Assignment 4

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Fig. 4: Poisson stem plot for X ($\lambda = 5$)

PROBLEM

(STATS P1 IES ISS 2019 Q16) Let X be a Poisson random variable with p.m.f

$$P(X = k) = \begin{cases} \frac{e^{-\lambda}\lambda^k}{k!}, & k = 0, 1, 2, ...; \lambda > 0 \\ 0 & \text{otherwise} \end{cases} \quad (0.0.1)$$

If $Y = X^2 + 3$, then what is $P(Y = y)$ equal to?

(A) $\frac{e^{-\lambda}\lambda^{\sqrt{y-3}}}{\sqrt{(y-3)!}}$, for $y = \{3, 4, 7, 12, ...\}$

(B) $\frac{e^{-\lambda}\lambda^{-\sqrt{y-3}}}{\sqrt{(3-y)!}}$, for $y = \{3, 4, 7, 12, ...\}$

(C) $\frac{e^{-\lambda}\lambda^{\sqrt{3-y}}}{\sqrt{(3-y)!}}$, for $y = \{4, 7, 12, ...\}$

(D) $\frac{e^{-\lambda}\lambda^{-\sqrt{3-y}}}{\sqrt{(3-y)!}}$, for $y = \{4, 7, 12, ...\}$

SOLUTION

$$Y = X^2 + 3 \quad (0.0.2)$$
$$X = \sqrt{Y - 3} \quad (0.0.3)$$

We can substitute $k = \sqrt{y - 3}$ in (0.0.1)

$$p_Y(y) = \begin{cases} \frac{e^{-\lambda}\lambda^{\sqrt{y-3}}}{\sqrt{(y-3)!}}, & y = 3, 4, 7, 12, ... \\ 0 & \text{otherwise} \end{cases} \quad (0.0.4)$$
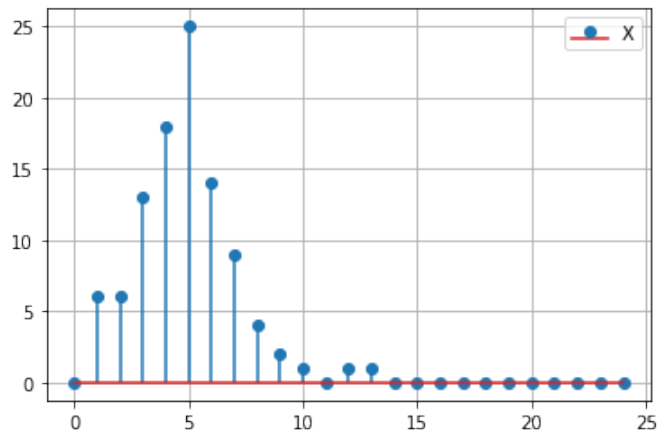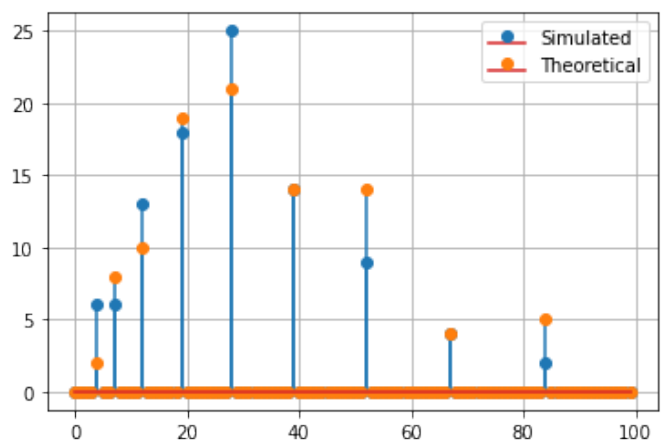
Hence, the correct option is (A).

Fig. 4: Poisson stem plot for Y (Simulated and Theoretical) ($\lambda = 5$)