Generating the first $T$ time unit of a Poisson process with rate $\lambda$

Algorithm 1

Because $P(N(t) \geq n) = P(S_n \leq t)$, where $S_n$ is the sum of $n$ i.i.d random variables with exponential distribution with mean $1/\lambda$, we generate $S_n$ instead.

Step 1. Set $t = 0, n = 0$.

Step 2. Generate a random number $U \in (0, 1)$, and let $t = t + (-\frac{1}{\lambda} \log U)$. If $t > T$, stop.

Step 3. $n = n + 1, S_n = t$.

Step 4. Go to Step 2.

The final value of $n$ represents the number of events by time $T$, and the values of $S(1), S(2), ..., S(n)$ are the $n$ events time in increasing order.