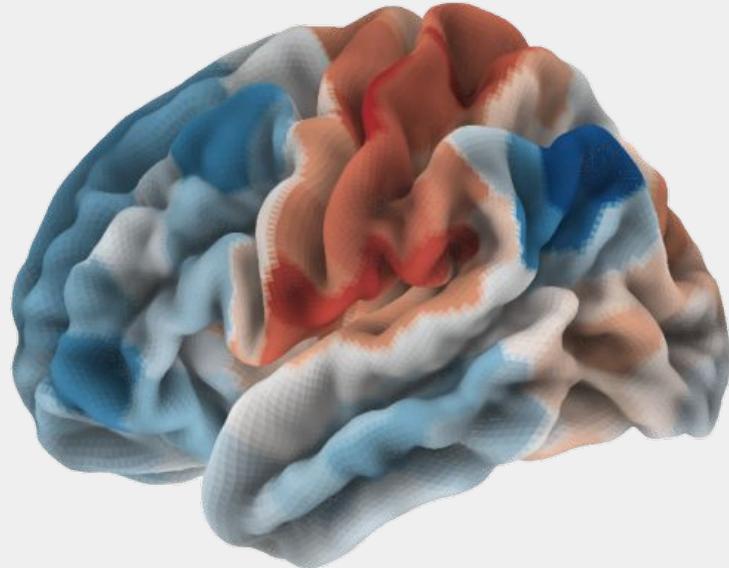


Advanced fMRI data analysis

Karolina Finc

Centre for Modern Interdisciplinary Technologies

Nicolaus Copernicus University in Toruń



COURSE #3: **fMRI data manipulation and plotting in python** | 27th March 2020

Study plan

Open science & neuroimaging



BEFORE

fMRI data manipulation
in python



fMRI data
preprocessing



Functional
connectivity



General
Linear Model



AFTER



Machine Learning
on fMRI data

Study plan

Open science & neuroimaging



BEFORE

fMRI data manipulation
in python



fMRI data
preprocessing



3

Functional
connectivity



5



4

General
Linear Model



AFTER



6

Machine Learning
on fMRI data

Structural vs. functional neuroimaging

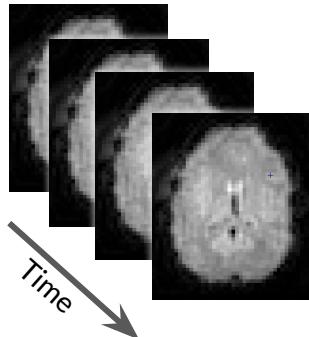
Structural

MRI (T1)



Functional

fMRI (T2*)



Structural vs. functional neuroimaging

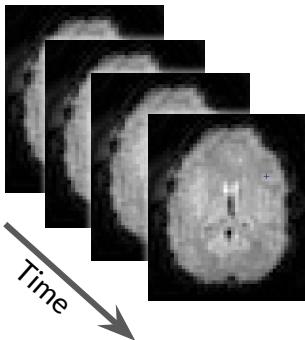
Structural

MRI (T1)

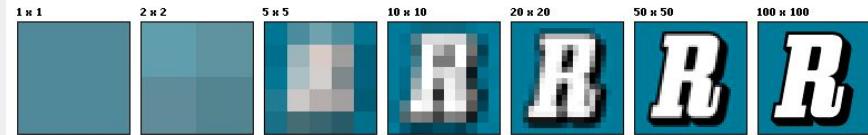


Functional

fMRI (T2*)



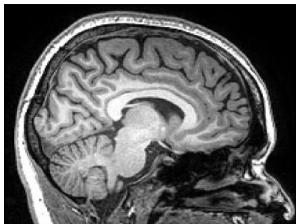
Spatial resolution - determines our ability to distinguish changes in an image across spatial location.



