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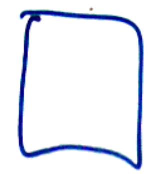

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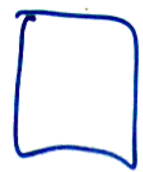

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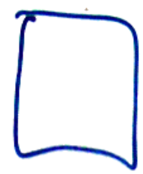

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$$p(x) = \sum_{i=}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$q \to (a_0, a_2, \ldots, a$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$q \to (a_0, a_2, \ldots, a_{n-2}) \qquad r \to (a_1, \ldots, a_{n-1})$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$q \to (a_0, a_2, \ldots, a_{n-2}) \quad r \to (a_1, \ldots, a_{n-1})$

P

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\,r(x^2)$$

$q \to (a_0, a_2, \ldots, a_{n-2})$ $\quad r \to (a_1, \ldots, a_{n-1})$

P

$w_n^0, w_n^1, \ldots, w_n^{n-1}$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\,r(x^2)$$

$$q \to (a_0, a_2, \ldots, a_{n-2}) \qquad r \to (a_1, \ldots, a_{n-1})$$

$$p(w_n^i) = q((w_n^i)^2) + w_n^i \cdot r((w_n^i)^2)$$

$$w_n^0, w_n^1, \ldots, w_n^{n-1}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$q \to \underbrace{(a_0, a_2, \ldots, a_{n-2})}_{\bar{a}_0} \qquad r \to \underbrace{(a_1, \ldots, a_{n-1})}_{\bar{a}_1}$$

$$[y_{0,0}, \ldots, y_{0,\frac{n}{2}-1}] \qquad [y_{1,0}, \ldots, y_{1,\frac{n}{2}-1}]$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$q \to \underbrace{(a_0, a_2, \dots, a_{n-2})}_{\bar{a}_0} \qquad r \to \underbrace{(a_1, \dots, a_{n-1})}_{\bar{a}_1}$$

$$[y_{0,0}, \dots, y_{0,\frac{n}{2}-1}] \qquad [y_{1,0}, \dots, y_{1,\frac{n}{2}-1}]$$

$$DFT(\bar{a}) = [y_0, \dots, y_{n-1}]$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\,r(x^2)$$

$$q \to \underbrace{(a_0, a_2, \ldots, a_{n-2})}_{\bar{a}_0} \qquad r \to \underbrace{(a_1, \ldots, a_{n-1})}_{\bar{a}_1}$$

$$[y_{0,0}, \ldots, y_{0,\frac{n}{2}-1}] \qquad [y_{1,0}, \ldots, y_{1,\frac{n}{2}-1}]$$

$$DFT(\bar{a}) = [y_0, \ldots, y_{n-1}]$$

$$k \in \{0, \ldots, \tfrac{n}{2}-1\} \qquad y_k =$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$q \to (\underbrace{a_0, a_2, \dots, a_{n-2}}_{\bar{a}_0}) \qquad r \to (\underbrace{a_1, \dots, a_{n-1}}_{\bar{a}_1})$$

$$[y_{0,0}, \dots, y_{0,\frac{n}{2}-1}] \qquad [y_{1,0}, \dots, y_{1,\frac{n}{2}-1}]$$

$$DFT(\bar{a}) = [y_0, \dots, y_{n-1}]$$

$$k \in \{0, \dots, \tfrac{n}{2}-1\} \qquad y_k = p(w^k)$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$q \to \underbrace{(a_0, a_2, \ldots, a_{n-2})}_{\bar{a}_0} \qquad r \to \underbrace{(a_1, \ldots, a_{n-1})}_{\bar{a}_1}$$

$$[y_{0,0}, \ldots, y_{0,\frac{n}{2}-1}] \qquad [y_{1,0}, \ldots, y_{1,\frac{n}{2}-1}]$$

$$DFT(\bar{a}) = [y_0, \ldots, y_{n-1}]$$

$$k \in \{0, \ldots, \tfrac{n}{2}-1\} \qquad y_k = p(w_n^k) = q((w_n^k)^2) + w_n^k \cdot r((w_n^k)^2)$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$q \to \underbrace{(a_0, a_2, \ldots, a_{n-2})}_{\bar{a}_0} \qquad r \to \underbrace{(a_1, \ldots, a_{n-1})}_{\bar{a}_1}$$

