Decision Science

1. Motivations
2. The Brazilian e-commerce platform Olist
3. Organizing a Project in Data Science and Analytics
4. Notebook like a pro
5. How to debug your code
6. Dealing with new datasets
7. Joining tables

The Big Picture

🔥 5 sessions working as a **Data Consultant** on a real case study!

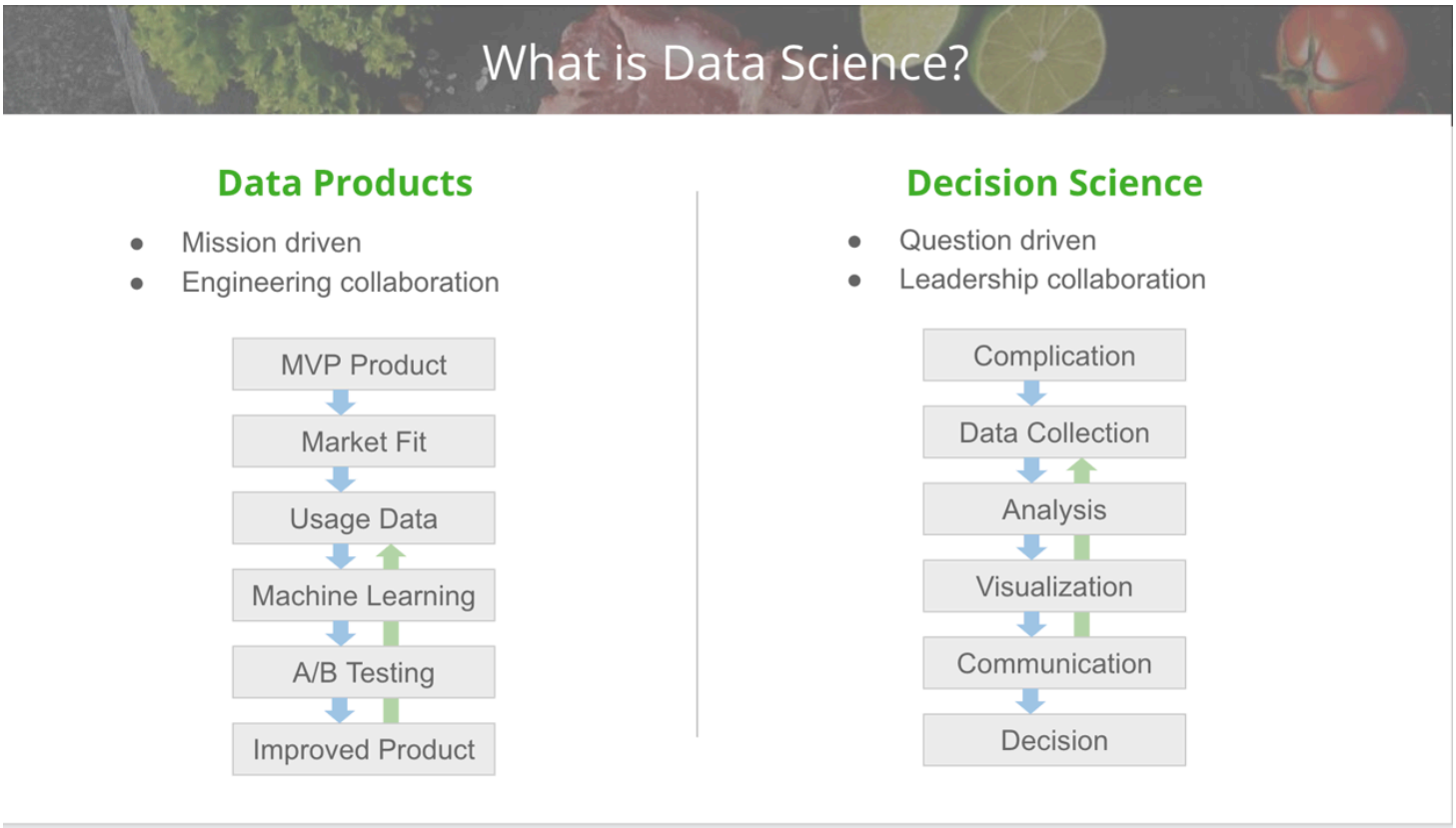
💸 Objective: help the business owners in their **Decision-Making Process**

📈 In-depth analysis of historical business data

🕵️ Discover your first (linear) **Statistical Models**: the Linear Regression and the Logistic Regression

- ❗ No fancy predictions of the future
- 👀 Find correlations between variables, i.e. make your data speak
- 🎲 Use **Statistical Inference** to prove the robustness of your findings