Structural vs. functional neuroimaging

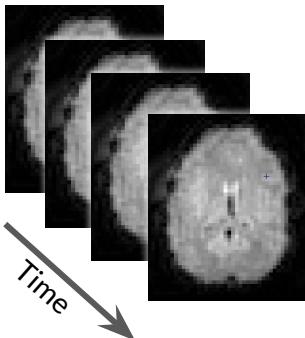
Structural

MRI (T1)



Functional

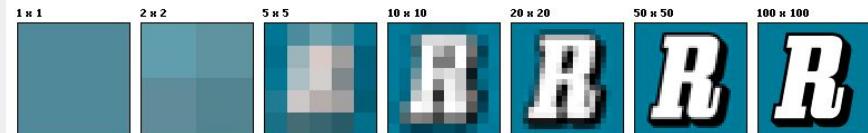
fMRI (T2*)



↑ spatial resolution



Spatial resolution - determines our ability to distinguish changes in an image across spatial location.



Structural vs. functional neuroimaging

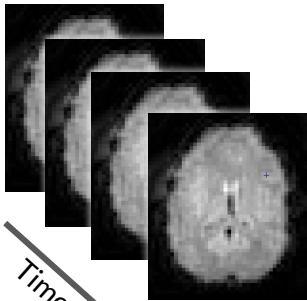
Structural

MRI (T1)



Functional

fMRI (T2*)



↑ spatial resolution



Spatial resolution - determines our ability to distinguish changes in an image across spatial location.

Temporal resolution - determines our ability to separate events in time (**TR**; r.g. TR = 2000 ms).

Structural vs. functional neuroimaging

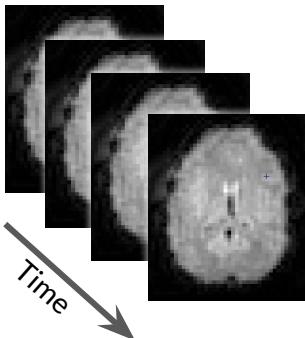
Structural

MRI (T1)



Functional

fMRI (T2*)



↑ spatial resolution



Spatial resolution - determines our ability to distinguish changes in an image across spatial location.

Temporal resolution - determines our ability to separate events in time (**TR**; r.g. TR = 2000 ms).

Frequency - number of measurements per second (Hz)

EEG? fMRI? Which one has better temporal resolution?



Structural vs. functional neuroimaging

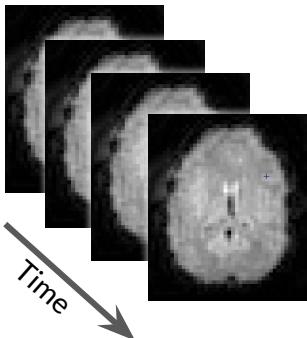
Structural

MRI (T1)



Functional

fMRI (T2*)



↑ spatial resolution



Spatial resolution - determines our ability to distinguish changes in an image across spatial location.

Temporal resolution - determines our ability to separate events in time (**TR**; r.g. TR = 2000 ms).

Frequency - number of measurements per second (Hz)

Structural vs. functional neuroimaging

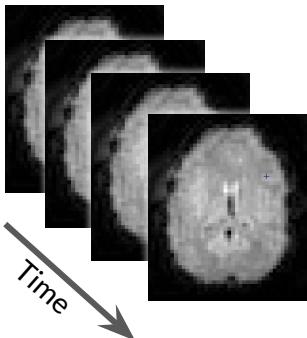
Structural

MRI (T1)



Functional

fMRI (T2*)



↑ spatial resolution



Spatial resolution - determines our ability to distinguish changes in an image across spatial location.

