**Computational MR imaging**

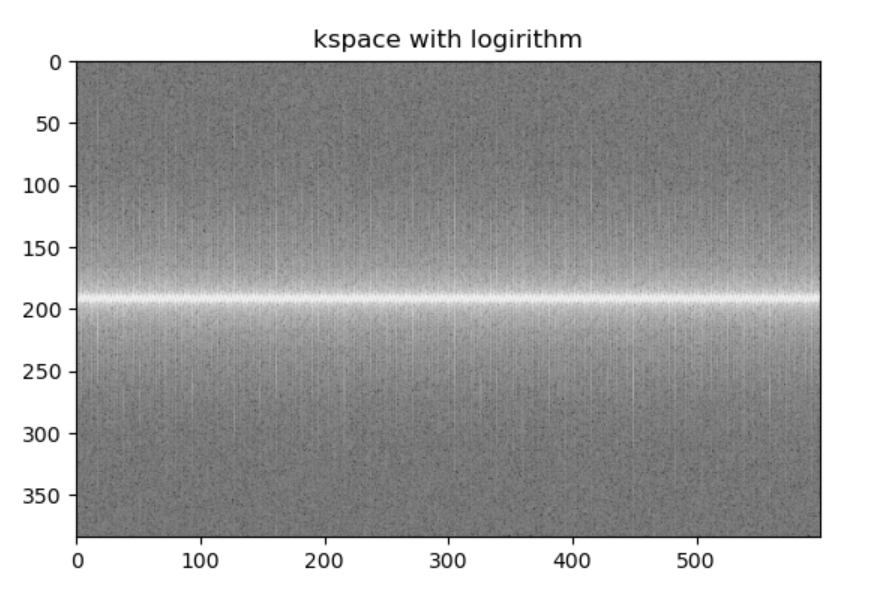
**Laboratory 4: Reconstruction of non-Cartesian k-space data**

**Nan Lan**

1. **Radial sampling pattern**

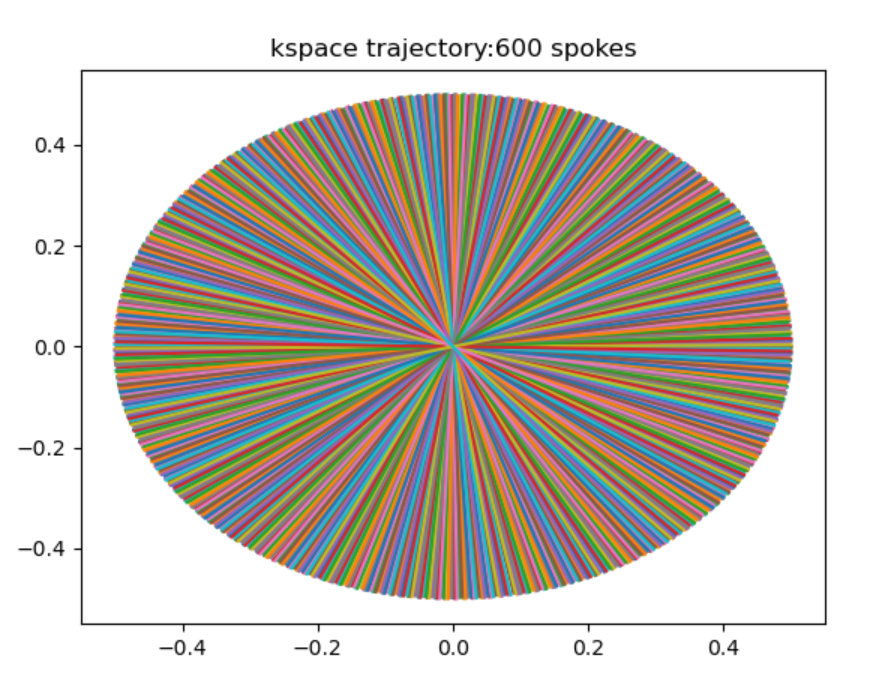
The result below shows the kspace with logorithm. The shape of kspace is 384×600.

There are 600 radial lines. Each column corresponds to the readout dimension for each radial line.

