

Multimodal registration

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Week 6 - today

9.00 – 11.00	Intro to multimodal registration
	Revisit rigid, affine and non-rigid registration
	Examples of multimodal datasets
	Open Source multimodal datasets
	<i>break</i>
	Experiment!
11.00-12.00	Work on hand in

Recap from last week on registration

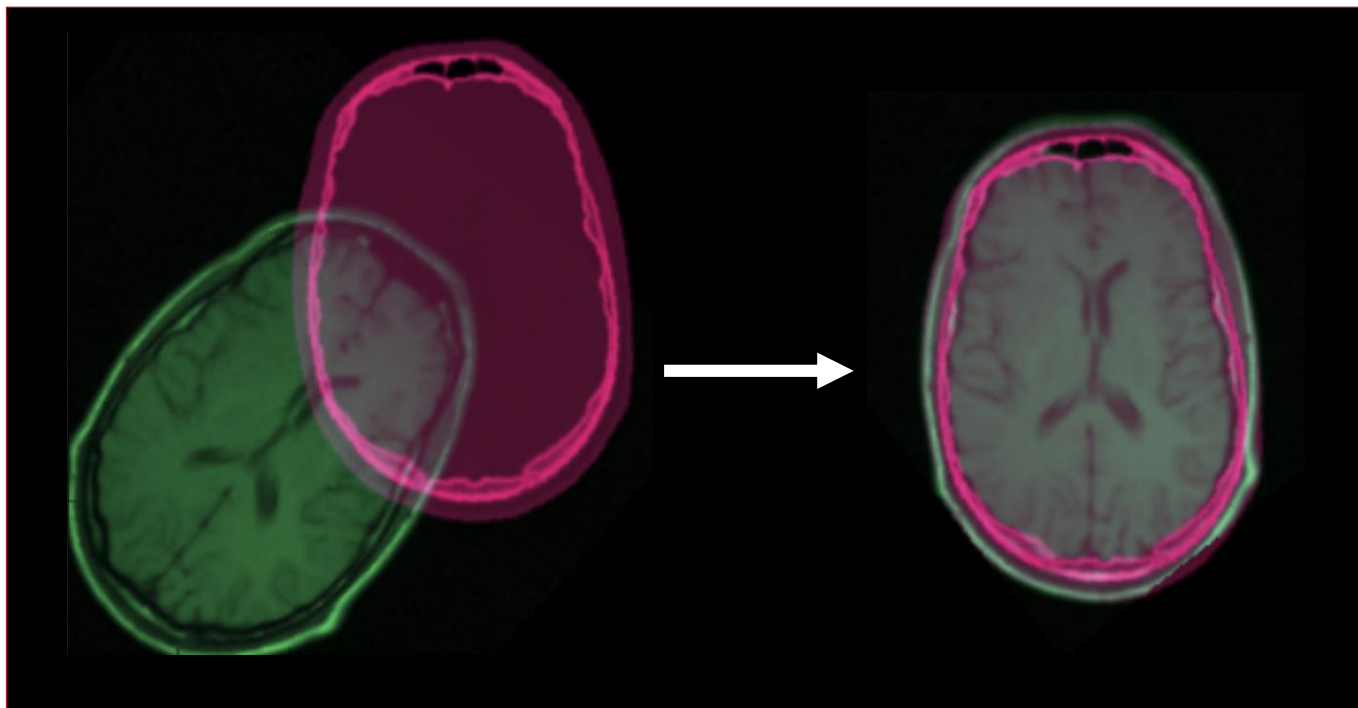
- Why do we need registration?
- What kind of similarity measures did Bulat introduce you to?
- How do we define a rigid registration?

Today's Learning Objectives

- Describe the difference between rigid, affine and non-rigid registration
- Find and access an open source multimodal dataset
- Carry out a registration in on an open source multimodal dataset

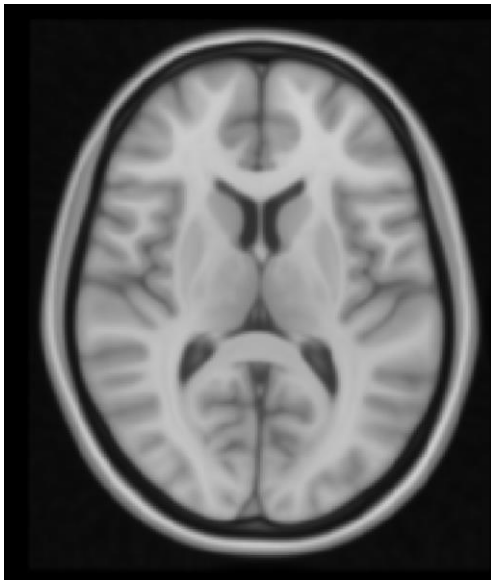
Multimodal registration – what is this?

- Aligning images from two different modalities often with different contrasts or highlighting different structures



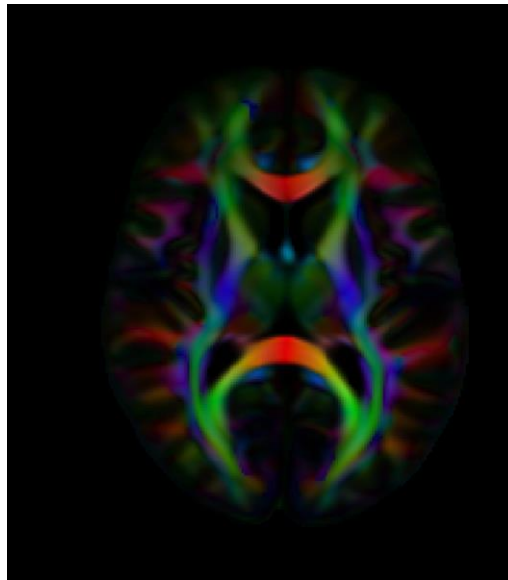
Example registration with different contrasts

Structural MRI



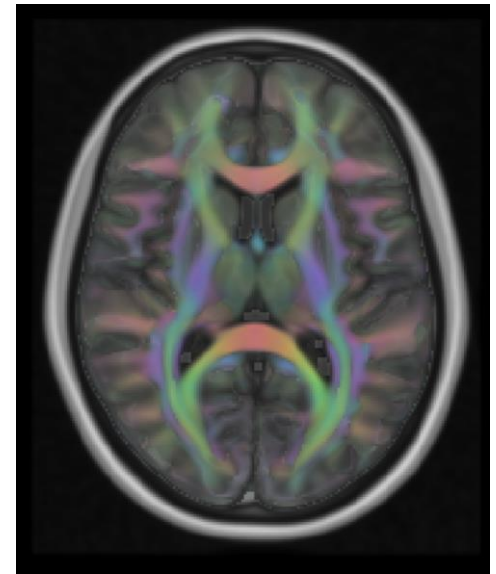
Good contrast between white and gray matter, but white matter lacks details