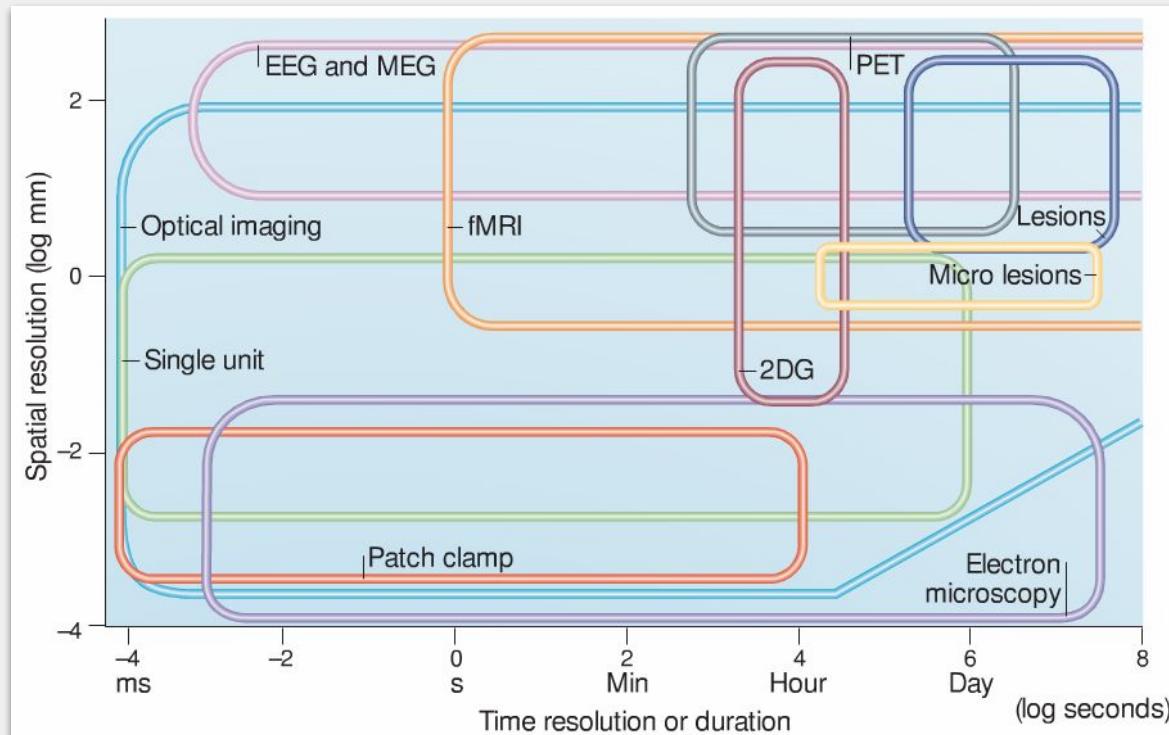
Temporal resolution - determines our ability to separate events in time (**TR**; r.g. TR = 2000 ms).

Frequency - number of measurements per second (Hz)

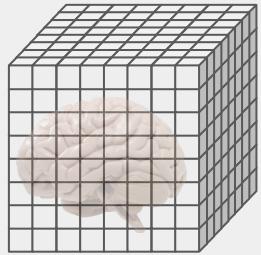
EEG: ~ 1000 Hz

fMRI: ~ 0.5 Hz

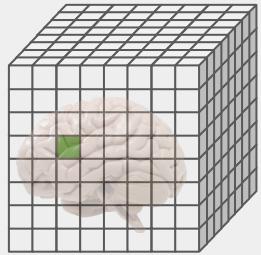
Neuroimaging techniques resolution



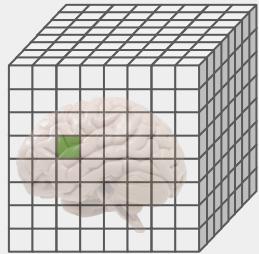
MRI data structure



MRI data structure



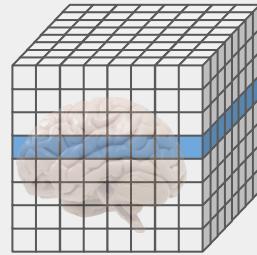
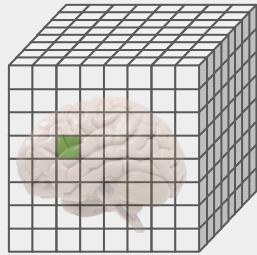
MRI data structure



Voxel

Voxel size
(e.g. $3 \times 3 \times 3$ mm)

