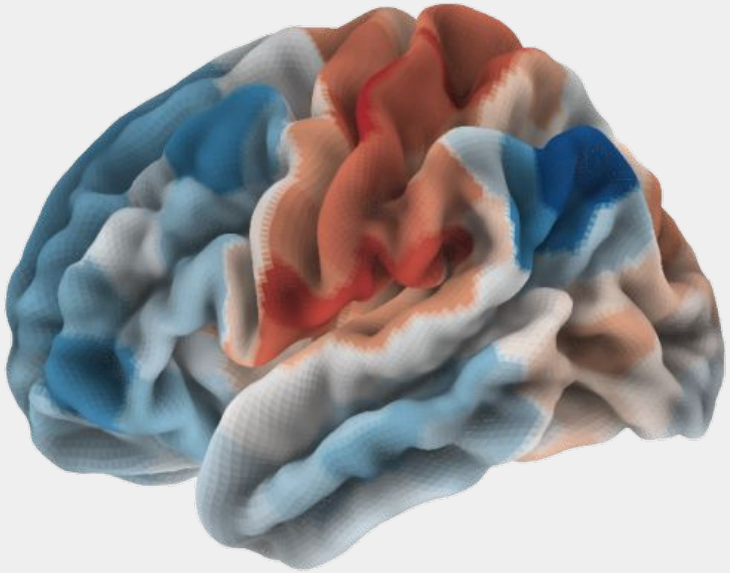
Advanced fMRI data analysis



Karolina Finc

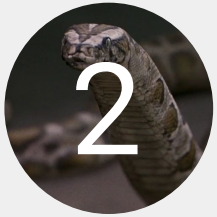
Centre for Modern Interdisciplinary Technologies

Nicolaus Copernicus University in Toruń

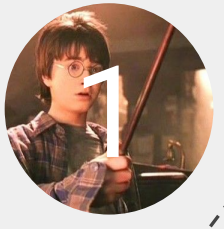
COURSE #7: **Machine learning on fMRI data** | 5th June 2020

