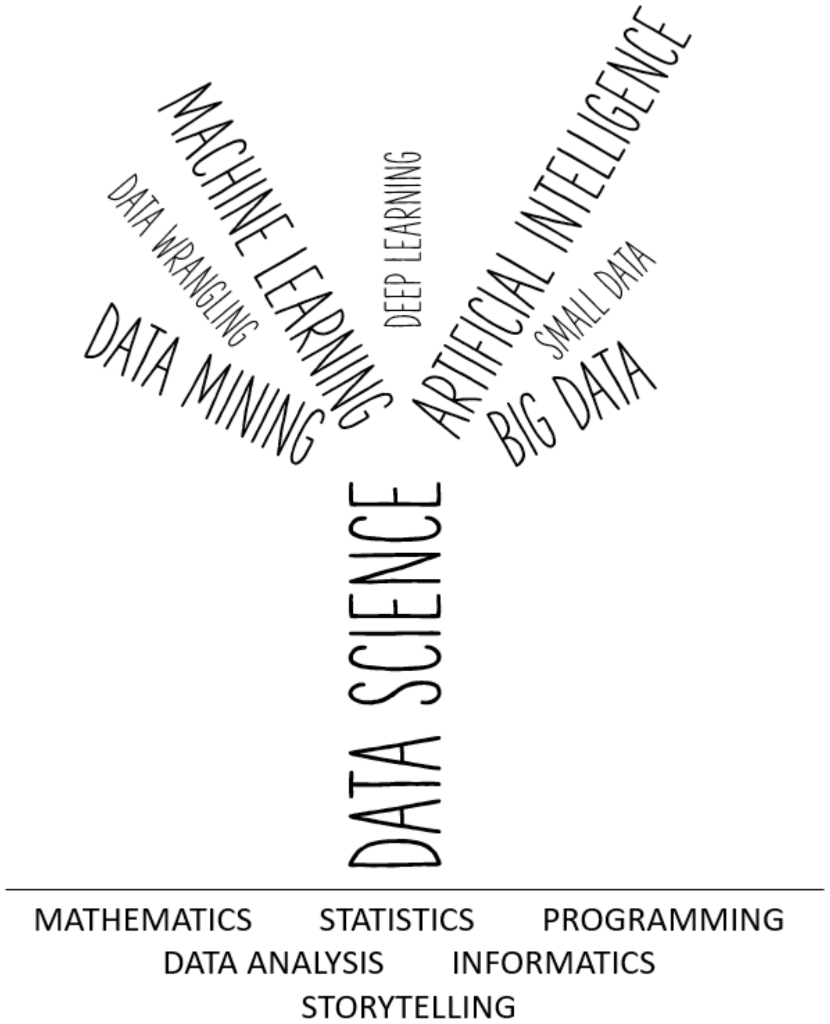
Why

When

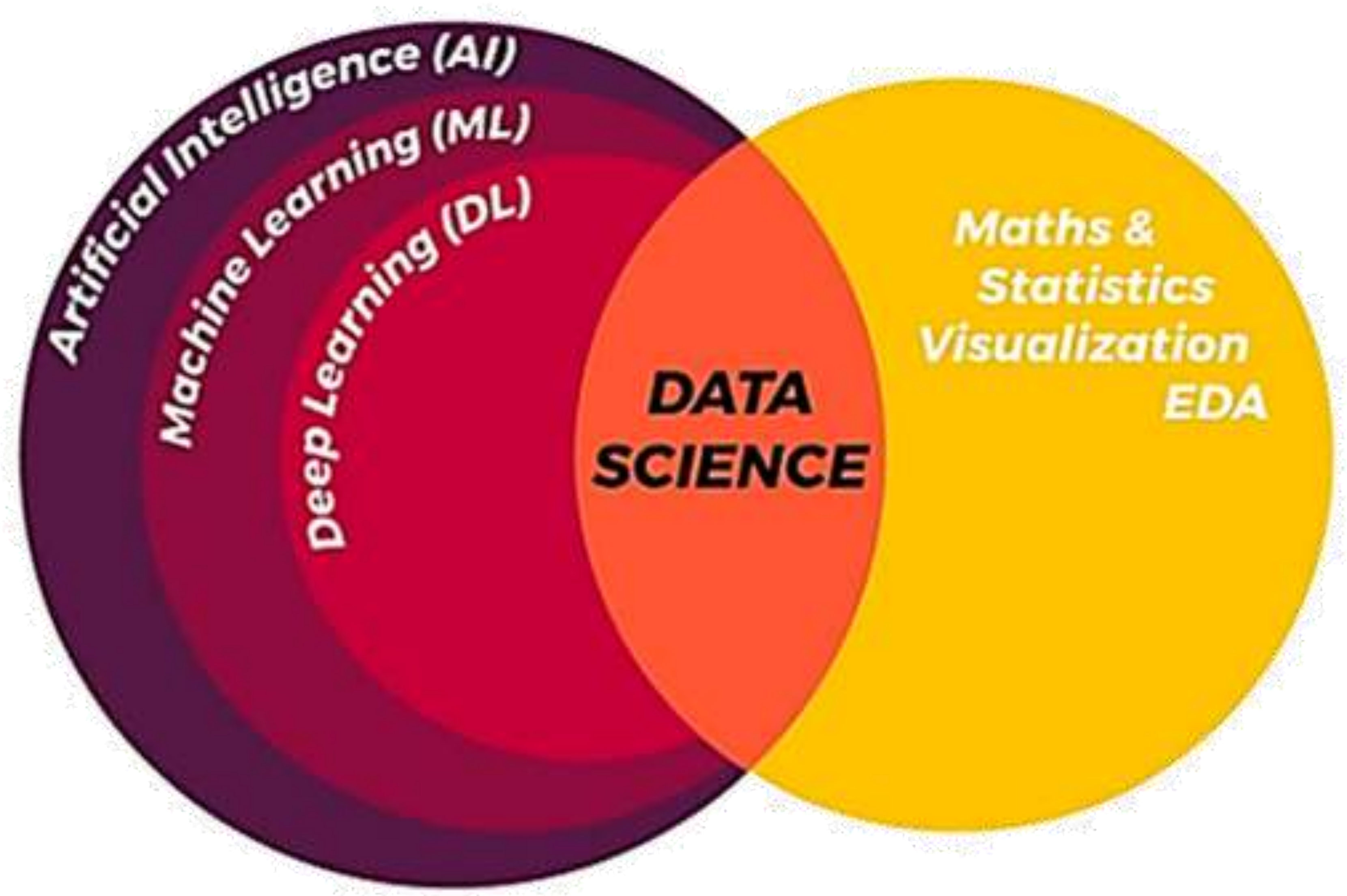
How

What is Data Science?

Interdisciplinary field focused on **extracting knowledge and insights** buried in **data and develop advanced tasks**.



What is Data Science?

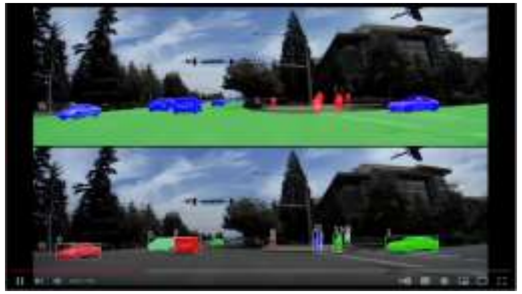


*IBM – Data science and artificial intelligence certification course

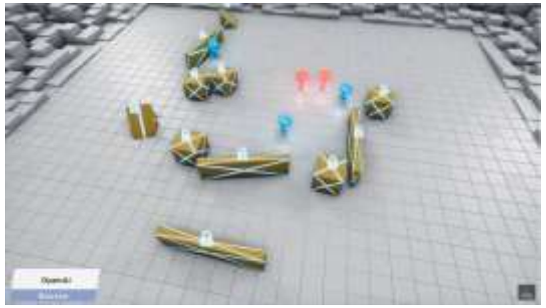
Examples

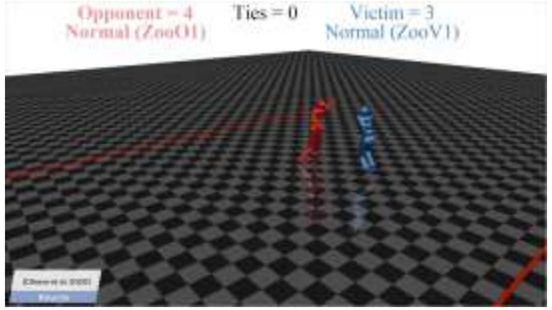
Deep fake

Autonomous driving



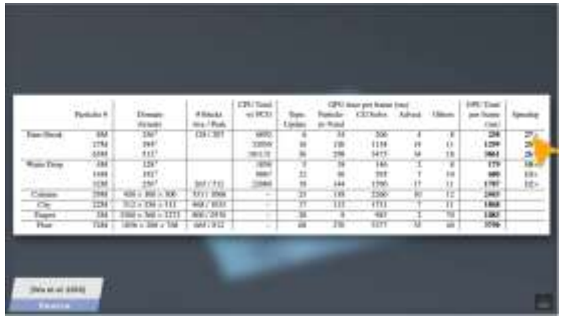
Reinforcement Learning





SOPHY in GT

Physics Simulation



Pre-definitions

Data Science

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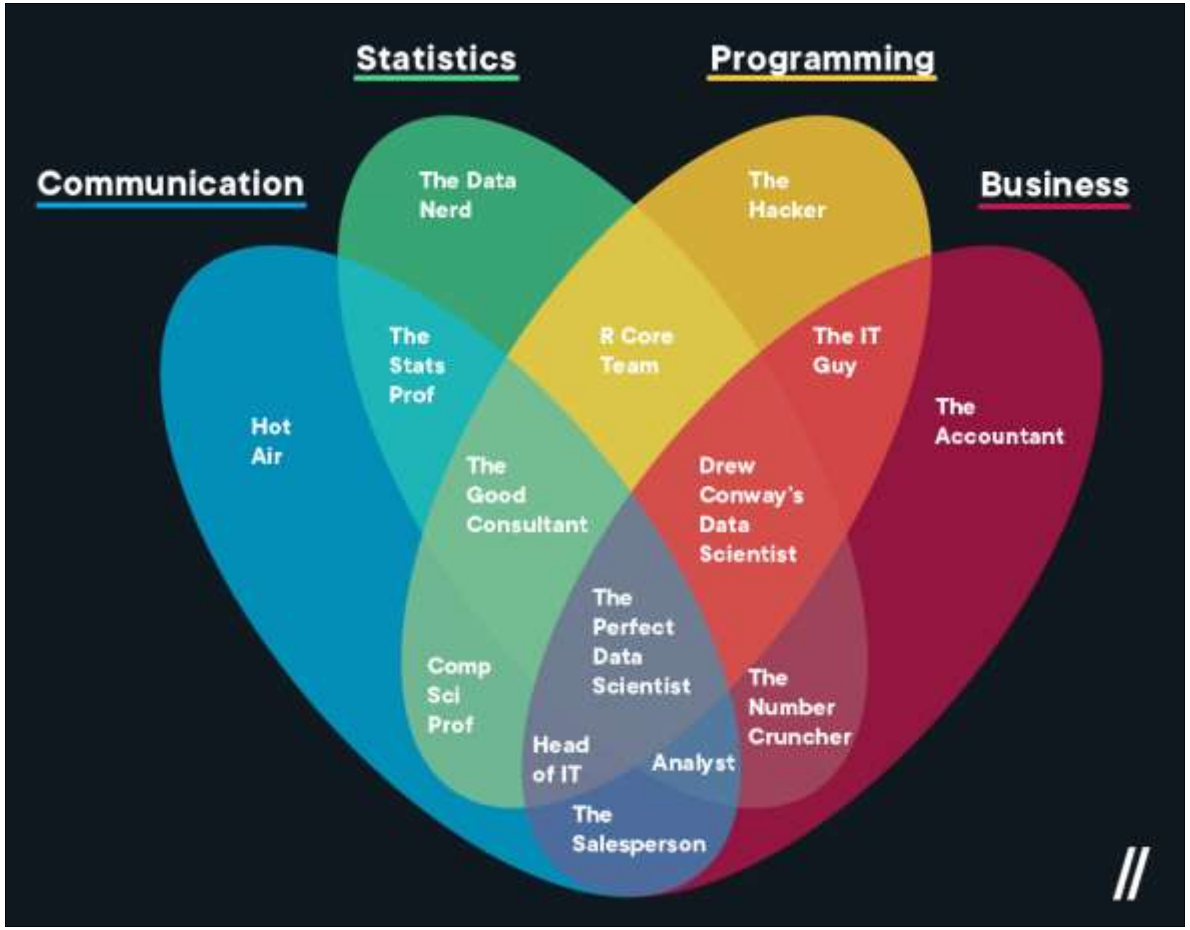
What is a Data Scientist?