$$[y_{0,0}, \ldots, y_{0,\frac{n}{2}-1}] \qquad [y_{1,0}, \ldots, y_{1,\frac{n}{2}-1}]$$

$$\boxed{w_{\frac{n}{2}\cdot\cancel{2}}^{k\cdot\cancel{2}}}$$

$$\mathrm{DFT}(\bar{a}) = [y_0, \ldots, y_{n-1}]$$

$$k \in \{0, \ldots, \tfrac{n}{2}-1\} \qquad y_k = p(w_n^k) = q((w_n^k)^2) + w_n^k \cdot r((w_n^k)^2)$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$q \to (\underbrace{a_0, a_2, \ldots, a_{n-2}}_{\bar{a}_0}) \qquad r \to (\underbrace{a_1, \ldots, a_{n-1}}_{\bar{a}_1})$$

$$[y_{0,0}, \ldots, y_{0,\frac{n}{2}-1}] \qquad [y_{1,0}, \ldots, y_{1,\frac{n}{2}-1}]$$

$$\boxed{\omega^{1\cdot\cancel{2}}_{\frac{n}{2}\cdot\cancel{2}}}$$

$$DFT(\bar{a}) = [y_0, \ldots, y_{n-1}]$$

$$k \in \{0, \ldots, \tfrac{n}{2}-1\} \qquad y_k = p(\omega_n^k) = q((\omega_n^k)^2) + \omega_n^k \cdot r((\omega_n^k)^2)$$

$$= q(\omega_{\frac{n}{2}}^k) + \omega_n^k \cdot r(\omega_{\frac{n}{2}}^k)$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$q \to \underbrace{(a_0, a_2, \ldots, a_{n-2})}_{\bar{a}_0}$ $\quad r \to \underbrace{(a_1, \ldots, a_{n-1})}_{\bar{a}_1}$

$[y_{0,0}, \ldots, y_{0,\frac{n}{2}-1}]$ $\quad [y_{1,0}, \ldots, y_{1,\frac{n}{2}-1}]$

$$\boxed{w^{\cancel{1 \cdot 2}}_{\cancel{\frac{n}{2} \cdot 2}}}$$

$$DFT(\bar{a}) = [y_0, \ldots, y_{n-1}]$$

$k \in \{0, \ldots, \frac{n}{2}-1\}$ $\quad y_k = p(w_n^k) = q((w_n^k)^2) + w_n^k \cdot r((w_n^k)^2)$

$$= q(w_{\frac{n}{2}}^k) + w_n^k \cdot r(w_{\frac{n}{2}}^k)$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$q \to \underbrace{(a_0, a_2, \ldots, a_{n-2})}_{\bar{a}_0} \qquad r \to \underbrace{(a_1, \ldots, a_{n-1})}_{\bar{a}_1}$$

$$[y_{0,0}, \ldots, y_{0,\frac{n}{2}-1}] \qquad [y_{1,0}, \ldots, y_{1,\frac{n}{2}-1}]$$

$$\boxed{\omega_{\frac{n}{2}\cdot\cancel{2}}^{k\cdot\cancel{2}}}$$

$$DFT(\bar{a}) = [y_0, \ldots, y_{n-1}]$$

$$k \in \{0, \ldots, \tfrac{n}{2}-1\} \qquad y_k = p(\omega_n^k) = q((\omega_n^k)^2) + \omega_n^k \cdot r((\omega_n^k)^2)$$

$$= q(\omega_{\frac{n}{2}}^k) + \omega_n^k \cdot r(\omega_{\frac{n}{2}}^k)$$

$$= y_{0,k}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$a_0 + a_1 x + a_2 x^2 + a_3 x^3$