Study plan

BEFORE



fMRI data manipulation
in python



Open science &
neuroimaging

fMRI data
preprocessing

General
Linear Model

Functional
connectivity

AFTER

Machine Learning
on fMRI data

Study plan

BEFORE

fMRI data manipulation
in python

Open science &
neuroimaging

fMRI data
preprocessing

General
Linear Model

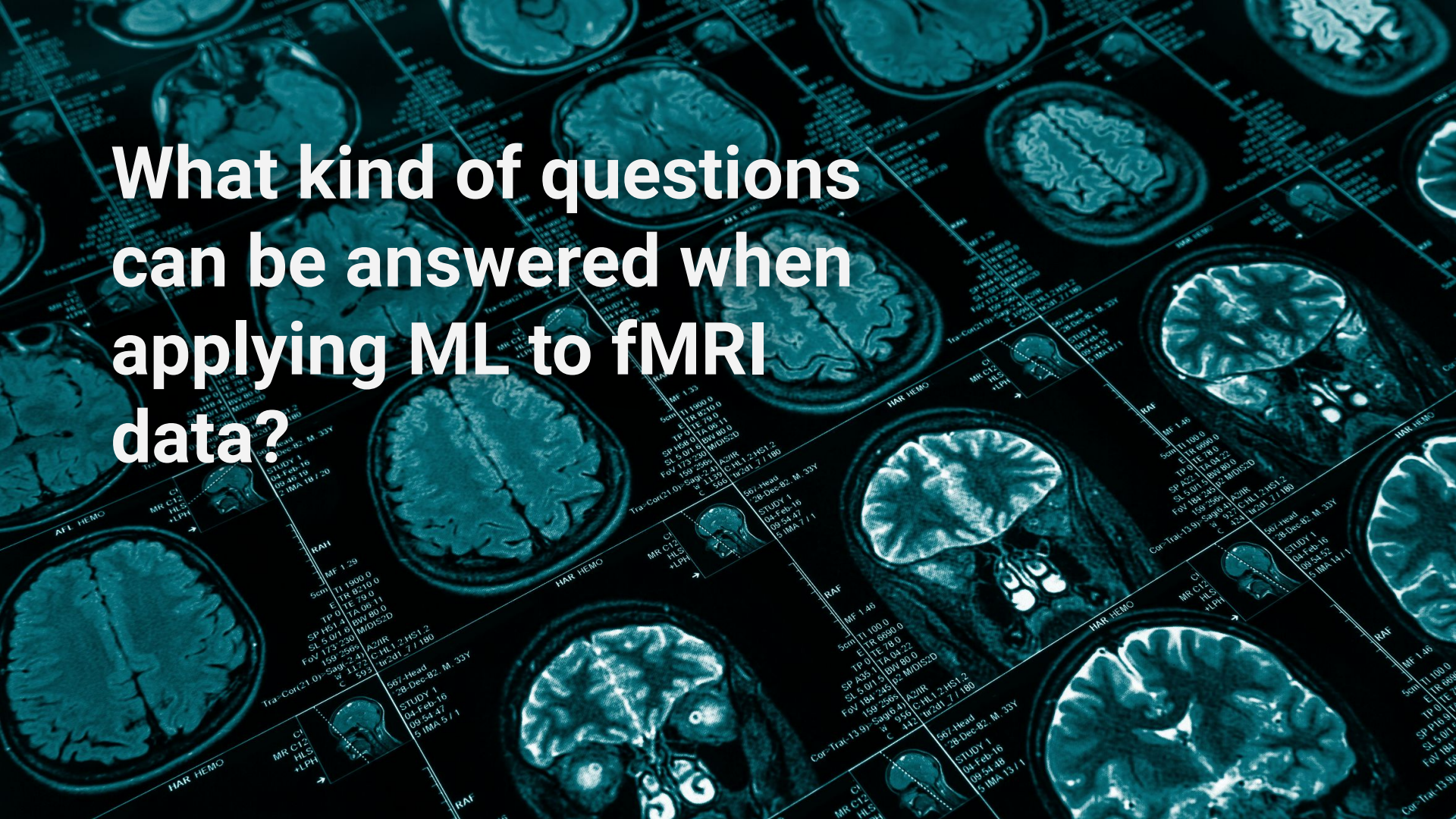
Functional
