What if $K \in (0,\infty)$? is the top pdf Legal and the Bottom pmf Legal? yes

$$\int_0^\infty \frac{\lambda^k e^{-\lambda t} t^{k-1}}{\Gamma(k)} dt = 1 \quad \text{and} \quad \sum_{t=0}^{\infty} \frac{\Gamma(k+t)}{\Gamma(k)t!}(1-p)^t p^k = 1$$

Which means... these are rv's

$$X \sim Gamma(\alpha, \beta) := \frac{\beta^\alpha}{\Gamma(\alpha)} t^{\alpha-1} e^{-\beta t} \mathbb{1}_{t \geq 0}$$

Ext

$X \sim NegBin(k, p)$ ...

Transformation for discrete rv's

$$X \sim Bern(p), \; Y = X+3 \sim \begin{cases} 3 & \text{wp } 1-p \\ 4 & \text{wp } p \end{cases} = p^{Y-3}(1-p)^{1-(Y-3)} \mathbb{1}_{Y \in \{3,4\}}$$

$p^x(1-p)^{1-x}\mathbb{1}_{x\in\{0,1\}}$

How do I Express the transform pmf using the original pmf

if $Y = g(X) \sim P_Y(Y) =$

$= P_X(g^{-1}(Y))$ $\quad g^{-1}(Y) = X$

is this formula general? No, this is only the formula for g invertible. If g non-Invertible.

$X \sim U(\{1,2,\dots 10\}) = \frac{1}{10} \mathbb{1}_{x\in\{1,2,\dots 10\}}$

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$X_1, X_2, \ldots$ iid $Exp(\lambda)$

$T_k \sim Erlang(k, \lambda)$, $N \sim poisson(\lambda)$

$P(T_k > 1)$

$= 1 - F_{T_k}(1) = Q(k, \lambda)$ $\qquad F_N(x) = Q(x+1, \lambda)$

$\Rightarrow 1 - F_{T_k}(1) = F_N(k-1)$ "poisson Process"

$0 \qquad 1 \qquad \to t\,(sec)$

$k=5$ $\{T_5 > 1\} = \{X_1+X_2+X_3+X_4 < 1\} \cup \{X_1+X_2+X_3 < 1\} \cup$
$\{X_1+X_2 < 1\} \cup \{X_1 < 1\} \cup \{X_1 > 1\}$

$1 - F_{T_5}(1)$ $\quad F_N(4)$ $= \{N=4\} \cup \{N=3\} \cup \{N=2\} \cup \{N=1\} \cup \{N=0\}$

$P(T_5 > 1) = P(N \le 4)$

$T \sim Erlang(k, \lambda) = \dfrac{\lambda^k e^{-\lambda t}\, t^{k-1}}{(k-1)!} 1_{t>0} = \dfrac{\lambda^k e^{-\lambda t}\, t^{k-1}}{\Gamma(k)} 1_{t>0}$

$k \in \mathbb{N}$, $\lambda \in (0, \infty)$

$T \sim NegBin(k, p) = \binom{k+t-1}{k-1}(1-p)^t p^k 1_{t \in \mathbb{N}_0} =$

$\dfrac{\Gamma(k+t)}{\Gamma(k)\, t!}(1-p)^t p^k 1_{t \in \mathbb{N}_0}$ $\qquad k \in \mathbb{N}$, $p \in (0,1)$