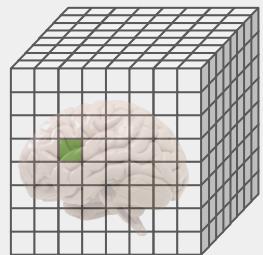
MRI data structure



Voxel

Voxel size
(e.g. $3 \times 3 \times 3$ mm)

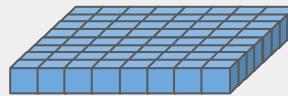
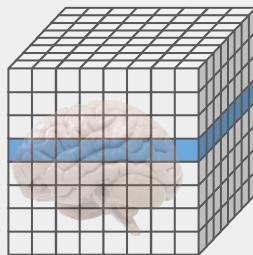
MRI data structure



15

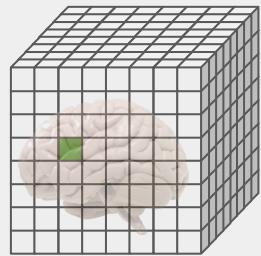
Voxel

Voxel size
(e.g. $3 \times 3 \times 3$ mm)

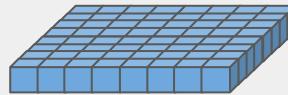
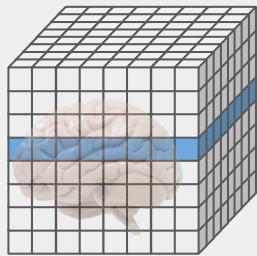


Slice

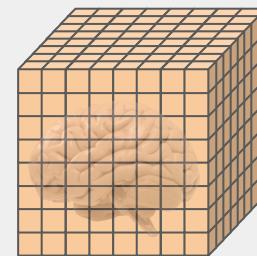
MRI data structure



Voxel

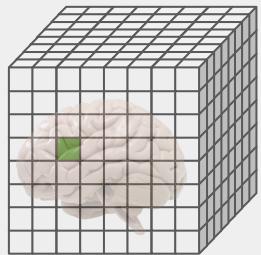


Slice

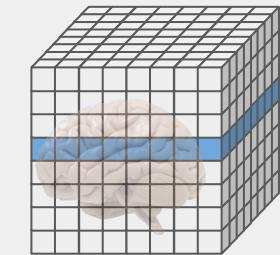


Voxel size
(e.g. $3 \times 3 \times 3$ mm)