🗣️ **Communicate** your results



1. Motivations

❗ Overlooked qualities of Data Analysts and Data Scientists

🤝 **Domain Knowledge** > Technical Expertise

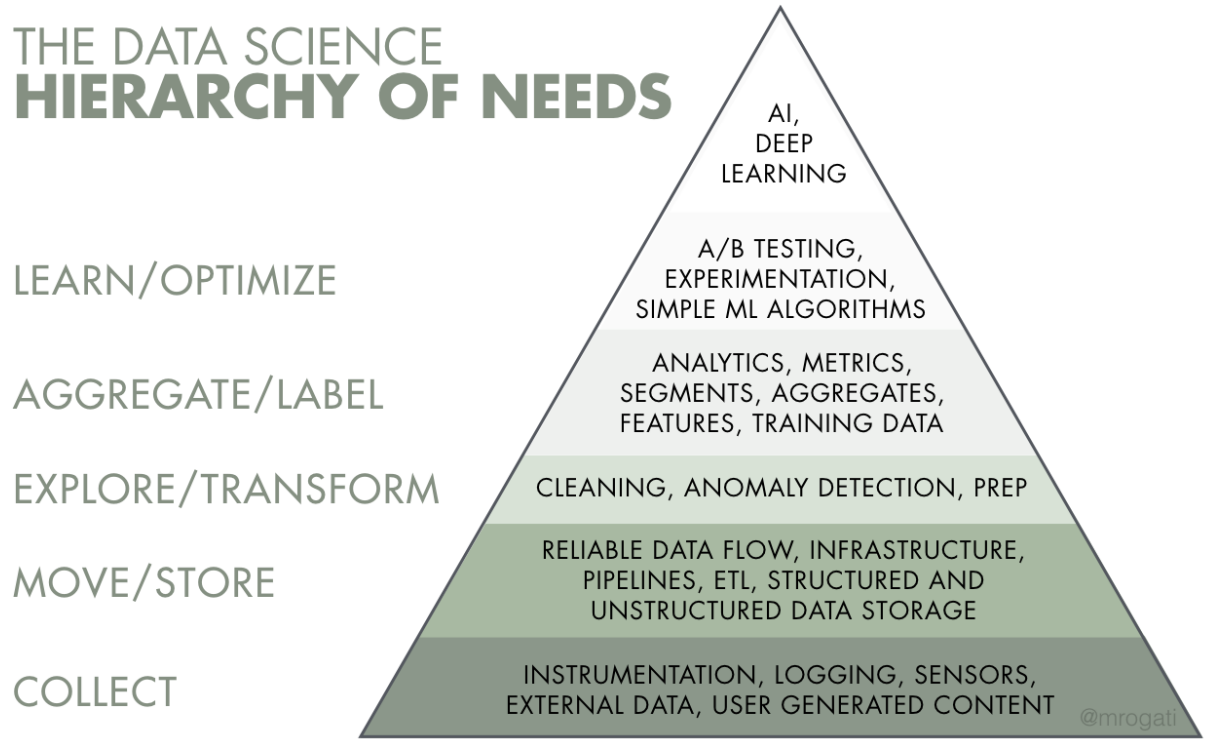
🚀 **Solve real issues**

😬 Handle **vague problems**

🔥 **Build with scale** in mind

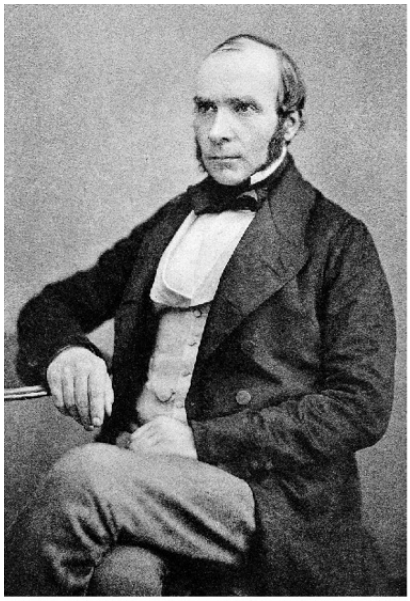
🗣️ **Communicate** well

Pyramid of Needs (#data preparation is key)

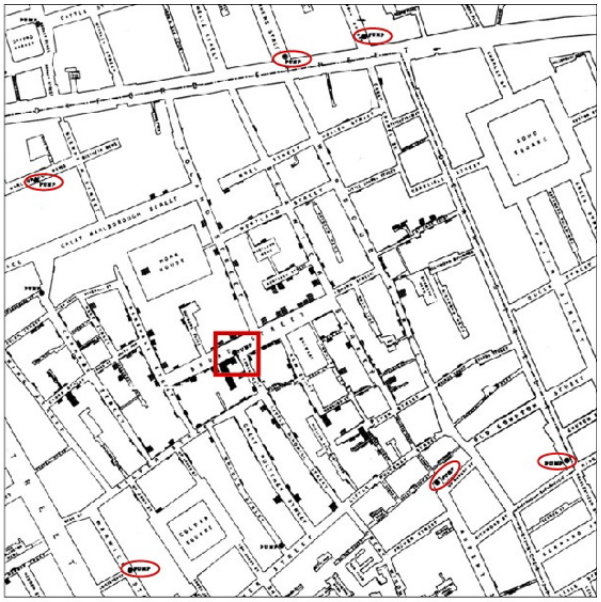


[The AI Hierarchy of Needs (https://hackernoon.com/the-ai-hierarchy-of-needs-18f111fcc007)](https://hackernoon.com/the-ai-hierarchy-of-needs-18f111fcc007), Monica Rogati, ex VP Data @ LinkedIn

John Snow & Cholera outbreak (#communicate)



(a)

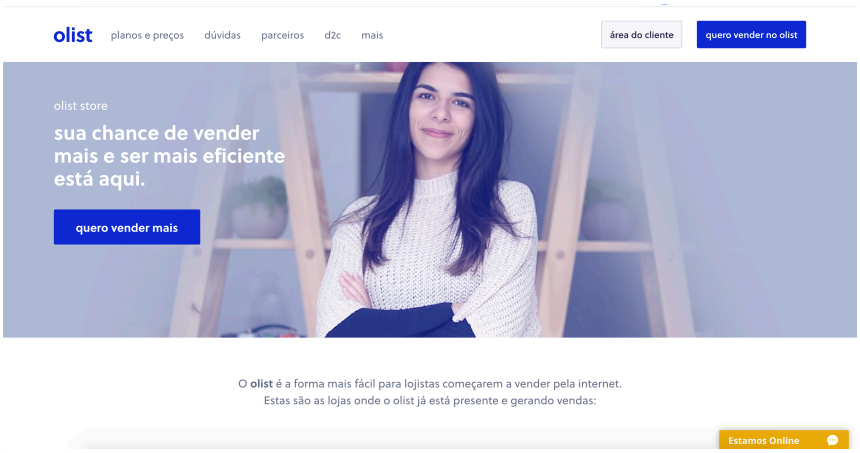


(b)

