1.

$$I \doteq i \leqslant N \wedge \sum_{k=0}^{i-1} v[k] \leqslant lim \wedge \left(\sum_{k=0}^{i} v[k] > lim \vee i = N \right) \wedge sum = \sum_{k=0}^{i-1} v[k]$$

$$Q \doteq \sum_{k=0}^{i} v[k] \leqslant lim \wedge \left(\sum_{k=0}^{i+1} v[k] > lim \vee i = N \right)$$

2.

$$T(N) = \begin{cases} 0 & , N \leqslant 0 \\ 1 + 2 \cdot T\left(\frac{N}{2}\right) & , N > 0 \end{cases}$$

$$T(N) = 2^{\log_2 N+1} \cdot 0 + \sum_{i=0}^{\log_2 N} \left(2^i \cdot 1\right) = \sum_{i=0}^{\log_2 N} 2^i = \frac{2^{\log_2 N+1} - 1}{2 - 1} = 2N - 1$$

3.

4.