$(a_0, a_1, a_2, a_3, 0, 0, 0, 0)$ $\quad q \to \underbrace{(a_0, a_2, \ldots, a_{n-2})}_{\bar{a}_0}$ $\quad r \to \underbrace{(a_1, \ldots, a_{n-1})}_{\bar{a}_1}$

$$w^{\cancel{k \cdot 2}}_{\frac{n}{2} \cdot \cancel{2}}$$

$[y_{0,0}, \ldots, y_{0,\frac{n}{2}-1}]$ $\quad [y_{1,0}, \ldots, y_{1,\frac{n}{2}-1}]$

$$DFT(\bar{a}) = [y_0, \ldots, y_{n-1}]$$

$k \in \{0, \ldots, \frac{n}{2}-1\}$

$$y_k = p(w_n^k) = q((w_n^k)^2) + w_n^k \cdot r((w_n^k)^2)$$

$$= q(w_{\frac{n}{2}}^k) + w_n^k \cdot r(w_{\frac{n}{2}}^k)$$

$$\boxed{= y_{0,k} + w_n^k \cdot y_{1,k}}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(x) = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$a_0 + a_1 x + a_2 x^2 + a_3 x^3$

$(a_0, a_1, a_2, a_3, 0, 0, 0, 0)$ $q \to (\underbrace{a_0, a_2, \dots, a_{n-2}}_{\bar{a}_0})$ $r \to (\underbrace{a_1, \dots, a_{n-1}}_{\bar{a}_1})$

$[y_{0,0}, \dots, y_{0,\frac{n}{2}-1}]$ $[y_{1,0}, \dots, y_{1,\frac{n}{2}-1}]$

$\omega_{\frac{n}{2}}^{\cancel{1 \cdot 2}}$

$\omega_{\frac{n}{2} \cdot \cancel{2}}$

$$DFT(\bar{a}) = [y_0, \dots, y_{n-1}]$$

$k \in \{0, \dots, \frac{n}{2}-1\}$

$$y_k = p(\omega_n^k) = q((\omega_n^k)^2) + \omega_n^k \cdot r((\omega_n^k)^2)$$

$$= q(\omega_{\frac{n}{2}}^k) + \omega_n^k \cdot r(\omega_{\frac{n}{2}}^k)$$

$$\boxed{= y_{0,k} + \omega_n^k \cdot y_{1,k}}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$\ldots = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$\left(w_n^{\frac{n}{2}+k}\right)^2$$

$$w_n^{n+2k} = w_n^n \cdot w_n^{2k}$$

$$q \to \underbrace{(a_0, a_2, \ldots, a_{n-2})}_{\bar{a}_0} \qquad r \to \underbrace{(a_1, \ldots, a_{n-1})}_{\bar{a}_1}$$

$$[y_{0,0}, \ldots, y_{0,\frac{n}{2}-1}] \qquad [y_{1,0}, \ldots, y_{1,\frac{n}{2}-1}]$$

$$w_{\frac{n}{2} \cdot \cancel{2}}^{1 \cdot \cancel{2}}$$

$$DFT(\bar{a}) = [y_0, \ldots, y_{n-1}]$$

$$k \in \{0, \ldots, \tfrac{n}{2}-1\} \qquad y_k = p(w_n^k) = q((w_n^k)^2) + w_n^k \cdot r((w_n^k)^2)$$

$$= q(w_{\frac{n}{2}}^k) + w_n^k \cdot r(w_{\frac{n}{2}}^k)$$

$$\boxed{= y_{0,k} + w_n^k \cdot y_{1,k}}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$= \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$\left(w_n^{\frac{n}{2}+k} \right)^2$$

$$w_n^{n+2k}$$

$$= \cancel{w_n^{n}} \cdot w_{\frac{n}{2} \cdot 2}^{2k}$$

$$= w_{\frac{n}{2}}^{k}$$

$$q(w_{\frac{n}{2}}^{k}) + w_n^{\frac{n}{2}+k} \cdot r(w_{\frac{n}{2}}^{k})$$

$$y_{0,k}$$

$$w_{\frac{n}{2} \cdot \cancel{2}}^{k \cdot \cancel{2}}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$\left(w_n^{\frac{n}{2}+k} \right)^2 \quad \ldots = \sum_{i=0}^{\frac{n}{2}-1} a_{2i} (x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

w_n^{n+2k}

$= w_n^{n} \cdot w_{\frac{n}{2} \cdot 2}^{2k}$

$= w_{\frac{n}{2}}^{k}$

$$q(w_{\frac{n}{2}}^{k}) + w_n^{\frac{n}{2}+k} \cdot r(w_{\frac{n}{2}}^{k})$$

$$y_{0,k} + w_n^{\frac{n}{2}} \cdot w_n^{k}\, r(w_{\frac{n}{2}}^{k})$$

$$w_{\frac{n}{2} \cdot \cancel{2}}^{k \cdot \cancel{2}}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$= \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$\left(w_n^{\frac{n}{2}+k} \right)^2$$