Diffusions MRI (FA map)



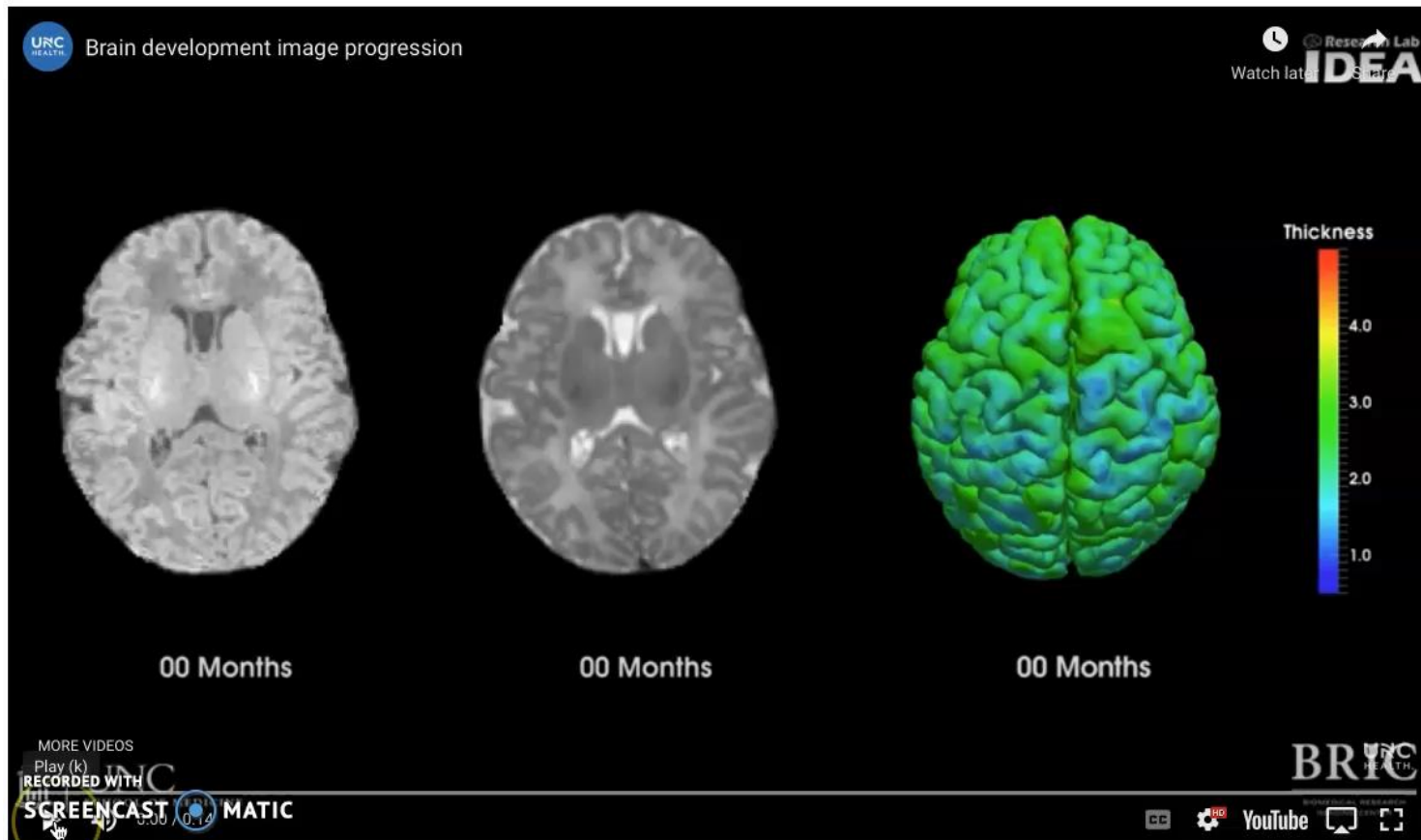
Good contrast in white matter, but is missing anatomical information especially in gray matter and CSF

Registered images



Best of both worlds

Example registration across time

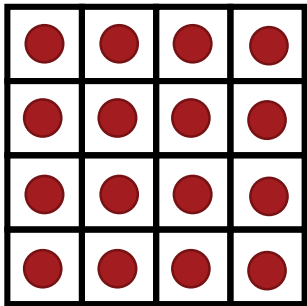


Let's revisit different types of registration

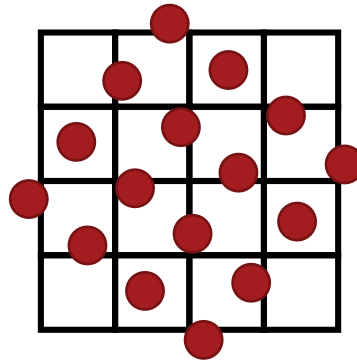
- Which types of registration has Bulat introduced you to?
 - Rigid
 - Affine
 - Non-rigid

Rigid and affine transformations

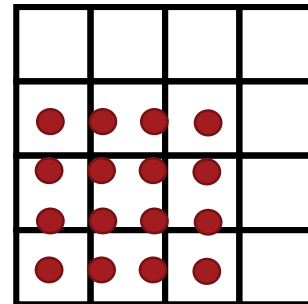
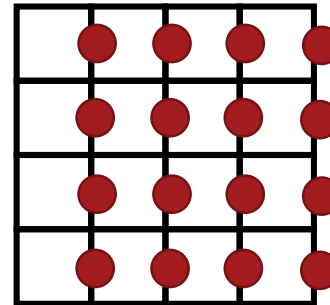
Input