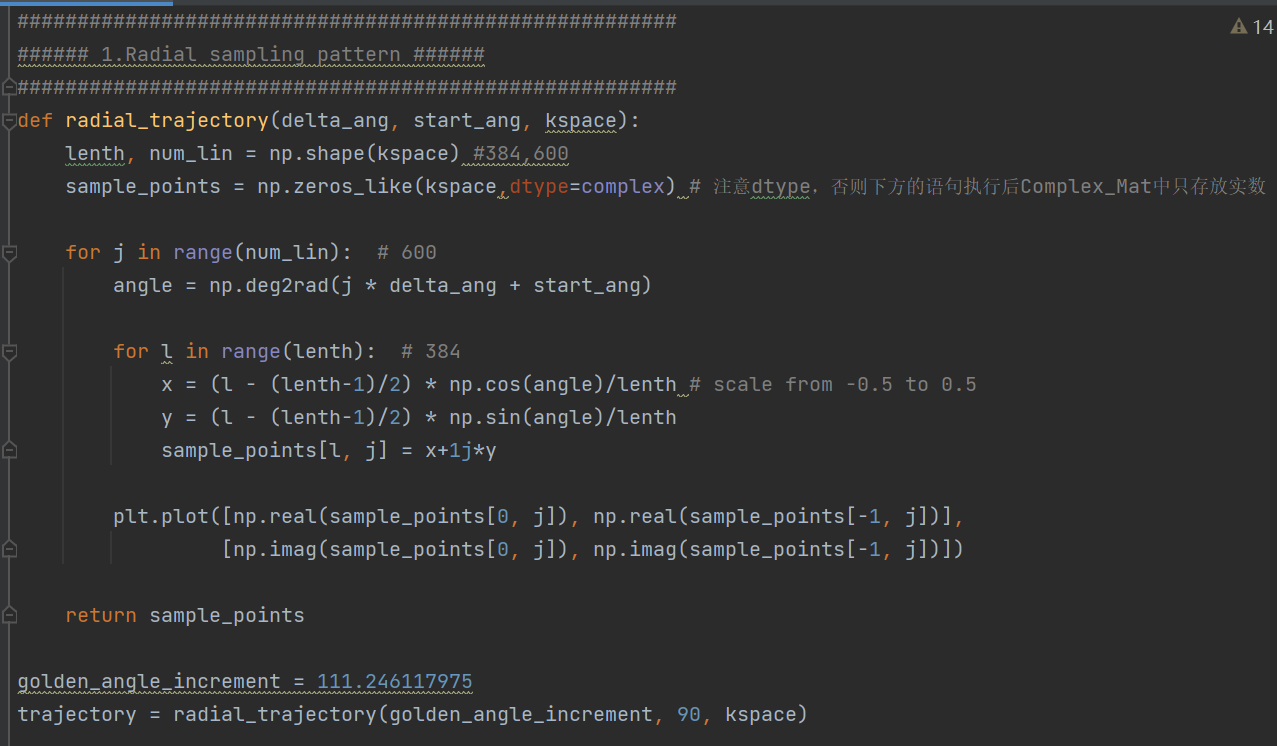


If the matrix size for Cartesian imaging is 384x384, the number of radial lines corresponding to the Nyquist rate is 600.

The image below shows a sampling trajectory that corresponds to the above kspace data for the reconstruction. This radial trajectory is generated with golden angle increment(111.246117975°) and the first angle is at pi/2.



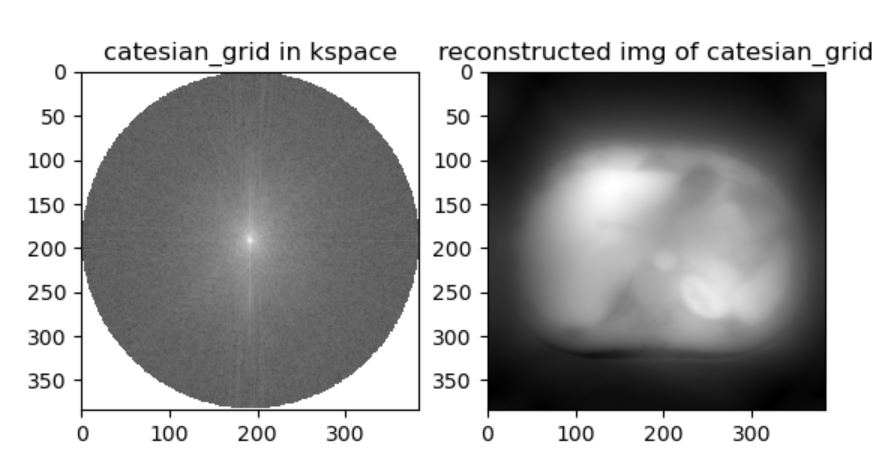
The process of this ratial trajectory is as follow:



1. **Basic gridding reconstruction**

The image below shows the Cartesian in kspace and the corresponding reconstructed image, based on the grid function. The grid function grids 2D non-Cartesian k-space data to Cartesian k-space data using triangular gridding kernel of width 2.