$$w_n^{n+2k}$$

$$= w_n^{n} \cdot w_{\frac{n}{2}\cdot 2}^{2k}$$

$$= w_{\frac{n}{2}}^{k}$$

$$q(w_{\frac{n}{2}}^{k}) + w_n^{\frac{n}{2}+k} \cdot r(w_{\frac{n}{2}}^{k})$$

$$y_{0,k} + w_n^{\frac{n}{2}} \cdot w_n^{k}\, r(w_{\frac{n}{2}}^{k})$$

$$= \left(e^{\frac{2\pi i}{n}} \right)^{\frac{n}{2}}$$

$$\boxed{w_{\frac{n}{2}\cdot \cancel{2}}^{1\cdot \cancel{2}}}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$\left(w_n^{\frac{n}{2}+k}\right)^2 \quad = \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$w_n^{n+2k}$$

$$= w_n^{n} \cdot w_{\frac{n}{2} \cdot \cancel{2}}^{\cancel{2}k}$$

$$= w_{\frac{n}{2}}^{k}$$

$$q(w_{\frac{n}{2}}^k) + w_n^{\frac{n}{2}+k} \cdot r(w_{\frac{n}{2}}^k)$$

$$y_{0,k} + w_n^{\frac{n}{2}} \cdot w_n^k \, r(w_{\frac{n}{2}}^k)$$

$$= \left(e^{\frac{2\pi i}{n}}\right)^{\frac{n}{2}} = -1$$

$$\boxed{w_{\frac{n}{2} \cdot \cancel{2}}^{1 \cdot \cancel{2}}}$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$= \sum_{i=0}^{\frac{n}{2}-1} a_{2i}(x^2)^i + x \cdot \sum_{i=0}^{\frac{n}{2}-1} a_{2i+1} \cdot (x^2)^i = q(x^2) + x\, r(x^2)$$

$$\left(w_n^{\frac{n}{2}+k} \right)^2$$

$$w_n^{n+2k}$$

$$= w_n^{n} \cdot w_{\frac{n}{2}\cdot 2}^{2k}$$

$$= w_{\frac{n}{2}}^{k}$$

$$q(w_{\frac{n}{2}}^{k}) + w_n^{\frac{n}{2}+k} \cdot r(w_{\frac{n}{2}}^{k})$$

$$y_{0,k} + w_n^{\frac{n}{2}} \cdot w_n^{k}\, r(w_{\frac{n}{2}}^{k})$$

$$\boxed{w_{\frac{n}{2}\cdot \cancel{2}}^{k\cdot \cancel{2}}}$$

$$y_1 = y_{0,1} + w_n^{1} \cdot y_{1,1}$$

$$: \left(e^{\frac{2\pi i}{n}}\right)^{\frac{n}{2}} = -1$$

1

(Q_0)

$W^{1\cdot\cancel{2}}_{\frac{n}{2}\cdot\cancel{2}}$

1

(Q_0)

$$\boxed{W^{1 \cdot \cancel{x}}_{\frac{n}{2} \cdot \cancel{x}}}$$

1 (a_0)

$DFT((a_0)) = [a_0]$

$X - 1$

1 2 (a_0, a_1)

$p(x) = a_0 + a_1 X$

$p(1), p(-1)$

$\boxed{\omega^{1 \cdot \cancel{x}}_{\frac{n}{2} \cdot \cancel{x}}}$

1 $\qquad (a_0)$

$\mathrm{DFT}((a_0)) = [a_0]$

$X - 1$

1 $\qquad$ 2 $\qquad (a_0, a_1)$

$p(x) = a_0 + a_1 X$

$\mathrm{DFT}((a_0, a_1)) =$

$[a_0 + a_1, a_0 - a_1]$

$w_2^0 \cdot w_2^1 \qquad [p(1), p(-1)]$

$w_2 = e^{\frac{2\pi i}{2}} = -1$

$\boxed{w^{\cancel{1 \cdot 2}}_{\frac{n}{2} \cdot \cancel{2}}}$

1

(a_0)

$DFT((a_0)) = [a_0]$

$X - 1$

1 2

(a_0, a_1)