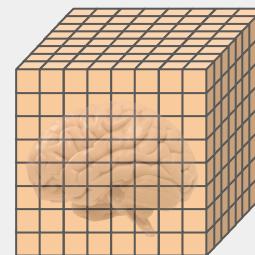
MRI data structure



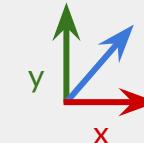
Voxel



Slice



Volume

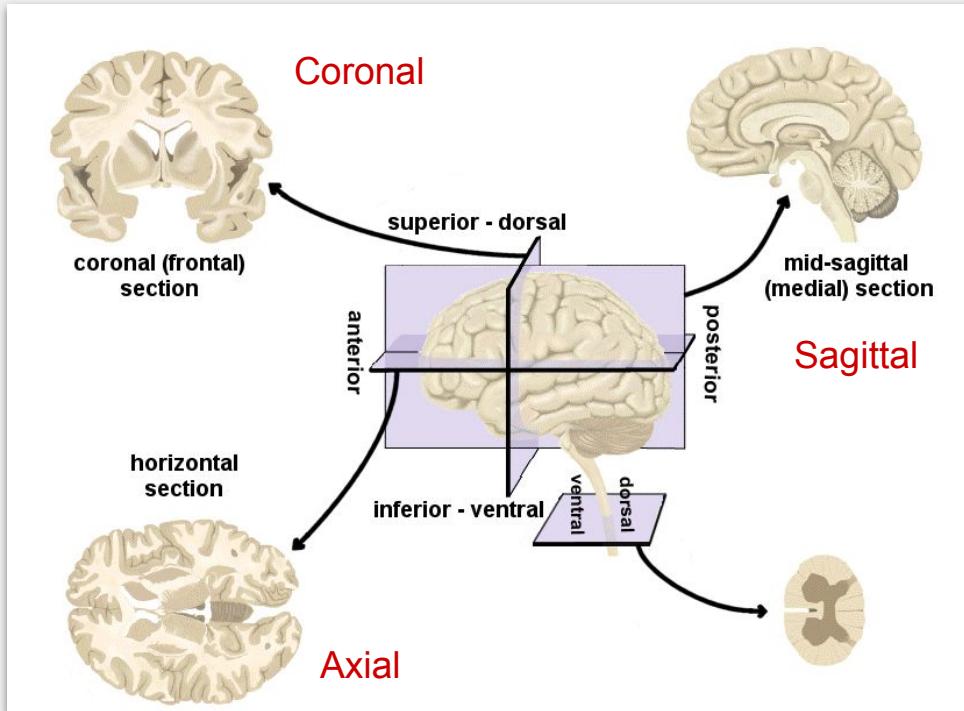


Field of view
(FOV; e.g. 192 mm)

Matrix size
(e.g. 64×64)

Voxel size
(e.g. $3 \times 3 \times 3$ mm)

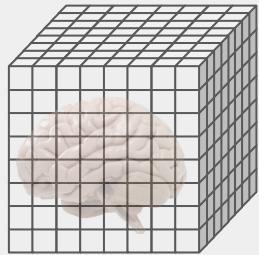
Brain sections



http://homepage.smc.edu/russell_richard/Psych2/Graphics/human_brain_directions.htm

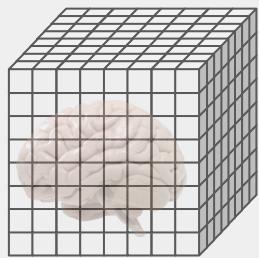
fMRI data structure

Structural data

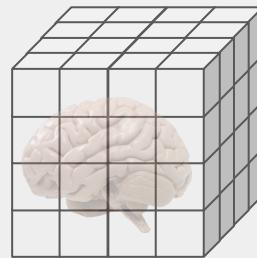


fMRI data structure

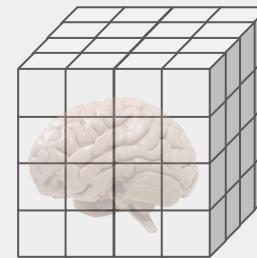
Structural data



Functional data

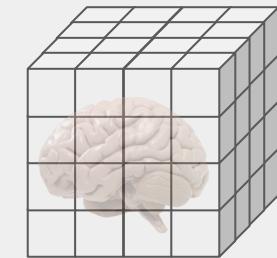


1



2

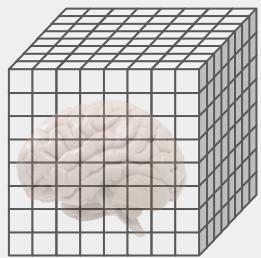
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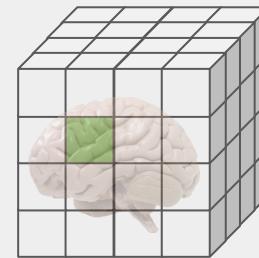
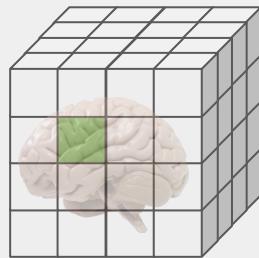
T

