

# CS195: Computer Vision

## Probabilistic Model Learning Maximum Likelihood (ML) Estimate



Md Alimoor Reza

Assistant Professor of Computer Science

# Today

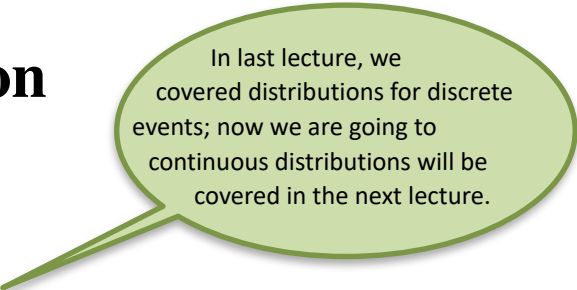
- **Continuous Probability Distribution**
- Joint Probability Distribution
- Marginal Probability Distribution
- Conditional Probability Distribution
- Bayes Rule

# Continuous Probability Distribution

- **Probability Distribution**

- Discrete Probabilities

- Continuous Probabilities



In last lecture, we covered distributions for discrete events; now we are going to continuous distributions will be covered in the next lecture.

- **Continuous Probability Distribution and Random Variable**

- Probability distribution is a function which will depend on a random variable eg,  $x$
  - If the random variable  $x$  takes continuous values then you get continuous probabilities

# Gaussian Distribution (1D)

A Gaussian distribution has two parameters:

- mean  $\mu$
- standard deviation  $\sigma$

A one-dimensional Gaussian distribution can be expressed using the following probability density function (pdf)

$$P(x) = \frac{1}{\sqrt{(2\pi\sigma^2)}} \exp \frac{-(x-\mu)^2}{2\sigma^2}$$

A one-dimensional Gaussian distribution with  $\mu = 0$ ,  $\sigma = 1$  can be expressed using the following probability density function (pdf)

$$P(x) = \frac{1}{\sqrt{(2\pi)}} \exp \frac{-(x)^2}{2}$$

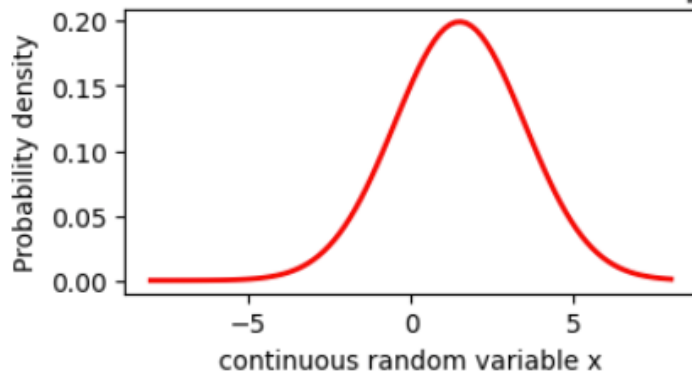
# Gaussian Distribution (1D)

```
plt.figure(figsize=(4,2))

mean      = -1.5
std_dev   = 0.5
xmin      = -8
xmax      = 8
x         = np.linspace(xmin, xmax, 100)
p         = np.exp(-0.5*((x-mean)/std_dev)**2) / (std_dev * np.sqrt(2*np.pi))
plt.plot(x, p, 'r', linewidth=2)

plt.title('Gaussian distribution with mean='+str(mean)+' , std_dev='+str(std_dev))
plt.xlabel('continuous random variable x' )
plt.ylabel('Probability density')
plt.show()
```

Gaussian Distribution with mean=1.5 and std\_dev=2.0



Gaussian Distribution with mean=-1.5 and std\_dev=0.5