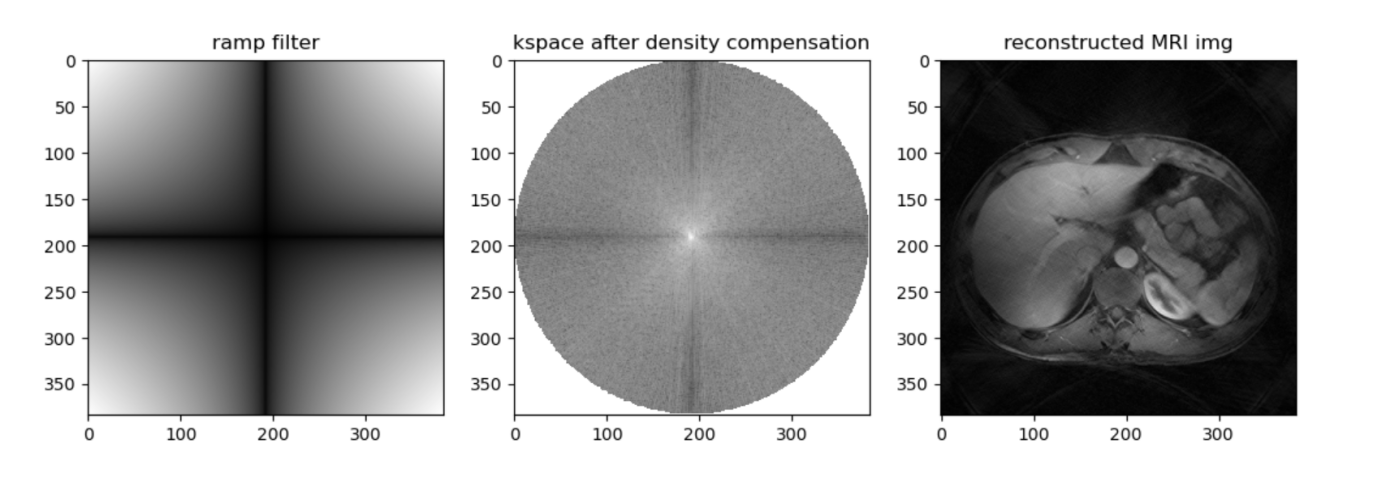
The reconstructed MRI image is the abdomen along the transverse plane. The reconstructed MRI image is quite blur. The reason is that the center region of kspace is oversampling, if radial trajectory is applied in kspace.



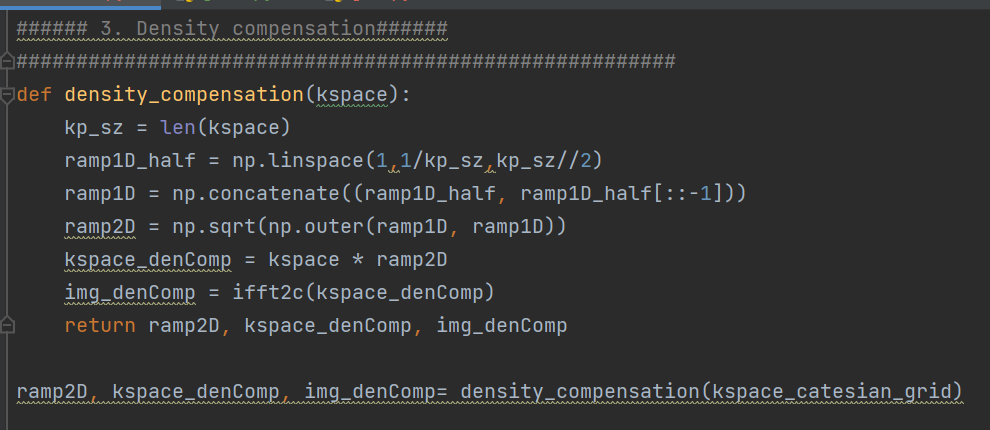
1. **Density compensation**

Density compensation is to deal with the problem of oversampling in kspace center.

The images below show the kspace after density compensation, using 2D ramp filter. The reconstructed MRI image has obviously higher spatial resolution after density compensation.



