



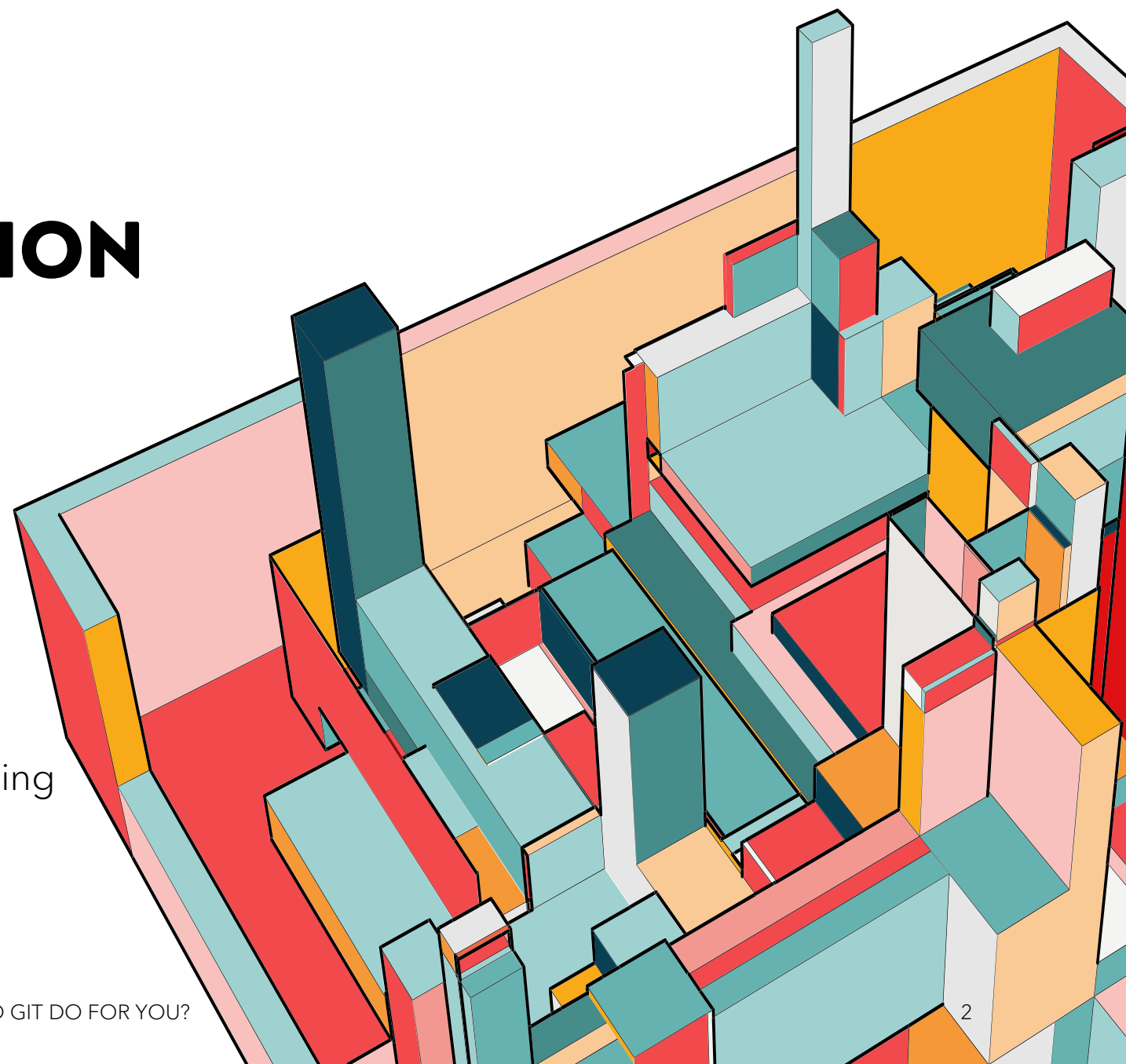
WHAT COULD OOP AND GIT DO FOR YOU?