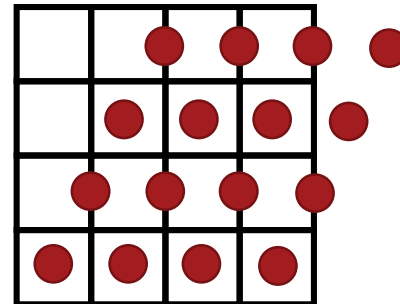
Rotation



Translation

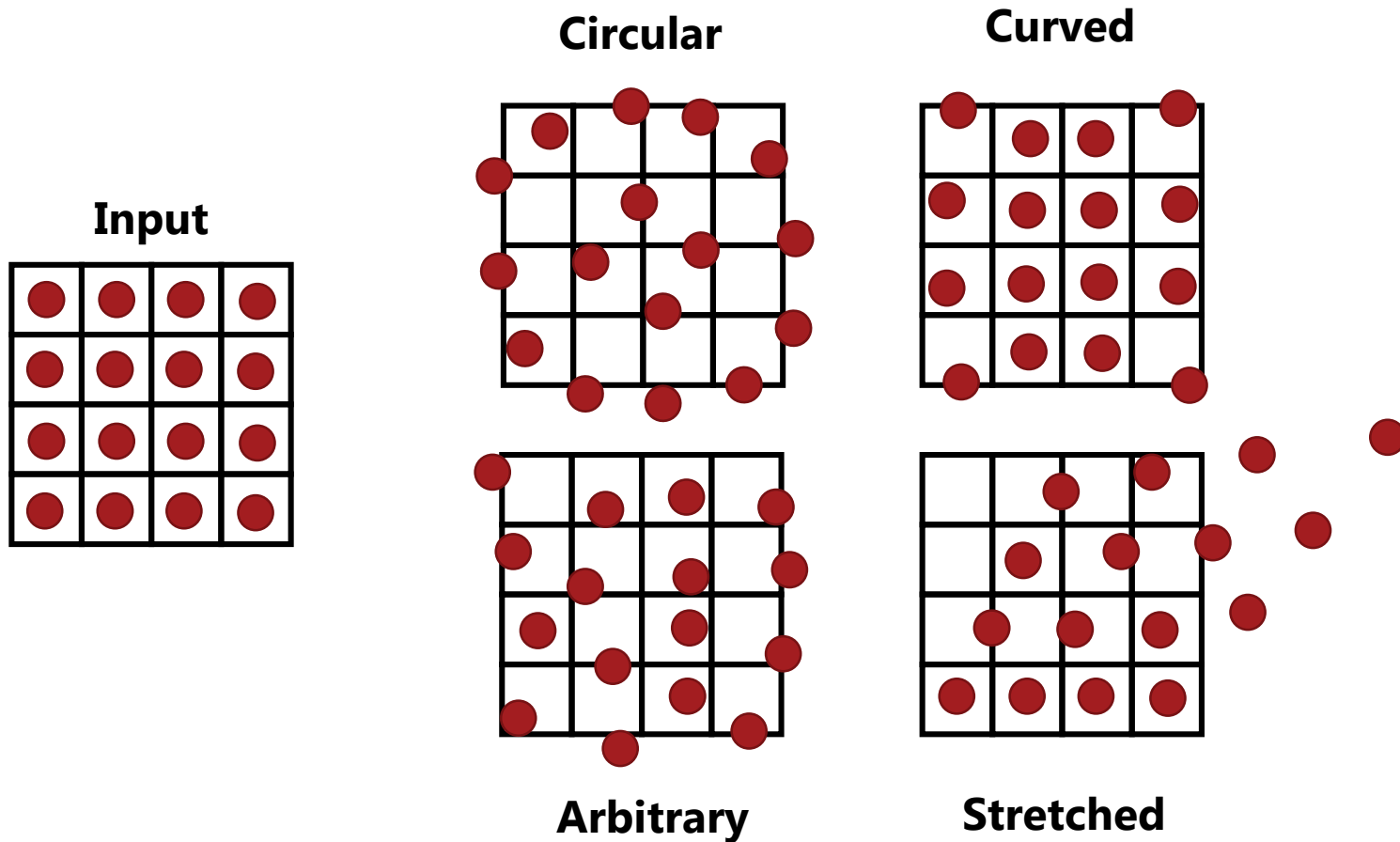


Scaling



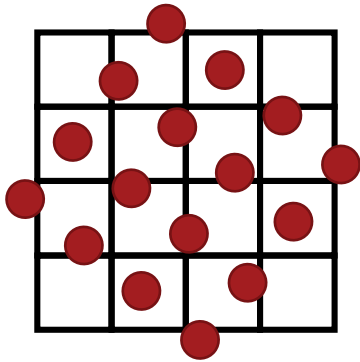
Shear

Non-rigid transformations

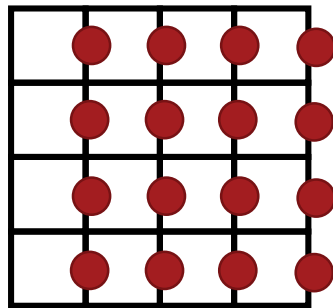


Rigid registration

Rotation

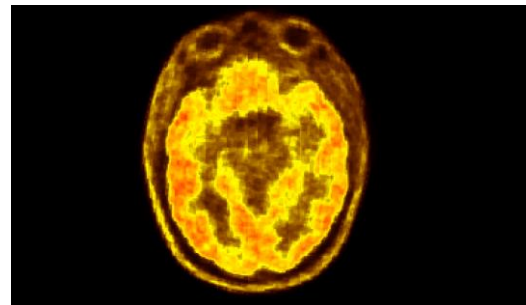
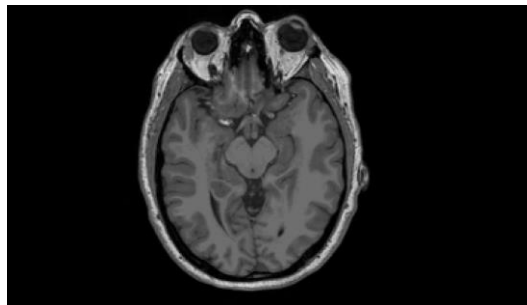


Translation

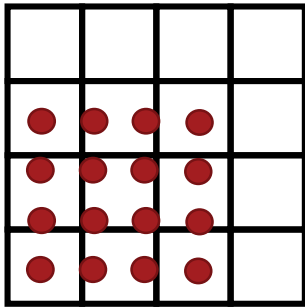


$$M = \begin{pmatrix} \cos \theta & -\sin \theta & t_x \\ \sin \theta & \cos \theta & t_y \\ 0 & 0 & 1 \end{pmatrix}$$

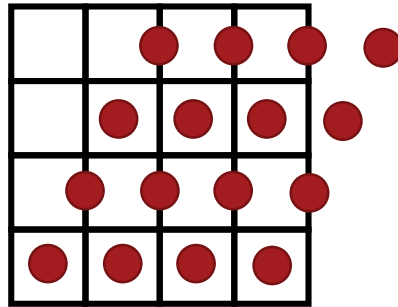
- In what kind of applications do we want to use rigid registrations?
 - E.g. intra-subject rigid body