The process of the density compensation is as follow:

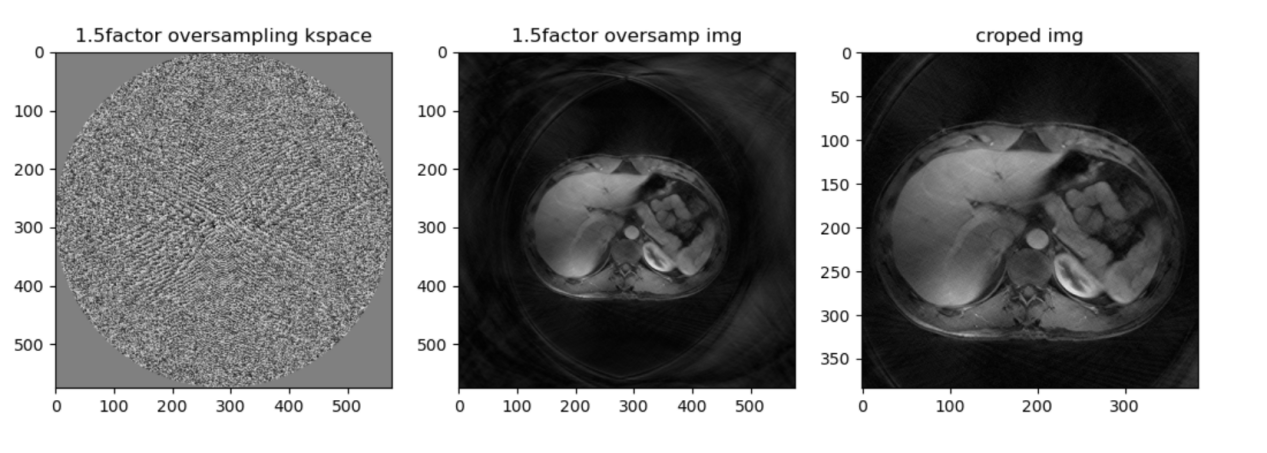


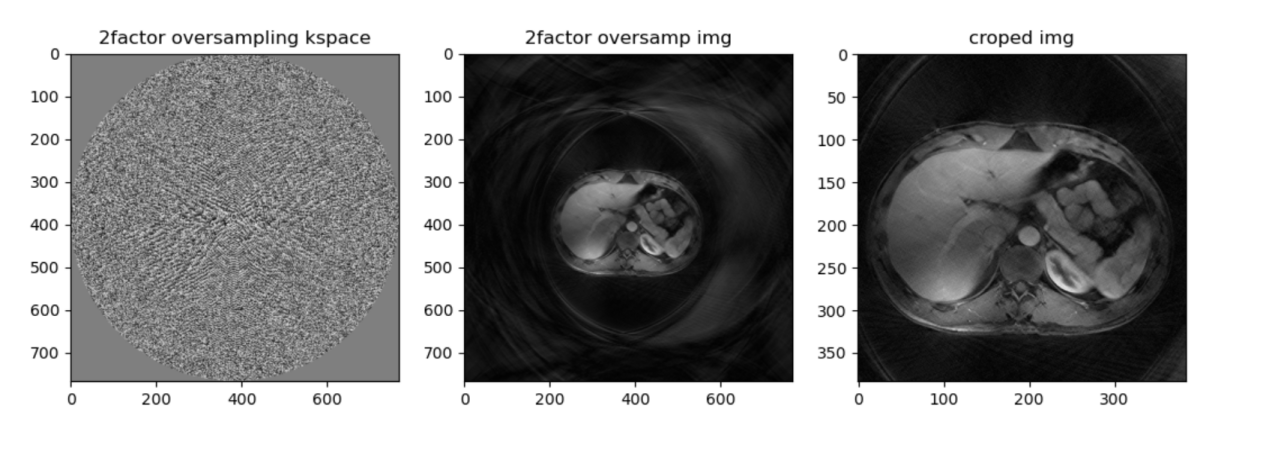
1. **Oversampling**

Field of View(FoV) is inversely proportional to the interval of kspace (Fov ~ 1/△k). Oversampling increase the sampling points, which means decrease the interval of kspace. Therefore, oversampling will produce a larger field of view, which also require more data to be stored and processed.

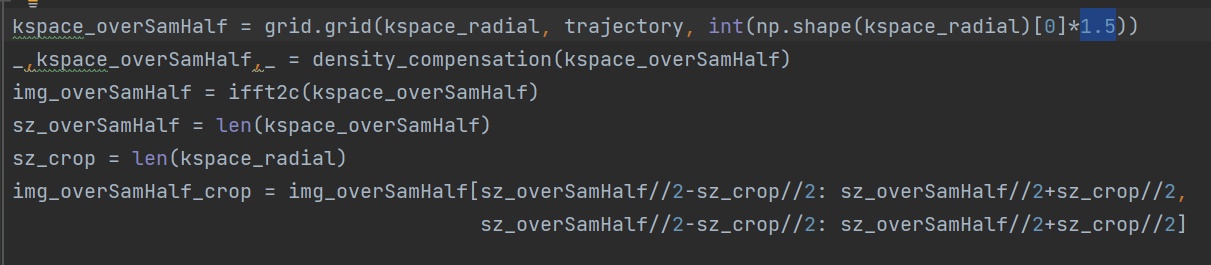
But oversampling moves the replica sidelobes out after cropping the reconstructed MRI image, reducing aliasing, and allowing less apodization.