Ambre VISIVE
(BE-EA-PR)

OPERA-2D & PYTHON

- Newest versions of Opera-2D meant to be use with Python

- Python
 - Functional Programming
 - Object-Oriented Programming



PRESENTATION OVERVIEW

What is OOP?

Simple explanation for non-computer scientists

How can OOP be used?

Type of classes and methods that can be created

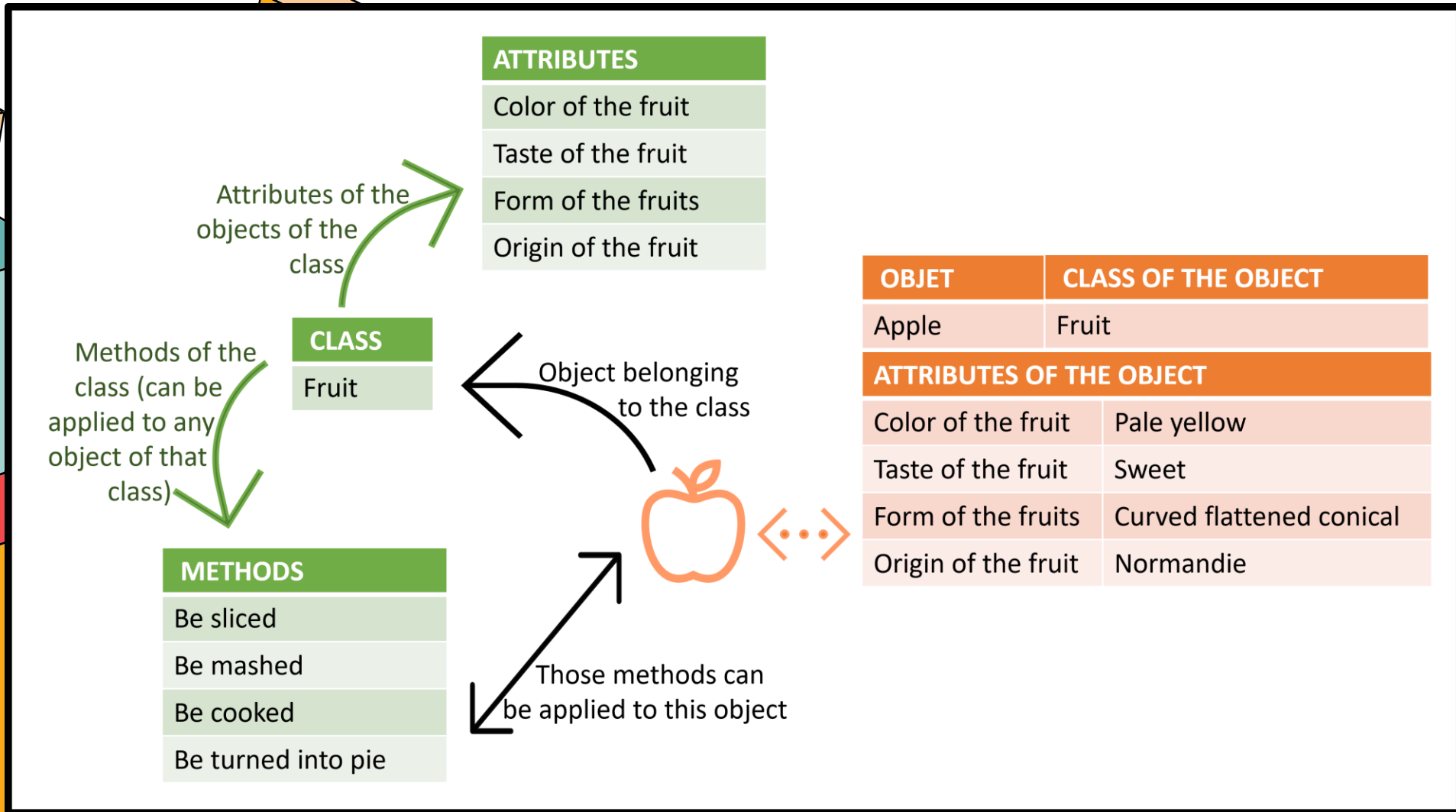
But why Git?