Data scientists **analyse, process, and model data** to find trends and uncover solutions.
Then they communicate the results.



Hard Skills

Maths
Statistics
Programming

Soft Skills

Curiosity
Story telling
Teamwork
Humbleness

Field knowledge
New technologies
Avid learner

https://flatironschool.com/blog/data-science-programming-languages and https://www.mastersindatascience.org/careers/data-scientist/

What is a Data Scientist?

Data Science is not owned by Data Scientists!

Data Science is a very big and diverse field.

Humbleness is a must in Data Science as many people may know more than you in specific methods.

What is a Data Scientist?

Data Scientists create *data models*

What is a Data Scientist?

Data Scientists create *data* ***models***

A model is a virtual representation of the behaviour of a system
in a subdomain of the variables space. It maps inputs and outputs.

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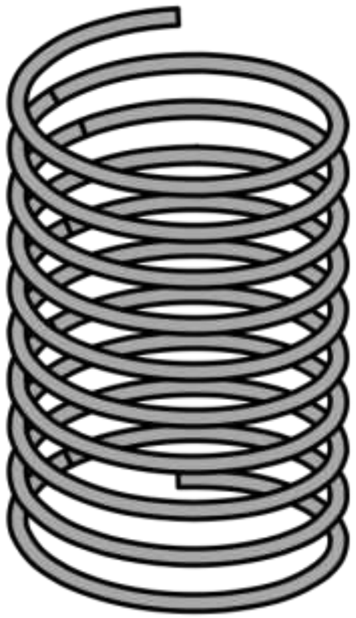

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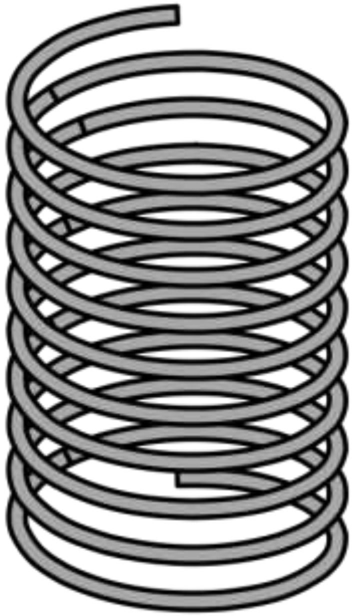

Hooke Law

$$F = k\Delta x$$

(in the linear range)

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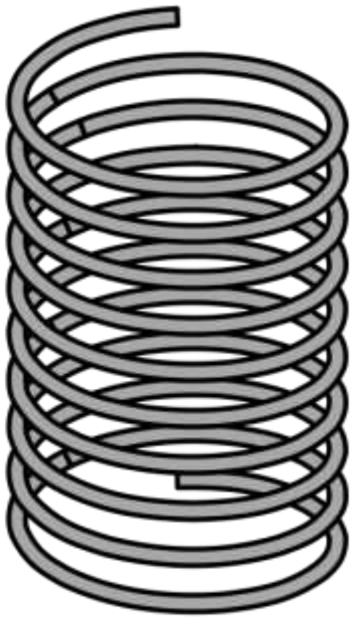

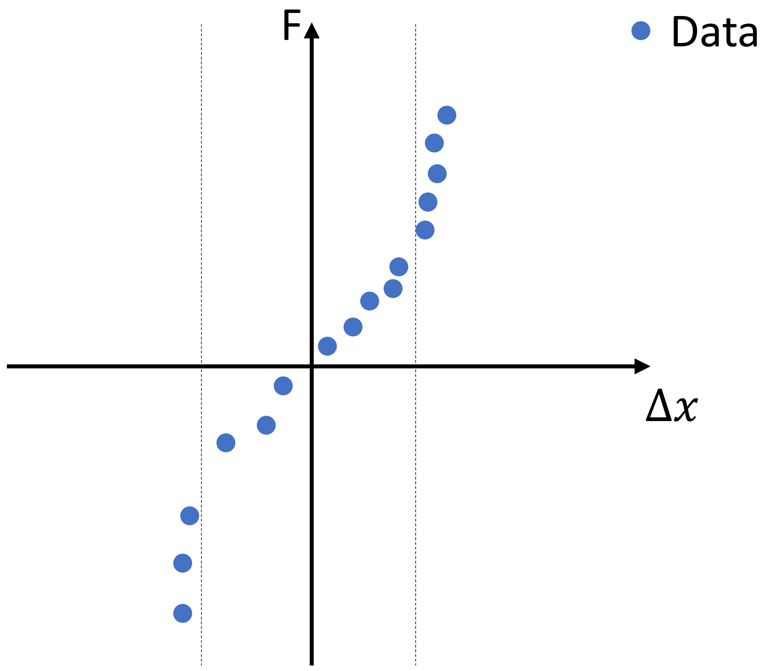

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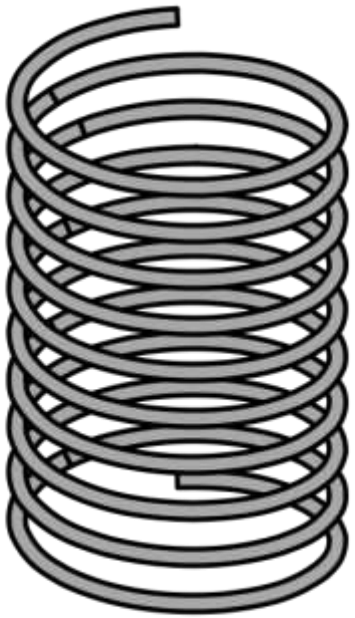
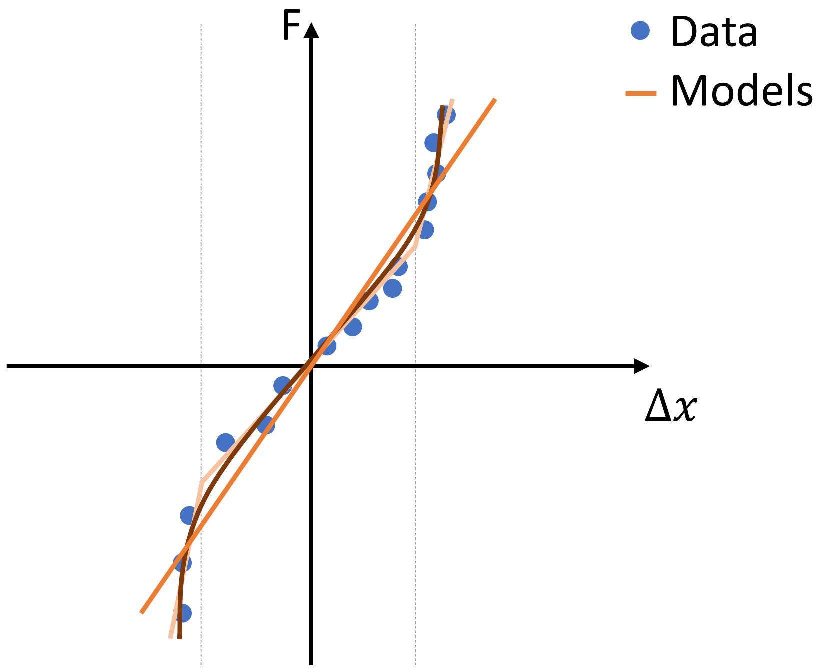




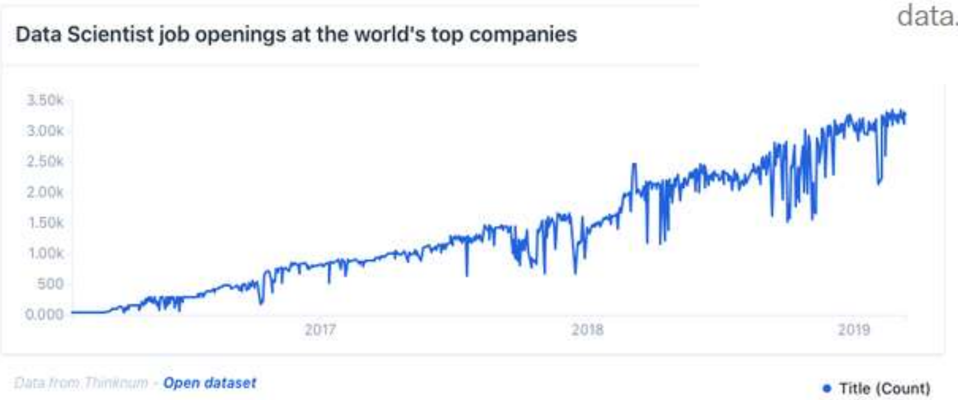
What is a Data Scientist?

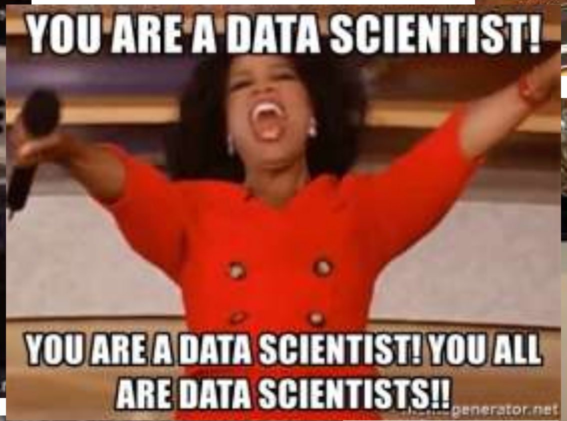
Analytics And Data Science

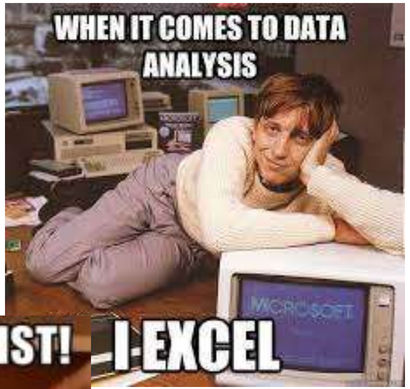
Data Scientist: The Sexiest Job of the 21st Century

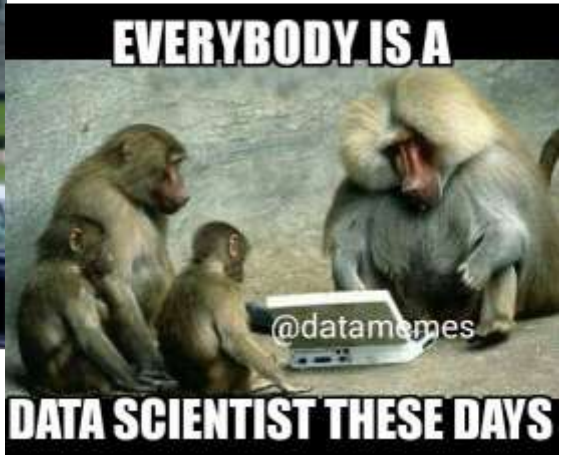
Meet the people who can coax treasure out of messy, unstructured data. by Thomas H. Davenport and D.J. Patil

From the Magazine (October 2012)









Pre-definitions

Data Science

What

Who

Why

When

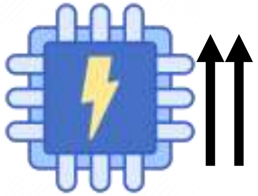
How

Why data, Why now?