Source: [Wikipedia, 1854 - Broad Street Cholera Outbreak (https://en.wikipedia.org/wiki/1854_Broad_Street_cholera_outbreak)](https://en.wikipedia.org/wiki/1854_Broad_Street_cholera_outbreak)

2. The Brazilian e-commerce platform Olist

Introduction



`Olist` (https://olist.com/)

🗓️ Founded in 2015

🇧🇷 Operates in Brazil

💻 100% digital company
(Pure Digital Player, i.e. business operations fully managed online)

💸 Total Funding Amount
≈
136M USD (accumulated from 2015 to 2021)
Source: CrunchBase/Olist/CompanyFinancials (https://www.crunchbase.com/organization/olist/company_financials)

🛒 Online e-commerce service for sellers

🤝 Connects (small) merchants to the most important marketplaces in Brazil (Amazon, Bahia, Walmart, ...)

✅ Offers *Logistic and Inventory Management Services* to sellers

❗ Does *NOT* sell anything directly to consumers

The **Seller** workflow ⚙️

The seller:

1. joins Olist
2. uploads their product catalogues
    - (Olist) displays these catalogues to existing marketplaces (Amazon, Bahia, Walmart, ...)
3. gets notified whenever a product is sold
4. hands over the ordered items to third-party logistic carriers

Note: Multiple sellers can be involved in one customer's order!

The **Customer** workflow ⚙️

The customer:

1. browses products on marketplaces (Amazon, Bahia, Walmart, ...)
2. purchases products listed via `Olist.store`
3. gets an expected date for delivery
   - *ETA = Estimated Time of Arrival (of the orders)*
4. receives the order(s)
5. leaves a review

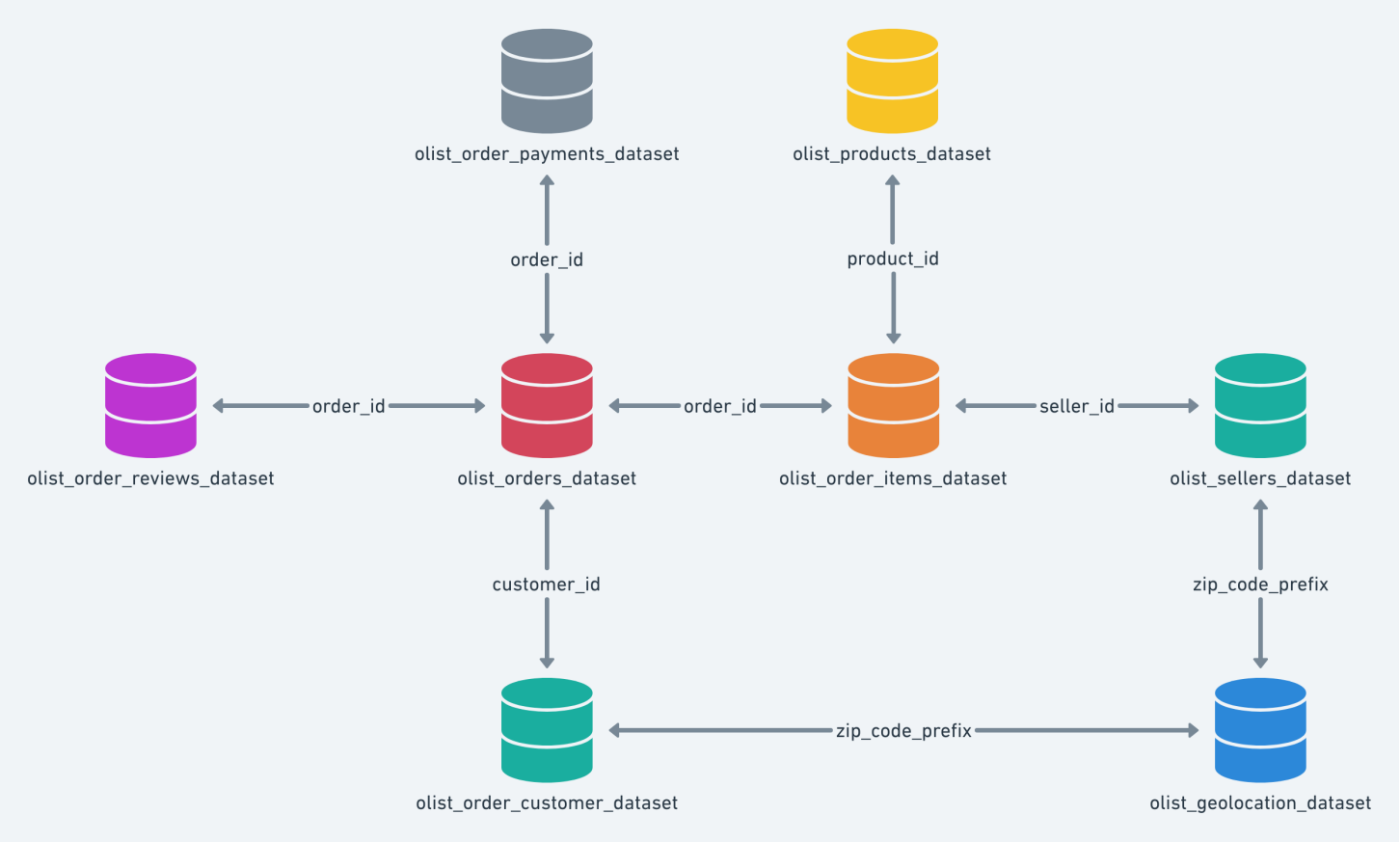
Note: Between 2016 and mid-2018, a review could be left as soon as the order was sent, meaning that a customer could potentially leave a review for a product they hadn't received yet!

