$x = [0 \quad 3 \quad 7 \quad 2 \quad 1 \quad 5]$

```
print( np.amax(x))
```

np.amax   np.maximum

7

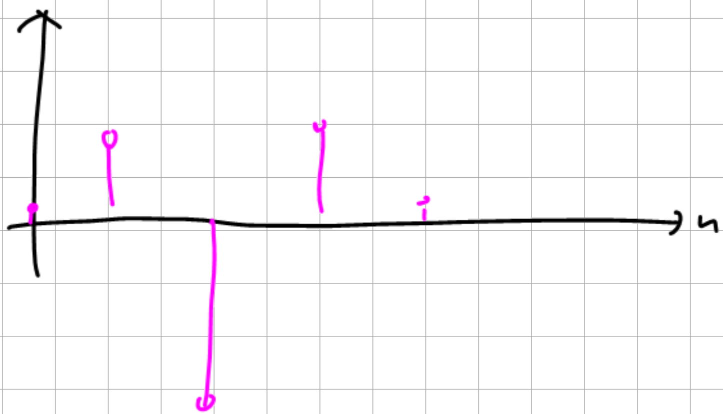
```
print( np.argmax(x))
```

2

FIR

$x(n) \rightarrow \boxed{h(n)} \rightarrow y(n)$

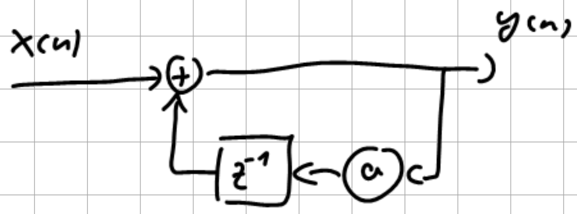
$$h(n) = \underbrace{[0.1 \quad 2 \quad -7 \quad 2 \quad 0.1]}_{\text{Finite length of } h(n)}$$

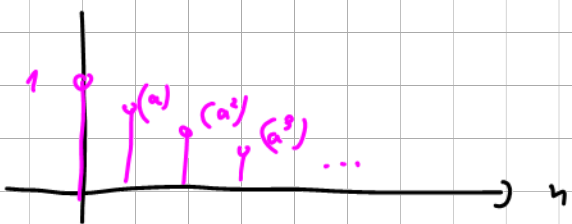


$$y(n) = \sum_{k=0}^{K-1} h(k) \cdot x(n-k)$$

IIR

$$y(n) = x(n) + a \cdot y(n-1)$$





$$y(n) = a\, y(n-1) + (1-a)\, x(n)$$

$$Y(z) = a \cdot z^{-1}\, Y(z) + (1-a)\, X(z)$$

$$Y(z)\,(1 - a z^{-1}) = (1-a)\, X(z)$$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{1-a}{1-az^{-1}} \qquad z = e^{j2\pi f/r}$$

$$\boxed{H(f) = \frac{1-a}{1-a\,e^{-j2\pi f/r}}}$$

1) procedure

H_{max} at $f=0$

$$H_{max} = H(f=0) = \frac{1-a}{1-a\,e^{-j2\pi 0/r}} = \frac{1-a}{1-a} = \underline{\underline{1}}$$

cutoff frequency $\frac{|H(f_c)|}{H_{max}} = \frac{1}{\sqrt{2}}$

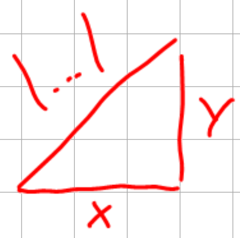
$$\left| \frac{1-a}{1-a\,e^{-j2\pi f_c/r}} \right| = \frac{1}{\sqrt{2}}$$

$$\frac{\overset{>0}{|1-a|}}{|1-ae^{-j2\pi f_c/r}|} = \frac{1}{\sqrt{2}} \qquad 3-\sqrt{8} < a < 1$$

$$\frac{1-a}{|1-a\,e^{-j2\pi f_c/r}|} = \frac{1}{\sqrt{2}}$$

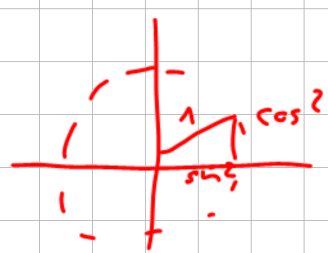
$$e^{jx} = \cos(x) + j\sin(x)$$

$$\frac{(1-a)\sqrt{2}}{|1-a\cos(2\pi f_c/r) + ja\sin(2\pi f_c/r)|} = 1$$



$$\frac{(1-a)\sqrt{2}}{\sqrt{(1-a\cos(2\pi f_c/r))^2 + a^2\sin^2(2\pi f_c/r)}} = 1$$

$$\frac{2\cdot(1-a)^2}{(1-a\cos(2\pi f_c/r))^2 + a^2\sin^2(2\pi f_c/r)} = 1$$



$$2\cdot(1-a)^2 = (1-a\cos(2\pi f_c/r))^2 + a^2\sin^2(2\pi f_c/r)$$

$$2\cdot(1-2a+a^2) = 1 + \underline{a^2\cos^2(2\pi f_c/r)} - 2a\cos(2\pi f_c/r) \underline{+ a^2\sin^2(2\pi f_c/r)}$$

$$2 - 4a + 2a^2 = 1 + a^2 - 2a\cos(2\pi f_c / r)$$

$$\boxed{0 = -1 - a^2 + a\left(-2\cos(2\pi f_c / r) + 4\right)} \rightarrow a = \ldots \text{ your job}$$

$$= p_2 a^2 + p_1 a + p_0 \rightarrow \texttt{np.roots([}p_2, p_1, p_0\texttt{])}$$

$$f_c = \ldots$$

$$2a\cos(2\pi f_c / r) = -1 - a^2 + 4a$$

$$\cos(2\pi f_c / r) = \frac{-1 - a^2 + 4a}{2a}$$

$$\frac{2\pi f_c}{r} = 2\pi f_c / r = \cos^{-1}\left(\frac{-1 - a^2 + 4a}{2a}\right)$$

$$\boxed{f_c = \frac{r}{2\pi}\cos^{-1}\left(\frac{-1 - a^2 + 4a}{2a}\right)}$$ 2) procedure