connectivity

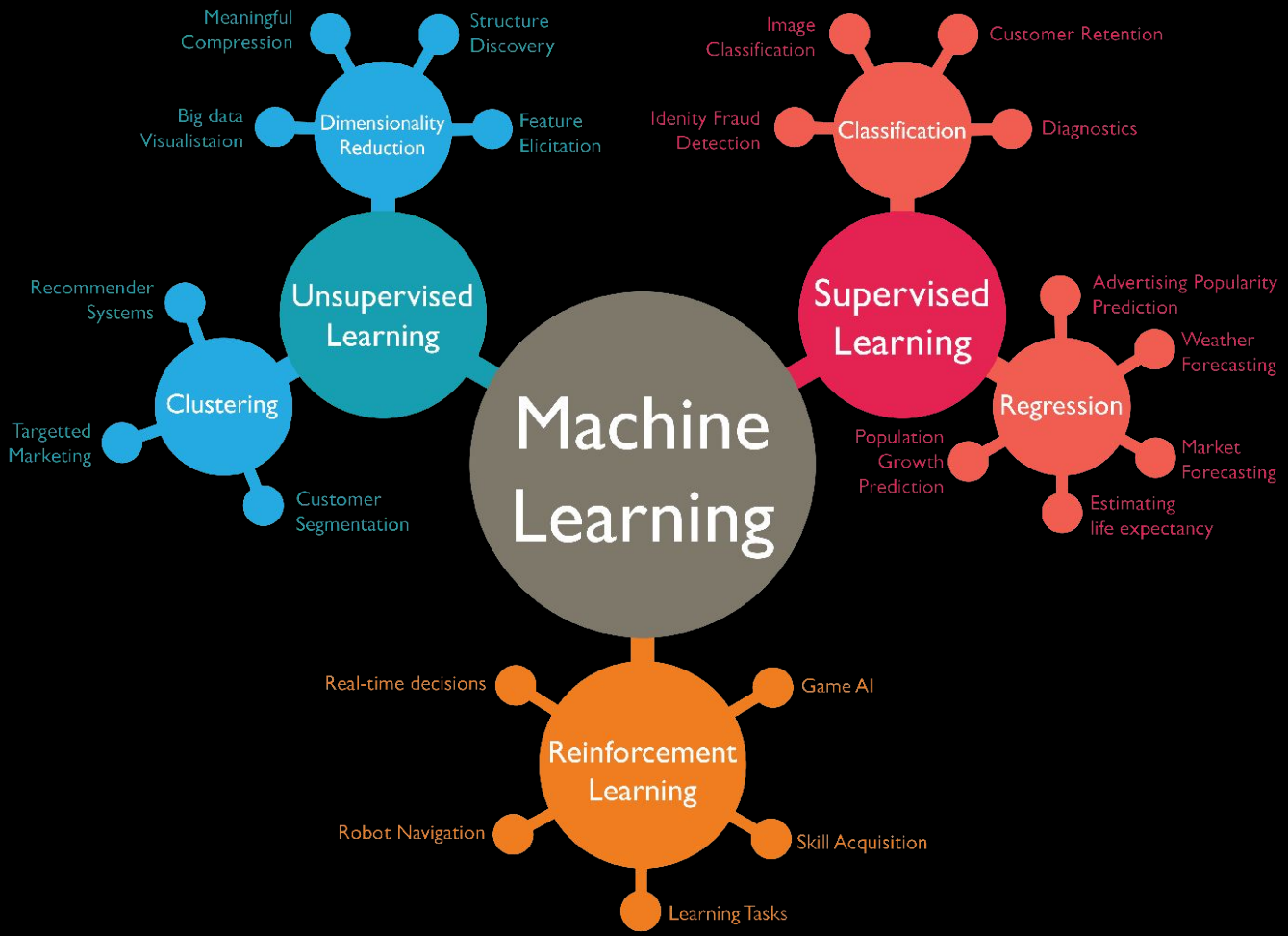
AFTER

Machine Learning
on fMRI data

What’s machine learning?

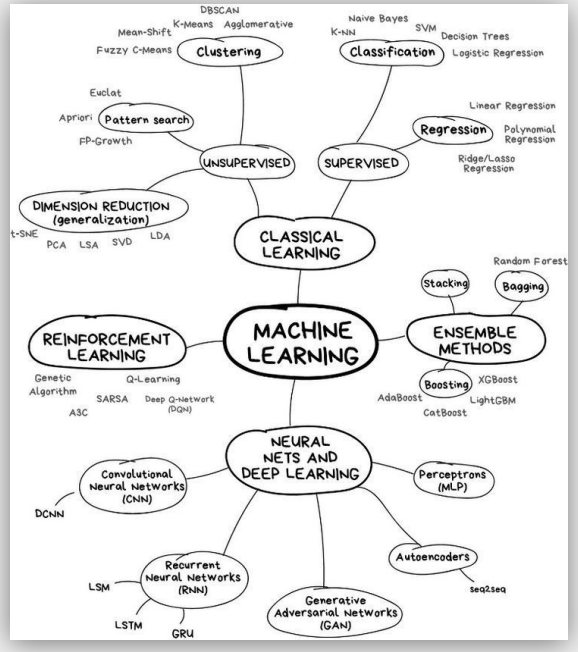
Machine learning - the art and science of giving computers the ability to learn to make decisions from data, without being explicitly programmed.


What kind of questions can be answered when applying ML to fMRI data?