The results below show the kspace, MRI image and crop MRI image, with oversampling factors of 1.5 and 2. The Fov increase with factors of 1.5 and 2 correspondingly.





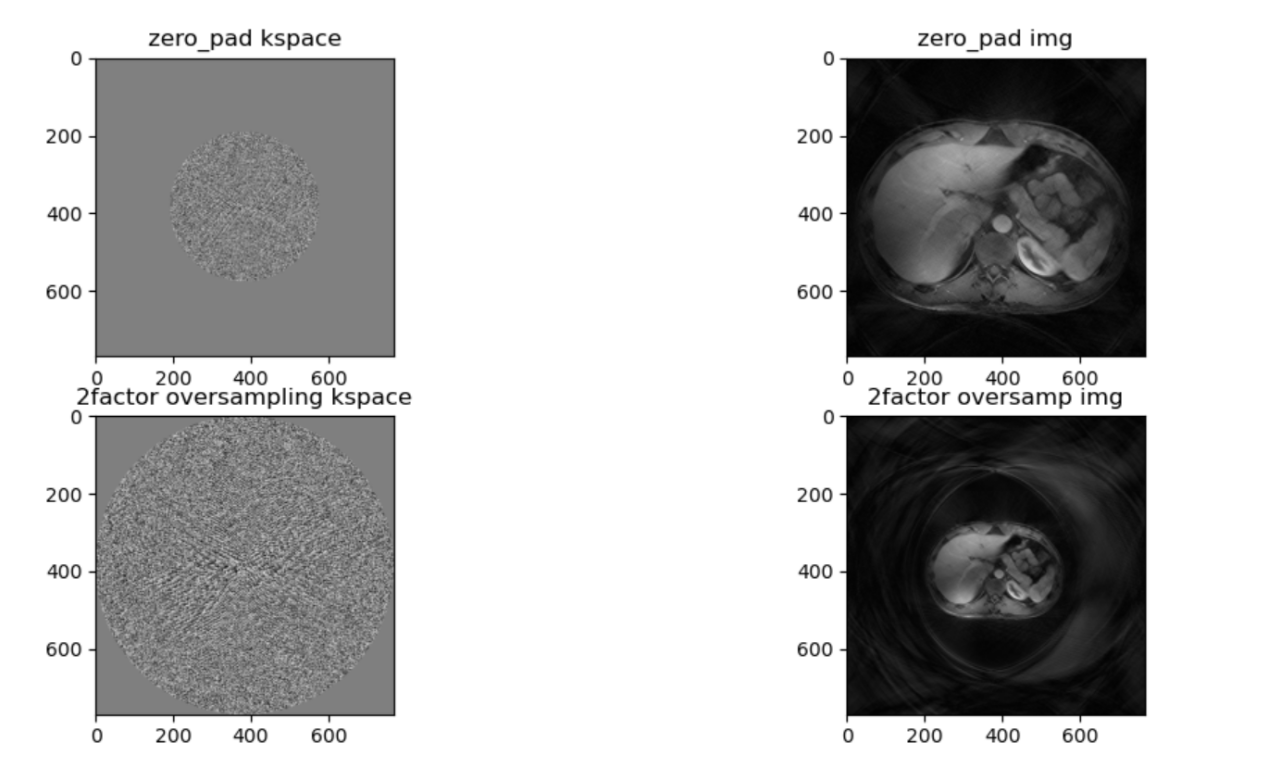
The process of oversampling is as follow:



**PS: Comparison between oversampling and zero padding**

The results below show the comparison between oversampling and zero padding

Oversampling increases FoV, but zeropadding won’t increase Fov, because zeropadding doesn’t increase the sampling points i kspace.



1. **De-apodization**

Aaa

1. **NUFFT toolbox**

The results below show the reconstructed MRI image by myself and by Torch KB-NUFFT toolbox.

This toolbox implements a non-uniform Fast Fourier Transform with Kaiser-Bessel gridding in PyTorch.