Sensors are everywhere
(Volume of data doubles every three years)

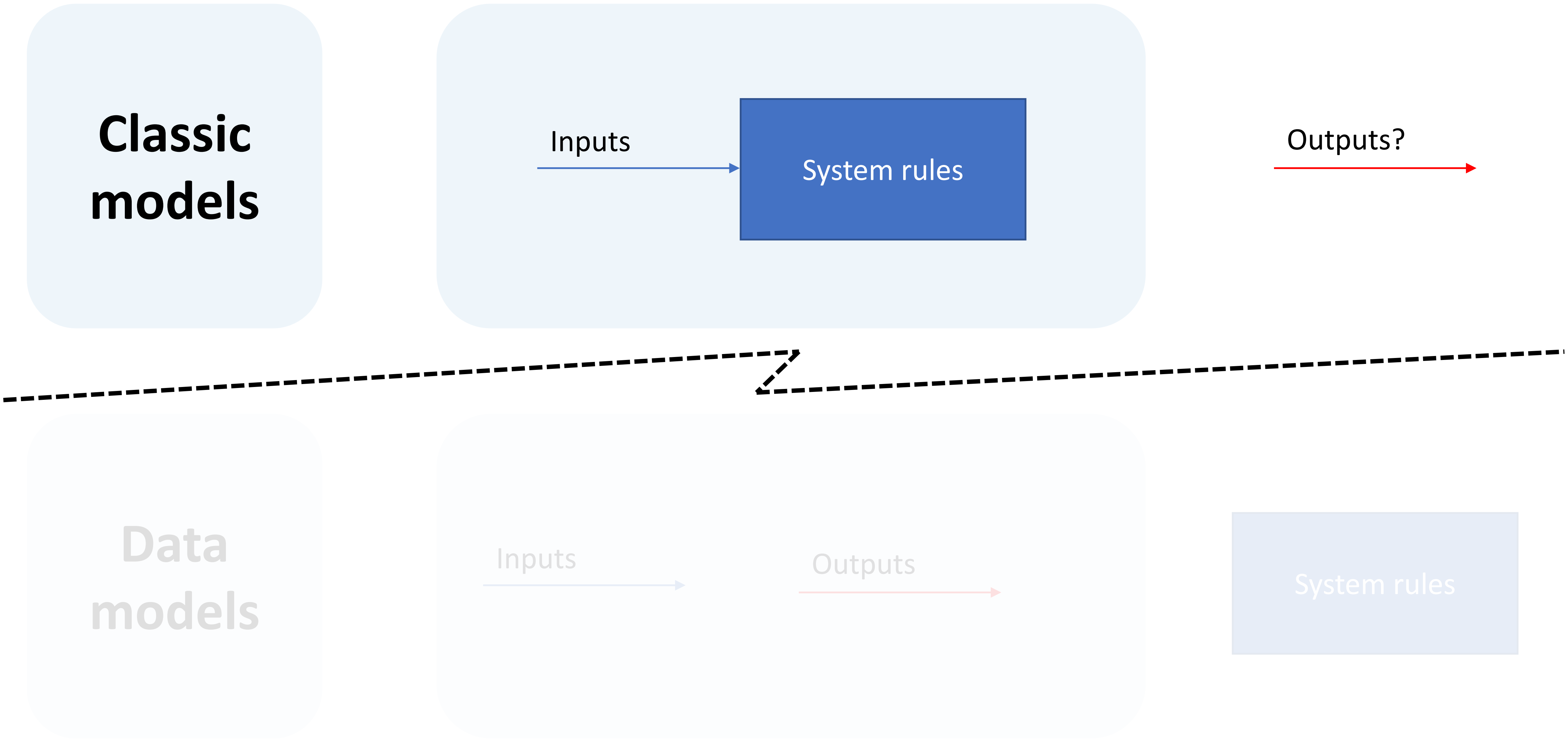
Data storage and computing power has increased, cost has plummeted

Algorithms are advancing



* MGI - THE AGE OF ANALYTICS: COMPETING IN A DATA-DRIVEN WORLD (Dec 2016)

Data Paradigm



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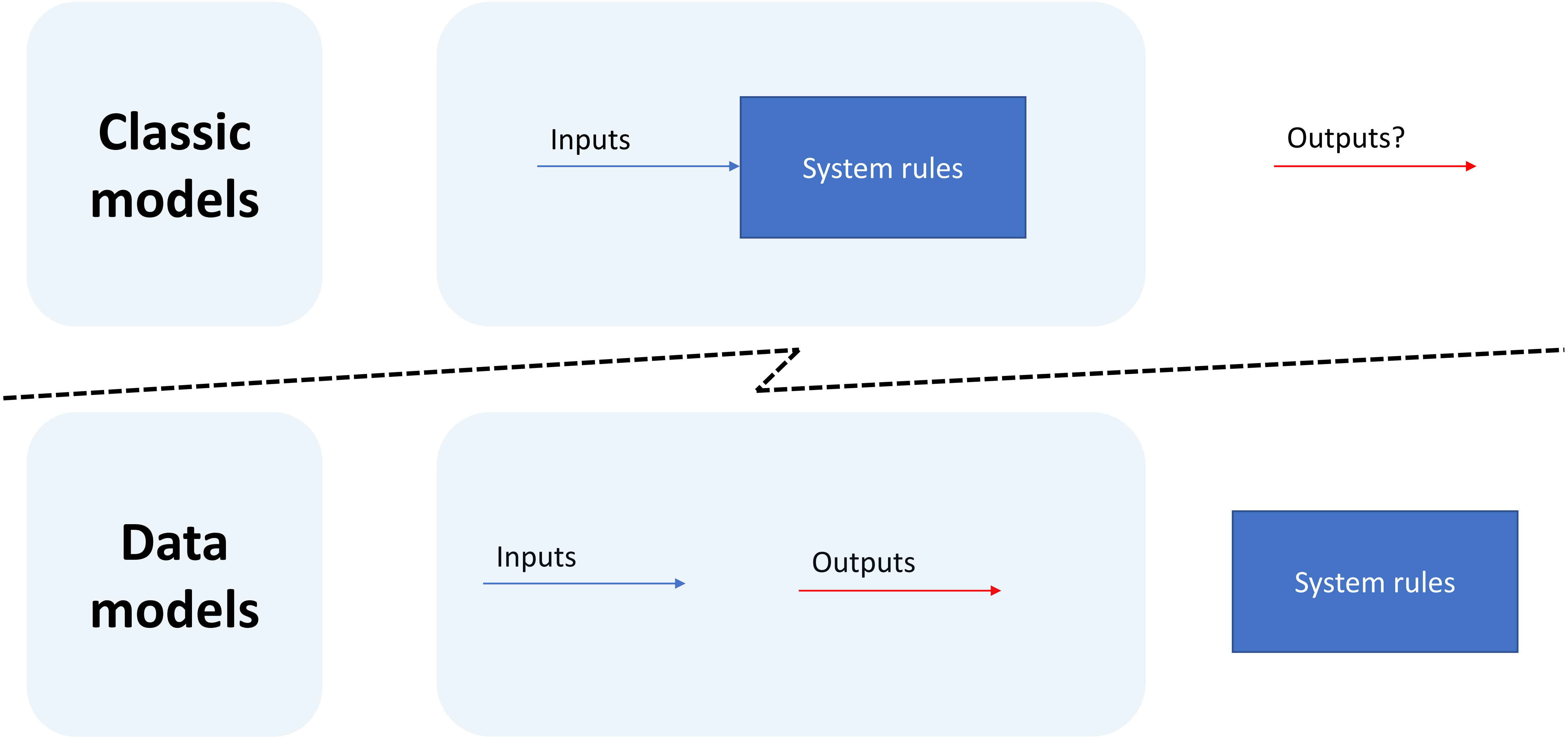

Pre-definitions

Data Science

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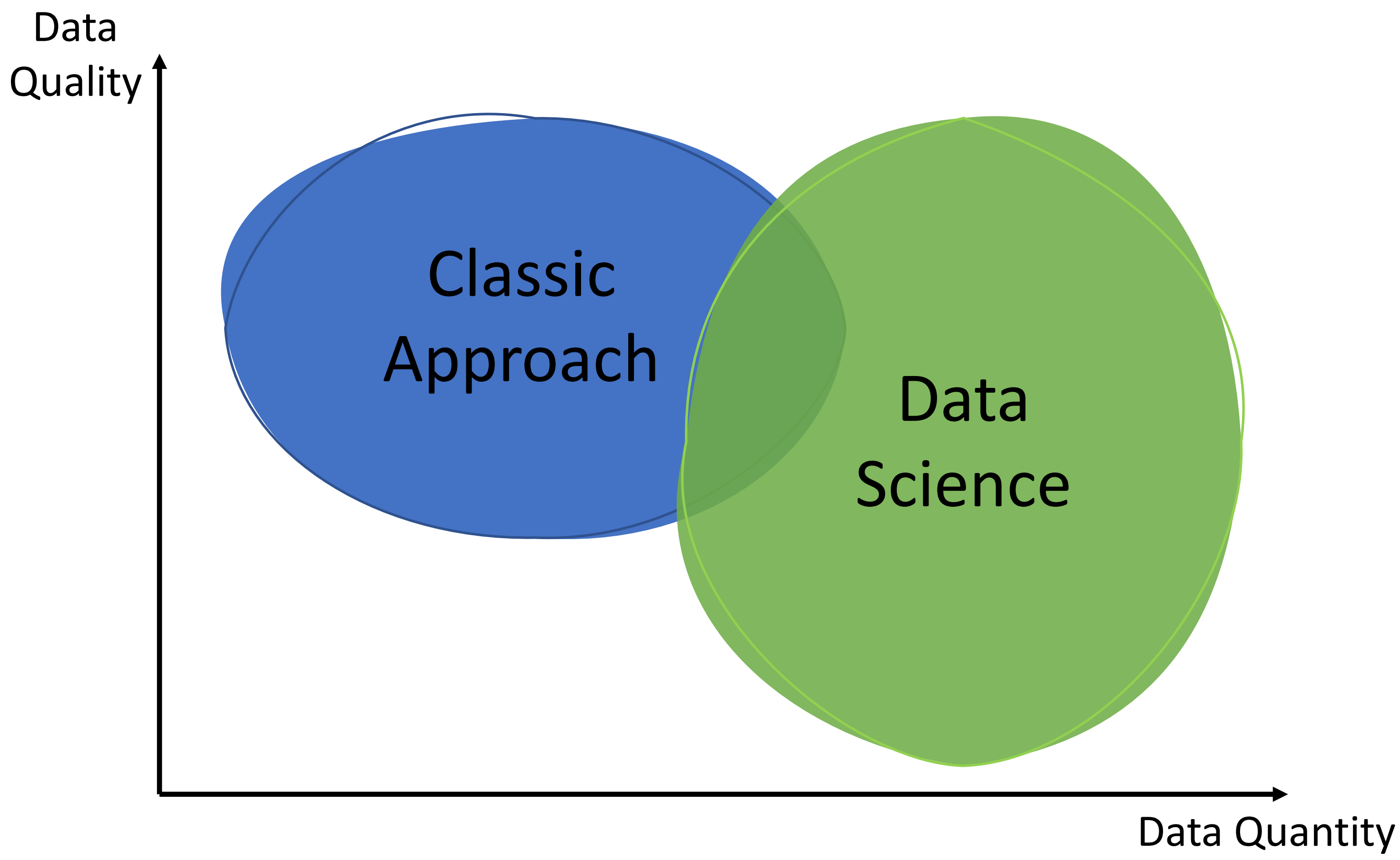
When Data Science?