Dataset

About the data: 🔢

- Released on Kaggle in November 2018
  - kaggle.com/olistbr/brazilian-ecommerce (https://www.kaggle.com/olistbr/brazilian-ecommerce)
- **`Information about ~100k orders made between 2016 and 2018`**
- **`8 csv files, ~120mb`**
- Real data!
  - Marketplaces' and merchants' identifiable information have been anonymized
- The full documentation is available in the `/data` directory of the 1st challenge of the unit

Data Model:



Revenues

💸 📈 **Olist's Revenues**:

Sellers have to pay to use Olist.

How does Olist earn revenues from the sellers?

`Variable revenues`

Olist charges a **10% cut** on each product sold by a seller, if the order was delivered.

`Fixed revenues`

Sellers have to pay Olist **80 BRL per month** to use the platform.

Costs

💸 📉 Olist's Costs

`IT Costs`

- We will make the (*simplified*) assumption that the IT Costs scale with the square root of the total number of sellers, as well as the square root of the total number of items sold.
- In other words, we assume that IT costs grow relatively slower and slower for each additional seller and additional item sold (economies of scale)

`Reputation Costs`

Bad reviews affect Olist's reputation and long term profits.

Let's quantify these impacts as follows:

review_score	cost (BRL)
1	100
2	50
3	40
4	0
5	0

❗ Warning ❗

- Keep in mind that we will be using these simplified assumptions for our Data Science Consulting project because we have five days to answer the question.
- In a Data Analyst interview, you will be given some datasets (`.csv`) and you will be asked to answer questions in a limited amount of days (3-5 days).
  - So you will also need to make some assumptions
  - Also, because in the recruiting process, you do not have access to the real costs of the company

Your mission

You have been tasked by Olist's CEO Tiago Dalvi (https://www.linkedin.com/in/tiagodalvi/?locale=pt_BR) to make sense of the dataset to give recommendations about the following question:

> *How to increase customer satisfaction (so as to increase profit margin) while maintaining a healthy order volume?*

3. Project Organization

3.1 Repository

```
.
├── 01-Project-Setup
│   │   # Your whole code logic and data, this is your "package"
│   ├── data-context-and-setup
│   │   ├── data                # your data source (git ignored)
│   │   │   ├── csv
│   │   │   │   ├── olist_customers_dataset.csv
│   │   │   │   ├── olist_orders_dataset.csv
│   │   │   │   └── ...
│   │   │   └── README.md       # database documentation
│   │   │
│   │   └── olist               # your data-processing logic
│   │       ├── data.py
│   │       ├── product.py
│   │       ├── seller.py
│   │       ├── utils.py
│   │       └── __init__.py     # turns the olist folder into a "package"
│   │
│   │   # Your notebooks & analyses, day-by-day, challenge-by-challenge
│   ├── data-data-preparation
│   └── data-exploratory-analysis
├── 02-Statistical-Inference
│   └── ...
├── 03-Linear-Regression
│   └── ...
└── 04-Logistic-Regression
    └── ...
```

👩🏻‍🏫 Our methodology:

1. Manipulate data in Notebooks `.ipynb`
2. Encode confirmed processing steps in Python `.py` scripts within **classes**
3. Import your scripts and instantiate your **classes** when needed for new analysis

👉 We will create the following classes:

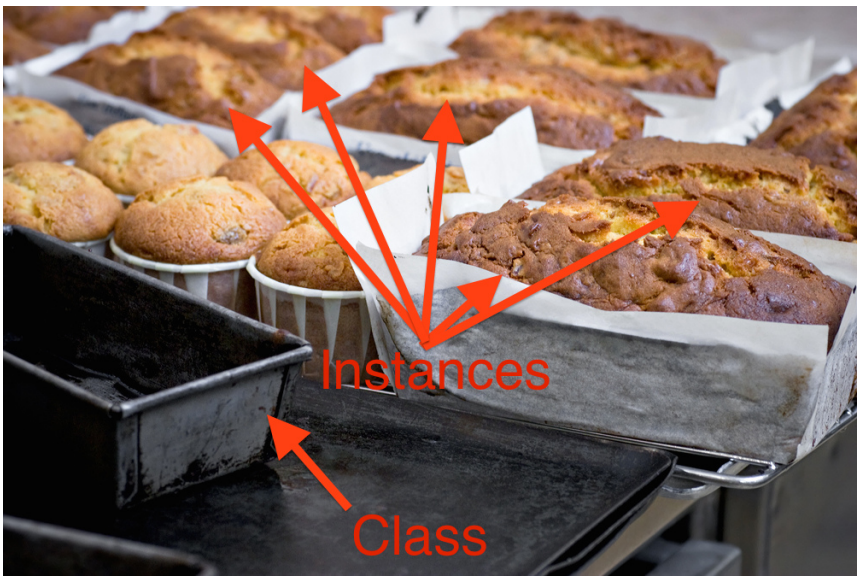
- `Olist`
- `Order`
- `Seller`
- `Product`

😉 Feel free to revisit this Olist data science consulting mission after the bootcamp to create additional classes for further analysis!