Version-Controlled system to keep track of all changes

Example of application

The Tool, PyMagnets and the EA Magnet Database

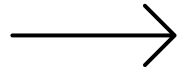
OBJECT-ORIENTED PROGRAMMING



HOW CAN IT BE USED? (1/2)

CLASSES

- Type of Materials
- BH Libraries
- Type of Magnets
- Type of Coils
- *Postprocessor*
-



ATTRIBUTES

Anything that *belongs* to an object of a certain defined class

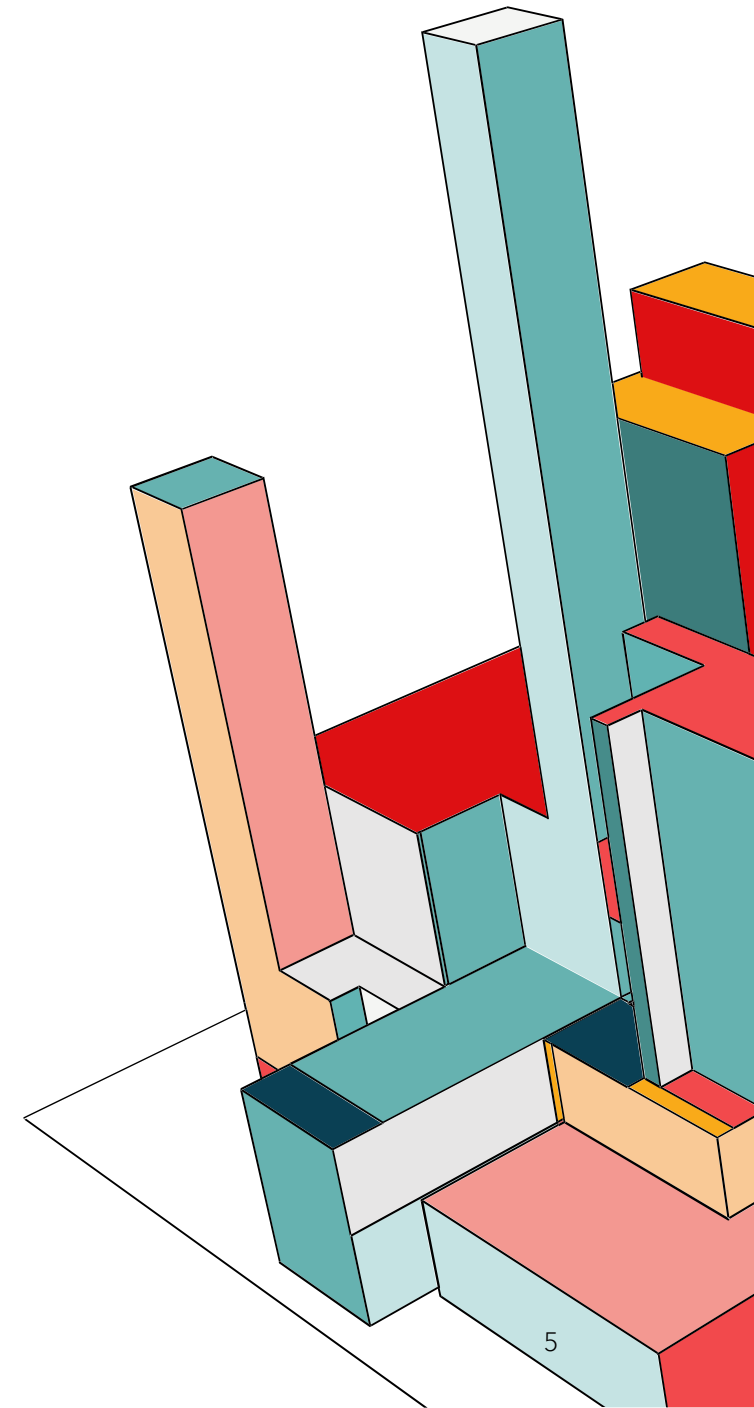


OBJECTS

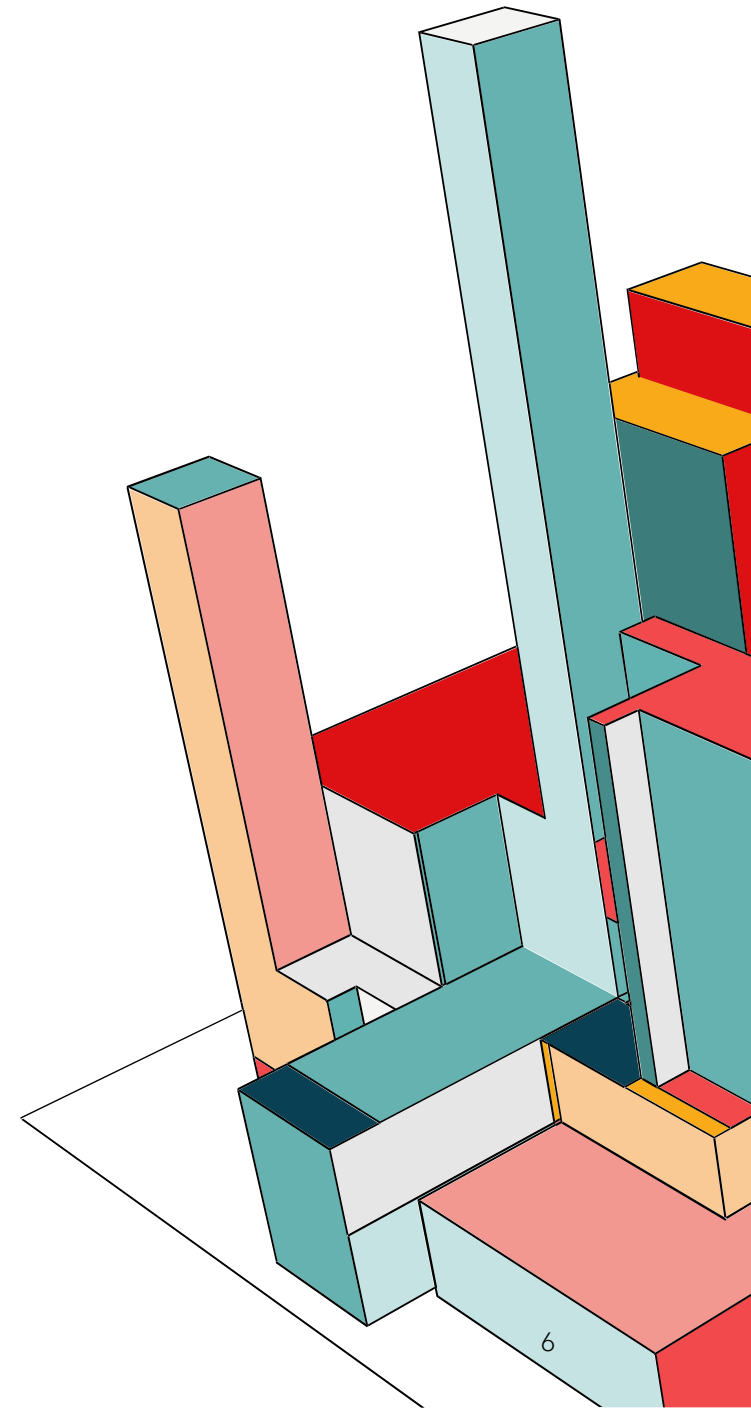
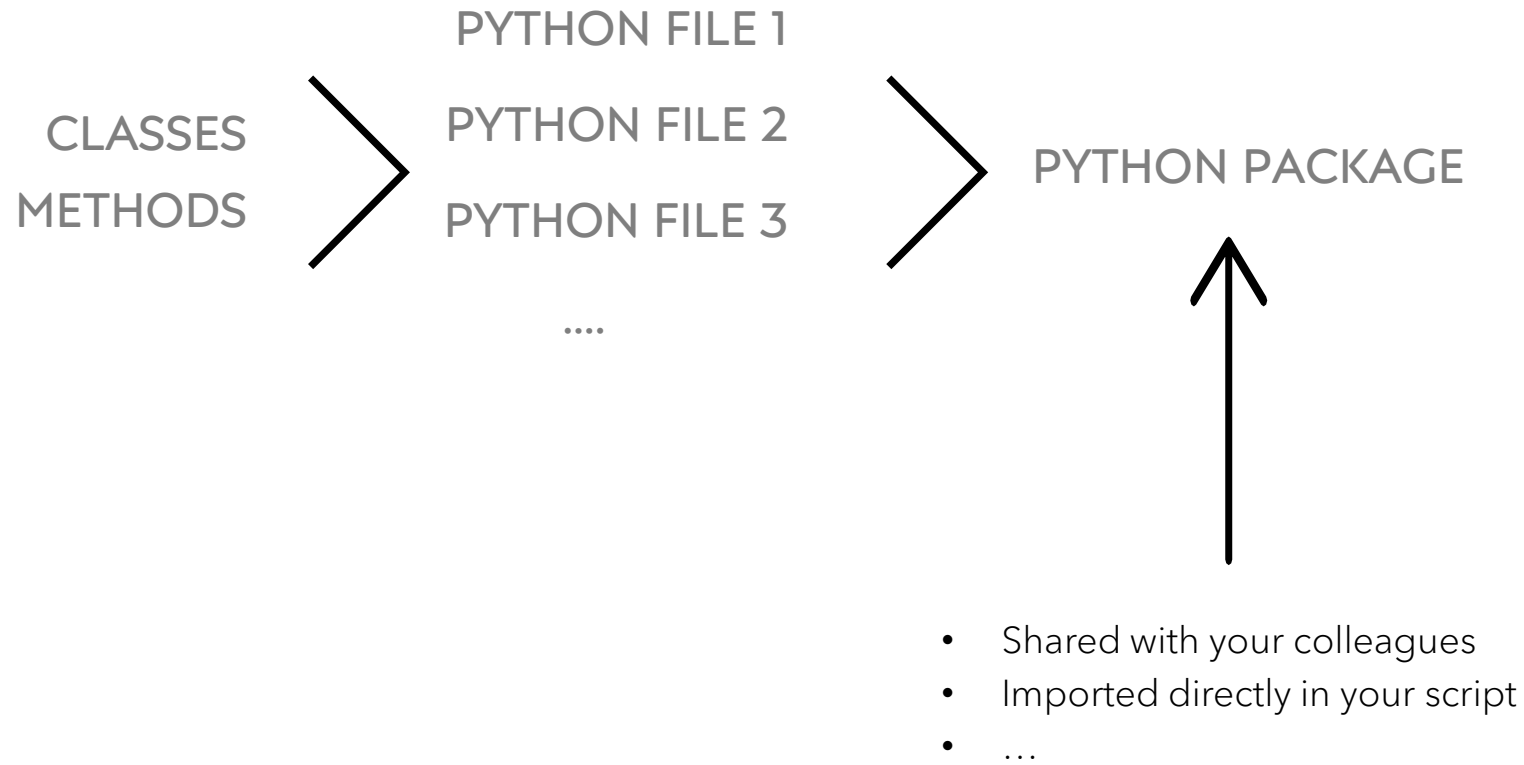
- A BH curve
- A coil
- The Steel
- ...