Affine registration



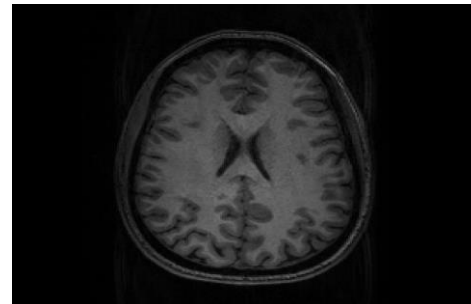
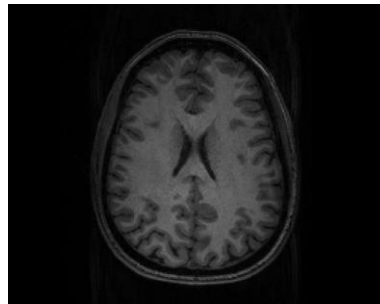
Scaling



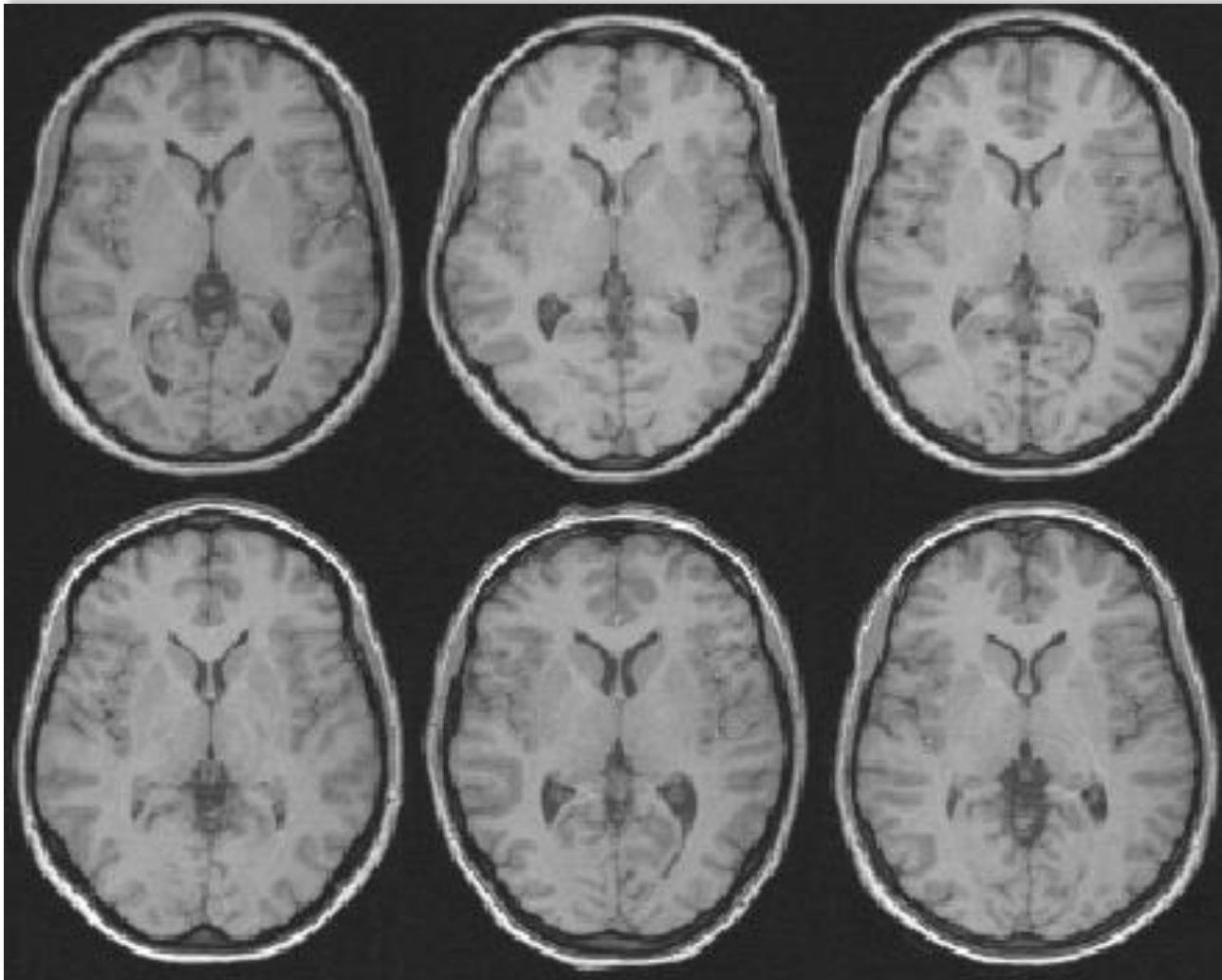
Shear

$$M = \begin{pmatrix} m_1 & m_2 & m_3 \\ m_4 & m_5 & m_6 \\ 0 & 0 & 1 \end{pmatrix}$$

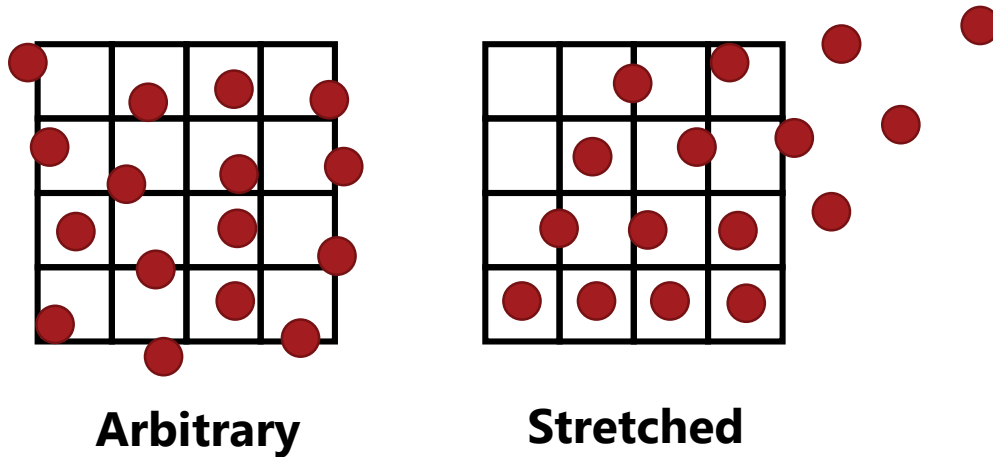
- In what kind of applications do we want to use affine registrations?
 - E.g. inter-subject