3.2 Classes

A **`class`** is just a template designed to build **`instances`** which share common **`attributes`**

💡 Think about a "Mold" *vs.* a "Cake"



💻 Let's create our first class in a new project

```
mkdir lewagon-project
cd lewagon-project
mkdir csv
mkdir notebooks
mkdir lewagon
touch lewagon/student.py
touch lewagon/__init__.py
code .
```

```
class Student:
    # class attribute
    school = 'lewagon'

    # initializer of instance attributes
    def __init__(self, name, age): # Note the `self` parameter
        self.name = name.capitalize()
        self.age = age

    # instance method
    def says(self, something): # x.f(y) equivalent to Class.f(x,y)
        print(f'{self.name} says {something}')
```

In [ ]:
```
boris = Student('boris', 31) # Instantiating a student named `boris`
print(boris.school)          # who is 31 yrs old
boris.says('hi')             # eq. to Student.says(boris, 'hi')
```

```
lewagon
Boris says hi
```

Class method

💻 What if we want to instantiate a student from their birth date instead ?

```
from datetime import date


class Student:
    # [...]

    # Class method
    @classmethod
    def from_birth_year(cls, name, birth_year): # Note the `cls` parameter
        return cls(name, date.today().year - birth_year)
```

In [ ]:
```
zuza = Student.from_birth_year('zuza',  1963)  # Instantiating a stude
nt name `zuza`
print(zuza.age)                                # who was born in 1963
zuza.says("Heyyyyy, I'm younger !!!!")
```

```
58
Zuza says Heyyyyy, I'm younger !!!!
```

Class inheritance

In [ ]:
```
class DataStudent(Student):
    cursus = 'datascience'
    def __init__(self, name, age, batch):
        super().__init__(name, age)
        self.batch = batch
```

In [ ]:
```
boris = DataStudent('boris', 30, 359)
boris.__dict__
```

Out[ ]:
```
{'name': 'Boris', 'age': 30, 'batch': 359}
```

Code refactoring

Now that we know how the class inheritance works, let's talk about best practices:

❌ Multiple classes in one `.py` file

✅ One class per `.py` file

```
touch lewagon/data_student.py
```

In [ ]:
```
# lewagon/data_student.py

class DataStudent(Student):
    cursus = 'datascience'
    def __init__(self, name, age, batch):
        super().__init__(name, age)
        self.batch = batch
```

❗ When creating a sub-class that inherits from a parent class, do *NOT* forget to import the parent class ❗

In [ ]:
```
# lewagon/data_student.py

# the import will only work if executed from lewagon-project directory
# unless you have set up the PYTHONPATH

from lewagon.student import Student

class DataStudent(Student):
    cursus = 'datascience'
    def __init__(self, name, age, batch):
        super().__init__(name, age)
        self.batch = batch
```

In [ ]:
```
boris = DataStudent('boris', 30, 359)
boris.batch
```

Out[ ]:
```
359
```

💡 Call the IPython **`autoreload`** (https://ipython.readthedocs.io/en/stable/config/extensions/autoreload.html) extension to avoid restarting the kernel everytime you modify the `.py` within your package.

```
In [1]: %load_ext autoreload

In [2]: %autoreload 2
```

Naming conventions

- Packages and modules have **short, all-lowercase** names: `pandas`, `lewagon`.
- Class names use **UpperCamelCase**: `DataFrame`, `Student`.
- Variables and functions use **lower_snake_case**: `name`, `first_name`, `from_birth_year()`.

👉https://www.python.org/dev/peps/pep-0008/#naming-conventions (https://www.python.org/dev/peps/pep-0008/#naming-conventions)

3.3 Package and Module Imports in Python

❓ How can we call custom Python `.py` scripts in a Jupyter Notebook or an iPython session ❓

```
from olist.data import *
```

🤔 **Problems**:

- The way you import your modules depends on where you run your notebook or your iPython session
- It becomes quickly tedious to import modules living in a completely different place!

👉 **A first solution**:

Add the following code in each iPython session or Notebook:

```
root_path = "/Users/..../lewagon-project"
import sys; sys.path
sys.path.append(root_path)
```

💪 **A more robust and easier solution: the `PYTHONPATH` :**

Add your repository path to a `PYTHONPATH` global environment variable

```
# open your zshrc file
code ~/.zshrc

# add this at the bottom of your zshrc file
export PYTHONPATH='/Users/.../lewagon-project'

# restart your zsh shell
exec zsh
```

Restart your Jupyter Notebook server or iPython

```
# you can check your pythonpath specifically
import os; os.environ['PYTHONPATH']

# double check your root_dir is your path list for package imports
import sys; sys.path
```

3.4 Where am I ?

We need to access our data files from inside our Python code.

Our data will be in a folder in our file system:

```
/
├── Users                                  # on macOS - `home` on Linux / WSL
│   ├── your-username
│   │   ├── code                           # all coding projects you work on
│   │   │   ├── your-github-username       # the coding projects you own
│   │   │   │   ├── project-name           # your project folder
│   │   │   │   │   ├── data               # your data folder
│   │   │   │   │   │   ├── orders.csv
│   │   │   │   │   │   └── ...
│   │   │   │   │   ├── package-name
│   │   │   │   │   │   ├── data.py
│   │   │   │   │   │   ├── order.py
│   │   │   │   │   │   └── ...
│   │   │   │   ├── other-project
│   │   │   │   └── ...
│   │   ├── Documents
│   │   └── ...
```

So the *absolute path* to your data file is for example:

```
/Users/your-username/code/your-github-username/project-name/data/orders.csv
```

But we can't use that in our code! Why not?