Machine Learning
Unsupervised Learning
Dimensionality Reduction
Meaningful Compression
Structure Discovery
Big data Visualistaion
Feature Elicitation
Clustering
Recommender Systems
Targetted Marketing
Customer Segmentation
Supervised Learning
Classification
Image Classification
Customer Retention
Idenity Fraud Detection
Diagnostics
Regression
Advertising Popularity Prediction
Weather Forecasting
Market Forecasting
Estimating life expectancy
Population Growth Prediction
Reinforcement Learning
Real-time decisions
Game AI
Robot Navigation
Skill Acquisition
Learning Tasks

Types machine learning

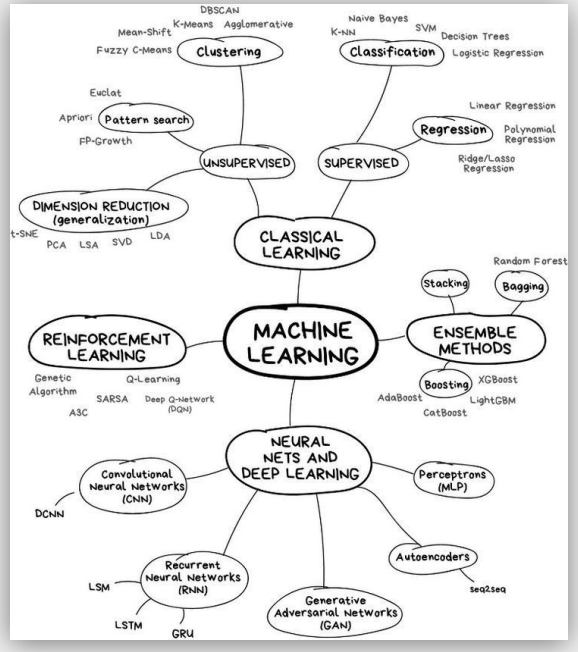
Supervised learning - predicting the target variable, given the predictor variables (labeled data)



Types machine learning

Supervised learning - predicting the target variable, given the predictor variables (labeled data)

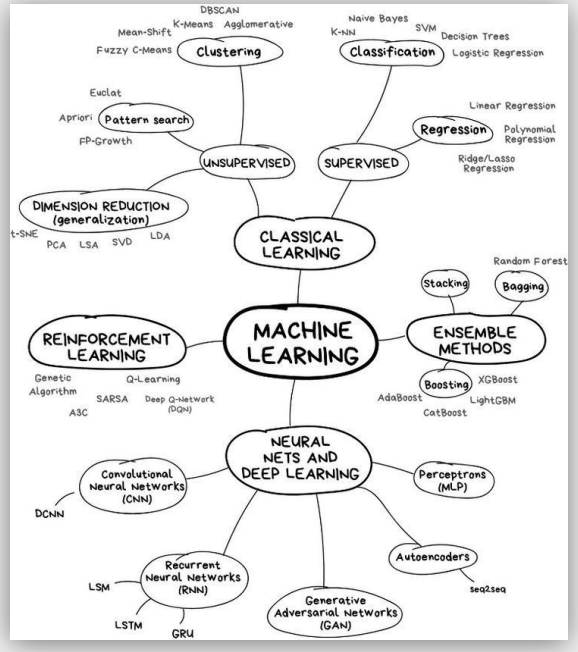
- **Classification** - target variable consists of categories (for example automating diagnosis)



Types machine learning

Supervised learning - predicting the target variable, given the predictor variables (labeled data)

- **Classification** - target variable consists of categories (for example automating diagnosis)
- **Regression** - target variable is continuous (for example predicting brain activity)

