Simple M=2 FIR filter design method

Not the best, but works and is easy.

- Task: Design a LP or HP that passes freq W_p
  stops freq W_s

- Assume h[n] is FIR, M=2, ie h[n] = [a b a]
  ↑
  (depending on a, b the filter can be hp or lp)

- To find a, b: $\begin{bmatrix} 2\cos Wp & 1 \\ 2\cos Ws & 1 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

Theory (useful!)

- $H(e^{jw}) = h[0] + h[1]e^{-j\omega} + h[2]e^{-j2\omega} + \cdots$
  for given h[n]
  $= a + be^{-j\omega} + ae^{-j2\omega}$
  $= e^{-j\omega}\left[ae^{j\omega} + ae^{-j\omega} + b\right]$
  $= e^{-jw}[2a\cos\omega + b]$
- $\left|H(e^{jw})\right| = \left|e^{-j\omega}\right||2a\cos\omega + b| = 2a\cos\omega + b$
- At pass freq W_p: desire $\left|H(e^{j\omega})\right| = 1 => 2a\,\omega_s\,W_p + b = 1$
- At stop freq W_s: desire $\left|H(e^{j\omega})\right| = 0 => 2a\,\omega_s\,W_s + b = 0$
- So $\begin{bmatrix} 2\cos W_p & 1 \\ 2\cos W_s & 1 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$