Example of affine registration across several subjects

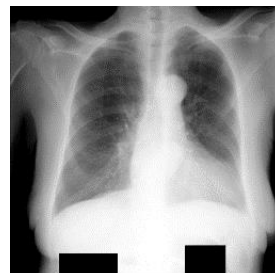


Non-rigid registration

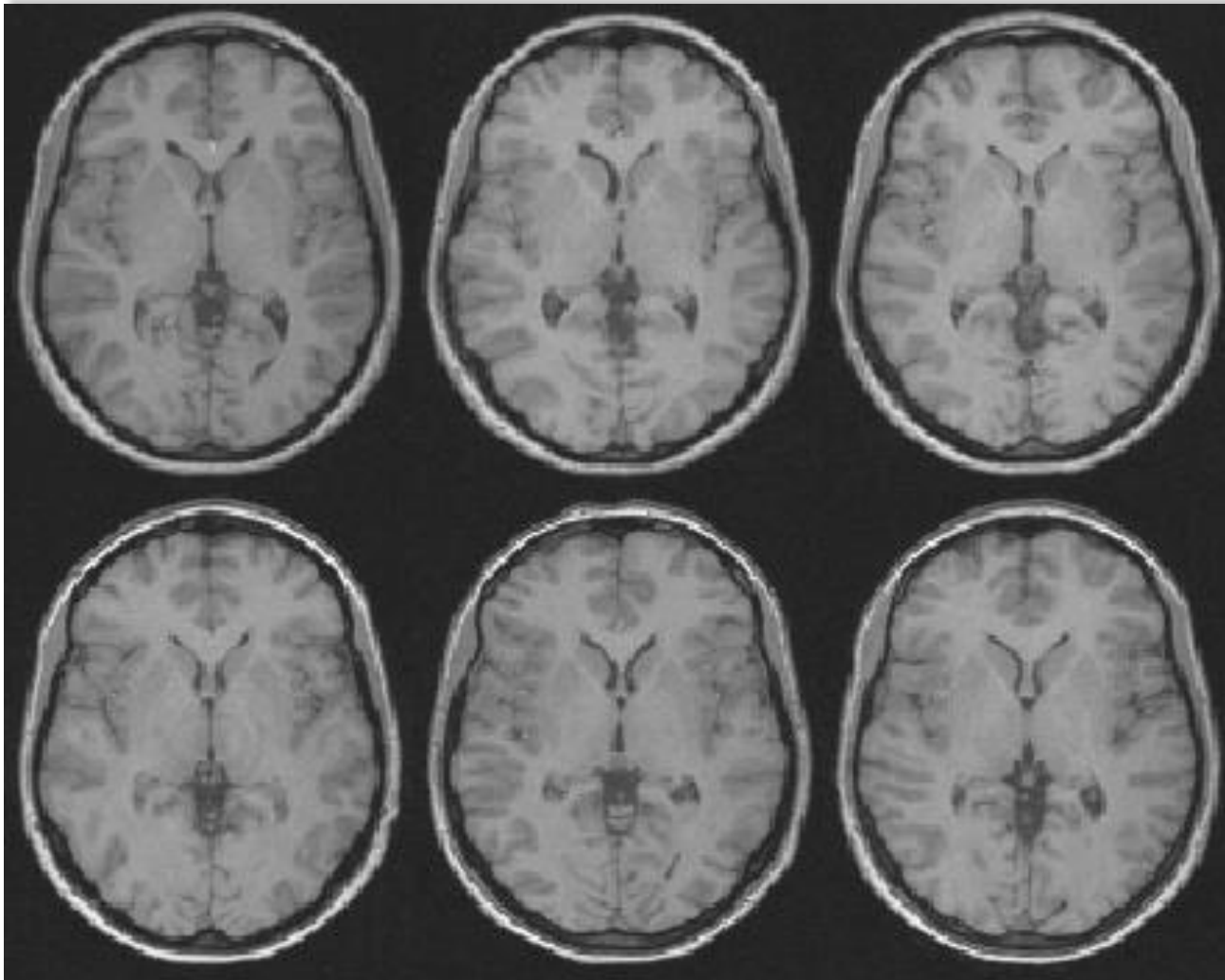


$$M = \begin{pmatrix} m_1 & m_2 & m_3 \\ m_4 & m_5 & m_6 \\ m_7 & m_8 & m_9 \end{pmatrix}$$