METHODS

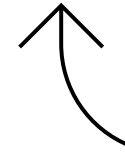
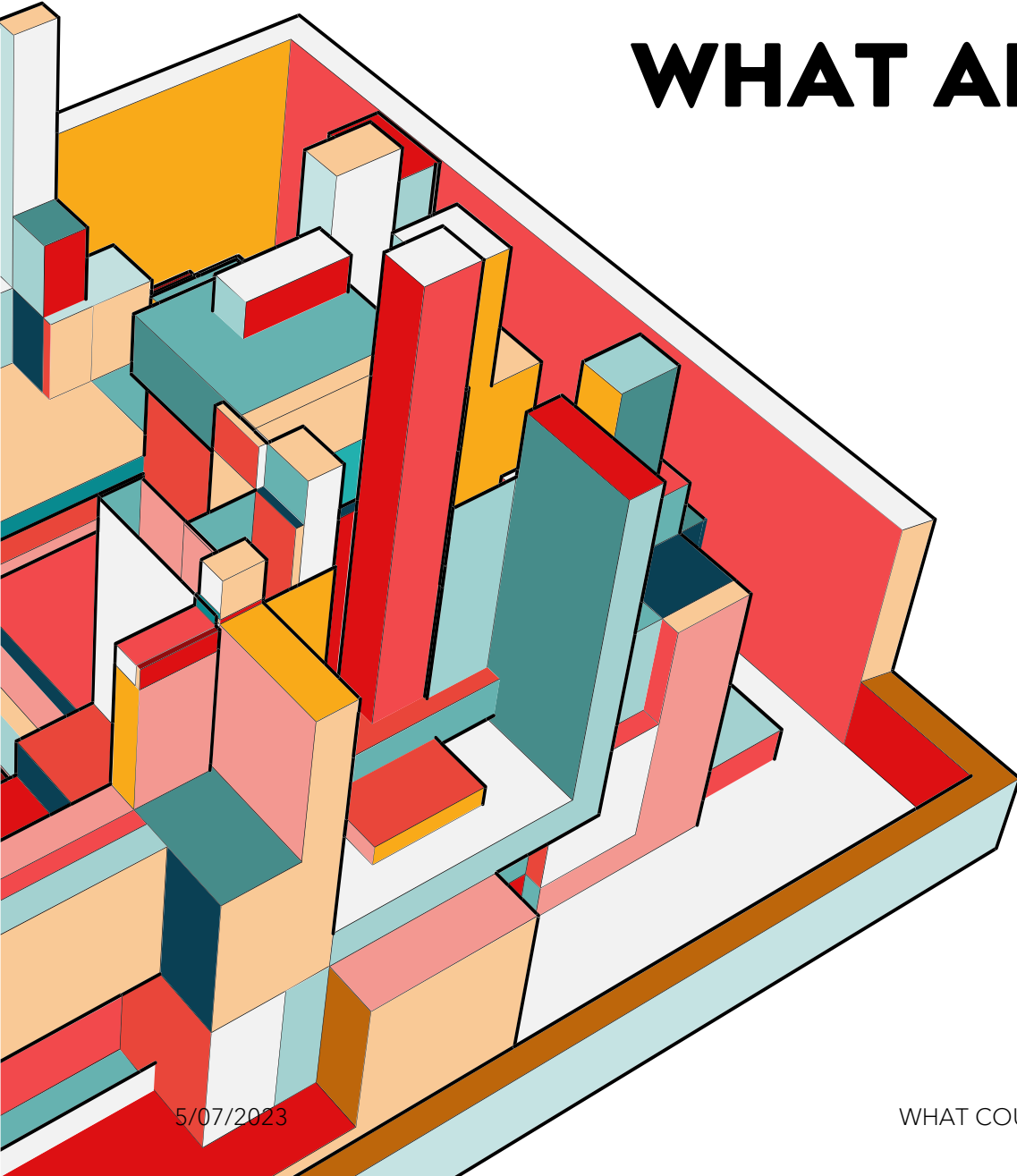
- Plotting the flux lines
- Draw edges for a set of points
- Create field maps
- Set the current density
- Attribute a material to a body
- Measuring the field quality
-



HOW CAN IT BE USED? (2/2)



WHAT ABOUT GIT?



