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Sampling frequency.

Discrete time could be defined as a vector in Matlab.

$t = 0 : T_s : 5/f \longrightarrow$ signal frequency.

$T_s \downarrow$ 1/Sampling Frequency f_s

Spectra plot.

$$X(k) = \sum_{n=0}^{N-1} x(n)\, e^{-j\frac{2\pi}{N}kn} \qquad 0 \le k \le N-1.$$

Let $W_N = e^{-j\frac{2\pi}{N}}$.

$$X(k) = \sum_{n=0}^{N-1} x(n)\, W_N^{kn} \qquad 0 \le k \le N-1.$$

Matrice. Fouriers.

$$X = \begin{bmatrix} X_0 \\ X(1) \\ \vdots \\ X(N-1) \end{bmatrix} = \begin{bmatrix} 1 & 1 & \cdots & 1 \\ 1 & W_N^1 & \cdots & W_N^{N-1} \\ \vdots & & & \\ 1 & W_N^{N-1} & \cdots & W_N^{(N-1)(N-1)} \end{bmatrix} \begin{bmatrix} x(0) \\ x(1) \\ \vdots \\ x(N-1) \end{bmatrix}$$

. Input-based perspective.

$x[n] \rightarrow \boxed{h[n]} \rightarrow y[n]$

$x[n] = \sum x[i]\,\delta[n-i] \Rightarrow y[n] = \sum x[i]\,h[n-i]$.

Note: Matlab matrix starts from 1 !

$$\boxed{\text{Length } y[n] = \text{length } x[n] + \text{length } h[n] - 1}$$

②. Output-based Perspective.

$\leftarrow$ ADD [length(h[n]) -1] here

$$\begin{bmatrix} h[0] & h[1] & \cdots & h[4] \end{bmatrix} \begin{bmatrix} x[0] \\ x[1] \\ \vdots \\ x[3] \end{bmatrix}$$

$\leftarrow$ ADD [length[h[n]] -1] here

$$\hat{h}(w) = \sum h[n]\, e^{-jwn}.$$

Also we can use matrix.

length [n] -1

$$\begin{bmatrix} e^{-jw_0 \cdot 0} & e^{-jw_0 1} & \cdots & e^{-jw_0 \cdot} \\ e^{-jw_1 0} & e^{-jw_1 1} & \cdots & \\ \vdots & & & \vdots \end{bmatrix} \begin{bmatrix} h[0] \\ h[1] \\ \vdots \\ h[4] \end{bmatrix}$$

$w = w_0 : \frac{2\pi}{1024} : w_N.$