FFT Introduction

① FFT-Extra

DFT

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

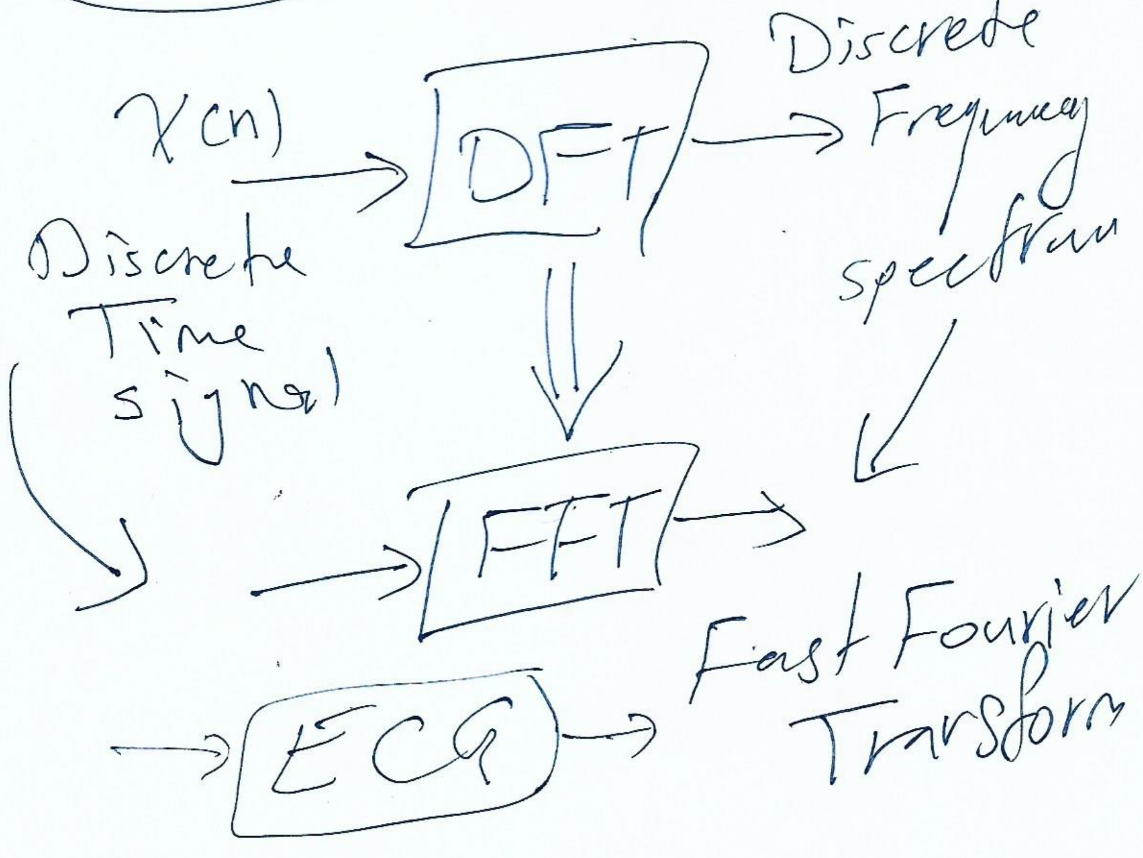
$n = 0 \; --- \; N-1$

$K = 0 \; -- \; N-1$

$N = 4$

4 points DFT

FFT efficient algoritm



② FFT-Extra

$$\left.\begin{array}{l} \omega = 2\pi f \\ f = \frac{1}{T} \end{array}\right\} \quad T \to N\text{: period}$$

$$e^{-j\frac{2\pi}{N}} \Longrightarrow 2\pi f$$

$N = 256$

256-points DFT

$X(k)$ = 256 complex multiplication
256 − 1 = 255 complex addition

n — $N-1$

$N^2 = (256)^2$ complex multiplication

$N(N-1) = 256 \times 255$ complex addition

③

FFT-Extra

$A_1 + jB_1$

$A_2 + jB_2$

Multiplication Requires ?

$$= (A_1 + jB_1)(A_2 + jB_2)$$

$$= \underbrace{A_1 A_2}_{\text{multiplication ①}} + \underbrace{A_1 \, jB_2}_{\text{multiplication ②}} + \underbrace{jB_1 \, A_2}_{\text{multiplication ③}} + \underbrace{jB_1 \, jB_2}_{\text{multiplication ④}}$$

$$= \underbrace{\overbrace{\boxed{A_1 A_2 + jB_1 \, jB_2}}^{\text{Real part}}}_{\text{Addition ①}} \underbrace{+ j}_{\text{Complex addition}} \underbrace{\overbrace{\boxed{(A_1 B_2 + A_2 B_1)}}^{\text{Imaginary part}}}_{\text{Addition ②}}$$

? ⇒ The mathematical operation requires

- One complex multiplication can be performed by:
- Four real multiplications
- Two real additions

4

FFT-Extra

N-points DFT

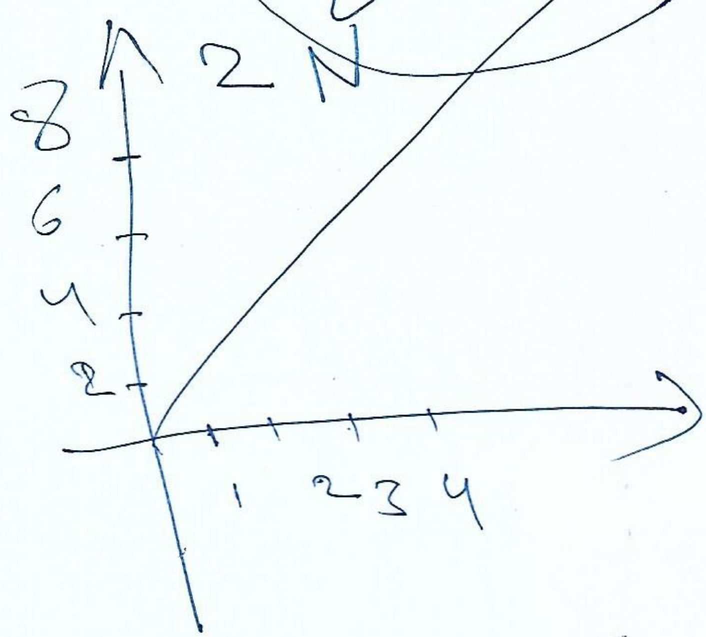
⇓

~~Quadrature~~

⇓

Linear

FFT



N-points DFT

quadrature

N^2 complex multiplication

$\underbrace{N(N-1)}_{\approx N}$ complex addition

$N = \underline{1024}$

$N-1 = 1024 - 1 = \underline{1023}$