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Compressed Sensing and Its Applications to Magnetic Resonance Imaging (MRI)

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In physics and engineering, there exists a class of inverse problems in which scientists must reconstruct a desired signal (sound, image, wave, etc) from a given, incomplete set of linear measurements to solve a system of equations. The system can often be undetermined: instead of having a unique solution, it has infinitely many.

Traditional methods try to tackle this problem by oversampling enough data to solve the equations, but this strategy is too costly with respect to time. However, if one knows, a priori, that the signal is sparse, i.e. the vast majority of the signal's information is concentrated at a few points along its solution, then compressed sensing (CS) algorithms can find the exact solution at the expense of far fewer measurements.

For this reason, it is possible to use CS to recreate Magnetic Resonance Images (MRI) of the brain with insufficient data (in this case, we measure a partial set of Fourier coefficients) because large chunks of the signal's information is concentrated at a few points along its solution. Therefore, we investigate the use of CS theory to harness the MRI signal's sparsity to significantly reduce the time needed to recreate anatomical images of the brain.