Recurrence Relation
Substitution Method

$$T(n) = \begin{cases} 1, & n = 1 \\ 2T(n/2) + n. \end{cases}$$

$$T(n) = 2T(n/2) + n$$

$$= 2\left[2T\left(\frac{n}{2^2}\right) + \frac{n}{2}\right] + n$$

$$\boxed{T\left(\frac{n}{2}\right) = 2T\left(\frac{n}{2^2}\right) + \frac{n}{2}}$$

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

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

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

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

$$= 2^2\left[2T\left(\frac{n}{2^3}\right) + \frac{n}{2^2}\right] + 2n$$

$$= 2^3 T\left(\frac{n}{2^3}\right) + \cancel{\frac{2^2}{2^2}}\cdot n + 2n$$

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

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

$$\vdots$$

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

$$= 2^k T(1) + k\cdot n \qquad \boxed{\frac{n}{2^k} = 1}$$

$$= 2^k * 1 + k\cdot n \qquad \boxed{\Rightarrow n = 2^k}$$

$$= 2^k + k\cdot n \qquad \boxed{\Rightarrow k = \log_2 n}$$

$$= n + n\log n$$

$$= O(n\log n)$$