Rules of ML (by Google)

Before ML	Rule 01: Go for simple heuristics first. Rule 02: Design and implement metrics. Rule 03: Choose ML over complex heuristics.
First Pipeline	Rule 04: Keep the first model simple and get the infrastructure right. Rule 07: Turn heuristics into features. Rule 13: Choose a simple metric for your first objective Rule 16: Plan to launch and iterate.
Feature Engineering	Rule 19: Use very specific features when you can. Rule 23: You are not a typical end user. Rule 24: Measure the delta between models.
Growth	Rule 43: …

*https://developers.google.com/machine-learning/guides/rules-of-ml

Pre-definitions

Data Science

What

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- Context
- Toolkit
- Project
- Data in F1
- Programming

Pre-definitions

Data Science

What

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When

How

Context

Toolkit

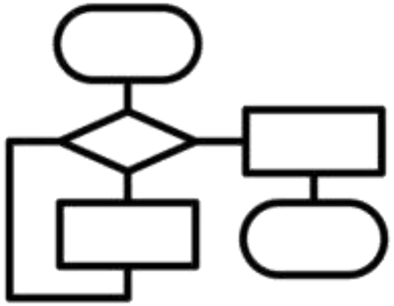
Project

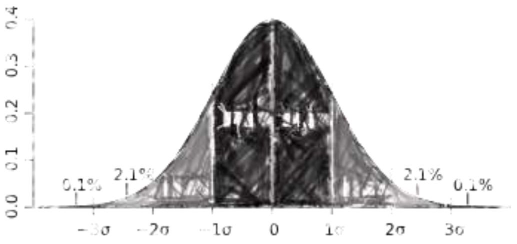
Data in F1

Programming

Data Analyst

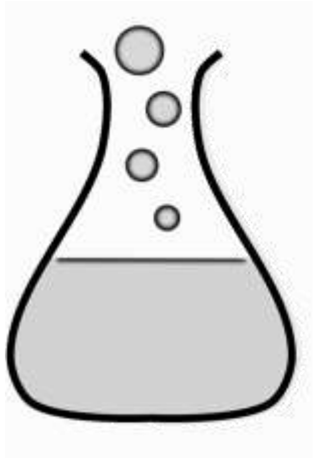
Overview/pre-analysis





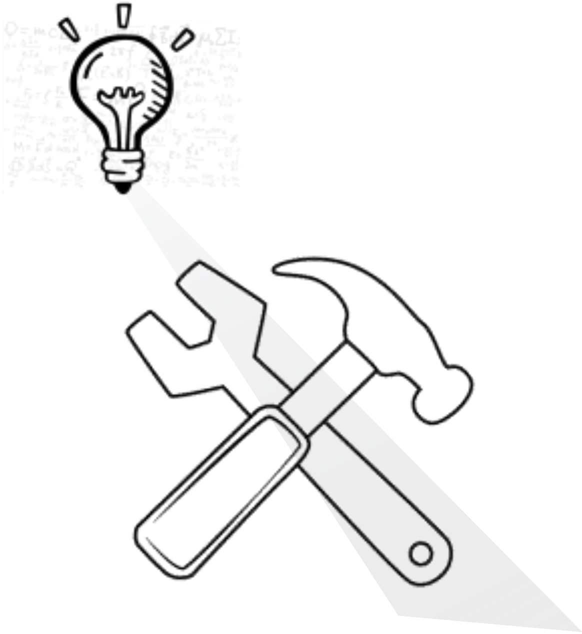
Data Scientist

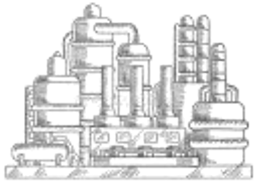
Algorithms/models



ML Engineer

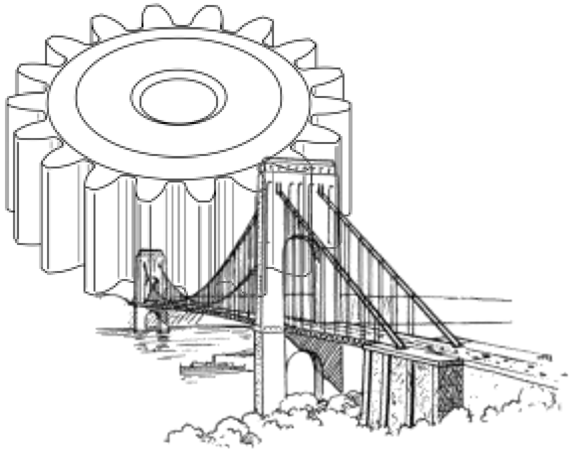
Implementation

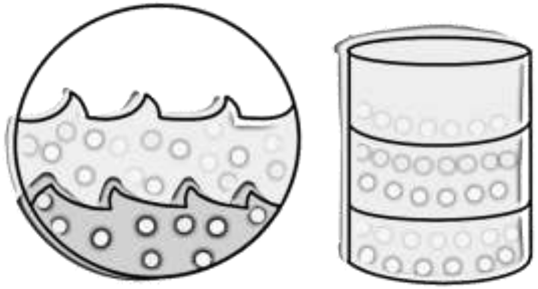




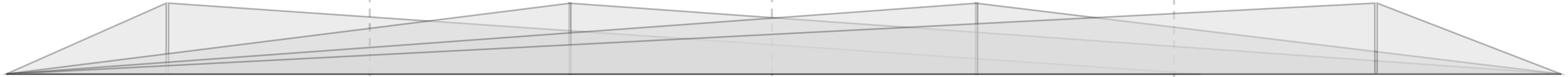
Data Engineer

Infrastructure

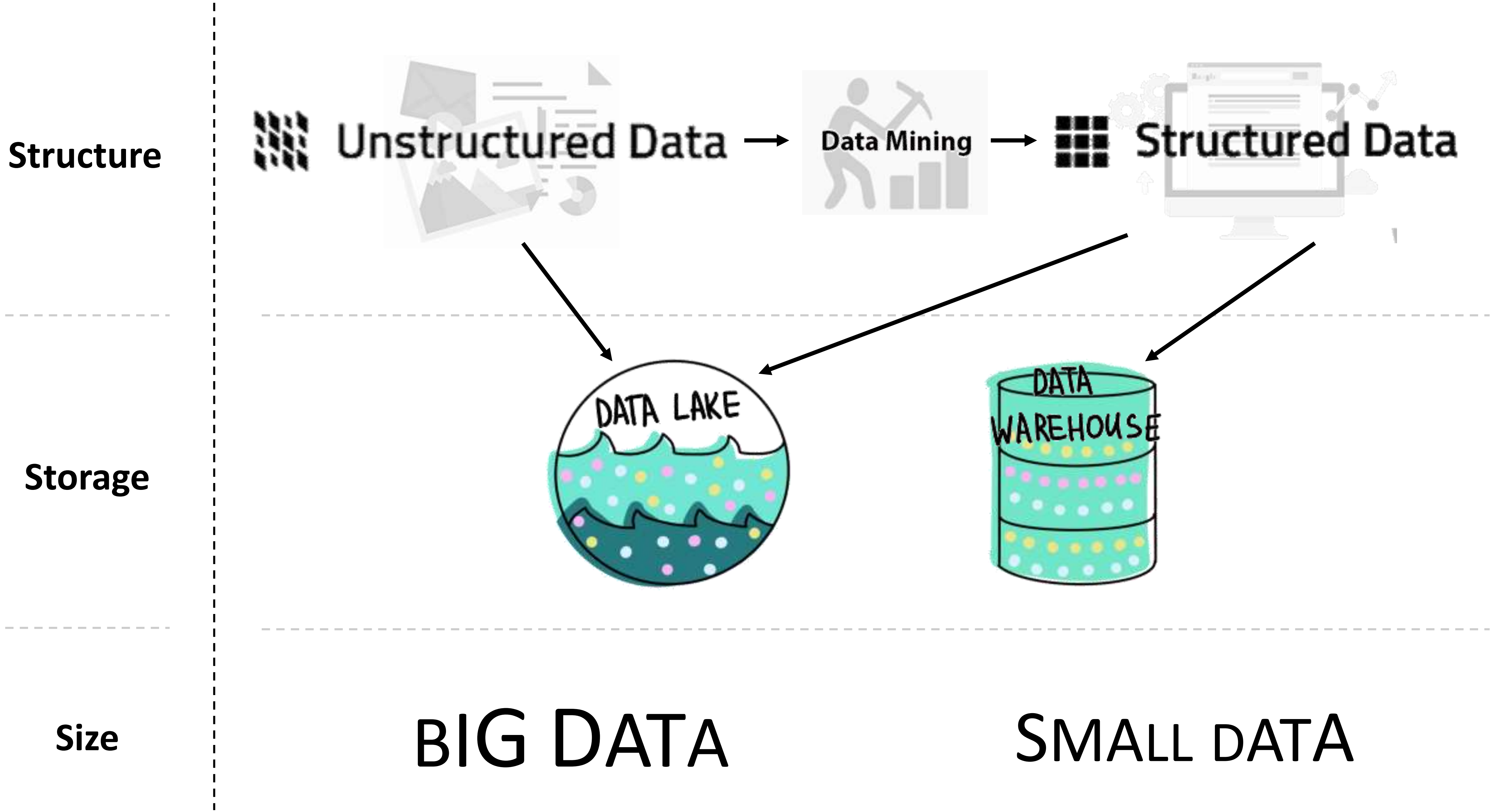




Technology stack



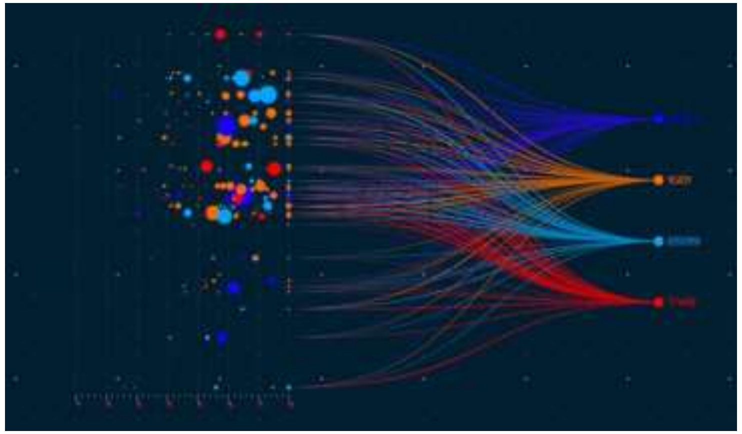
Data Analyst	Data Scientist	ML Engineer	Data Engineer
Overview/pre-analysis	*Algorithms/models*	*Implementation*	*Infrastructure*



*https://aws.amazon.com/es/big-data/datalakes-and-analytics/what-is-a-data lake/#:~:text=A%20data%20lake%20is%20a,unstructured%20data%20at%20any%20scale.

Data Science Work Flow

DATA



* https://www.emlv.fr/big-data-outils-analyser-donnees/

Data Science Work Flow

DATA

Structured

Databases (SQL, non SQL …)

CSV, JSON files

Proprietary file formats

Unstructured

Websites

Videos, pictures, audio…

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Modelling

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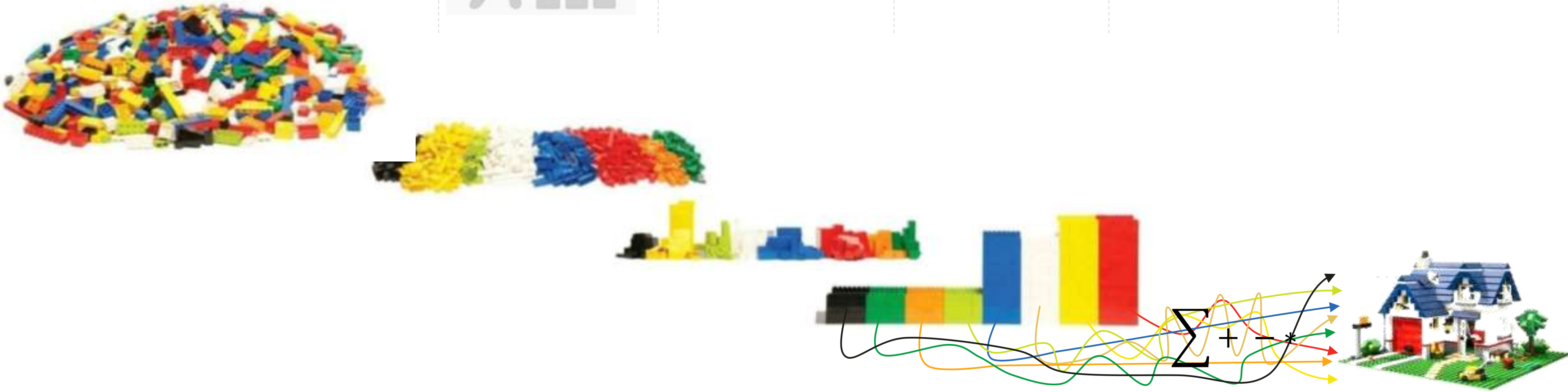


* https://www.emlv.fr/big-data-outils-analyser-donnees/

Pre-definitions

Data Science

What

Who

Why

When

How

- Context
- **Toolkit**
- Project
- Data in F1
- Programming

Modelling Toolkit

Inputs → Rules → Outputs

Features

Labels

*https://dethwench.com/healthcare-data-science-newbie-toolkit/?__cf_chl_jschl_tk__=t92eT2ztXr6SmbKokeQBqDypvU5chZoEYCFpXb6m1y4-1636022237-0-gaNycGzNCCU