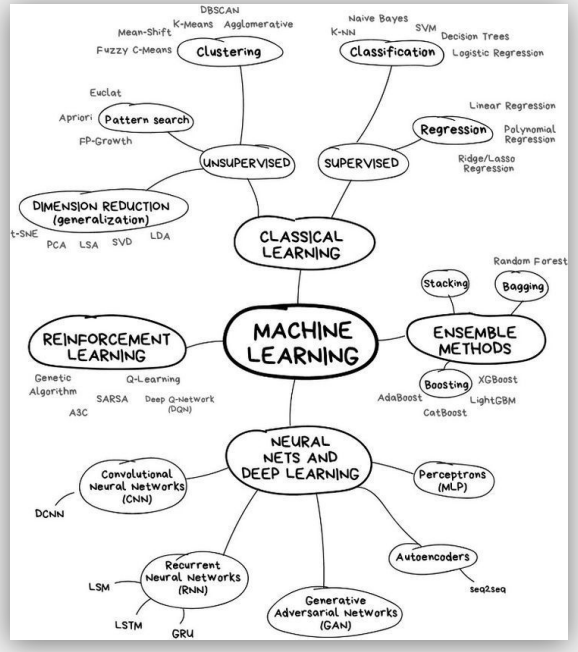


Types machine learning

Supervised learning - predicting the target variable, given the predictor variables (labeled data)

- **Classification** - target variable consists of categories (for example automating diagnosis)
- **Regression** - target variable is continuous (for example predicting brain activity)

Unsupervised learning - uncovering hidden structures and patterns (unlabeled data)



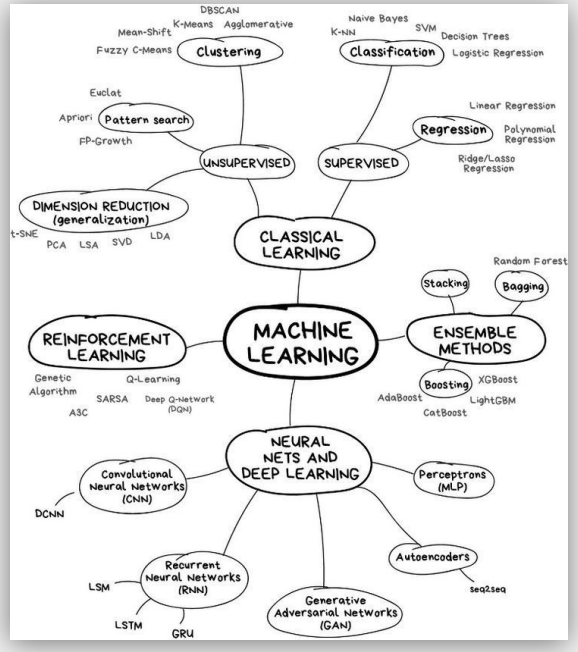
Types machine learning

Supervised learning - predicting the target variable, given the predictor variables (labeled data)

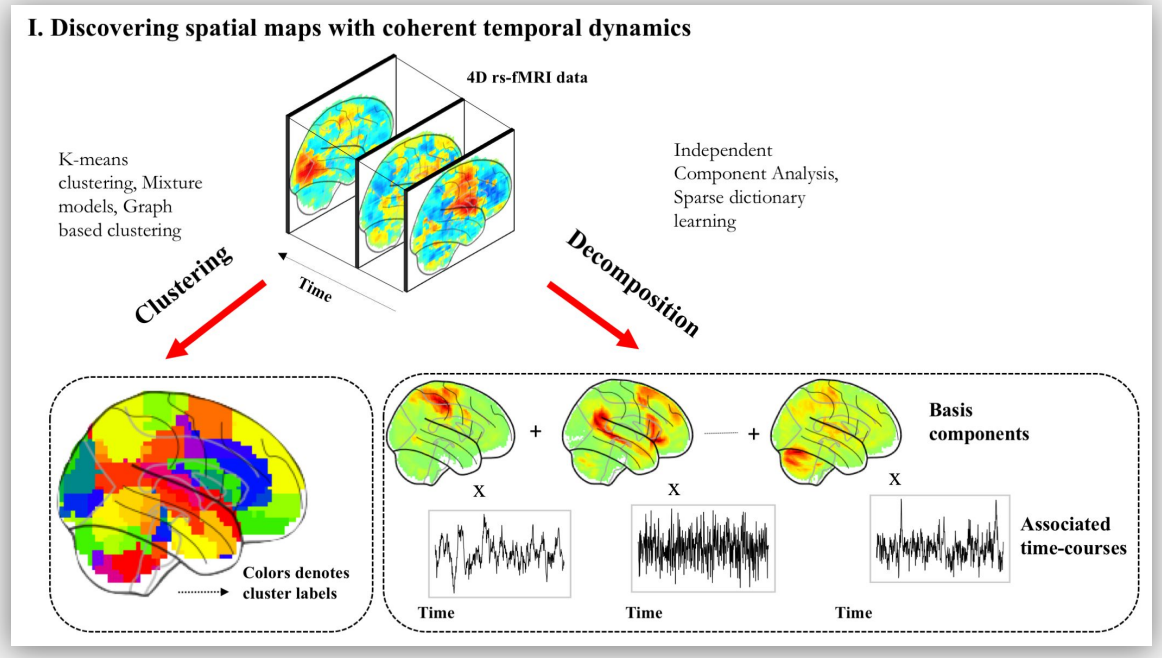
- **Classification** - target variable consists of categories (for example automating diagnosis)
- **Regression** - target variable is continuous (for example predicting brain activity)