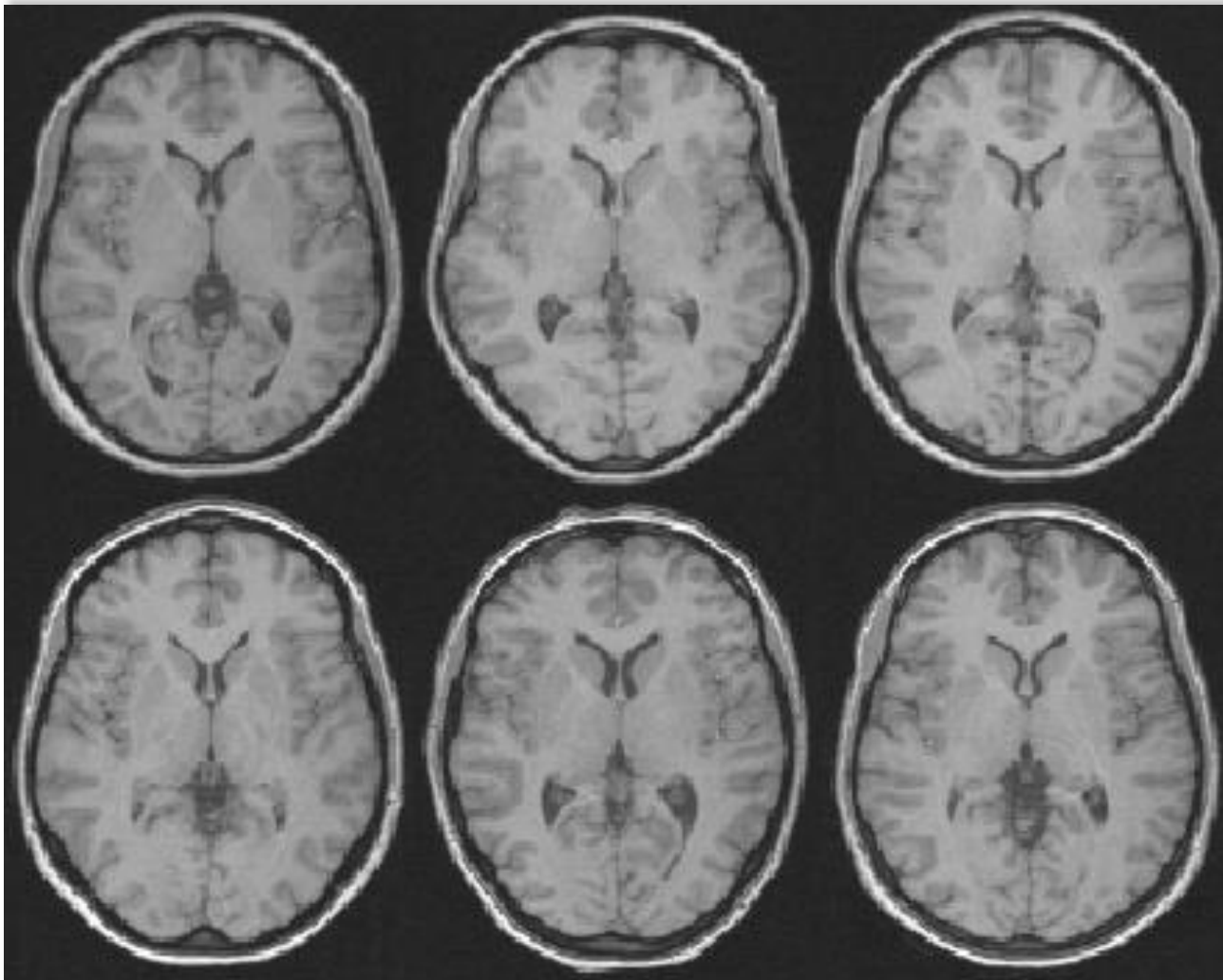
- In what kind of applications do we want to use non-rigid registrations?
 - E.g. intra or inter-subject non-rigid body



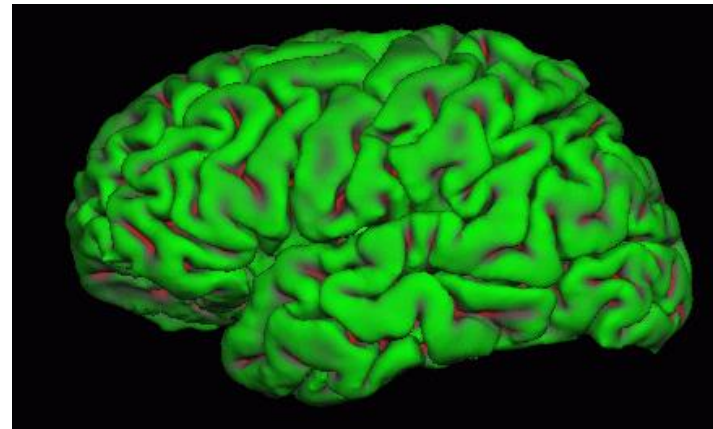
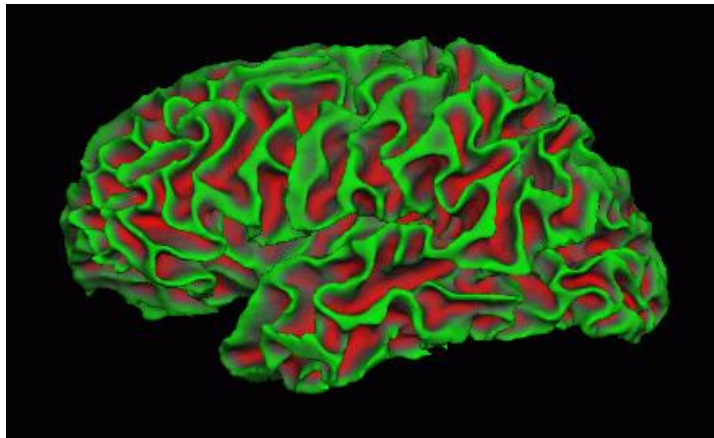
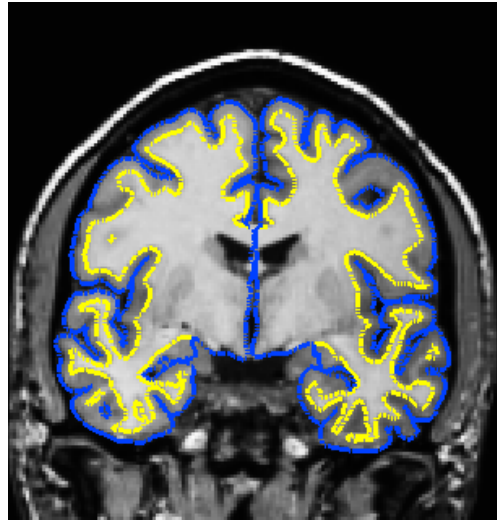
Example of non-rigid registration across several subjects



