Different types of Distribution

We can divide it into two types:

- Continuous Distributions
- Discrete Distributions

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Distributions

1 CONTINUOUS DISTRIBUTIONS

If a function satisfies the following conditions:

- *It is non-negative for all real x*
- *The probability that x is between two points a and b is*

$$p[a \leq x \leq b] = \int_a^b f(x)\, dx$$

- *The integral of the probability function is one, that is*

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

2 DISCRETE DISTRIBUTIONS

If a function satisfies the following conditions:

- *It is non-negative for all real x*
- *The probability that x can take a specific value is p(x). That is*

$$P[X = x] = p(x) = p_x$$

- *The sum of p(x) over all possible values of x is 1, that is*

$$\sum_j p_j = 1$$

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Related Distributions

For relating distributions, we mainly use two functions:

1. **PDF(PROBABILITY DENSITY FUNCTION)**
   - *The probability density function (PDF) is the probability that the variate has the value x. Since the probability at a single point is zero for continuous distributions, this is often expressed in terms of integration between two points.*
   - *For continuous distribution:*

$$\int_a^b f(x)\,dx = P_r[a \le X \le b]$$

   - *For discrete distribution:*

$$f(x) = P_r[X = x]$$

2. **CDF(CUMULATIVE DISTRIBUTION FUNCTION)**
   - *The cumulative distribution function (CDF) is the probability that the variable takes a value less than or equal to x.*

$$F(x) = P_r[X \le x] = \alpha$$

   - *For continuous distribution:*

$$F(x) = \int_{-\infty}^{x} f(\mu)\,d\mu$$

   - *For discrete distribution:*

$$F(x) = \sum_{i=0}^{x} f(i)$$

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Continuous Distributions

MOST COMMONLY USED CONTINUOUS DISTRIBUTIONS

- Exponential
- Normal
- Lognormal
- Pareto

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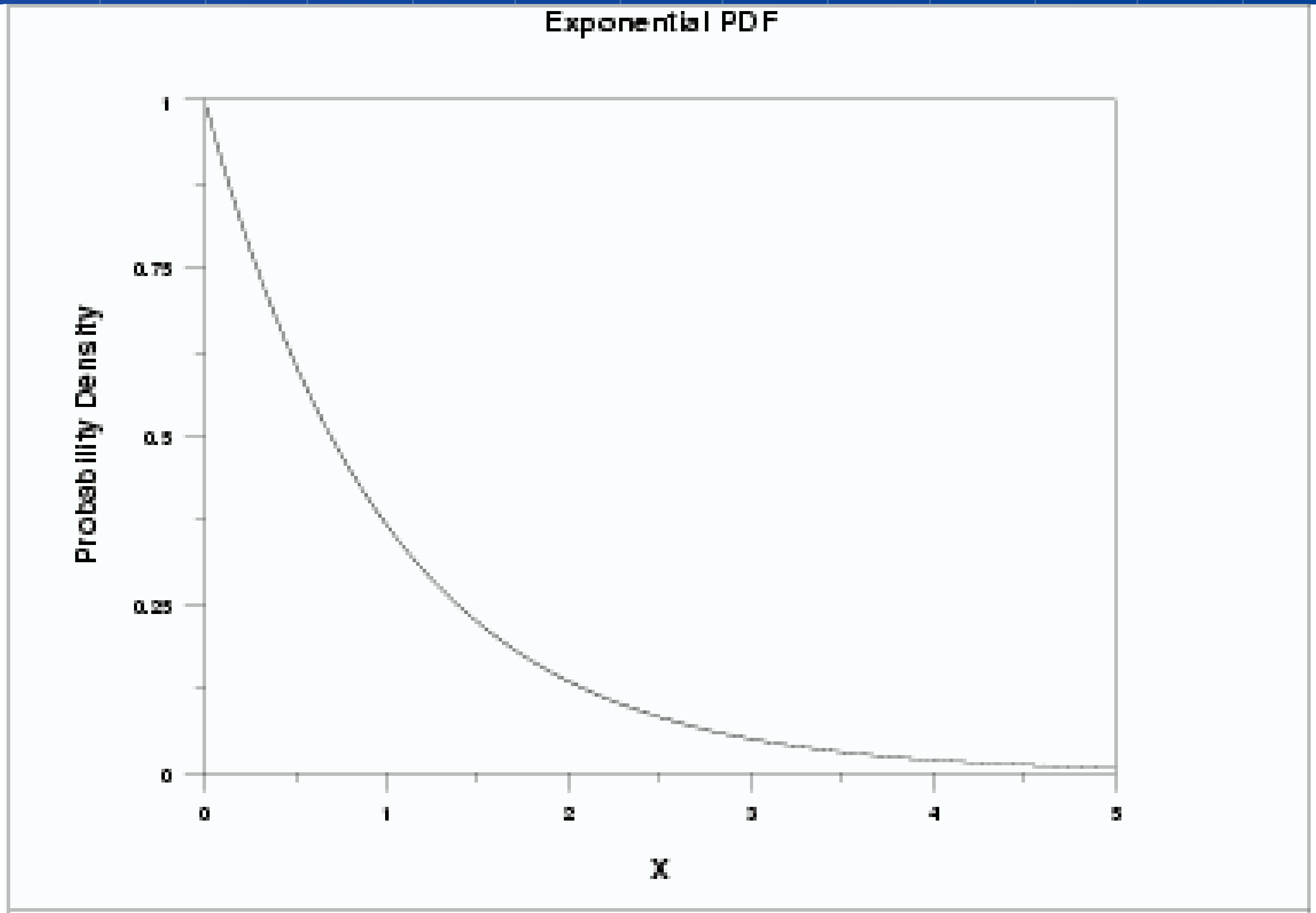
EXPONENTIAL DISTRIBUTION

