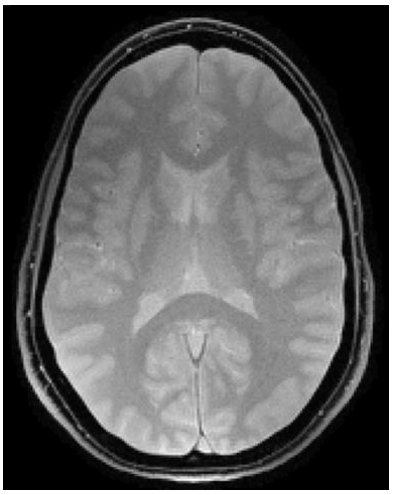
Biomedical Imaging FS 2020

MRI 3

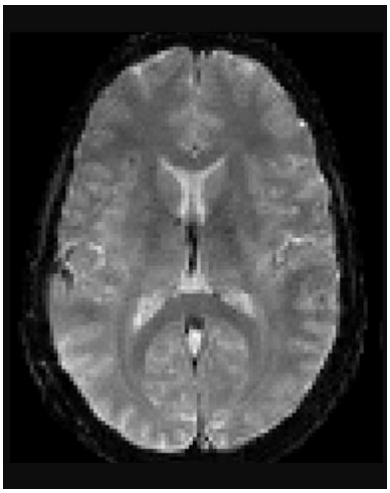
Exercises

The topic of this exercise is fMRI, i.e., functional MRI of the brain. Its goal is to detect brain activity based on a time series of images obtained while stimulating the brain with visual input.

Imaging was limited to a single transverse slice and performed with an echo-planar technique, scanning all of k-space for each image in one go (in 40 msec). Imaging was repeated every 3 sec, yielding 200 frames in a total of 10 min.

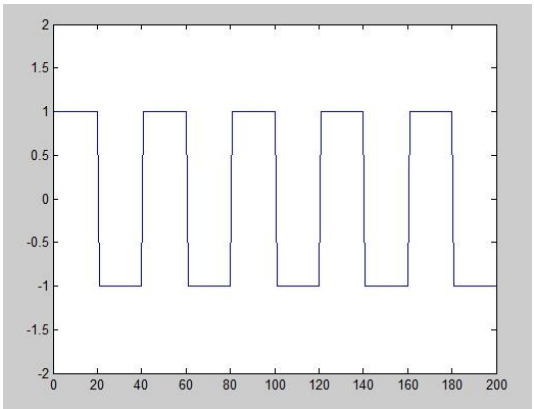


Anatomical image



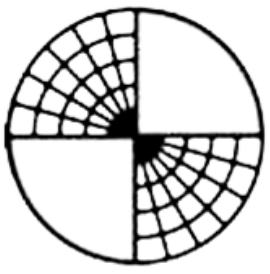
One frame of the time series

During these 10 minutes the brain was stimulated by visual presentation of (on-off) flickering patterns. The stimulation scheme ('paradigm') consisted in alternating between the two complementary wedge patterns shown below, comprising 10 episodes of 1 min each.

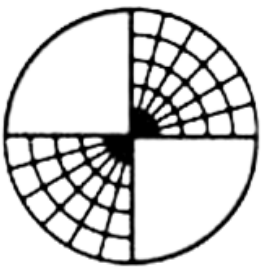


Stimulation paradigm, 10 min

Flickering patterns



Input = 1



Input = -1

The prepared code reads in

- a high-resolution anatomical image of the slice
- the paradigm
- the fMRI data set

Tasks

1. Display and study the signal time series of individual pixels of your choice. Try to find pixels whose temporal fluctuation resembles the paradigm.

2. Quantify the resemblance with the visual paradigm by calculating the scalar product (= product summed over time) of the pixel time series and the paradigm. Calculate the scalar product for all pixels and display the results as an image ('activation map').

3. Calculate the temporal standard deviation of the time series and display it as map. Estimate the thermal noise level from an area without activation.

4. To distinguish activations from noise choose a threshold and mask the activation map accordingly. Display the masked activation superimposed on the anatomical data. Propose an interpretation of the result. What does the sign of the activation indicate?

Questions?

Emily Baadsvik (baadsvik@biomed.ee.ethz.ch)
Eric Michael (michael@biomed.ee.ethz.ch)
Mathieu Suter (suter@biomed.ee.ethz.ch)