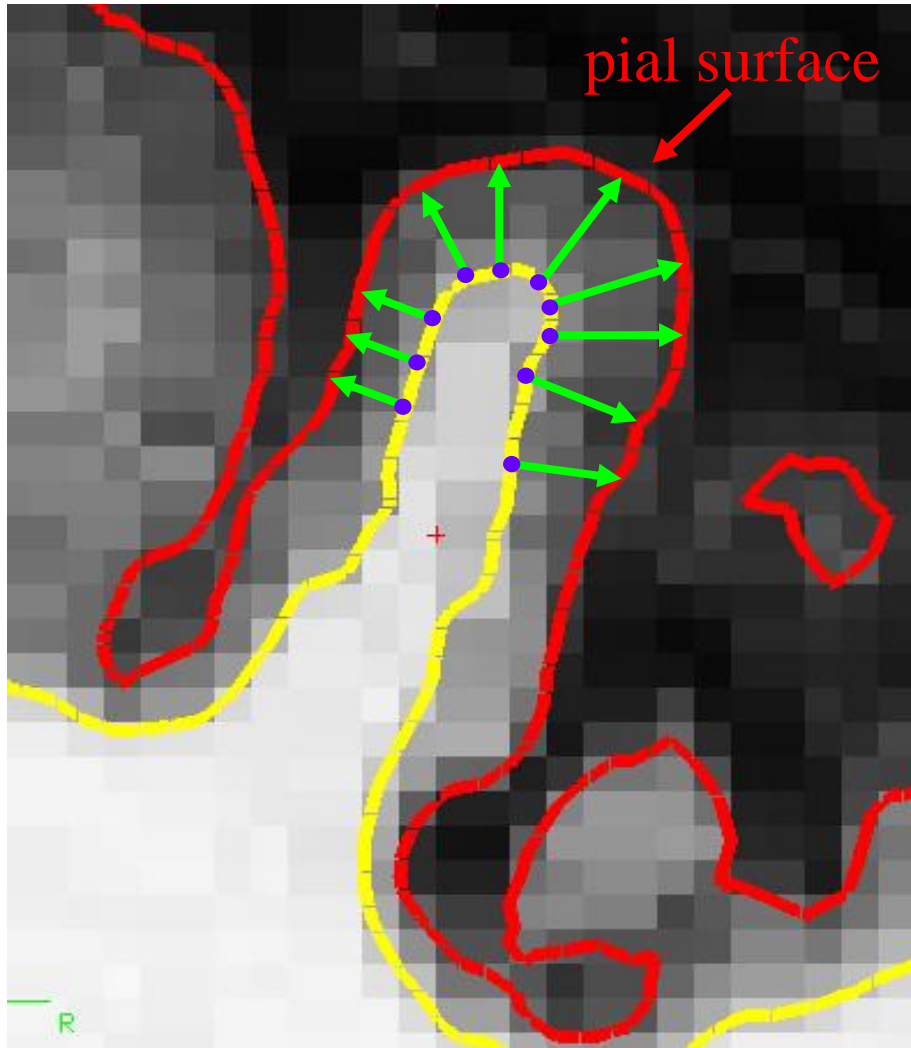
Example of affine registration across several subjects



Restructuring your registration problem

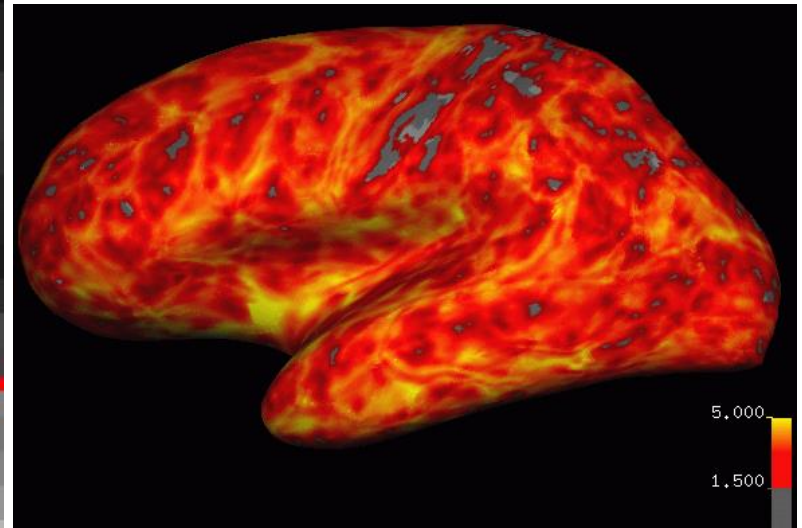


Cortical Thickness

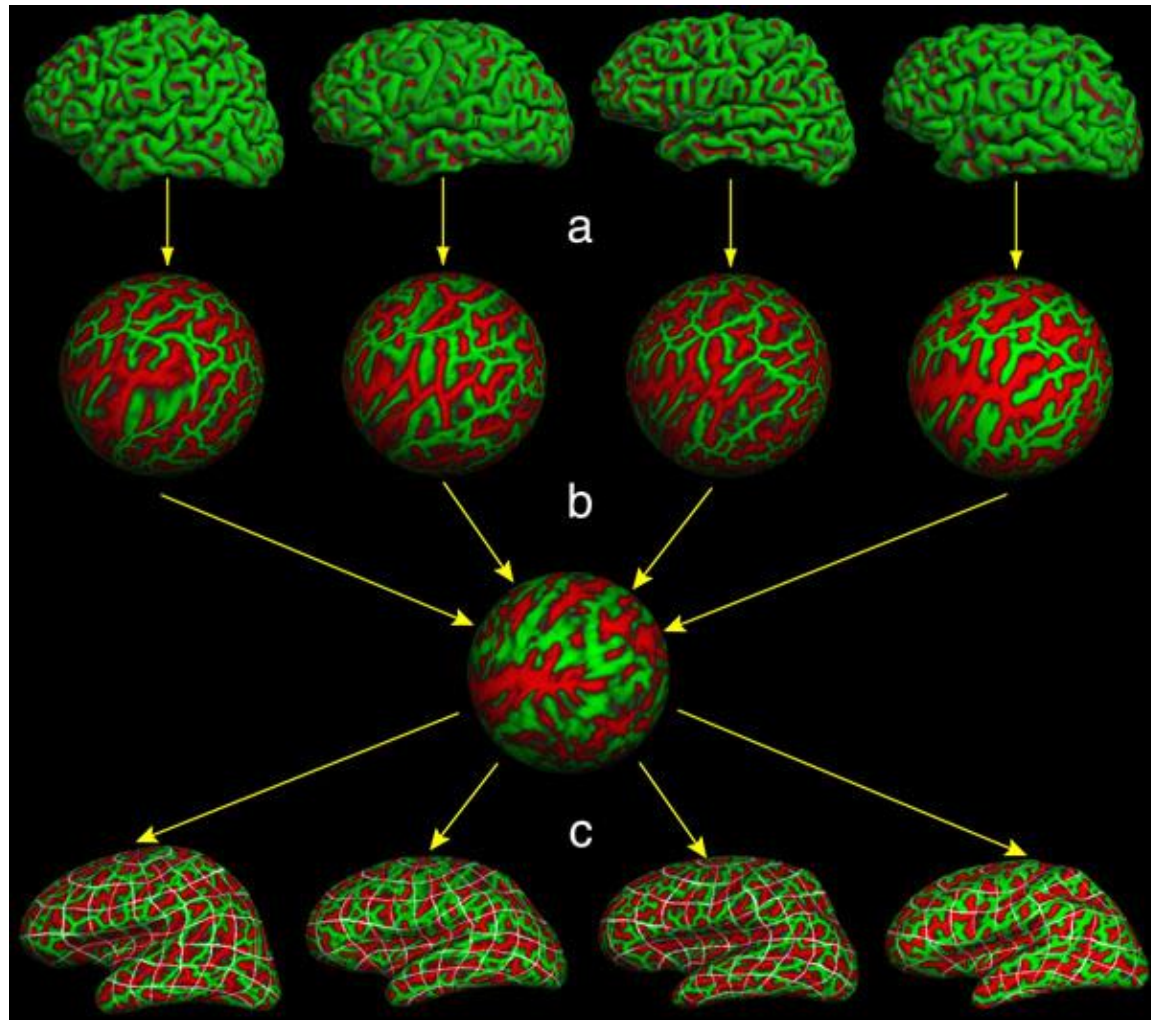


Distance between white and pial surfaces along normal vector.

