# Digital Filters

When looking at digital filters, there are two classifications used

* Infinite Impulse Response (IIR)
* Finite Impulse Response (FIR)

## Infinite Impulse Response (IIR)

IIR refers to a system/filter which has poles in its transfer functions. All analogue filters will fall into this category since it is not possible to synthesise an analogue filter without poles. The presence of poles means an IIR filter could potentially become unstable.

In general, IIR filters offer better frequency domain performance than FIR filters. However, they cannot be fully realised via the FFT due to the infinite in infinite impulse response. This problem can be overcome by choosing a finite portion of the infinite impulse response to look at.

### Techniques for IIR Design

By far the most common technique for IIR filter design is to preform the design using the analogue domain. This may seem strange since we are talking about designing digital filters.

Because of the amount of information available for analogue filters, as well as the number of techniques for making the filters means it is pointless to attempt to reproduce this work for the digital domain.

There is also the fact that there are relatively easy methods for transforming an analogue filter’s transfer function (TF) to a digital TF (Tustin’s bilinear transform) makes IIR design relatively simple when starting with an analogue design.

This means the IIR design process will be to find a digital transfer function whose frequency response most closely approximates that of the analogue prototype.

## Finite Impulse Response (FIR)

FIR refers to a system without poles. In general, FIRs offer better time domain performance (e.g. fewer calculations, less memory required) than IIR. In a real-world setting, this typically translates to lower system cost.

Since there are no poles in a FIR implementation, the filter will never be unstable.

## The Bilinear Transform

The bilinear transform, is defined as: