First Principles

1. $5n - 3 > c\log n$

$5n - 3 > 5\log^2 n > c\log n$

when $5n - 3 > 5\log^2 n$

$\Leftrightarrow n > \log^2 n + 3/5$

if $n > 100$

with $5\log^2 n > c\log n$

$5\log n > c$

$\log n > c/5$

$n > 2^{c/5}$

$n_0 = \max(100, 2^{c/5})$

2. $3n\log n - n \leq 3n\log n$ (when $n \geq 1$)

$3n\log n - n \geq 3n\log n - n\log n$ (when $n \geq 2$)

$\geq 2n\log n$

Thus, $2n\log n \leq 3n\log n - n \leq 3n\log n$, when $n \geq 2$

Thus, with $c_1 = 2$, $c_2 = 3$, $n_0 = 2$, we get that $3n\log n - n \in \Theta(n\log n)$

Code Analysis

1. loop 1: $\sum_{i=1}^{n} 1 = n$

loop 2: $\sum_{i=1}^{n/2} 1 = n/2$

$\vdots$

loop K: $\sum_{i=1}^{n/2^{K-1}} 1 = n/2^{K-1}$

Since there are $\log n$ loops, runtime is $\sum_{i=0}^{\log n} n/2^i = n\sum_{i=0}^{\log n} (1/2)^i$

$\leq 2n \in \Theta(n)$