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Master Worker Theorem:

$$T(n) = aT\left(\frac{n}{b}\right) + f(n) \quad T(1) = c$$

Definition

$$T(n) = \begin{cases} O(n^d) & \text{if } a < b^d \\ O(n^d \log n) & \text{if } a = b^d \\ O(n^{\log_b a}) & \text{if } a > b^d \end{cases}$$

1) $T(n) = 9T\left(\frac{n}{3}\right) + O(n^2)$

$a = 9 \quad b = 3 \quad d = 2$

Case 2: $a = b^d \quad (9 = 3^2)$

$\therefore O(n^2 \log n)$

2 $T(n) = 2T\left(\frac{n}{4}\right) + O(n)$

$a = 2 \quad b = 4 \quad d = 1$

Case 1: $a < b^d \quad (2 < 4^1)$

$\therefore O(n)$

3 $T(n) = 2T\left(\frac{n}{4}\right) + O(1)$

$a = 2 \quad b = 4 \quad d = 0$

Case 3: $a > b^d \quad (2 > 4^0)$

$\therefore O(\sqrt{n})$