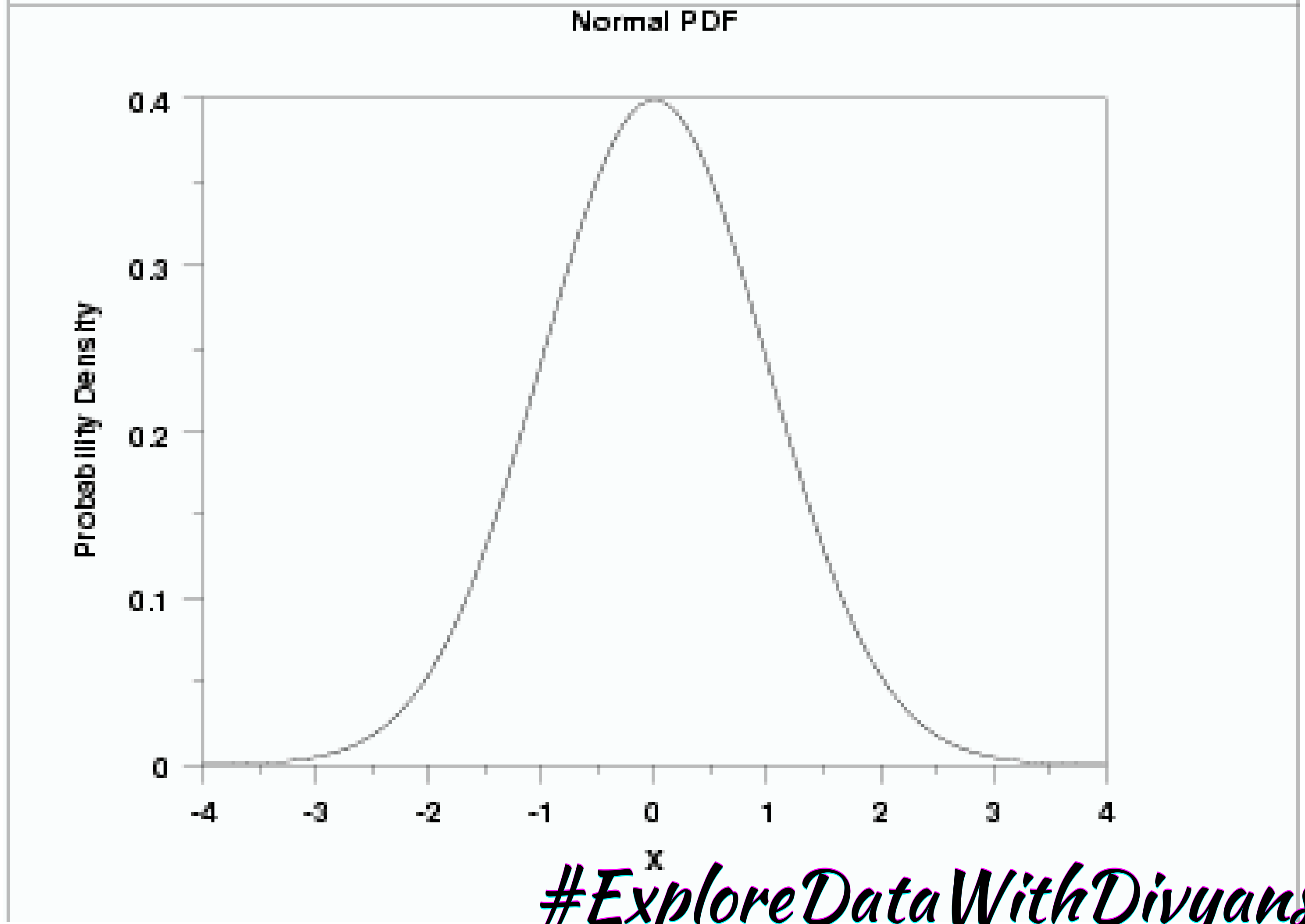
$$f(x;\lambda) = \begin{cases} \lambda e^{-\lambda x} & x \ge 0 \\ 0 & x < 0 \end{cases}$$