Current Working Directory

> *From where* are you executing your Notebook or iPython session or .py file?

```
# iPython session or Jupyter Notebook or .py file
import os; os.getcwd()
```

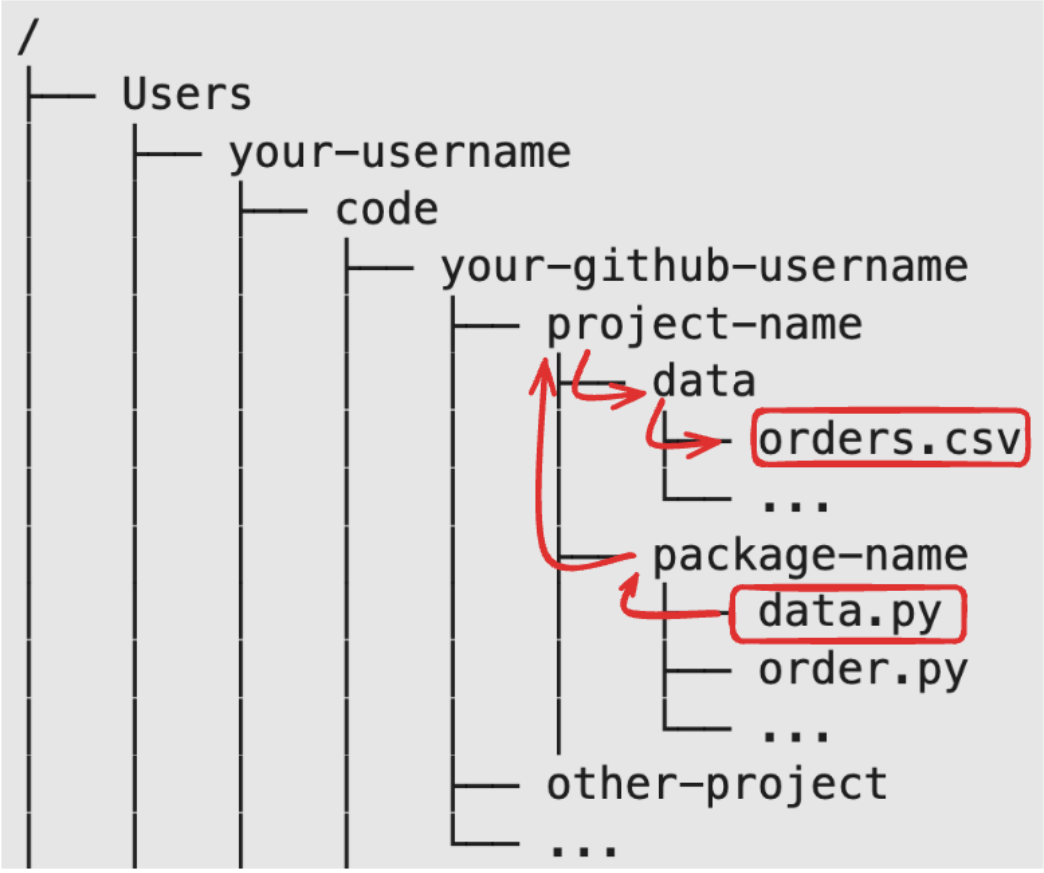
☝️ A **`relative path`** always starts from the **`"current working directory"`**

So we can't use relative paths in our code either. Why not?

It will break if we execute the code from inside another folder.

How to solve this?

If you know the location of your python file, you can find the location of your data!



Location of a python file

> Where is this `module.py` located on the disk?

Use the following piece of code within your python file:

```
__file__     # Contains the absolute path of module.py, including the filen
ame
```

How to get the directory of a python file?

```
os.path.dirname(__file__)   # Returns the directory where your module.py i
s stored
```

How to get the directory above the directory of a python file?

```
os.path.dirname(os.path.dirname(__file__))
```

⚠️ `__file__` is only available from python files, not from a notebook

Assembling paths

How to create paths from components?

