# Continuous Probability Densities

## Uniform

$$X \sim U(a, b)$$

Situation: $X$ is a random real number in the interval $x \in [a, b]$.

$$f_X(x) = \tfrac{1}{b-a} \text{ when } x \in [a, b]$$
$$F_X(x) = \tfrac{x-a}{b-a} \text{ when } x \in [a, b]$$
$$E(X) = \tfrac{1}{2}(a + b)$$
$$\text{Var}(X) = \tfrac{1}{12}(b - a)$$

## Exponential

$$X \sim \text{Exp}(\lambda)$$

Situation: $X$ is the amount of time until a Poisson event occurs.

$$f_X(x) = \lambda e^{-\lambda x} \text{ when } x \geq 0$$
$$F_X(x) = 1 - e^{-\lambda x} \text{ when } x \geq 0$$
$$E(X) = 1/\lambda$$
$$\text{Var}(X) = 1/\lambda^2$$

## Normal

$$X \sim N(\mu, \sigma)$$

Situation: $X$ is normal with mean $\mu$ and standard deviation $\sigma$.

$$f_X(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-(x-\mu)^2/2\sigma^2}$$
$$F_X(x) = \Phi(x)$$
$$E(X) = \mu$$
$$\text{Var}(X) = \sigma^2$$

## Gamma

$$X \sim \text{Gamma}(n, \lambda)$$

Situation: $X$ is the amount of time until $n$ Poisson events occur.

$$f_X(x) = \frac{\lambda^n x^{n-1}}{(n-1)!} e^{-\lambda x} \text{ when } x \geq 0$$
$$F_X(x) = 1 - e^{-\lambda x} \left( \sum_{k=0}^{n-1} \frac{(\lambda x)^k}{k!} \right), x \geq 0$$
$$E(X) = n/\lambda$$
$$\text{Var}(X) = n/\lambda^2$$