# Exploring the two-dimensional Fourier domain using MRI

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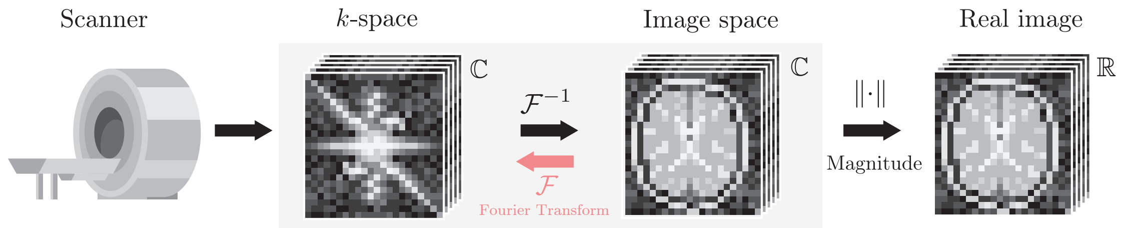
## Introduction

**Magnetic Resonance Imaging (MRI).** In contrast to conventional imaging systems, where the intensity of the image is measured directly pixel by pixel, MRI scanners measures variation in response of the target image to different frequencies. The result is a complex image that lies over the two-dimensional space of spatial frequencies, usually referred to as k-space.

The connection between the k-space and the image domain is the two-dimensional inverse Fourier transform, which translates the information from the k-space to the image domain.




The result of this transformation is a complex image, which contains information regarding the local density variations of the tissue. Nevertheless, in most MRI data analyses and applications, only the magnitude of this complex image is analyzed, and phase information is often discarded. This is because the phase contains limited biophysiological information.

**3D images.** In practice, scanners only capture a single 2D images at the same time. However, taking an a succession of 2D images, we can reconstruct a complete 3D image of a particular target.

## Exploration of the k-space

We will explore the two-dimensional Fourier domain using real MRI images. The file `RawMRI.mat` contains two images of the brain. These images are the raw output in the k-space from a real MRI brain scanner using different slicing modalities.

**Task 1.** Display the k-space and visualize both the real and imaginary parts. Using log-scale may help to see it better.

**Task 2.** Compute the inverse Fourier transform of each one of the images and visualize the brain images.

**Task 3.** Mask the center of the k-space setting to zero all the frequencies within a small radius $r$. What happen to the obtained images? Use different values of $r$ and report what happens.

**Task 4.** Mask all the frequencies of the k-pace outside a small circle from the center of the k-space, setting to zero all the values above a certain radious $r$.

**Task 5.** What happen if we use a squared mask instead of using a circular mask? Does the shape of the mask influence the final image?