❌ `"folder_path/subfolder/data.csv"`

✅ `os.path.join("folder_path", "subfolder", "data.csv")`

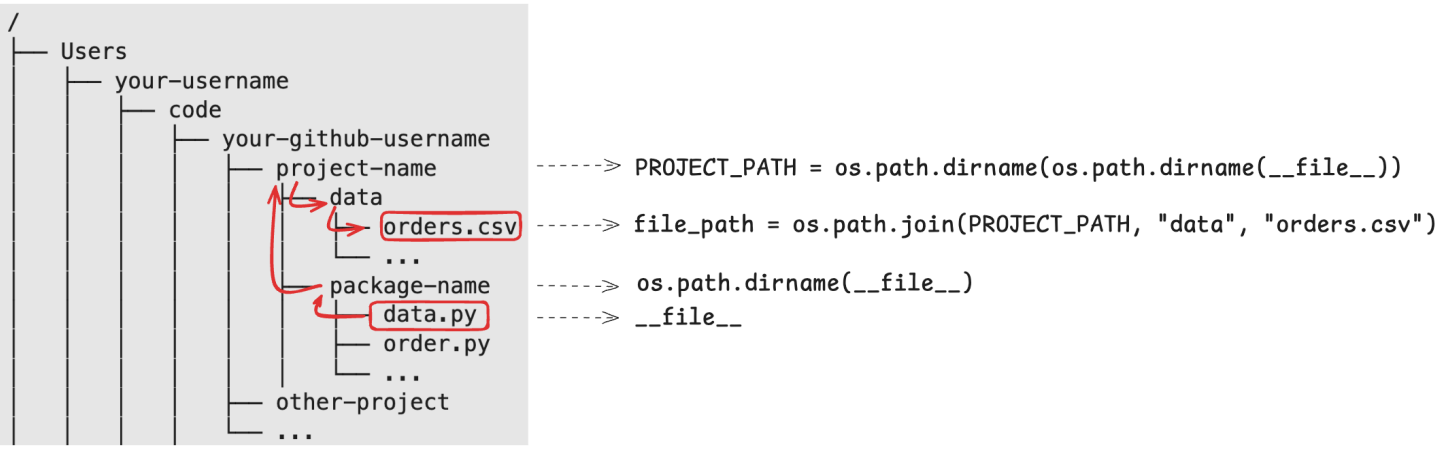
Slashes (`/`) only work on POSIX systems like Unix, Linux, FreeBSD, macOS.

Windows (outside of WSL) requires backslashes (`\`)

Putting it all together

How to create a path to your data files from your *module.py* file?

1. Obtain the path to your *module.py*
2. Use `os.path.dirname()` to find the root path of your project
3. Use `os.path.join()` to construct a path to your data files




```
PROJECT_FOLDER = os.path.dirname(os.path.dirname(__file__))
filename = os.path.join(PROJECT_FOLDER, "data", "orders.csv")
```

4 Notebook like a pro

General Principles of a Notebook

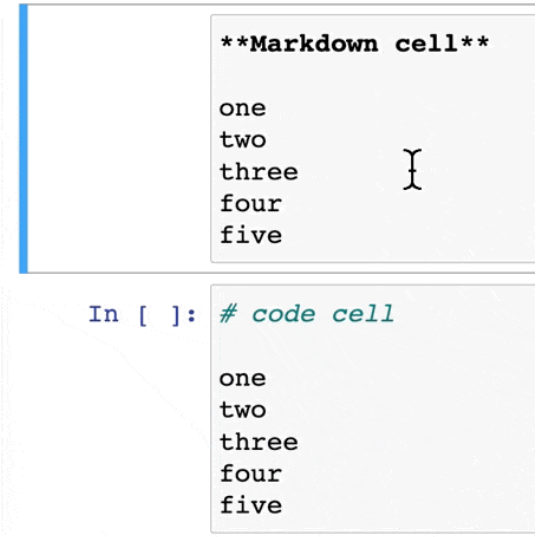
- Your Notebook should be runnable from top to bottom (`Run --> Run All Cells`)
- Name your variables carefully
- Clear your draft code
- Merge cells when relevant (`Shift M`)
- Un-merge when debugging (`Ctrl Shift -`)

Most frequently used Notebook shortcuts

- `Esc - A` 👉 insert a cell above
- `Esc - B` 👉insert a cell below
- `Esc - D - D` 👉 delete a cell
- `Esc` - arrows 👉 move between cells
- `Shift + Enter` 👉 execute the current cell and move the focus to the next one
- `Cmd + Enter` (Mac Users) 👉 run the current cell and keep the focus on the same cell
  `Ctrl + Enter` (Windows or Linux Users)
- `Shift + Tab` 👉 to get the docs! Repeat this combo many times to open the docs "*permanently*"

Multi-cursor select 🔥

- Hit `Alt / Option` on your keyboard and drag your cursor:



- Similar: hit `Ctrl / Cmd` on your keyboard and click on multiple places
- Select next occurence of the selection with `Cmd-D` or `Ctrl-D` like in VS Code?
  - The default setting in Jupyter is `Cmd-Shift-D` or `Ctrl-Shift-D`.
  - Open `jupyter lab`, go to `Settings > Settings Editor > Keyboard Shortcuts`
  - Find `Select Next Occurence` and change it to `Cmd-D` or `Ctrl-D`

5. Debug

```
# iPython debugger
breakpoint()
```

```
>>> s (step into)
>>> n (next = step over)
>>> c (continue to next error)
>>> u (up stack trace), d(down)
>>> return (continue until current function return)
>>> l (provide more context)
>>> q (quit) or exit
```

☝️ Works in iPython sessions and in Jupyter Notebooks as well!

⚠️ Always do a proper "clean exit" out of the debugger in Jupyter, otherwise you will have to restart the kernel.

You can also add a new cell under an error and run:

```
%debug # raises `breakpoint()` just before the error!
```

6. Dealing with new datasets

- Check DataFrame attributes `.shape`, `.columns`, `.dtypes`
- Use DataFrame methods `.head()`, `.info()`, `.describe()`, `nunique()`, `.isna().sum()`
- Plot distributions ...