- Distributed Version Controlled System
- Works with Locally-Cloned Copies
- Save only the changes in its history

Thanks to VCS, you can keep the different versions of your script, packages and models !
+ they will be available to all your colleagues

EXAMPLE OF APPLICATION

Issues face by the physicists of EA:

- how to produce new magnetic field map not only of the GFR but all regions above 25mT?
- how to easily access existing ones?

Solutions:

- Creating a intern tool for non-Opera users to create field maps
- Saving all created field maps and the magnet model in a Database

EXAMPLE OF APPLICATION

Methodology:

- Find geometry of magnet-type on technical drawings from 1970s
 - Add the new magnet-type in the PyMagnets package
 - Benchmark the model with the most recent available MM
 - Adjust the BH curve
-
- ```
graph TD; A[Adjust the BH curve] --> B[• new model ready to use by Users]; A --> C[• Users can create themselves field maps];
```
- new model ready to use by Users
  - Users can create themselves field maps

# EXAMPLE OF APPLICATION

## PyMagnets

### Model.py

- Model:
  - *Set\_Units*
  - *Set\_Settings*
  - *Generate\_Mesh*
  - *Solve*
- Region:
  - *AssignMaterial*
  - *AssignCurrent*
- CurrentLibrary:
  - *Set\_NoCurrent*
  - *Set\_PosCurrent*
  - *Set\_NegCurrent*
- PostProcessing:
  - *Plot\_DensityMap*
  - *Plot\_FluxMines*
  - *Plot\_minmaxDensityMap*
  - *Create\_Fieldmap\_TXTFormat*
  - *Create\_Fieldmap\_BDSIMFormat*
- Edges:
  - *AssignMesh*
  - *AssignBoundary*
- BoundaryType:
  - *Set\_Dirichlet*
  - *Set\_Neumann*

### Magnet.py

- Bodies:
  - *Set\_Yoke\_MCB*
  - *Set\_Coil\_1\_MCB*
  - *Set\_Coil\_2\_MCB*
  - *Set\_Background\_MCB*
  - *Set\_Yoke\_QSL*
  - *Set\_Coil\_1\_QSL*
  - ....
- Magnet:
  - *Set\_MCB*
  - *Set\_MBW*
  - *Set\_QNL*
  - ...

### Material.py

- MaterialLibrary: • *Set\_Air* • *Set\_Copper* • *Set\_Steel*
- BHcurveLibrary: • *Set\_UnknwonBHcurve* • *Set\_Default* • *Set\_Mildhigh* • *Set\_MBGSteel* • ...

Key:

Underlined = Classes

Italic = Methods

# EXAMPLE OF APPLICATION

|                          |          |
|--------------------------|----------|
| Name of the Magnet Type  | QSL      |
| Current (in A)           | 1000     |
| Liste of currents (in A) | [insert] |
| Path where to save model | F:/      |

|                                 |             |
|---------------------------------|-------------|
| <b>Solve and Save the Model</b> | <b>True</b> |
| field to be plotted             | [insert]    |
| resolution                      | [insert]    |
| path where to save it           | [insert]    |
| Coord. top left corner          | [insert]    |
| Coord. bott. right corner       | [insert]    |
| width of the plot               | [insert]    |
| height of the plot              | [insert]    |

|                           |             |
|---------------------------|-------------|
| <b>Plot Flux Lines</b>    | <b>True</b> |
| field to be plotted       | POT         |
| resolution                | 30          |
| path where to save it     | [insert]    |
| Coord. top left corner    | [insert]    |
| Coord. bott. right corner | [insert]    |
| width of the plot         | [insert]    |
| height of the plot        | [insert]    |

|                               |              |
|-------------------------------|--------------|
| <b>Create a TXT fieldmap</b>  | <b>False</b> |
| fieldmap units                | [insert]     |
| mesh in x dir. (size in unit) | [insert]     |
| mesh in y dir. (size in unit) | [insert]     |
| x start (in unit)             | [insert]     |
| y start (in unit)             | [insert]     |
| x end (in unit)               | [insert]     |
| y end (in unit)               | [insert]     |
| author                        | [insert]     |
| path where to save it         | [insert]     |