Approx. 1-5mm



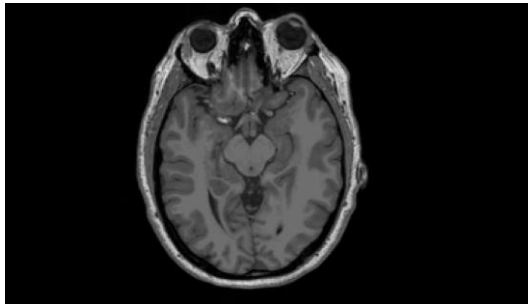
A surface-based inter-subject registration



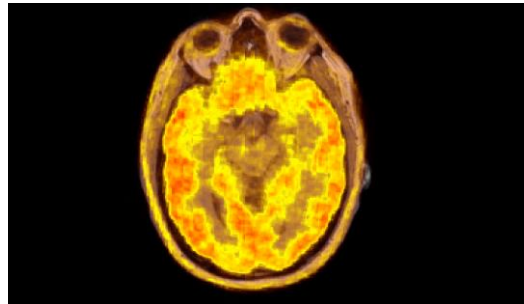
Common space for group analysis

Cortical surface for multimodal analysis

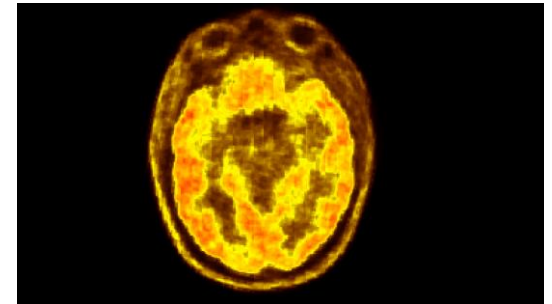
MRI



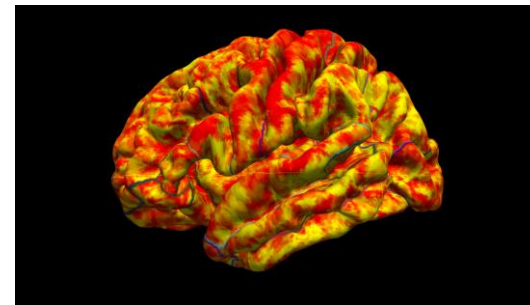
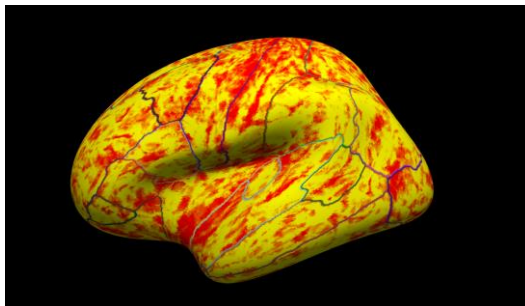
MRI + PET



PET



PET on the surface (inflated and not)

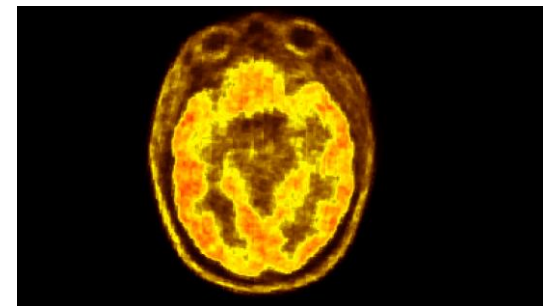
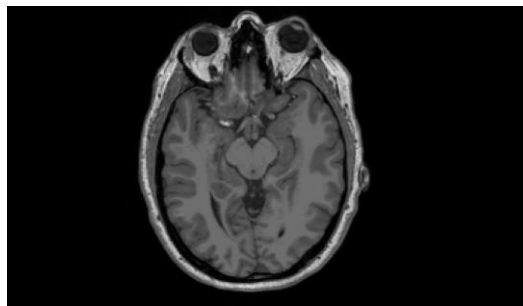


Now on to multimodal registration...

- What modalities have we covered so far?
- Which else can you come up with?
- With your neighbour, spend 2-3 minutes and think of an actual clinical problem where you would want a multimodal dataset.

Examples of multimodal registration problems

- MR/fMRI – structural and functional MRI
- PET/CT – metabolism and structure/density
- PET/MR – metabolism and structure
- Etc...



Let's find some real data...

- <https://openneuro.org/>
 - E.g. <https://openneuro.org/datasets/ds001421>
- <https://grand-challenge.org/>
 - E.g. <https://learn2reg.grand-challenge.org/Learn2Reg2020/> Or <https://continuousregistration.grand-challenge.org/home/>
- <https://www.cancerimagingarchive.net>
 - E.g. <https://wiki.cancerimagingarchive.net/pages/viewpage.action?pageId=52763679> (Need to install downloader)

BREAK

10 minutes

We'll make an experiment!

- Find an open source public multimodal dataset
- Can be 2D, can be 3D, doesn't matter; show me how you can find one and visualize it
- Use what you have implemented for the hand-in so far as basis for performing a multimodal registration. If you haven't implemented anything, get started!
- Or find whatever open source registration tool you like and use that!

Timeframe

- Spend not more than 10-15 minutes to find and download a dataset
- Spend 5-10 minutes to visualize the dataset
- Then spend the rest of the time until 10:45 to find and/or implement a multimodal registration
- Spend 5 minutes visualizing the results and add them to the discussion forum thread

Rest of today

- Work on hand-in
- 3rd assignment is due Monday the 17th of October

Rest of this week and next week

- Lectures on Thursday 9-11 with Bulat giving an intro to machine learning in the MIA context
- TA session on Thursday from 1 pm on
- Next week (week 42) is fall vacation and then we start again on Tuesday October 25th
- 4th assignment is due on Monday the 7th of November; challenge is due earlier!

Questions?

