Common Discrete Random Variables

**Geometric**  For a geometric variable $X$ with success probability $0 < q \leq 1$,

- $p_X(x) = (1 - q)^{x-1}q$,  \( x = 1, 2, 3, \ldots \)
- $E[X] = \sum_{x=1}^{\infty} x p_X(x) = \frac{1}{q}$.
- $\text{Var}[X] = E[X^2] - E[X]^2 = \frac{1-q}{q^2}$.

**Binomial**  For a binomial variable $X$ with $n$ trials and success probability $0 \leq q \leq 1$,

- $p_X(x) = \binom{n}{x} q^x (1-q)^{n-x}$,  \( x = 0, 1, \ldots, n \).
- $E[X] = \sum_{x=0}^{n} x p_X(x) = nq$.
- $\text{Var}[X] = E[X^2] - E[X]^2 = nq(1-q)$.

Common Continuous Random Variables

**Uniform**  For a random variable $X$ that is uniformly distributed between $a$ and $b$,

- $f_X(x) = \begin{cases} 1/(b-a), & \text{if } a \leq x \leq b. \\ 0, & \text{otherwise.} \end{cases}$
- $E[X] = \int_{-\infty}^{\infty} x f_X(x) \, dx = \frac{a+b}{2}$.
- $\text{Var}[X] = E[X^2] - E[X]^2 = \frac{(b-a)^2}{12}$.

**Exponential**  For an exponential variable $X$ with parameter $\lambda$, $P(X < 0) = 0$, and

- $f_X(x) = \lambda e^{-\lambda x}$,  \( x \geq 0. \)
- $E[X] = \int_{0}^{\infty} x f_X(x) \, dx = \frac{1}{\lambda}$.
- $\text{Var}[X] = E[X^2] - E[X]^2 = \frac{1}{\lambda^2}$.

**Normal**  For a normal or Gaussian variable $X$ with mean $\mu$ and variance $\lambda$,

- $f_X(x) = \frac{1}{\sqrt{2\pi\lambda}} \exp \left\{ -\frac{(x-\mu)^2}{2\lambda} \right\}$.
- $E[X] = \int_{-\infty}^{\infty} x f_X(x) \, dx = \mu$.
- $\text{Var}[X] = E[X^2] - E[X]^2 = \lambda$. 
Integrals and Derivatives

\[ \int_a^b x^n \, dx = \frac{b^{n+1} - a^{n+1}}{n+1}, \]

\[ \frac{d}{dx} x^n = nx^{n-1}. \]

\[ \int_a^b \frac{1}{x} \, dx = \ln(b) - \ln(a) = \ln \left( \frac{b}{a} \right), \]

\[ \frac{d}{dx} \ln(x) = \frac{1}{x}. \]

\[ \int_a^b e^{cx} \, dx = \frac{1}{c} (e^{cb} - e^{ca}), \]

\[ \frac{d}{dx} e^{cx} = ce^{cx}. \]