NORMAL DISTRIBUTION

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

- ***f(x) or f(x;λ) - pmf***
- ***λ - Rate Parameter***
- ***x - Random Variable***
- ***σ - Standard Deviation***
- ***μ - Mean***





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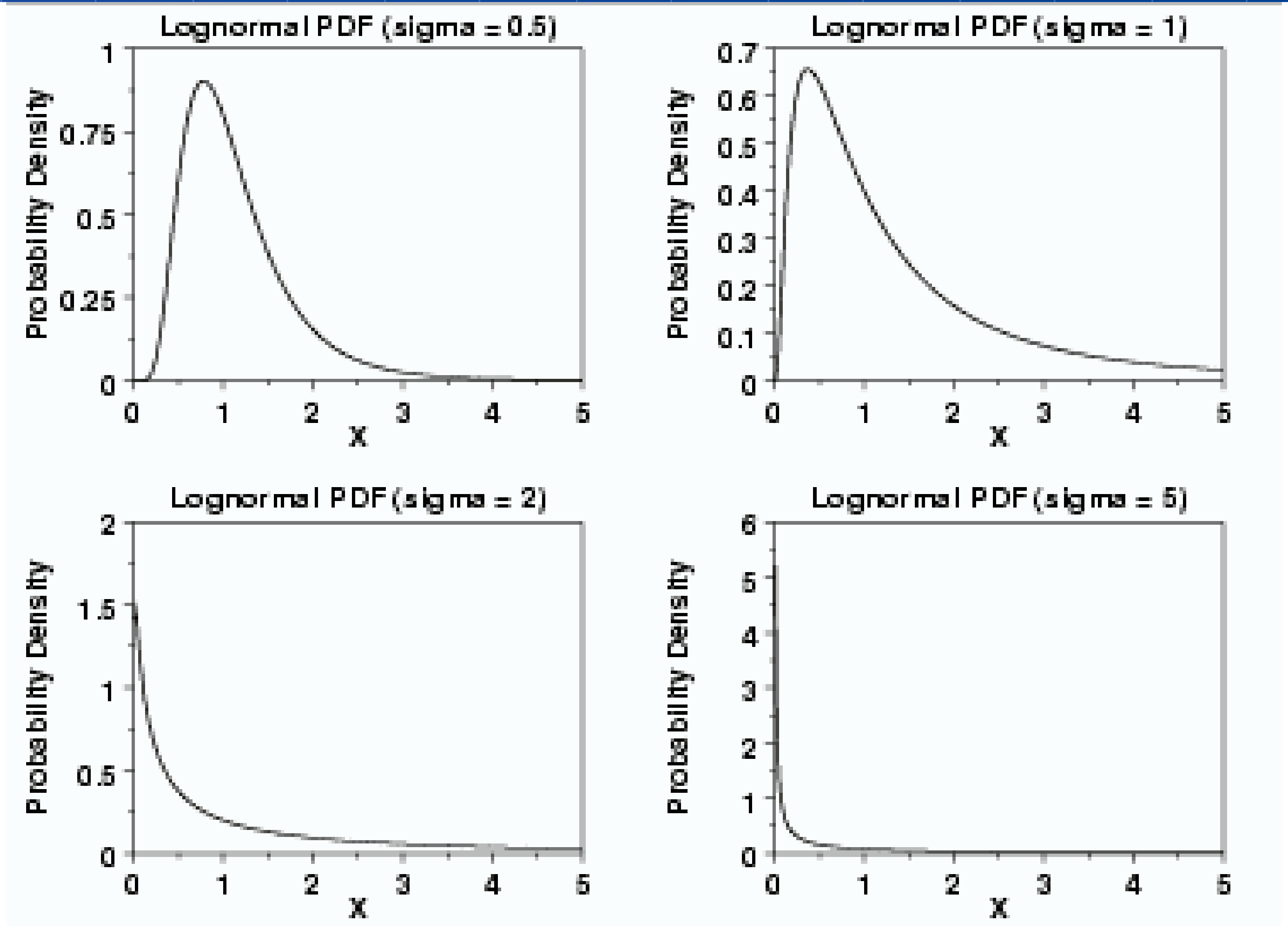
LOGNORMAL DISTRIBUTION

$$f(x) = \frac{e^{-((ln((x-\theta)/m))^2/(2\sigma^2))}}{(x-\theta)\sigma\sqrt{2\pi}}$$

