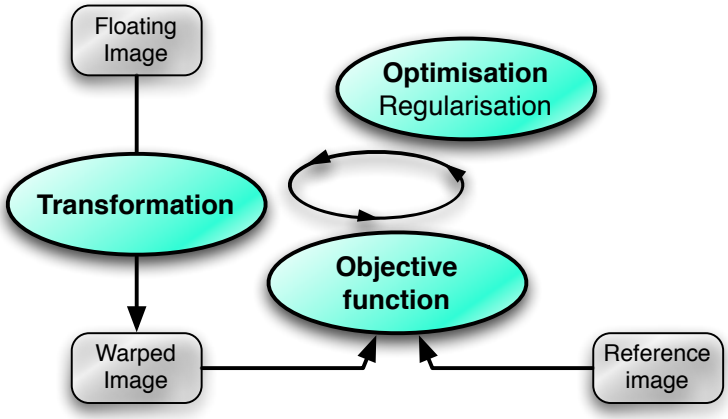
Medical Image Registration Workshop - Part 1
- Global registration -

Medical image registration consists of spatially aligning one or several images to a common space. A multitude of algorithms have been developed over the past two decades. They all follow the same scheme:



Briefly, a floating image is deformed using a transformation model. The transformation parameters are tuned to optimise an objective function scalar value. An optimal transformation is sought, one that maximises the similarity between the warped image and a reference image.

The transformation model is defined using a matrix form where each pixel ***x*** in the reference image has its corresponding position ***x'*** in the floating image. ***x'*** can be computed as:

$$\mathbf{x}' = \mathbf{A} \times \mathbf{x}$$

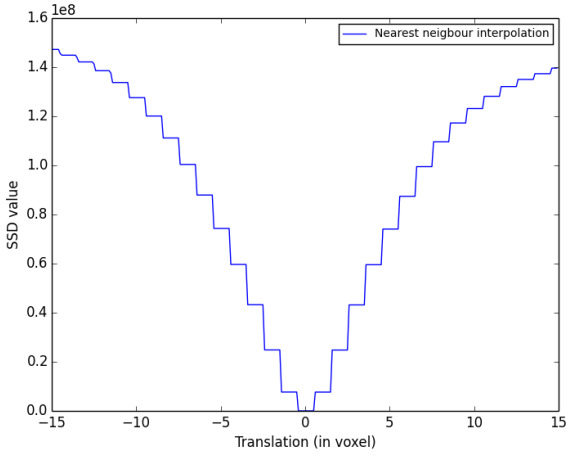
where

$$\mathbf{A} = \mathbf{Sk} \times \mathbf{Sc} \times \mathbf{Rz} + \mathbf{T}$$

with **Sk** being the skewing matrix, **Sc** the scaling matrix, **Rz** the rotation matrix along the z axis (or xy plane) and **T** the translation matrix.

In order to generate the warped image, one must resample the floating image in the space of the reference image.

The file *resampling.py* enables to generate the following aside. An image (BrainWeb_2D.png) is translated from -15 voxels to 15 voxels with a 0.25 increment. After each translation value is applied, the sum squared difference between the warped image and its original version is computed.



Task1: Create a new function to perform a linear interpolation and compare the obtained plot.

Task2: Implement the Normalised cross-correlation measure of similarity.

Task3: Implement the Normalised Mutual information. (The numpy.histogram2d function will enable you to easily create a joint histogram.)

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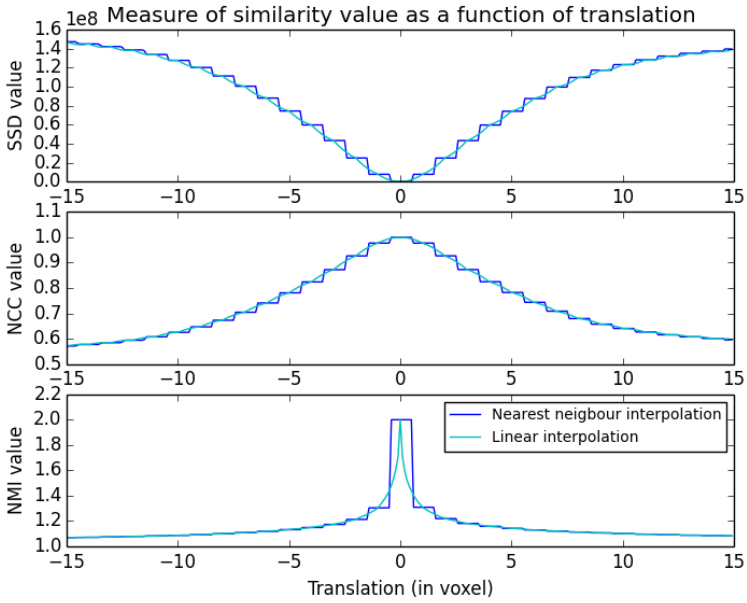
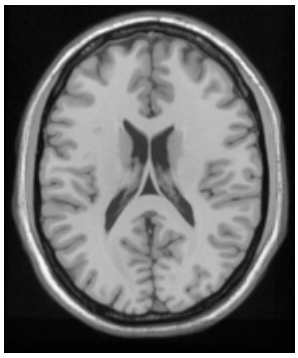
After implementation of task 1 to 3, you will be able to generate the following plot:

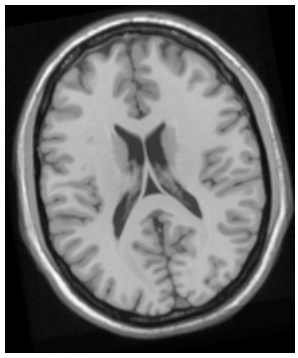


Task4: Modify the Normalised Mutual Information computation code to use the partial volume scheme. Use BrainWeb_2D.png as a reference image and Patient_2D.png as a floating image and compute the Normalise Mutual Information when applying a translation from -2 to 2 with a 0.05 increment with an without the partial volume scheme.

Task5: Load BrainWeb_2D.png and apply a 10º rotation applied to the centre of the image.



Reference image



Warped image

Task6: Using the previously written functions to resample an image and to compute a measure of similarity, write a registration algorithm that optimises translation only.