$p(x) = a_0 + a_1 X$

$DFT((a_0, a_1)) =$

$[a_0 + a_1, a_0 - a_1]$

$\omega^{1 \cdot \cancel{2}}_{\frac{n}{2} \cdot \cancel{2}}$

$\omega_2^0 \cdot \omega_2^1$

$[p(1), p(-1)]$

$\omega_2 = e^{\frac{2\pi i}{2}} = -1$

1

(a_0)

$\mathrm{DFT}((a_0)) = [a_0]$

$X - 1$

1 2

(a_0, a_1)

$P(X) = a_0 + a_1 X$

$[P(1), P(-1)]$

$\mathrm{DFT}((a_0, a_1)) =$

$[a_0 + a_1, a_0 - a_1]$

$W_2^0 \cdot W_2^1$

$W_2 = e^{\frac{\cancel{2}\pi i}{\cancel{2}}} = -1$

$W^{1 \cdot \cancel{2}}_{\frac{n}{2} \cdot \cancel{2}}$

1

(a_0)

$DFT((a_0)) = [a_0]$

$X - 1$

1

2

(a_0, a_1)

$p(x) = a_0 + a_1 X$

$DFT((a_0, a_1)) =$

$[a_0 + a_1, a_0 - a_1]$

$w^{\cancel{1 \cdot 2}}_{\frac{n}{2} \cdot \cancel{2}}$

$w_2^0 \cdot w_2^1$

$[p(1), p(-1)]$

$w_2 = e^{\frac{\cancel{2}\pi i}{\cancel{2}}} = -1$

1

(a_0)

$\mathrm{DFT}((a_0)) = [a_0]$

$X - 1$

1 2

(a_0, a_1)

$p(x) = a_0 + a_1 X$

$\mathrm{DFT}((a_0, a_1)) =$

$[a_0 + a_1, a_0 - a_1]$

$w_2^0 \cdot w_2^1$

$[p(1), p(-1)]$

$w_2 = e^{\frac{\cancel{2}\pi i}{\cancel{2}}} = -1$

$\boxed{w^{1 \cdot \cancel{2}}_{\frac{n}{2} \cdot \cancel{2}}}$

1

(a_0)

$DFT((a_0)) = [a_0]$

$X - 1$

1 2

(a_0, a_1)

$p(x) = a_0 + a_1 X$

$DFT((a_0, a_1)) =$

$[a_0 + a_1, a_0 - a_1]$

$w_2^0 \cdot w_2^1$

$[p(1), p(-1)]$

$w_2 = e^{\frac{\cancel{2}\pi i}{\cancel{2}}} = -1$

$w^{1 \cdot \cancel{2}}_{\frac{n}{2} \cdot \cancel{2}}$

1

(a_0)

$\mathrm{DFT}((a_0)) = [a_0]$

$X \sim 1$

1 2

(a_0, a_1)

$p(x) = a_0 + a_1 X$

$[p(1), p(-1)]$

$\mathrm{DFT}((a_0, a_1)) =$

$[a_0 + a_1, a_0 - a_1]$

$w_2^0 \cdot w_2^1$

$w_2 = e^{\frac{\cancel{2}\pi i}{\cancel{2}}} = -1$

$w^{1 \cdot \cancel{x}}_{\frac{n}{2} \cdot \cancel{x}}$

1

(a_0)

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$DFT((a_0)) = [a_0]$

$\Theta(n \log n)$

$X \sim 1$

1 2 (a_0, a_1)

$DFT((a_0, a_1)) =$

$p(x) = a_0 + a_1 X$

$[a_0 + a_1, a_0 - a_1]$

$\boxed{w^{1 \cdot \cancel{x}}_{\frac{n}{2} \cdot \cancel{x}}}$

$w_2^0 \cdot w_2^1$

$[p(1), p(-1)]$

$w_2 = e^{\frac{2\pi i}{2}} = -1$

1

(a_0)

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$DFT((a_0)) = [a_0]$

$\Theta(n \log n)$

$2^n < k < 2^{n+1}$

$O(2^{n+1}$

$\boxed{w^{1 \cdot \cancel{2}}_{\frac{n}{2} \cdot \cancel{2}}}$

1

(a_0)