Modelling Toolkit

Inputs → Rules → Outputs

	Inputs		Outputs
Supervised	Features		Labels
Un-Supervised	Features		~~Labels~~

Modelling Toolkit

Inputs → Rules → Outputs

Supervised Features Labels

Un-Supervised Features

Discrete Continuous

Classifier **Regressor**

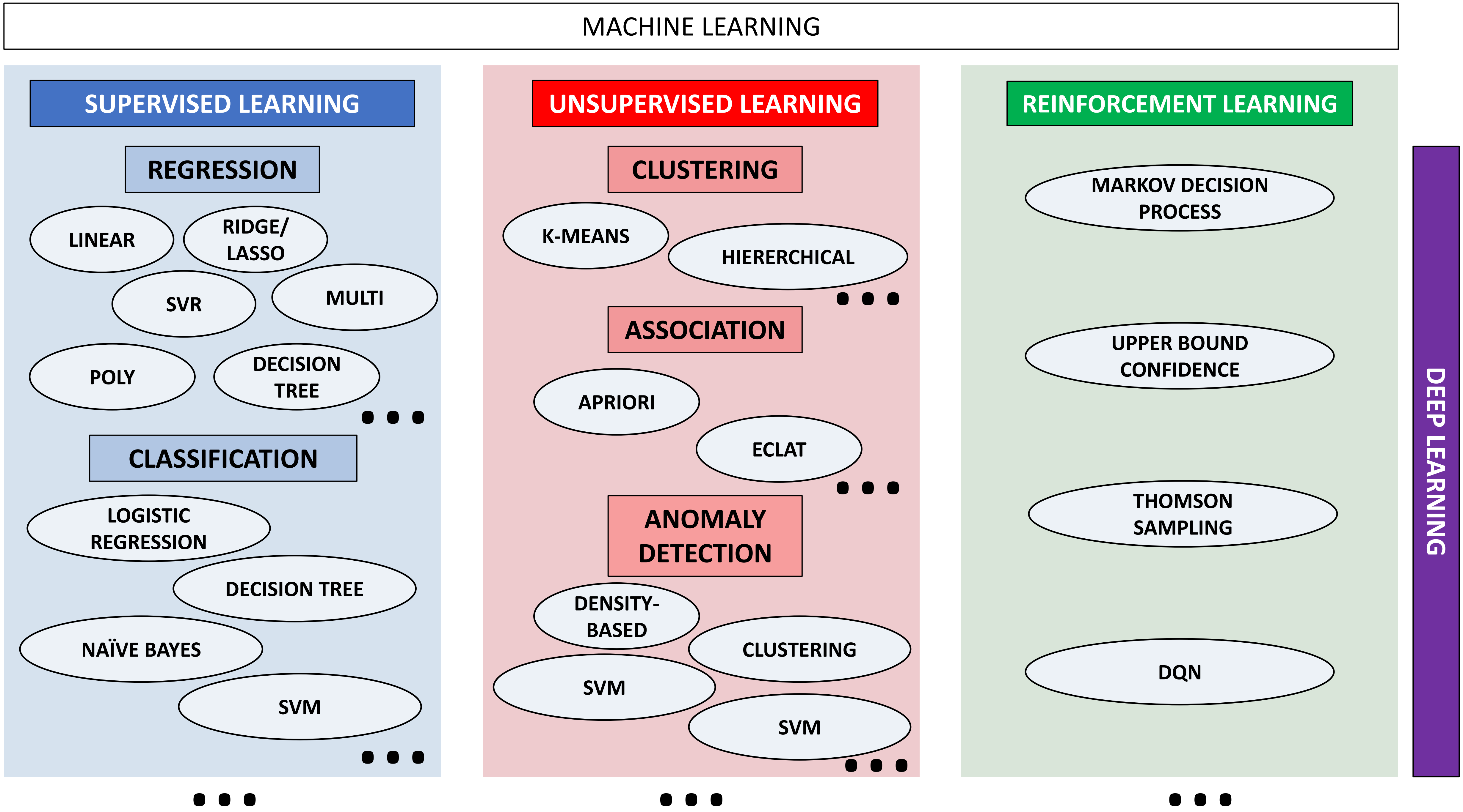
Modelling Toolkit

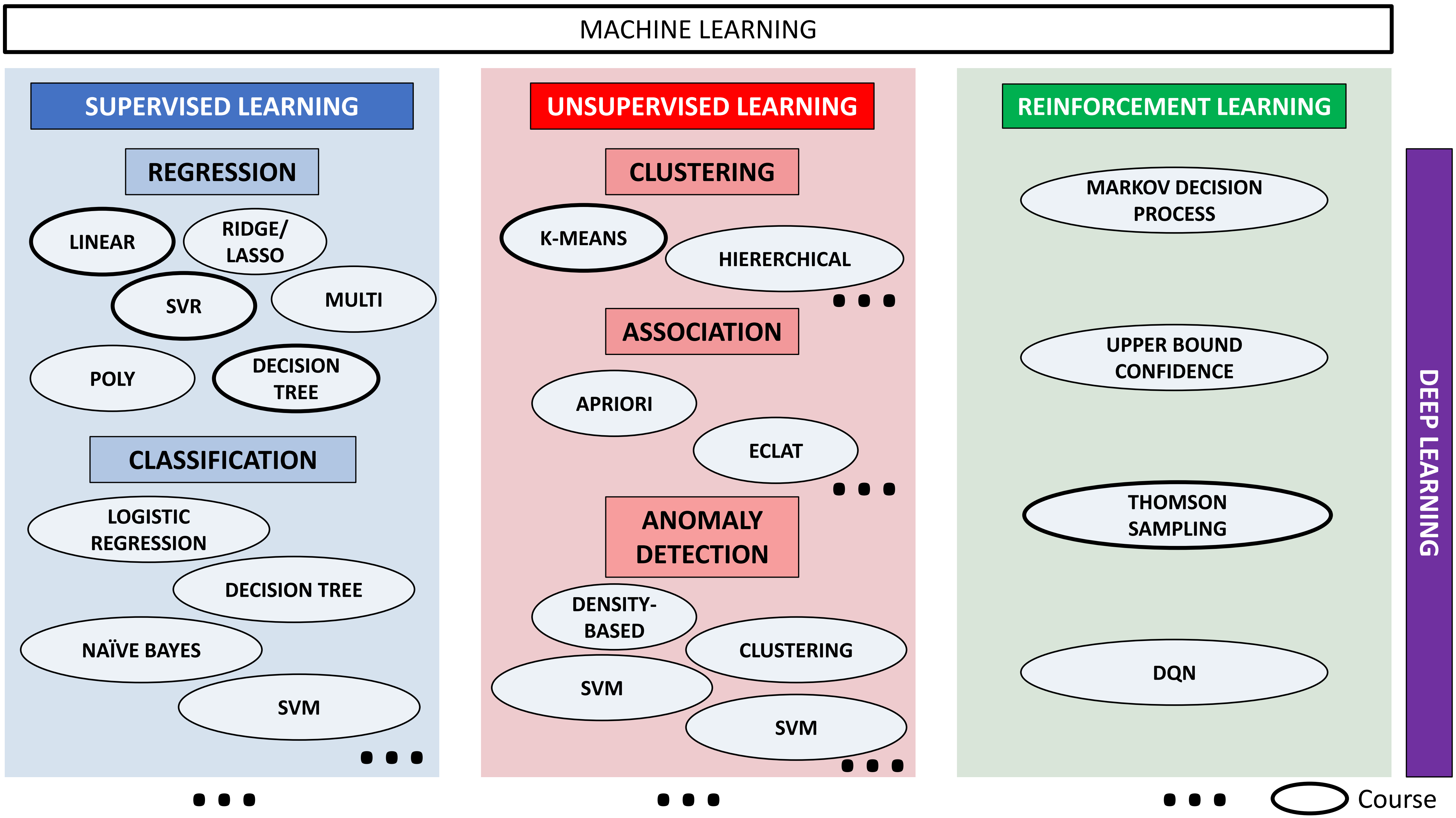
Inputs → Rules → Outputs

Supervised   Features   Labels

Un-Supervised   Features   Labels

Clustering   **Association**   **Anomaly Detection**


MACHINE LEARNING
SUPERVISED LEARNING
REGRESSION
LINEAR
RIDGE/ LASSO
SVR
MULTI
POLY
DECISION TREE
CLASSIFICATION
LOGISTIC REGRESSION
DECISION TREE
NAÏVE BAYES
SVM
UNSUPERVISED LEARNING
CLUSTERING
K-MEANS
HIERERCHICAL
ASSOCIATION
APRIORI
ECLAT
ANOMALY DETECTION
DENSITY-BASED
CLUSTERING
SVM
SVM
REINFORCEMENT LEARNING
MARKOV DECISION PROCESS
UPPER BOUND CONFIDENCE
THOMSON SAMPLING
DQN
DEEP LEARNING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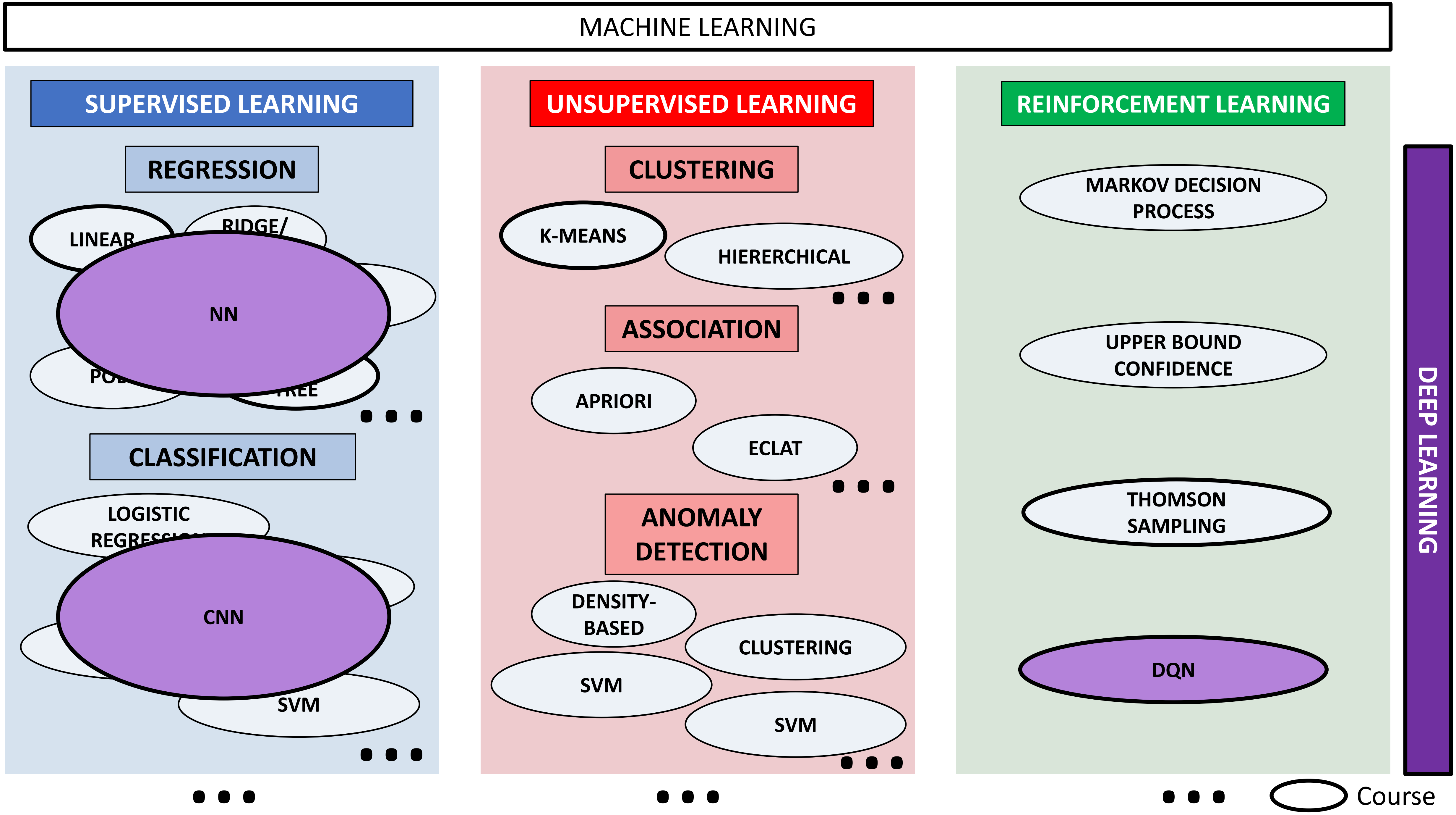
Course


MACHINE LEARNING
SUPERVISED LEARNING
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NN
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Course