Use `YData Profiling` 🔥🔥🔥 One-click EDA (Exploratory Data Analysis):

- Essentials
- Quantile statistics (min, Q1, median, Q3, max, ...)
- Most frequent values
- Histogram
- Correlations
- Missing values matrix, count, heatmap and dendrogram of missing values

👉 github.com/ydataai/ydata-profiling (https://github.com/ydataai/ydata-profiling)

In [ ]:
```
import ydata_profiling
mpg.profile_report()
```

Overview

Dataset statistics

Number of variables	9
Number of observations	398
Missing cells	6
Missing cells (%)	0.2%
Duplicate rows	0
Duplicate rows (%)	0.0%
Total size in memory	28.1 KiB
Average record size in memory	72.3 B

Variable types

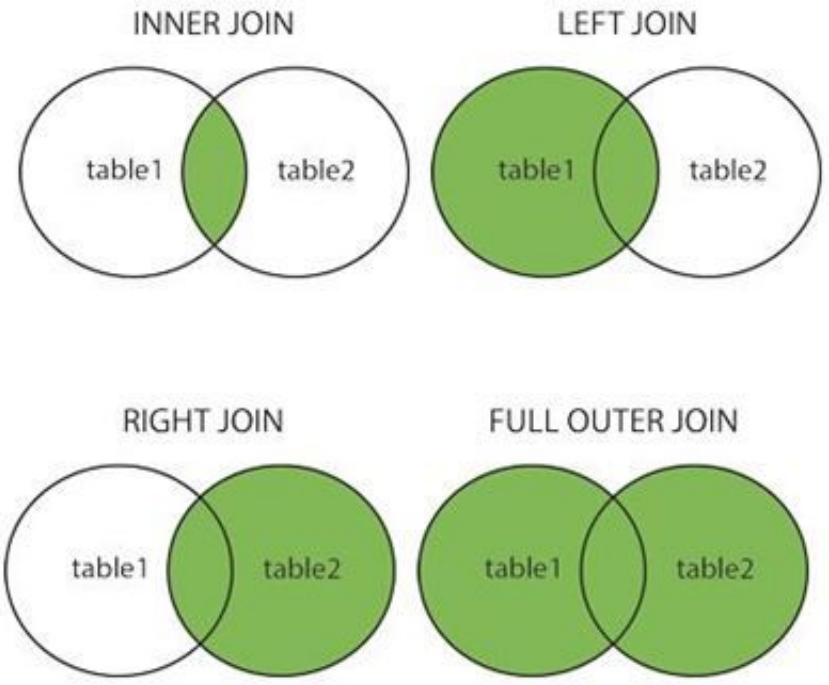
Numeric	6
Categorical	3

Warnings

`name` has a high cardinality: 305 distinct values	**High cardinality**
`mpg` is highly correlated with `cylinders` and 4 other fields (cylinders, displacement, horsepower, weight, model_year)	**High correlation**
`cylinders` is highly correlated with `mpg` and 4 other fields (mpg, displacement, horsepower, weight, acceleration)	**High correlation**

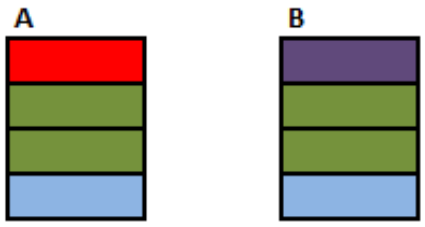
Out[ ]:

7. (Refresher) Get your head around `inner join` *vs.* `outer join`



❓ What will be the shape of the `inner` joined table ❓

```
A.merge(B, on='color', how='inner')
```



Answer: (5,2)

📚 Read the following thread:

- stackoverflow.com/questions/different-between-inner-join-and-outer-join (https://stackoverflow.com/questions/38549/what-is-the-difference-between-inner-join-and-outer-join#answer-27458534)

🚀 Your turn!

- **Sessions 1 & 2: Data Preparation (40%)**
  - Understand the problem
  - Organize your repo
  - Make sense of the data
- **Sessions 3 & 4: Data Analysis (40%)**
  - Break down the problem into smaller actionable analyses
  - Use Linear / Logistic Regression
- **Session 5: Communicate (20%)**
  - Realize a quantitative Cost-Benefit Analysis (https://www.investopedia.com/terms/c/cost-benefitanalysis.asp)
  - Present your results and convince your audience of your recommendations

What we'll do in the challenges

Challenge 1: setup our project

1. Setup our project structure

```
│   ├── folder-for-the-first-challenge
│   │   ├── data                # your data source (git ignored)
│   │   │   ├── csv
│   │   │   │   ├── olist_customers_dataset.csv
│   │   │   │   ├── olist_orders_dataset.csv
│   │   │   │   └── ...
│   │   │   └── README.md       # database documentation
│   │   │
│   │   └── olist               # your data-processing logic
│   │       ├── data.py
│   │       ├── product.py
│   │       ├── seller.py
│   │       ├── utils.py
│   │       └── __init__.py     # turns the olist folder into a "packa
ge"
```

2. Change `PYTHON_PATH` so we can use our package from anywhere on our machine

Challenge 2: Write reusable code to load our data

1. **Write code in a jupyter notebook** to load all the csv files into a dictionary of Pandas DataFrames:

```
{
    'orders': a DataFrame with the data from the orders csv,
    'sellers': a DataFrame with the data from the sellers csv,
    ...
}
```

2. **Refactor the code** from the notebook into `olist/data.py` :

   We'll create a class Olist with a `get_data()` method that will return the dictionary of Pandas DataFrames.

   This way we'll be able to load our data from anywhere using:

```
from olist.data import Olist
data = Olist().get_data()
orders = data['orders']
```

Challenge 3: Explore the data

Explore our data, using the refactored code in our package to load the data.

Bibliography

Good reads 📚

- 12 things I wish I'd known before starting as a Data Scientist (https://medium.com/deliberate-data-science/12-things-i-wish-id-known-before-starting-as-a-data-scientist-45989be6300e), Jason Goodman, Data Scientist @ Airbnb
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