fMRI data structure

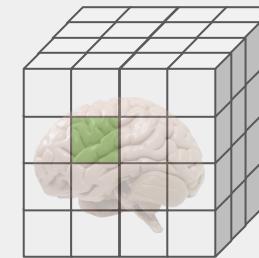
Structural data



Functional data



• • •

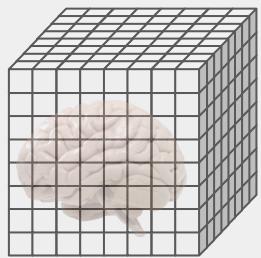


T

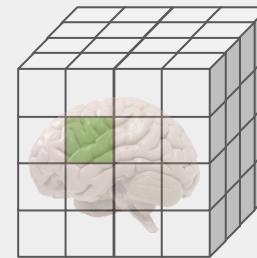
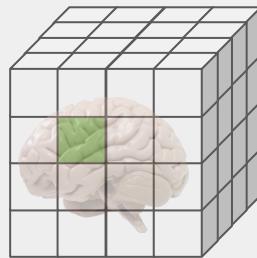


fMRI data structure

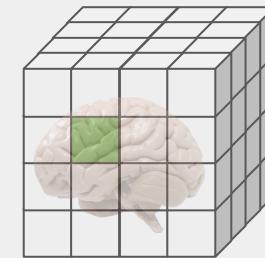
Structural data



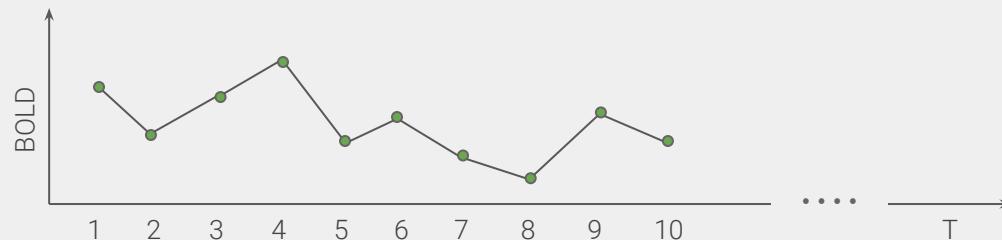
Functional data



• • •

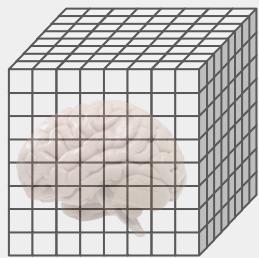


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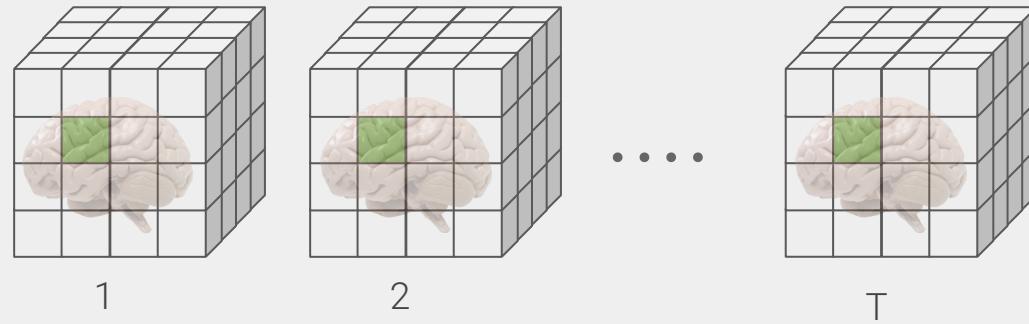


fMRI data structure

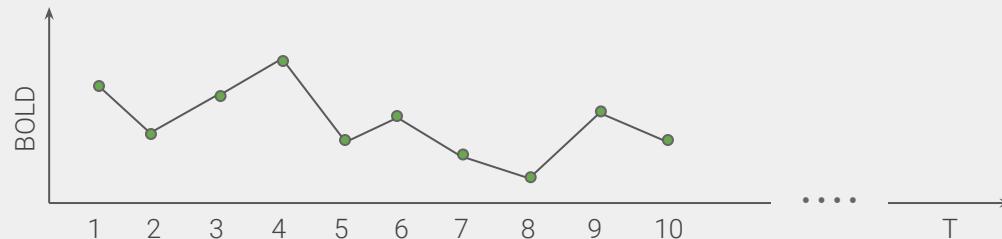
Structural data



Functional data

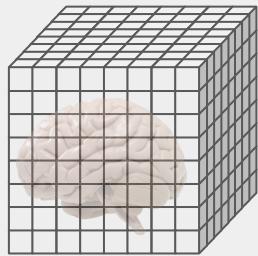


Time series - is a series of data points listed in time order.