Unsupervised learning - uncovering hidden structures and patterns (unlabeled data)

- **Clustering** - grouping data points into distinct categories (for example fMRI time-series into distinct brain states)



Other use-cases



Feature selection

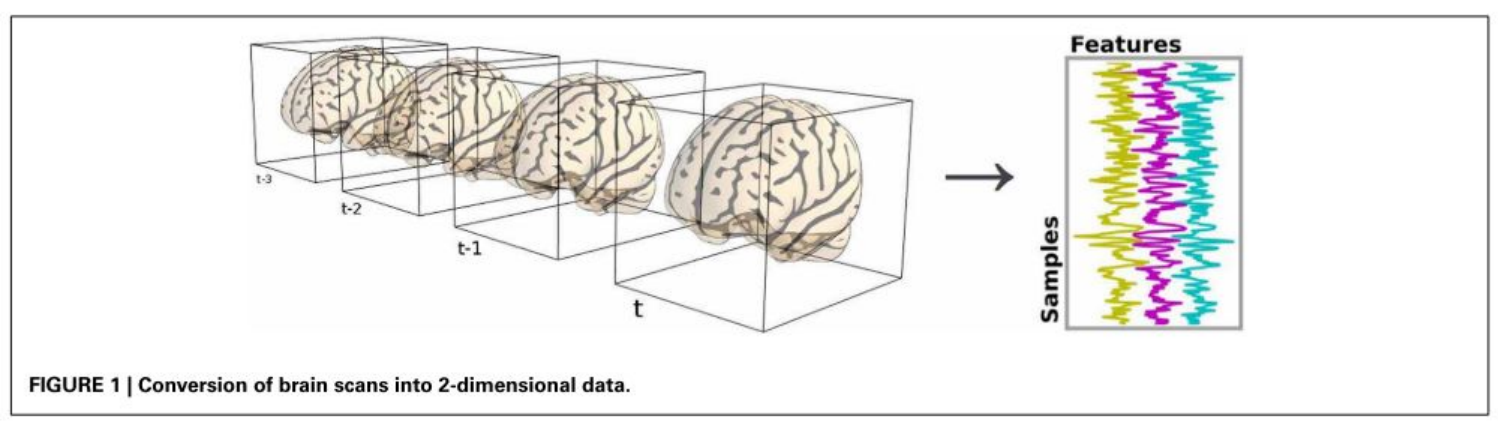
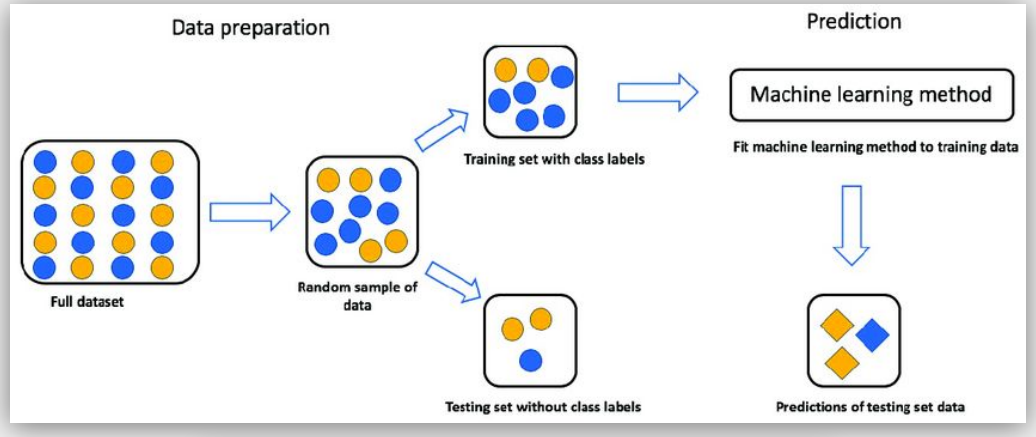
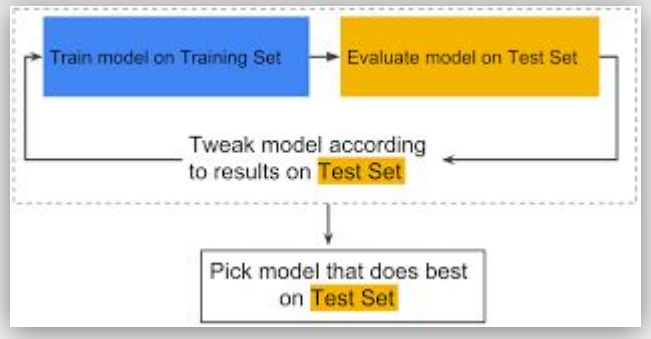


