Exercises 11: Image analysis

Introduction to data science and Python programming for medical research (2025)

For this exercise you will need to install the packages scipy, scikit-image and Simple ITK.

1 Background

Image registration is the process of finding a transform that can move or deform one image such that it matches another.

SimpleITK has several algorithms implemented for this purpose. In this exercise you will inspect the result of a deformable image registration performed using B-splines.

A segmentation mask is a pixel wise annotated image where each pixel is labeled as the object it belongs to.

Segmentation masks can be compared in different ways. Classification scores such as precision, recall and F1 score can be calculated.

A common distance metric to compare shapes is the Hausdorff distance. It describes a locally worst discrepancy between two shapes or image masks.

The two images used in this exercise are magnetic resonance images from neonatal children. Published with the annotated masks as part of the course *"Machine learning for biomedical applications"*.

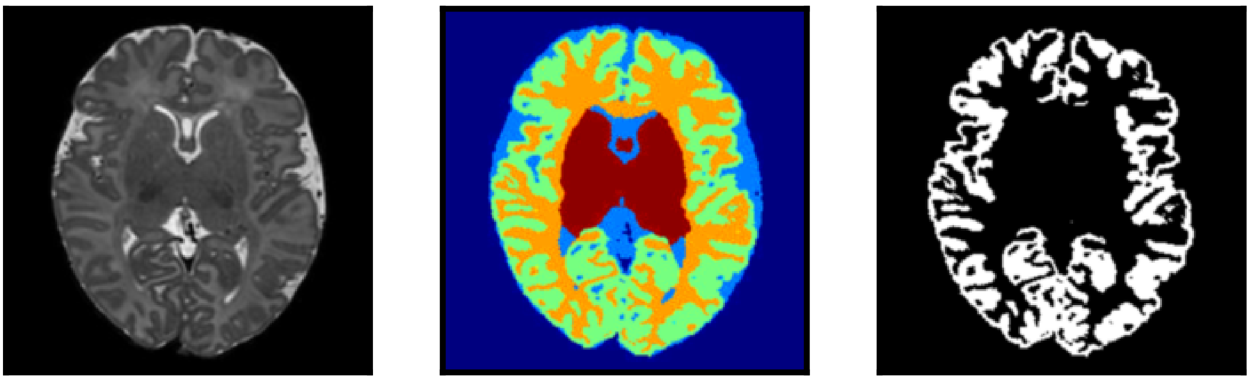

Figure 1: One of the images used in the exercise. The images have an annotated mask. One of the labeled regions are the cortex of the brain.

2 Image registration and comparison of masks

In this exercise you will run a code that will perform an image registration with a resulting transform that is applied both to the moving image and to its labeled mask image.

Two plots are created. The first shows the images before and after registration. The second compares the image masks before and after registration.

The original and the deformed mask is compared to the fixed image mask.

The Hausdorff distance, H, is indicated with a colored line and two points in the second plot.

- What can you say about the resulting image registration from inspecting the image result?
- What does the Hausdorff distance between the two image masks tell us?
- What do the Hausdorff distance and the mask comparing scores tell us about the image registration quality?
- Look in the code for the section where the images are loaded. Comment and uncomment the different lines indicated in the code to select different mask labels.

If you are using notebooks you might need to change the two `plt.savefig()` to `plt.show()`.
https://github.com/MachineLearningBiomedicalApplications