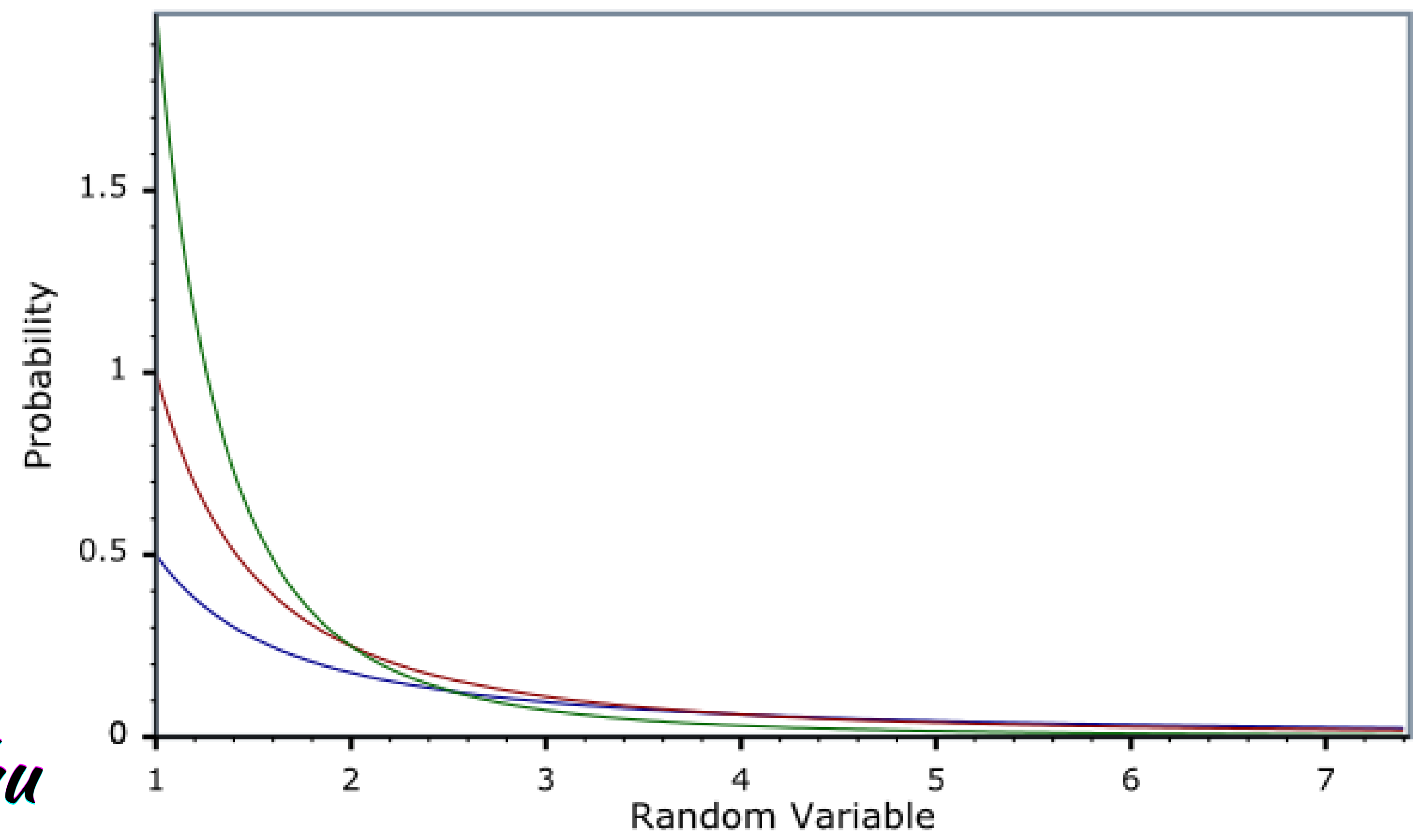
$$x > \theta; m, \sigma > 0$$



PARETO DISTRIBUTION

$$f(x) = 1 - \left(\frac{k}{x}\right)^{\sigma}$$

Pareto Distribution PDF (scale=1)



- ***f(x) - pmf***
- ***k - lower bound on data***
- ***x - Random Variable***
- ***σ - Shape Parameter***
- ***m - Scale Parameter***

