

# FIR filter design with Julia

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## 1 Introduction

This an example of a julia script that can be published using [Weave](#). The script can be executed normally using Julia or published to HTML or pdf with Weave. Text is written in markdown in lines starting with "#' " and code is executed and results are included in the published document.

Notice that you don't need to define chunk options, but you can using `#+.` just before code e.g. `#+ term=True, caption='Fancy plots.'`. If you're viewing the published version have a look at the [source](#) to see the markup.

## 2 FIR Filter Design

We'll implement lowpass, highpass and ' bandpass FIR filters. If you want to read more about DSP I highly recommend [The Scientist and Engineer's Guide to Digital Signal Processing](#) which is freely available online.

### 2.1 Calculating frequency response

DSP.jl package doesn't (yet) have a method to calculate the the frequency response of a FIR filter so we define it:

```
using Gadfly, DSP

function FIRfreqz(b::Array, w = linspace(0, 2π, 1024))
    n = length(w)
    h = Array{Complex64}(n)
    sw = 0
    for i = 1:n
        for j = 1:length(b)
            sw += b[j]*exp(-im*w[i])^j
        end
        h[i] = sw
        sw = 0
    end
    return h
end
```

## 2.2 Design Lowpass FIR filter

Designing a lowpass FIR filter is very simple to do with DSP.jl, all you need to do is to define the window length, cut off frequency and the window. We will define a lowpass filter with cut off frequency at 5Hz for a signal sampled at 20 Hz. We will use the Hamming window, which is defined as:  $w(n) = \alpha - \beta \cos \frac{2\pi n}{N-1}$ , where  $\alpha = 0.54$  and  $\beta = 0.46$

```
fs = 20
f = digitalfilter(Lowpass(5, fs = fs), FIRWindow(hamming(61)))
w = linspace(0, pi, 1024)
h = FIRfreqz(f, w)
```

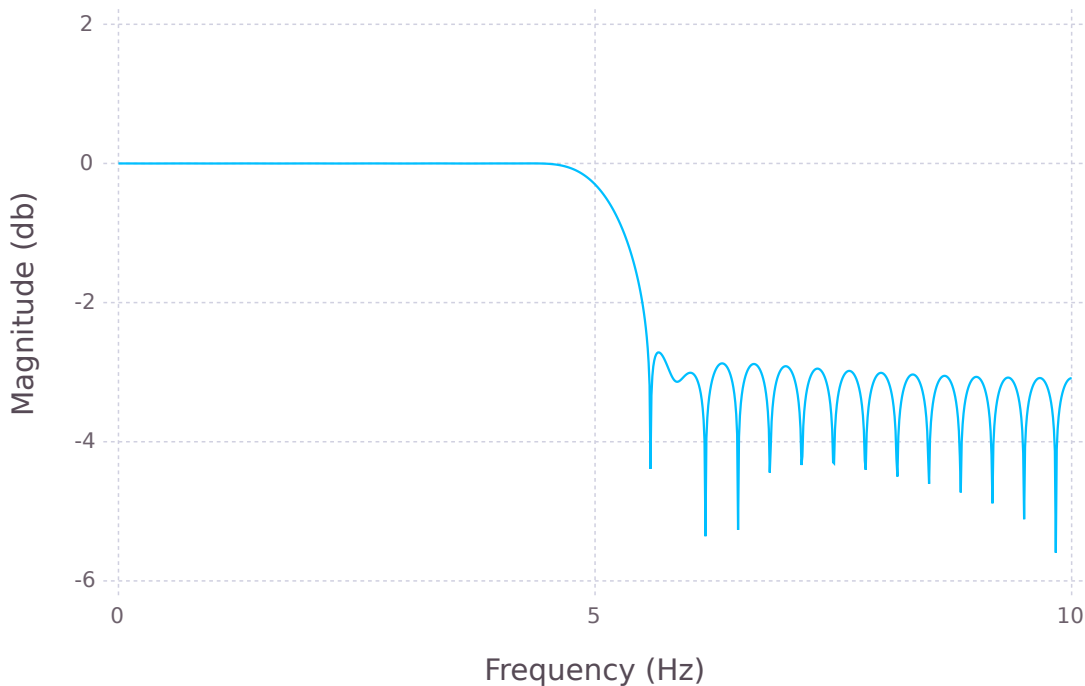
## 2.3 Plot the frequency and impulse response

The next code chunk is executed in term mode, see the [script](#) for syntax.

```
julia> h_db = log10(abs(h));

julia> ws = w/pi*(fs/2)
1024-element LinSpace{Float64}:
 0.0, 0.00977517, 0.0195503, 0.0293255, ..., 9.9609, 9.97067, 9.98045, 9.99022, 10.0

plot(y = h_db, x = ws, Geom.line,
     Guide.xlabel("Frequency (Hz)"), Guide.ylabel("Magnitude (db)"))
```



And again with default options

```
h_phase = unwrap(-atan2(imag(h), real(h)))
plot(y = h_phase, x = ws, Geom.line,
     Guide.xlabel("Frequency (Hz)"), Guide.ylabel("Phase (radians)"))
```

