Poisson random variable

- A r.v. that expresses the probability of how many times an event occurs in a fixed period of time if these events
  - occur with known average rate of λ
  - and independently of each other

$$P(X = x \mid \lambda) = e^{-\lambda}\frac{\lambda^x}{x!}$$

X	$P(X = x)$
0	$e^{-\lambda}$
1	$e^{-\lambda}\lambda$
2	$e^{-\lambda}\frac{\lambda^2}{2}$
$\vdots$	$\vdots$

- Discrete outcomes $\{0,1,2,3\ldots\}$
- Shorthand notation: $X \sim \text{Poisson}(\lambda)$
- $E(X) = V(X) = \lambda$
- If the data shows overdispersion (variance > mean) or underdispersion (variance < mean), other models like the Negative Binomial

negative binomial random variable

- A generalization of the geometric distribution Pascal(1,p)=Geometric(p)
- It relates to the random experiment of repeated independent trials until observing r successes
- Discrete outcomes $\{1,2,3\ldots\}$
- Two parameter
    - the number of success we are waiting for
    - the probability that a single experiment gives a "success"
- Shorthand notation: $X \sim \text{NegBin}(r, p)$
- $E(X) = \dfrac{r}{p},\ V(X) = \dfrac{r(1-p)}{p^2}$

$$P(X = x \mid r, p) = \binom{x-1}{r-1} p^r (1-p)^{x-r}$$