Data Science

Pre-definitions

What

Who

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Context

Toolkit

Project

Data in F1

Programming

System to study

Sensors study

Installation of sensors

Interface

Storing the data

Data Science Project

System to study

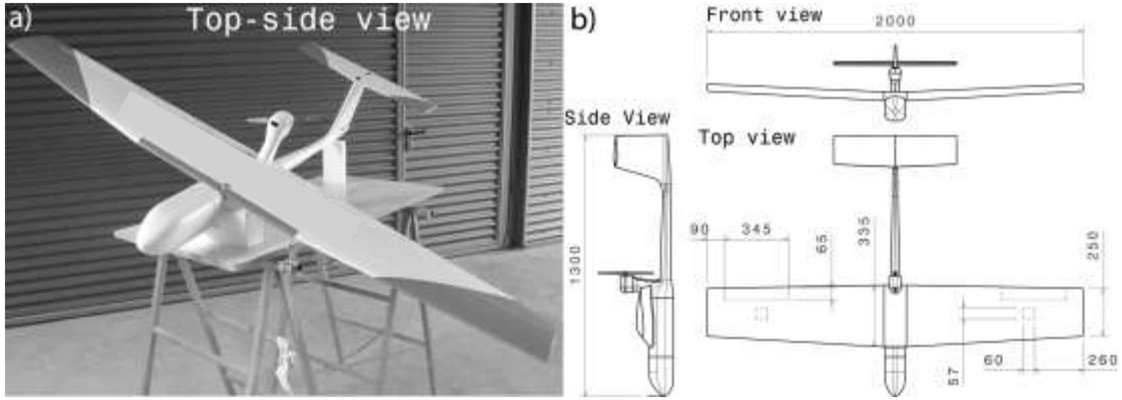
Sensors study

Installation of sensors

Interface

Storing the data

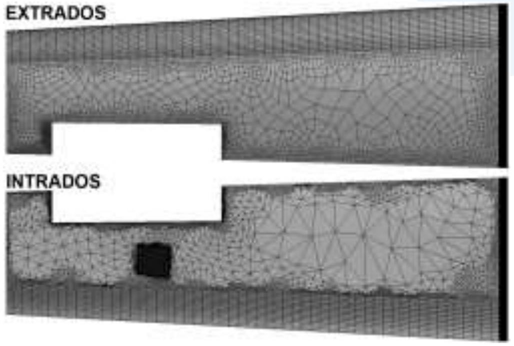
Data Science Project

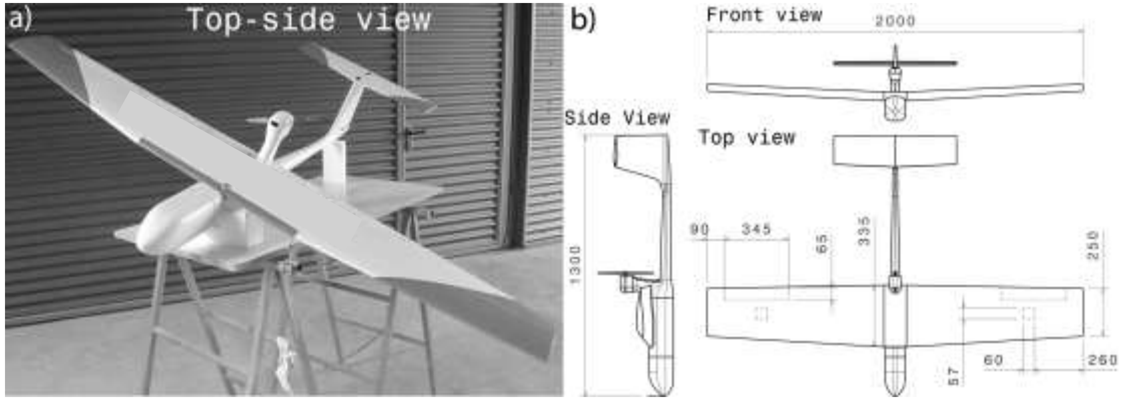


* Gutiérrez, Nicolás, et al. "Fiber Bragg grating application to study an unmanned aerial system composite wing." *Journal of Intelligent Material Systems and Structures* 30.8 (2019): 1252-1262.

System to study

Sensors study





Installation of sensors

Interface

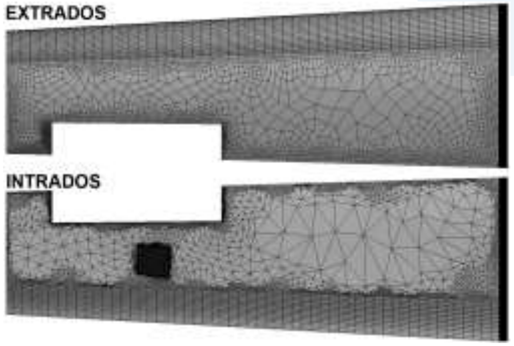
Storing the data

Data Science Project

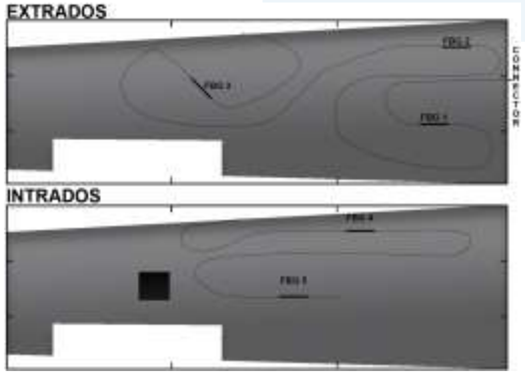
* Gutiérrez, Nicolás, et al. "Fiber Bragg grating application to study an unmanned aerial system composite wing." *Journal of Intelligent Material Systems and Structures* 30.8 (2019): 1252-1262.

System to study

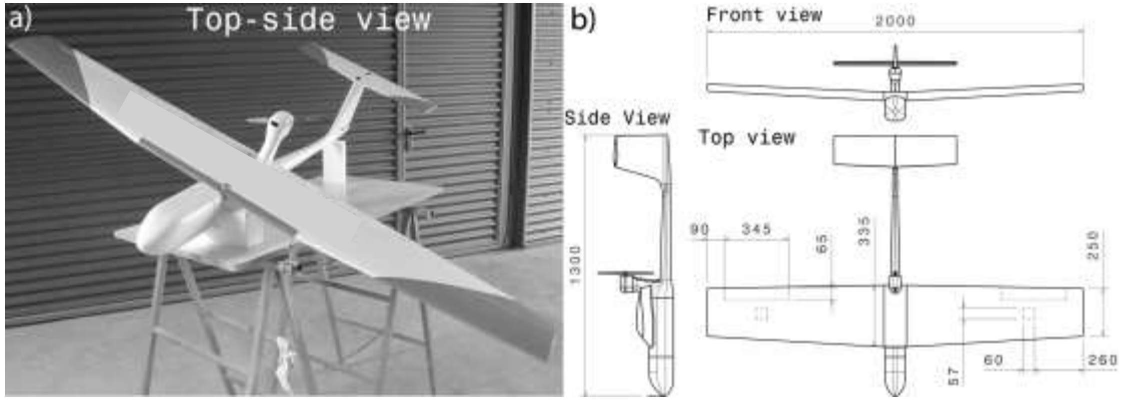
Sensors study



Installation of sensors



Load cell



Interface

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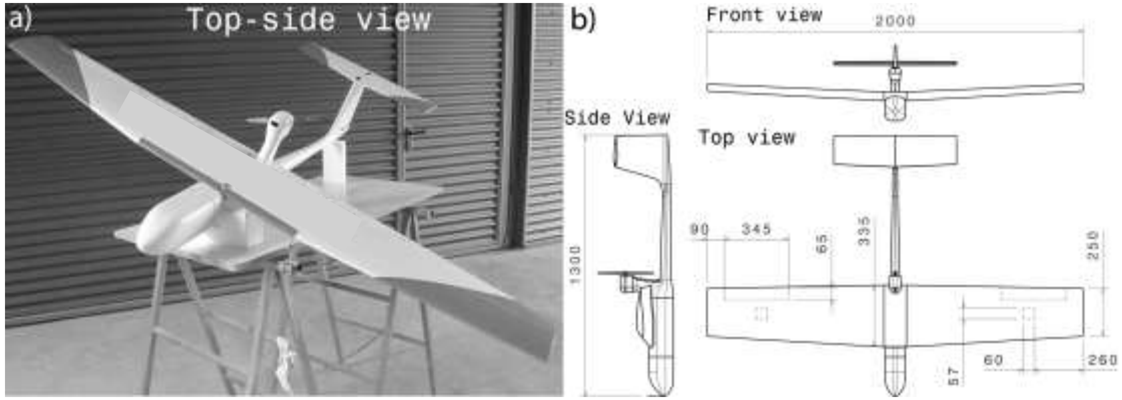
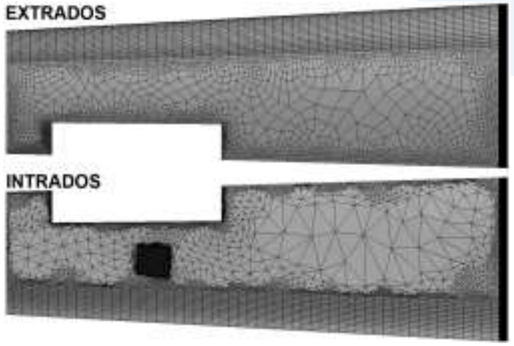


Sensors study



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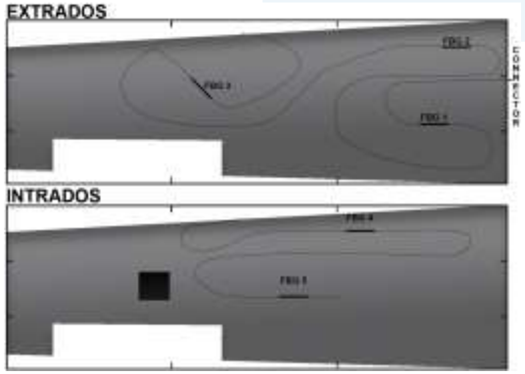