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$DFT((a_0)) = [a_0]$

$\Theta(n \log n)$

$2^m < n < 2^{m+1}$

$O(2^{m+1} \cdot \log(2^{m+1}))$

$w^{1 \cdot \cancel{x}}_{\frac{n}{2} \cdot \cancel{x}}$

1

(a_0)

$DFT((a_0)) = [a_0]$

$2^m < n < 2^{m+1}$

$2^{m+1} < 2n$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$\Theta(n \log n)$

$O(2^{m+1} \cdot \log(2^{m+1}))$

$c \cdot 2^{m+1} \cdot \log(2^{m+1})$

$c \cdot 2n \cdot \log(2n)$

$$\boxed{\omega^{1 \cdot \cancel{x}}_{\frac{n}{2} \cdot \cancel{x}}}$$

1

(a_0)

$$T(n) = 2T\left(\frac{n}{2}\right) + c\cdot n$$

$$DFT((a_0)) = [a_0]$$

$$\Theta(n \log n)$$

$$2^m < n < 2^{m+1}$$

$$O(2^{m+1}\cdot \log(2^{m+1}))$$

$$\omega^{1\cdot\cancel{2}}_{\frac{n}{2}\cdot\cancel{2}}$$

$$2^{m+1} < 2n$$

$$c\cdot 2^{m+1}\cdot \log(2^{m+1})$$

$$c\cdot 2n\cdot \log(2n)$$

1

(a_0)

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$DFT((a_0)) = [a_0]$

$\Theta(n \log n)$

$2^m < n < 2^{m+1}$

$O(2^{m+1} \cdot \log(2^{m+1}))$

$\boxed{\omega^{\frac{1 \cdot \cancel{2}}{\frac{n}{2} \cdot \cancel{2}}}}$

$2^{m+1} < 2n$

$c \cdot 2^{m+1} \cdot \log(2^{m+1})$

$c \cdot 2n \cdot \log(2n)$

$\cancel{w_n^0}, w_n^1, \dots, w_n^{n-1}$

$$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(1) = a_0 + a_1 + \dots + a_{n-1} = y_0$$

$$p(w_n) = a_0 + a_1 w_n + a_2 w_n^2 + \dots + a_{n-1} w_n^{n-1} = y_1$$

$$\Theta(n \log n)$$

$$\left(\quad \right) \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i \qquad P(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$$

$$P(w_n) = a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1 \qquad \Theta(n \log n)$$

$$\boxed{\begin{pmatrix} 1 & 1 & \cdots & 1 \\ 1 & w_n & w_n^2 \cdots & w_n^{n-1} \\ & & & \\ & & & \end{pmatrix}} \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$

$p(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$

$\Theta(n \log n)$

$p(w_n) = a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$

$$\boxed{\begin{pmatrix} 1 & 1 & \cdots & 1 \\ 1 & w_n & w_n^2 \cdots & w_n^{n-1} \\ & & & \\ & & & \end{pmatrix}} \begin{pmatrix} a_0 \\ \vdots \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\omega_n^0, \omega_n^1, \ldots, \omega_n^{n-1}$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$

$p(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$

$p(\omega_n) = a_0 + a_1 \omega_n + a_2 \omega_n^2 + \ldots + a_{n-1} \omega_n^{n-1} = y_1$

$\Theta(n \log n)$

$$\begin{pmatrix} 1 & 1 & \ldots & 1 \\ 1 & \omega_n & \omega_n^2 & \ldots \omega_n^{n-1} \\ & & & \end{pmatrix} \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$$T(n) = 2T\left(\frac{n}{2}\right) + c\cdot n$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$$

$$p(w_n) = a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$$

$$\Theta(n \log n)$$

$$\boxed{\begin{pmatrix} 1 & 1 & \ldots & 1 \\ 1 & w_n & w_n^2 \ldots & w_n^{n-1} \\ & & & \\ & & & \end{pmatrix}} \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$F_n \cdot \begin{pmatrix} a_0 \\ \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = F_n^{-1} \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w}_n^0, w_n^1, \ldots, w_n^{n-1}$

$$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i \qquad p(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$$

$$p(w_n) = a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1 \qquad \Theta(n \log n)$$

$$\boxed{\begin{pmatrix} 1 & 1 & \cdots & 1 \\ 1 & w_n & w_n^2 \cdots & w_n^{n-1} \\ & & & \\ & & & \end{pmatrix}} \begin{pmatrix} a_0 \\ \vdots \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$F_n \cdot \begin{pmatrix} a_0 \\ \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$$