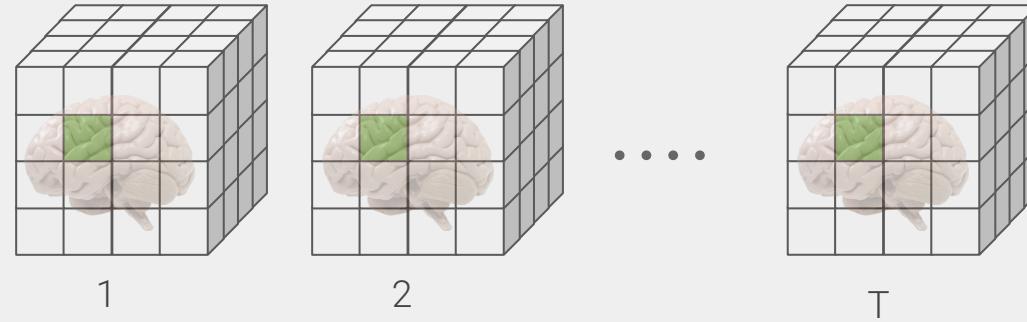


fMRI data structure

Structural data

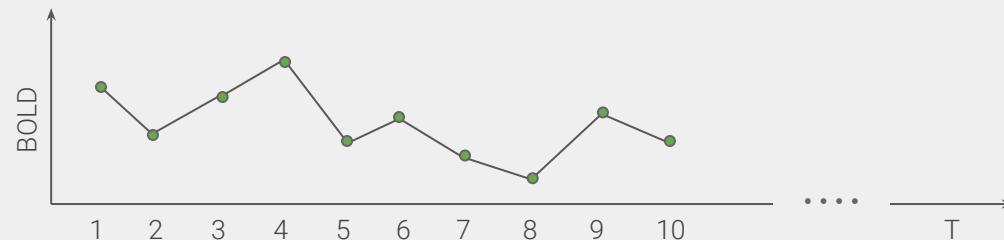


Functional data



Time series - is a series of data points listed in time order.