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Discrete Distributions

MOST COMMONLY USED DISCRETE DISTRIBUTIONS

- Binomial Distribution
- Poisson Distribution

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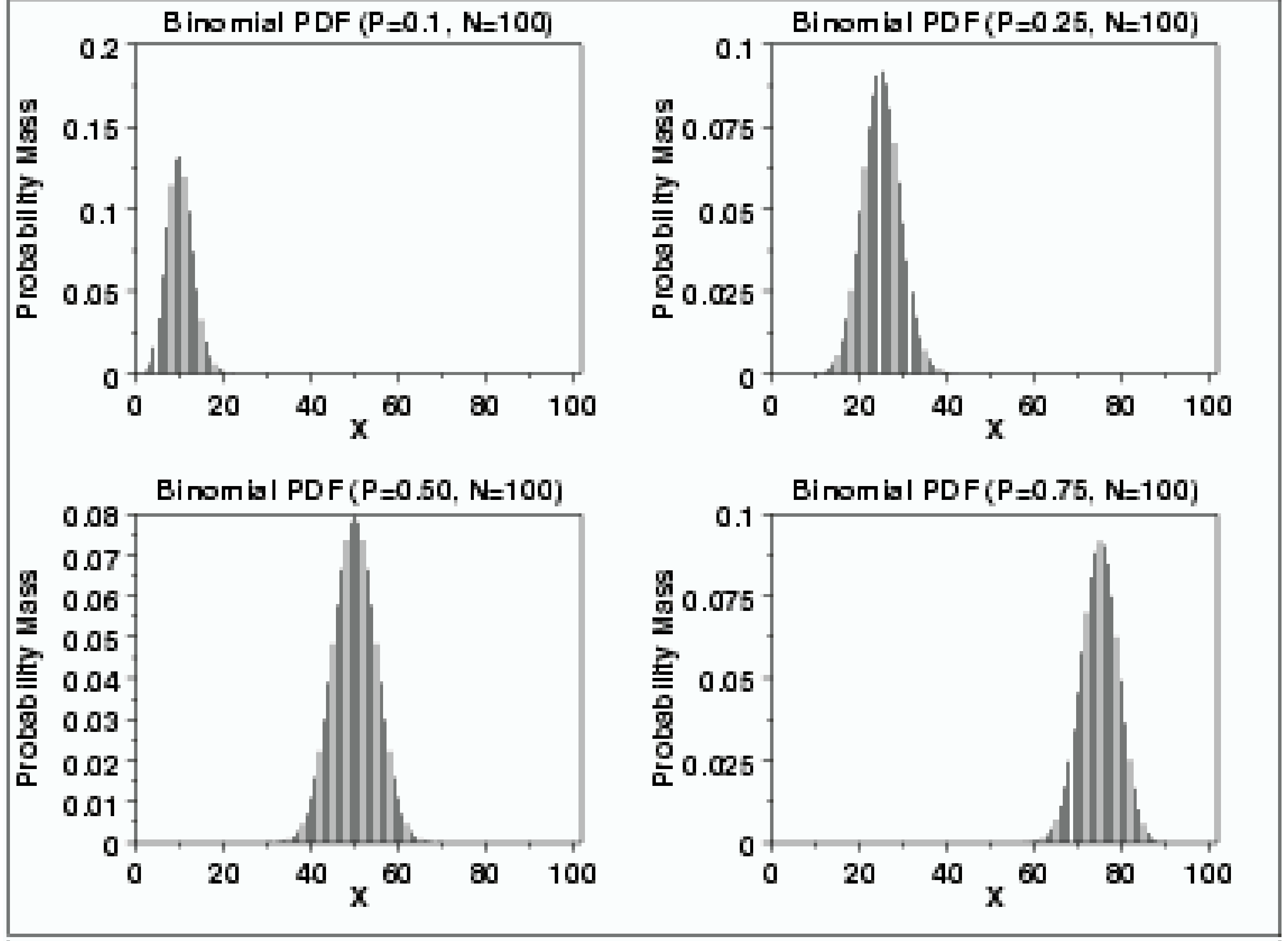
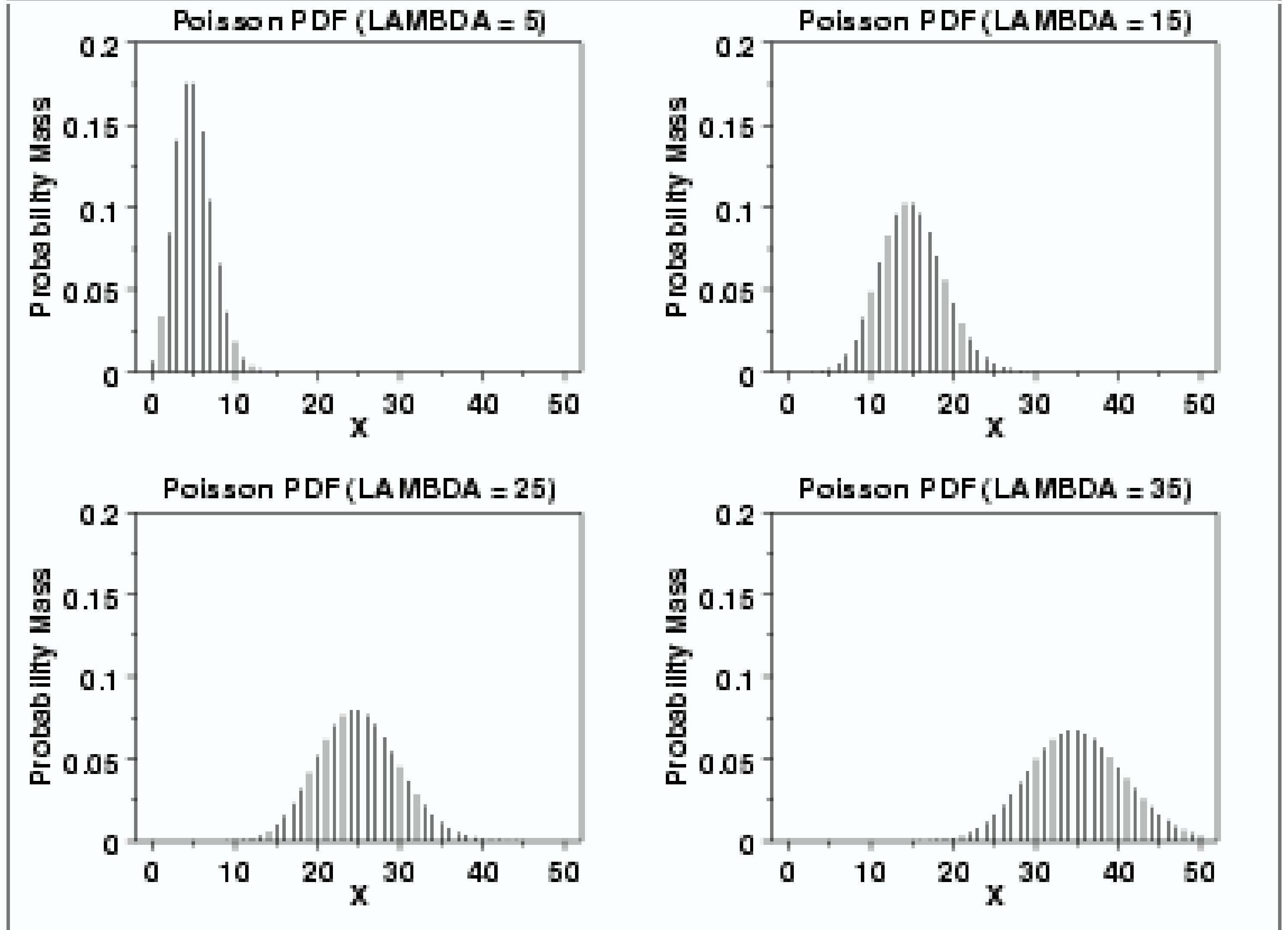
BINOMIAL DISTRIBUTION

$$p(x;p,n) = {}^{n}C_{x}\,(p^{x})\,(1-p)^{(n-x)} \quad for\ x = 0, 1, , ..n$$



POISSON DISTRIBUTION

$$p(x;\lambda) = \frac{e^{-\lambda}\,\lambda^{x}}{x!} \quad for\ x = 0, 1, 2, \ldots..$$



- ***f(x) - pmf***
- ***k - lower bound on data***
- ***x - Random Variable***
- ***σ - Shape Parameter***
- ***m - Scale Parameter***

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