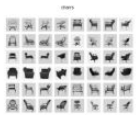
FIGURE 1 | Conversion of brain scans into 2-dimensional data.

Training & test set

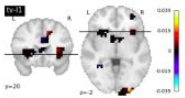




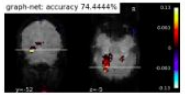
Nilearn tutorials



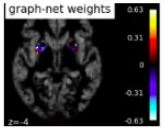
Show stimuli of Haxby et al. dataset



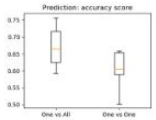
SpaceNet on Jimura et al "mixed gambles" dataset.



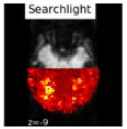
Decoding with SpaceNet: face vs house object recognition



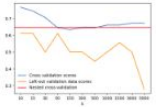
Voxel-Based Morphometry on Oasis dataset with Space-Net prior



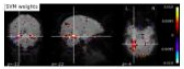
The haxby dataset: different multi-class strategies



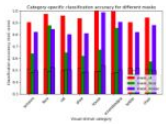
Searchlight analysis of face vs house recognition



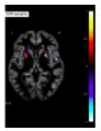
Setting a parameter by cross-validation



Decoding with ANOVA + SVM: face vs house in the Haxby dataset

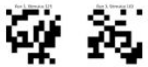


ROI-based decoding analysis in Haxby et al. dataset



Voxel-Based Morphometry on Oasis dataset

Example of pattern recognition on simulated data



Encoding models for visual stimuli from Miyawaki et al. 2008

scikit learn

8.1.4. A introduction tutorial to fMRI decoding

Here is a simple tutorial on decoding with nilearn. It reproduces the Haxby 2001 study on a face vs cat discrimination task in a mask of the ventral stream.