$$p(w_n) = a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$$

$$\Theta(n \log n)$$

$$\boxed{\begin{pmatrix} 1 & 1 & \ldots & 1 \\ 1 & w_n & w_n^2 \ldots & w_n^{n-1} \\ & & & \\ & & & \end{pmatrix}} \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$F_n \cdot \begin{pmatrix} a_0 \\ \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w}_n^0, w_n^1, \ldots, w_n^{n-1}$

$$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i \qquad p(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$$

$$p(w_n) = a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$$

$$\Theta(n \log n)$$

$$\boxed{\begin{pmatrix} 1 & 1 & \ldots & 1 \\ 1 & w_n & w_n^2 \ldots & w_n^{n-1} \\ & & & \\ & & & \end{pmatrix}} \begin{pmatrix} a_0 \\ \vdots \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$F_n \cdot \begin{pmatrix} a_0 \\ \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$

$P(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$

$P(w_n) = a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$

$\Theta(n \log n)$

$$\boxed{\begin{pmatrix} 1 & 1 & \cdots & 1 \\ 1 & w_n & w_n^2 \cdots & w_n^{n-1} \\ & & & \end{pmatrix}} \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$F_n \cdot \begin{pmatrix} a_0 \\ \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$$

$$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$$

$$p(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$$

$$p(w_n) = a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$$

$$\Theta(n \log n)$$

SHOR

$$\boxed{\begin{pmatrix} 1 & 1 & \ldots & 1 \\ 1 & w_n & w_n^2 \ldots & w_n^{n-1} \\ & & & \end{pmatrix}} \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ y_1 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$F_n \cdot \begin{pmatrix} a_0 \\ \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$

$p(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$

$a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$

$\Theta(n \log n)$

$F_n[i, j]$

w_n

$$F_n \cdot \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$

$P(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$

$\Theta(n \log n)$

$= a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$

$F_n[i,j] = \left(w_n^{i-1}\right)^{j-1}$

$\quad\| \qquad = w_n^{(i-1)(j-1)}$

$F_n[j,i]$

$$F_n \cdot \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$

$P(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$

$a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$

$\Theta(n \log n)$

$F_n[i,j] = \left(w_n^{i-1}\right)^{j-1} = w_n^{(i-1)(j-1)}$

$\parallel$

$F_n[j,i]$

$$F_n \cdot \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$

$p(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$

$= a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$

$\Theta(n \log n)$

$F_n[i,j] = \left(w_n^{i-1}\right)^{j-1}$

$= w_n^{(i-1)(j-1)}$

$\parallel$

$F_n[j,i]$

$a + bi$

$\overline{a+bi} = a - bi$

$$F_n \cdot \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$$

$\cancel{w_n^0}, w_n^1, \ldots, w_n^{n-1}$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i \qquad P(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$

$= a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$

$\Theta(n \log n)$

$F_n[i,j] = \left(w_n^{i-1}\right)^{j-1}$

$= w_n^{(i-1)(j-1)}$

$\|$

$F_n[j,i]$

$a + bi$

$\overline{a+bi} = a - bi$

$F_n \cdot \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$

$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$

$w_n^0, w_n^1, \ldots, w_n^{n-1}$

$T(n) = 2T\left(\frac{n}{2}\right) + c \cdot n$

$p(x) = \sum_{i=0}^{n-1} a_i \cdot x^i$ $\quad P(1) = a_0 + a_1 + \ldots + a_{n-1} = y_0$

$\Theta(n \log n)$

$= a_0 + a_1 w_n + a_2 w_n^2 + \ldots + a_{n-1} w_n^{n-1} = y_1$

$F_n[i,j] = \left(w_n^{i-1}\right)^{j-1} = w_n^{(i-1)(j-1)}$

$\| $

$F_n[j,i]$

$F_n \cdot \begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$

$A^*[i,j] = \overline{A[j,i]}$

$\begin{pmatrix} a_0 \\ \vdots \\ a_{n-1} \end{pmatrix} = \frac{1}{n} F_n \begin{pmatrix} y_0 \\ \vdots \\ y_{n-1} \end{pmatrix}$