Load cell

Interface

Storing the data

Data Science Project

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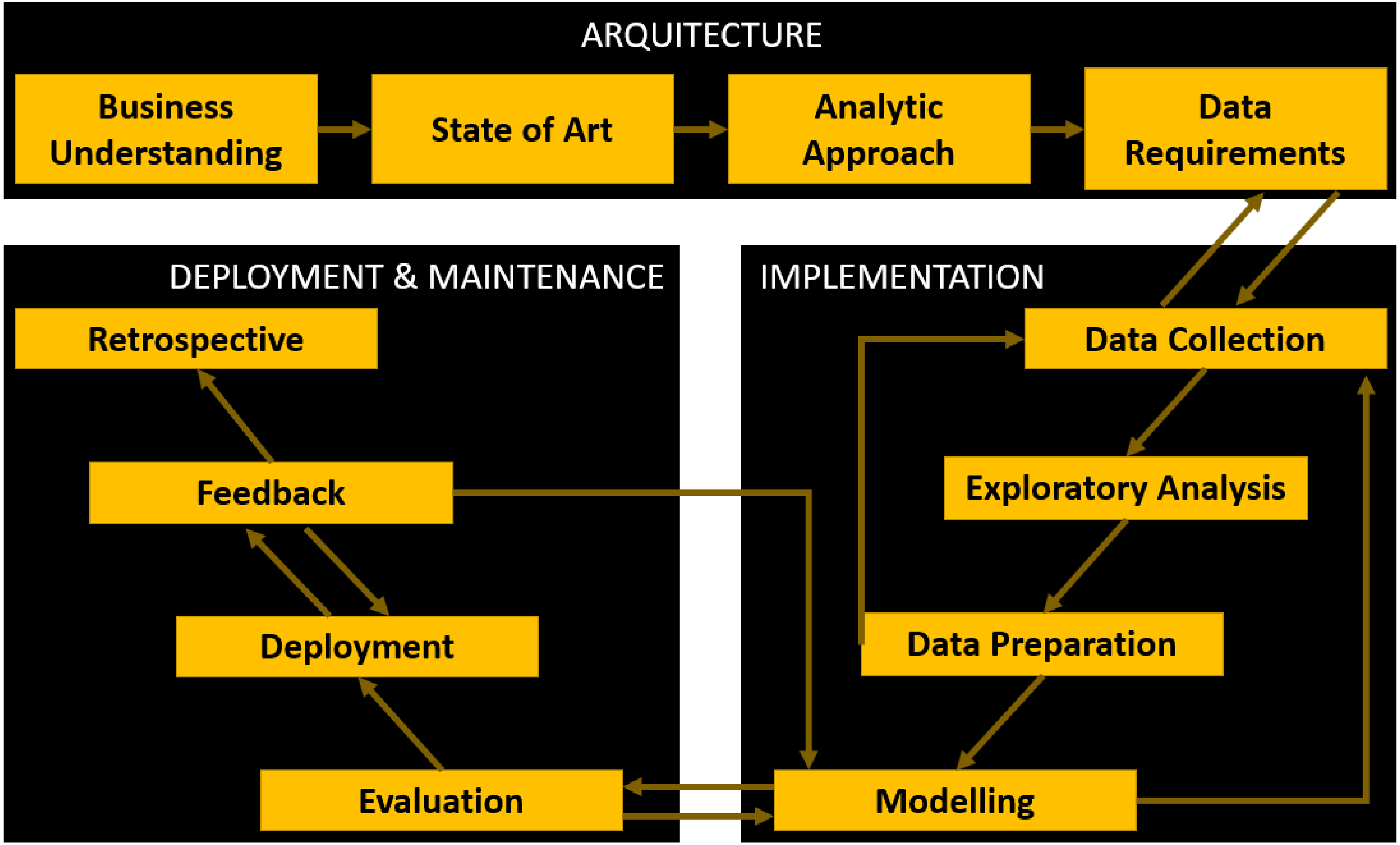
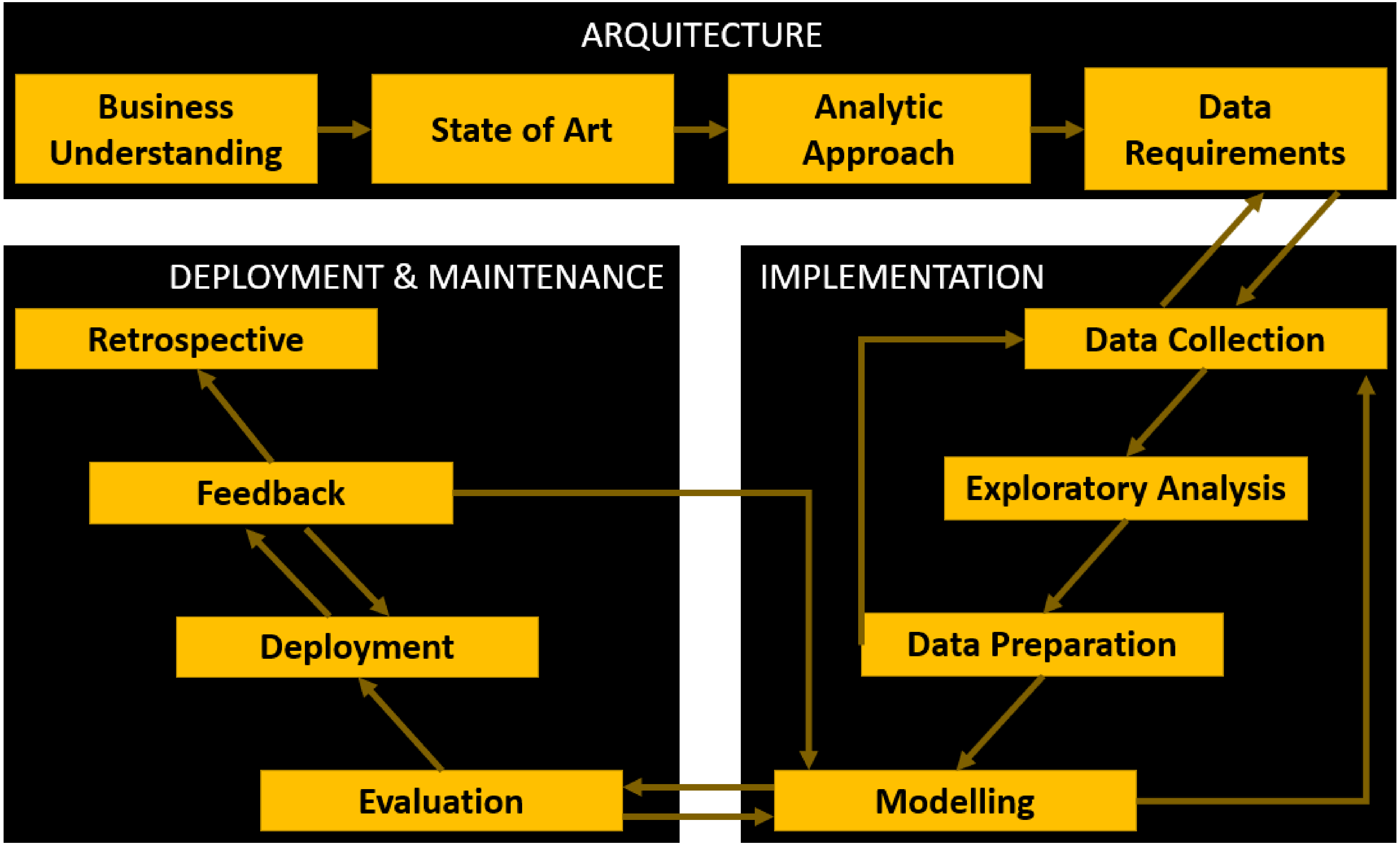
Standard
Tape 33$ TB
Disk 45$ TB

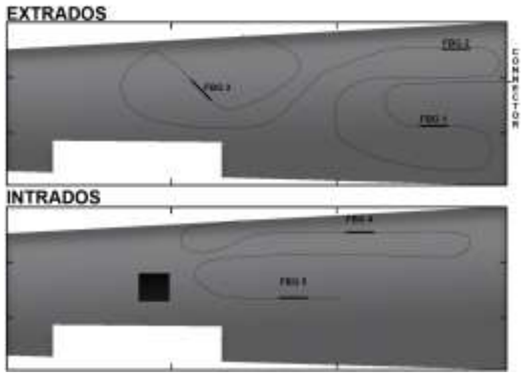
Storing the data

Data Science Project



Data Science Project


ARQUITECTURE
Business Understanding
State of Art
Analytic Approach
Data Requirements
DEPLOYMENT & MAINTENANCE
Retrospective
Feedback
Deployment
Evaluation
IMPLEMENTATION
Data Collection
Exploratory Analysis
Data Preparation
Modelling



Load cell

Storing the data

- Alarms (thresholds) for load and strains
- Fatigue analysis
- Impact detection
- Dynamic analysis (aeroelasticity?)
- Distribution of the loads

- Regression models load-strain.
- Clustering of maneuvers.
- Patterns repeated in time.
- Anomaly detection (Sensor error or dangerous maneuvers)
- Classification of structural state.
- …

Refinement of design and calculation, reduce of costs and improvement of performances

Improvement of the product

* https://towardsdatascience.com/why-we-need-more-ai-product-owners-not-data-scientists-e481cef39b90

Pre-definitions

Data Science

What

Who

Why

When

How

Context

Toolkit

Project

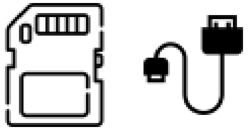
Data in F1

Programming

Data in F1

≈ (O) 100 sensors
≈ (O) 10Gb per weekend

Data in F1



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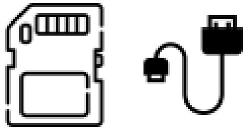
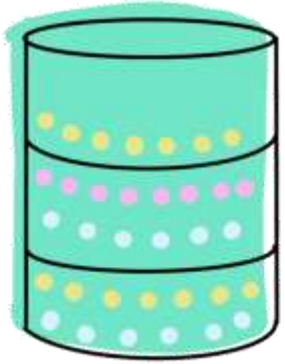
Data in F1

Trackside
engineers



Design, calculation and manufacturing



≈ (O) 100 sensors
≈ (O) 10Gb per weekend

Data in F1

≈ (O) 100 sensors
≈ (O) 10Gb per weekend

Trackside engineers

Design, calculation and manufacturing

Vehicle Performance Group

Control Systems Modelling Group

Design Office

Aero

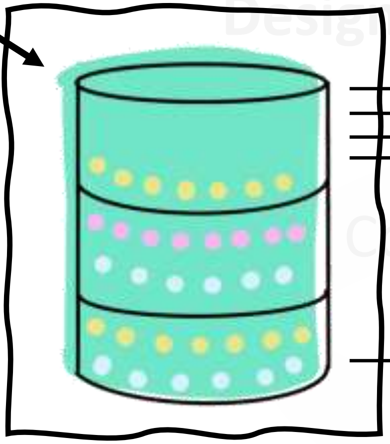
IT

…

Data in F1

≈ (O) 100 sensors
≈ (O) 10Gb per weekend

Trackside engineers



Classic Models

Data Models

Design, calculation and manufacturing

Control Systems Modelling Group

Design Office

Aero

IT

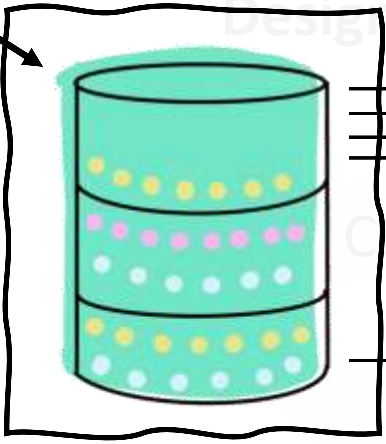
...

Data in F1

Trackside engineers

≈ (O) 100 sensors
≈ (O) 10Gb per weekend

Data Science is exploding in F1, stay tuned if you are interested!!



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Data Models

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...

Pre-definitions

Data Science

What

Who

Why

When

How

- Context
- Toolkit
- Project
- Data in F1
- **Programming**

Coding for Data Science

Data Science requires a support, a tool that allows quick and easy interaction with data.

Additionally the “bigger” the data, the “higher” the computational demands.

Coding for Data Science

Top 6 Data Science Programming Languages 2021 [Hand-Picked]

1. Python
2. JavaScript
3. Scala
4. R
5. SQL
6. Julia

edX Blog

9 Top Programming Languages for Data Science

1. Python
2. R
3. SQL
4. Scala
5. Julia
6. JavaScript
7. Java
8. C/C++
9. Matlab

// FLATIRON SCHOOL

The 10 Best Data Science Programming Languages to Learn in 2021

1. Python
2. JavaScript
3. Java
4. R
5. C/C++
6. SQL
7. Matlab
8. Scala
9. Julia
10. SAS

BIG DATA MADE SIMPLE

Top 8 programming languages every data scientist should master in 2019

1. Python
2. R
3. Java
4. SQL
5. Julia
6. Scala
7. Matlab
8. (Tensorflow)

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Why Python?