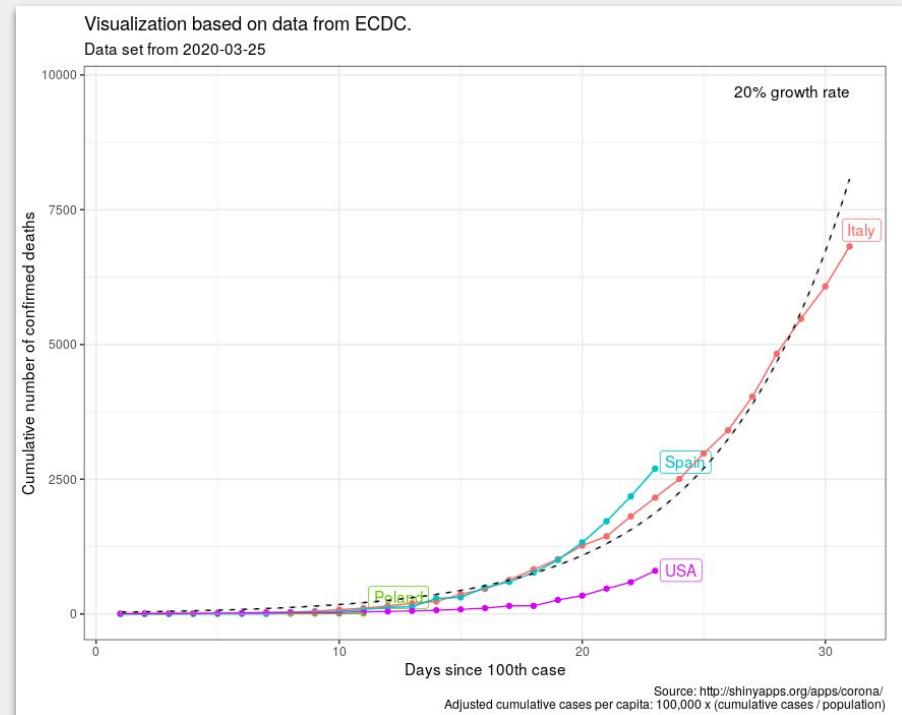
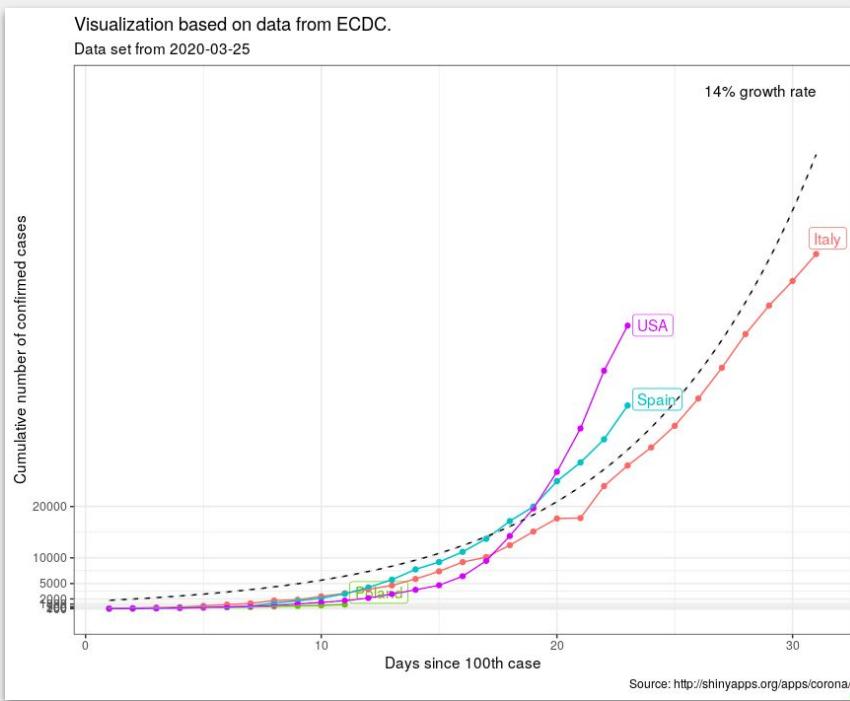
Every voxel has its own time-series.



What data can also be represented as time-series?



Time-series example - COVID-19



Python exercises



<https://github.com/fMRIAnalysisCourse/fmri-analysis-course>



Homework

Logo contest!

1. GitHub Classroom

Data manipulation in Python

Deadline: 10-04-2020

2. Data Camp Classroom

Assignments		
ACTIVE ASSIGNMENTS	ARCHIVED ASSIGNMENTS	
NAME	ASSIGNED TO	ASSIGNED AT
Introduction to Data Visualization with Matplotlib	Organization	Mar 26, 2020
Merging DataFrames with pandas	Organization	Mar 26, 2020
Data Manipulation with pandas	Organization	Mar 20, 2020

A screenshot of a GitHub Classroom repository page. The repository is named 'fMRIAnalysisCourse'. It contains 13 repositories. The main content shows four private Jupyter Notebook assignments created by GitHub Classroom, each with 0 stars and 0 issues, updated 6 days ago. The assignments are titled '01-fmrida-homework-amazonini', '01-fmrida-homework-valtavan', '01-fmrida-homework-krasniewska', and '01-fmrida-homework-randompythonista'. On the right side, there are sections for 'Top languages' (Jupyter Notebook), 'Most used topics' (Loading...), and 'People' (1). A red arrow points to the repository logo.

Next



Preprocessing