# Unit 6: Discrete Fourier Transforms

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As discussed in <u>Unit 4: Fourier Transform</u>, for continuous-time (CT) signals, the Fourier transform is used to analyse the behaviour of signals and systems in the frequency domain  $j\omega$ .

For discrete-time (DT) signals and systems we derive and use a discrete Fourier transform (DTFT) to analysis the behaviour of sampled-data systems in frequency domain.

The DFT is arguably one of the most important discrete transforms, and is used to perform Fourier analysis in many practical applications. In digital signal processing,

sound wave, a radio signal, or daily temperature readings, sampled over a finite time interval (often defined by a window function). In image processing, the samples can be the values of pixels along a row or column of a raster image. The DFT is also used to efficiently solve partial differential equations, and to perform other operations such as convolutions or multiplying large integers.

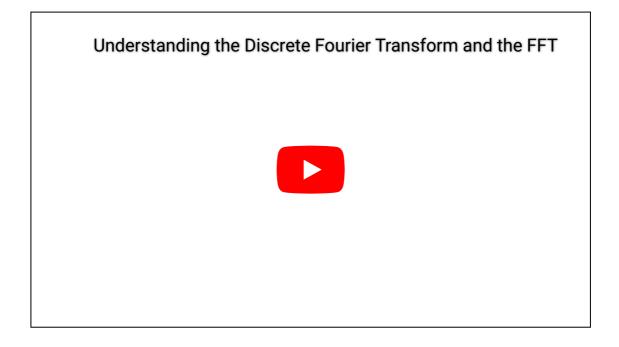
Since it deals with a finite amount of data, it can be implemented in computers by numerical algorithms or even dedicated hardware. These implementations usually employ efficient fast Fourier transform (FFT) algorithms; so much so that the terms "FFT" and "DFT" are often used interchangeably.

- Wikipedia Discrete Fourier transform

In this unit we will define the DFT and then show how the FFT is derived and implemented.

# Understanding the Discrete Fourier Transform and the FFT

This video, published on YouTube on 29th November 2023 by Brian Douglas ([Douglas, n.d.]) for the MathWorks as a MATLAB Tech Talk, is a nice gentle introduction to the DFT. It would be useful to watch this video in advance of the first class on this topic



# Scope and Background Reading

The primary source for the content of this unit is Chapter 10 of [Karris, 2012] but there are many other places online where you can find out more about the DFT and FFT. A good starting point is the Wikipedia article <u>Discrete Fourier Transform</u> quoted above. We also recommend the video from Brian Douglas, **Understanding the Discrete Fourier**Transform and the FFT embedded above. The MathWorks article *Discrete Fourier*Transform ([MathWorks, n.d.]) is a useful introduction to the fft function used in MATLAb for FFT analysis.

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- Unit 6.2: The Fast Fourier Transform

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