|                                |              |
|--------------------------------|--------------|
| <b>Create a BDSIM fieldmap</b> | <b>False</b> |
| mesh in x dir. (size in mm)    | [insert]     |
| mesh in y dir. (size in mm)    | [insert]     |
| x start (in mm)                | [insert]     |
| y start (in mm)                | [insert]     |
| x end (in mm)                  | [insert]     |
| y end (in mm)                  | [insert]     |
| author                         | [insert]     |
| path where to save it          | [insert]     |

|                       |           |
|-----------------------|-----------|
| Mesh element type     | Quadratic |
| Global mesh factor    | 1         |
| Mesh factor of yoke   | 1         |
| Mesh factor of coils  | 1         |
| Mesh factor of backgd | 1         |

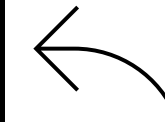
  

|                            |              |
|----------------------------|--------------|
| <b>Expert users</b>        |              |
| <b>Benchmark the Model</b> | <b>False</b> |
| field used to benchmark    | [insert]     |
| x coord. field point (mm)  | [insert]     |
| y coord. field point (mm)  | [insert]     |
| liste of bh curves' paths  | [insert]     |
| liste of bh curves' names  | [insert]     |
| path where to save files   | [insert]     |

|                                                     |              |
|-----------------------------------------------------|--------------|
| <b>Advanced users</b>                               |              |
| <b>Solve the model with another BH curve</b>        | <b>False</b> |
| name of bh curve                                    | [insert]     |
| path of bh curve                                    | [insert]     |
| <b>Plot a Density Color Map for a certain range</b> | <b>True</b>  |
| min value of B (in T)                               | [0.025]      |
| max value of B (in T)                               | [1.25]       |
| path where to save it                               | F:/          |
| <b>Don't Save the Model and Show the Mesh</b>       | <b>False</b> |

Script to be adapted every time by users and run in Opera-2D



Import the PyMagnets package

# EXAMPLE OF APPLICATION

## NCMagnets\_GitRepository

- .gitlab-ci.yml
- README.md
- NCMagnets\_UserScript.py
- .gitmodules

### Fieldmaps

- .gitlab-ci.yml
- README.md
- QNL\_fieldmapBDSIM\_416A\_pymagnetsV1-2-1\_20230628-103438.dat
- MBW\_fieldmapTXT\_416A\_pymagnetsV1-1-9\_20230528-124558.txt
- ...

### PyMagnets

- \_\_init\_\_.py
- magnet.py
- material.py
- model.py

#### src/pymagnets

- .gitlab-ci.yml
- .gitignore
- LICENSE.txt
- README.md
- pyproject.toml
- setup.cfg
- setup.py
- Copy\_UserScript.py

### Documentations

- .gitlab-ci.yml
- README.md
- MCB\_Documentation.pdf
- MCB\_Benchmarking.xlsx
- ...

### OperaFE-2DModels

- .gitlab-ci.yml
- README.md
- QNL\_Opera2D-FEmodelWithBHdefault\_416A\_pymagnetsV1-2-1\_20230628-103438.op\_h5
- QNL\_Opera2D-FEmodelWithBHdefault\_416A\_pymagnetsV1-2-1\_20230628-103438.res
- QNL\_UserScript\_416A\_pymagnetsV1-2-1\_20230628-103438.py
- ...

Where all the versions of the package can be found in the history

Store the script + the Opera file of the saved model + compiled resources

# EXAMPLE OF APPLICATION

## Perks of The Tool:

- Physicists are now autonomous in their production of the *specific* field maps they need
- Everything is store in Git and accessible to all
- All results are reproducible even after a couple of years
  
- The Tool is just a start and can be extended to more applications

# THANK YOU

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