Compressive Sensing for Magnetic Resonance Imaging

Exercise Sheet 1 - Down the rabbit hole

1 What is the radio-frequency range? How does it relate to MRI?

2 What is the nuclear magnetic moment and the gyromagnetic ratio? Describe it for different atoms.

3 Do the calculations and check that the function presented as a solution to the Bloch is indeed a solution.

4 Show that the angle between **B** and **M** does not change.

5 What is a rotation matrix? Explain why

$$\begin{pmatrix} \cos(\gamma B_0 t) & \sin(\gamma B_0 t) & 0 \\ -\sin(\gamma B_0 t) & \cos(\gamma B_0 t) & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

is a rotation matrix around the z-axis.

6 What proceeds more rapidly, T_1 or T_2? Why? What do 37% and 3% mean for the relaxation times?

7 Describe the order of magnitude of T_1 and T_2 for different biological tissues?

8 *Hello world in Julia:* Install Julia$--$ >Plot a Shepp-Logan Phantom$--$ >Plot the fourier transform of the Shepp-Logan Phantom$--$ >Plot the Wavelets transform of the Shepp-Logan Phantom

9 Now get some data from `http://mridata.org/`, load it in Julia and do the same procedure as in the exercise above.

10 Load an angiogram and a brain image in Julia, apply the Wavelets transform and the DCT transform to both and plot the histogram of coefficients. Compare, for the two different images, which transform performs better for a sparse representation. Discuss the results

11 In order to write you report, please check `https://www.youtube.com/watch?v=Q83QfFi2HI4` and send me a Julia notebook with the solutions!