High level language

Easy to read, learn and write

Great community support

Famous and gaining more popularity

Interpreted

Free and open source

Great for Data Science

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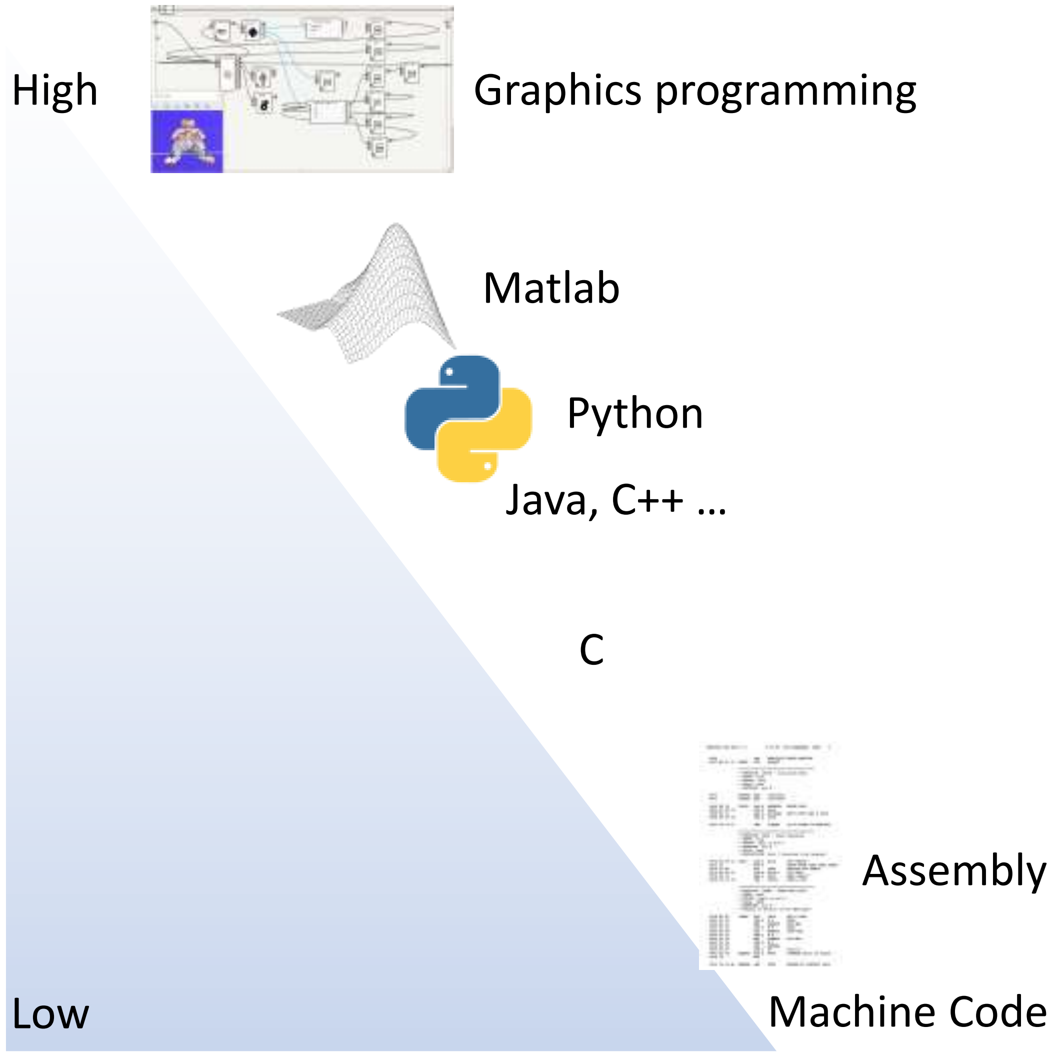

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Clean syntax and indentation structure

```
# Python 3: Simple output (with Unicode)
>>> print("Hello, I'm Python!")
Hello, I'm Python!

# Input, assignment
>>> name = input('What is your name?\n’)
>>> print('Hi, %s.' % name)
What is your name?
Python
Hi, Python.
```

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*Study by SlashData

The size of programming language communities in Q3 2020 is as follows:

1. JavaScript
Active developers: 12.4 million
Most popular in: Web, Cloud
Least popular in: Data Science, Machine Learning, AR/VR

2. Python
Active developers: 9 million
Most popular in: Data Science, Machine Learning, IoT
Least popular in: Mobile, Web

3. Java
Active developers: 8.2 million
Most popular in: Mobile, Cloud
Least popular in: Data Science, Machine Learning, Web

4. C/C++
Active developers: 6.3 million
Most popular in: IoT, AR/VR
Least popular in: Web, Cloud, Mobile

5. PHP
Active developers: 6.1 million
Most popular in: Web, Cloud
Least popular in: Data Science, Machine Learning, Mobile

6. C#
Active developers: 6.0 million
Most popular in: Games, AR/VR, Desktop
Least popular in: Data Science, Machine Learning, Mobile

*https://content.techgig.com/10-programming-languages-with-the-biggest-community-support/articleshow/78908491.cms

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TIOBE Index

Aug 2021	Aug 2020	Change	Programming language	Ratings	Change
1	1		C	12.57%	-4.41%
2	3	↑	Python	11.86%	+2.17%
3	2	↓	Java	10.43%	-4.00%
4	4		C++	7.36%	+0.52%
5	5		C#	5.14%	+0.46%
6	6		Visual Basic	4.67%	+0.01%
7	7		JavaScript	2.95%	+0.07%
8	9	↑	PHP	2.19%	-0.05%
9	14	↑↑	Assembly language	2.03%	+0.99%
10	10		SQL	1.47%	+0.02%
11	18	↑↑	Groovy	1.36%	+0.59%
12	17	↑↑	Classic Visual Basic	1.23%	+0.41%
13	42	↑↑	Fortran	1.14%	+0.83%
14	8	↓↓	R	1.05%	-1.75%
15	15		Ruby	1.01%	-0.03%
16	12	↓↓	Swift	0.98%	-0.44%
17	16	↓	MATLAB	0.98%	+0.11%
18	11	↓↓	Go	0.90%	-0.52%
19	36	↑↑	Prolog	0.80%	+0.41%
20	13	↓↓	Perl	0.78%	-0.33%

PYPL Index (Worldwide)

Aug 2021	Change	Programming language	Share	Trends
1		Python	29.93 %	-2.2 %
2		Java	17.78 %	+1.2 %
3		JavaScript	8.79 %	+0.6 %
4		C#	6.73 %	+0.2 %
5	↑	C/C++	6.45 %	+0.7 %
6	↓	PHP	5.76 %	-0.0 %
7		R	3.92 %	-0.1 %
8		Objective-C	2.26 %	-0.3 %
9	↑	TypeScript	2.11 %	+0.2 %
10	↓	Swift	1.96 %	-0.3 %
11	↑	Kotlin	1.81 %	+0.3 %
12	↓	Matlab	1.48 %	-0.4 %
13		Go	1.29 %	-0.2 %
14	↑↑	Rust	1.21 %	+0.2 %
15	↓	VBA	1.16 %	-0.1 %
16	↓	Ruby	1.02 %	-0.1 %
17		Scala	0.79 %	-0.1 %
18	↑	Ada	0.77 %	+0.2 %
19	↓	Visual Basic	0.75 %	+0.0 %
20		Dart	0.68 %	+0.2 %
21		Lua	0.58 %	+0.1 %
22	↑↑	Cobol	0.51 %	+0.1 %
23		Groovy	0.51 %	+0.1 %
24	↓↓	Abap	0.46 %	-0.0 %
25	↑	Perl	0.45 %	+0.1 %
26	↓	Julia	0.39 %	-0.0 %
27	↑	Haskell	0.24 %	-0.0 %
28	↓	Delphi/Pascal	0.2 %	-0.1 %

*https://statisticstimes.com/tech/top-computer-languages.php

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>>> print('Hi, %s.' % name)
What is your name?
Python
Hi, Python.
```

VS

Compiled

```
public void InitAnimations()
{
    viewportSizeY = GetViewportRect().Size.y;
    spawnY = viewportSizeY / 2.0f + 16f;

    // Player Anim
    Animation anim = GetNode<AnimationPlayer>("FlyInAnim").GetAnimation("FlyIn");
    anim.TrackSetKeyValue(0, 0, new Vector2(0, -viewportSizeY / 2.0f + -80f));
    anim.TrackSetKeyValue(0, 1, new Vector2(0, (-viewportSizeY / 2.0f) + viewportSizeY / 3.0f));
    player.Position = new Vector2(0, -viewportSizeY / 2.0f + -80f);

    anim = GetNode<AnimationPlayer>("BgChangeAnim").GetAnimation("BgChangeAnim");
    anim.TrackSetKeyValue(1, 0, new Vector2(0, 0));
    anim.TrackSetKeyValue(1, 1, new Vector2(0, -viewportSizeY / 2.0f - 200.0f));


    GetNode<Sprite>("SpaceBGOverlay").Position = new Vector2(0, 0);


    anim = GetNode<AnimationPlayer>("BackgroundAnim").GetAnimation("BackgroundAnim");
    GetNode<AnimatedSprite>("BackgroundSprite").Frame = random.RandiRange(0, 1);
    anim.TrackSetKeyValue(0, 0, new Vector2(0, -viewportSizeY / 2.0f + 225.0f));
    anim.TrackSetKeyValue(0, 1, new Vector2(0, +viewportSizeY / 2.0f - 225.0f));
    GetNode<AnimatedSprite>("BackgroundSprite").Position = new Vector2(0, -viewportSizeY / 2.0f + 225.0f);

    GetNode<Sprite>("PrototypLogo").Position = new Vector2(0, 32f);// new Vector2(0,viewportSizeY/2.0f-(viewportSizeY/3.0f));
}
```

*https://www.python.org/ and https://i.stack.imgur.com/EPgUV.png

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Great for Data Science

No royalties or licenses

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NumPy

SciPy

pandas

matplotlib

TensorFlow

...

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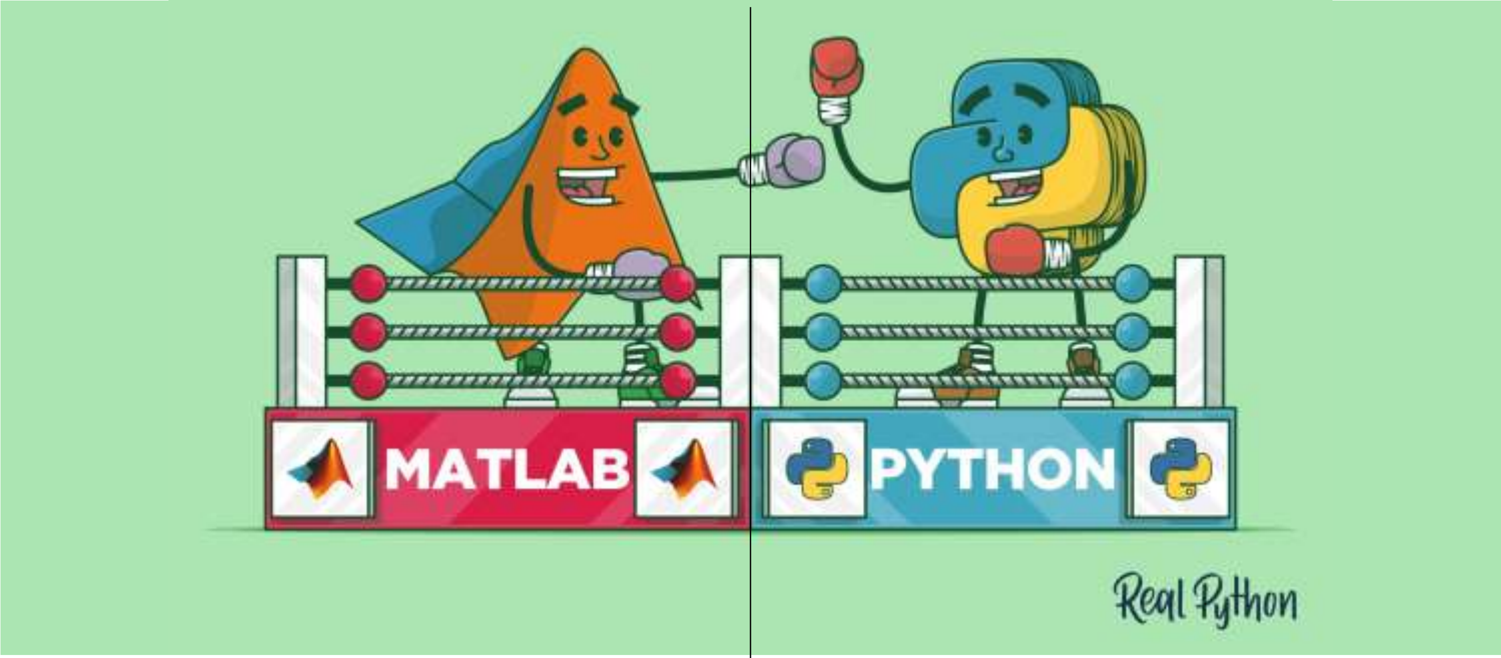
Python vs Matlab

Interpreted
High level and easy to use



Slightly higher performing (out of the box)
Proprietary (Pricey!)
Closed source
Poor deployment options
Integration with Simulink
King of simulation
Single IDE, Toolboxes agreed with MathWorks
Amazing help developed by MathWorks

Free
Open Source
Good deployment options
Integration with a huge amount of packages
King of Data Science
Multiple IDEs and packages
Huge community support (and growing!)

*https://realpython.com/matlab-vs-python/#:~:text=The%20biggest%20technical%20difference%20between,type%20of%20object%20called%20str%20.

Starting with Python for Data Science

Bare Python

Python from python.org
Select an IDE
Link the IDE to the Python interpreter

ANACONDA

Great for Data Science
GUI for environments
Easy import-export of env
Easy integration with IDEs
It can be used for Jupyter as well

jupyter

Nice interface to program and share.
Need Python first (Or docker)

Virtual environments

Python from python.org

pipx
pipenv

→ Env per project_1
→ Env per project_2
→ Env per project_3

• • •

QUESTIONS?