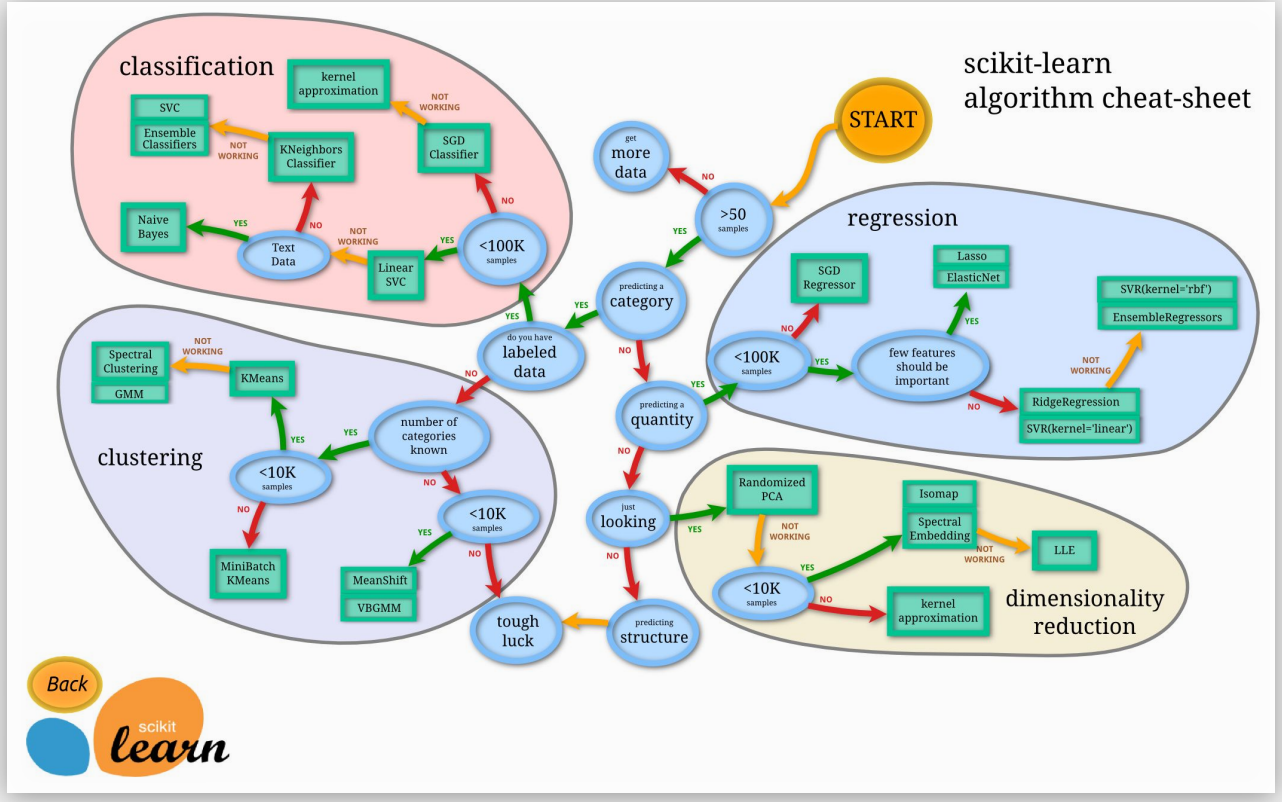
This tutorial is meant as an introduction to the various steps of a decoding analysis.

It is not a minimalistic example, as it strives to be didactic. It is not meant to be copied to analyze new data: many of the steps are unecessary.

Contents

- Retrieve and load the fMRI data from the Haxby study
- Decoding with an SVM
- Measuring prediction scores using cross-validation
- Inspecting the model weights
- Further reading

Sklearn cheat sheet



Poster for extra points!

Analysis of fMRI data
Author

Logo

What I did and why?

My results

How I did it?

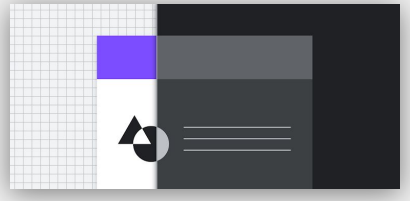
Some conclusions

References

Rules:

Be visual: use less text, more pictures

Follow a good design rules and avoid clutter



https://material.io/design