## Discrete Distribution Overview:

### Bernoulli Distribution w/ parameters (m, p)

$X \sim \text{Bernoulli}(m, p)$ — $p$: probability of trial success; $0 \le p \le 1$; $m$: # of trials

$P(X=x) = \binom{m}{x} p^x (1-p)^{m-x}$ for $x = 1, 2, 3, \ldots$

$E(X) = mp$

$V(X) = mp(1-p)$

$X$ counts total # of successes in $m$ independent trials

### Poisson Distribution w/ parameters ($\lambda$)

$X \sim \text{Poisson}(\lambda)$ $\lambda > 0$

$P(X=x) = \frac{\lambda^x}{x!} e^{-\lambda}$ for $x = 0, 1, 2, \ldots$

$E(X) = \lambda$

$V(X) = \lambda$

when you have a binomial r.v. w/ large $m$ and small $p$ where $\lambda = mp$

### Geometric Distribution w/ parameters (p)

$X \sim \text{Geometric}(p)$ $0 \le p \le 1$

$P(X=x) = (1-p)^{x-1} \cdot p$ for $x = 1, 2, 3, \ldots$

$E(X) = \frac{1}{p}$

$V(X) = \frac{1-p}{p^2}$

$X$ is the total # of trials for the 1st success, when the trials are independent w/ success probability $p$

### Negative Binomial Distribution w/ parameters (R, p)

$X \sim \text{Neg Bin}(R, p)$ $R \ge 1$, $0 \le p \le 1$

$P(X=x) = \binom{x-1}{R-1} p^R (1-p)^{x-R}$ for $k = R, R+1, R+2, \ldots$

$E(X) = \frac{R}{p}$

$V(X) = \frac{R(1-p)}{p^2}$

$X$ is the total # of independent trials needed to collect $R$ successes for the first time when $P(\text{success}) = p$

### Hyper Geometric Distribution w/ parameters (w, R, n)

$X \sim \text{HyperGeometric}(w, R, n)$

$P(X=x) = \frac{\binom{w}{x}\binom{R}{n-x}}{\binom{w+R}{n}}$ for $n = \max\{0, n-R\} \ldots \min\{w, n\}$

Urn has $w$ white balls and $r$ red balls

$X$ = total number of white balls in a sample w/o replacement of size $n$

## General Information

$X \sim$ r.v.

discrete r.v. → probability mass function, pmf: $P(X=x)$ pmf: $f(x)$ $f(5) \to P(X=5)$

cumulative density function cdf: $P(X \le x)$ → can be discrete or continuous

probability density function → pdf: $P(X \in I)$, $I = (a, b)$ i.e. $\int_a^b g(x)\,dx$

continuous r.v. pdf: $g(x)$

↳ properties: non-negative

$\int_{-\infty}^{\infty} g(x)\,dx = 1$

probability at any value $X$ is identically equal to 0