Give the order of growth (as a function of N) of the running times of each of the following code fragment:

```
int sum = 0;
for (int n = N; n > 0; n /= 2)
   for (int i = 0; i < n; i++)
      sum++;
```

1st Loop n $\Rightarrow$ $N, N/2, N/4, N/8 \ldots$

2nd Loop i varies $\Rightarrow$ $[0,1,\ldots N]$, $[0,1,2 \ldots N/2]$, $[0,1,2,\ldots N/4]$.

no of times 2nd loop is executed is

$$N + N/2 + N/4 + \ldots$$

order of growth $= N + N/2 + N/4 + N/8 + \ldots$

$$X = N\left[1 + 1/2 + 1/4 + 1/8 + \ldots\right]$$

geometric progression of converging series

$$\max(X) = N \times \frac{1}{1 - 1/2}$$

$$= 2N$$

order of growth $\leq N$

linear growth