# Robotics

## Estimation and Learning with Dan Lee

# Week 1. Gaussian Model Learning

## 1.2.1 1D Gaussian Distribution

Penn Engineering

# Gaussian Distribution

## Why Gaussian?

- The two parameters (mean and variance) are easy to compute and interpret.

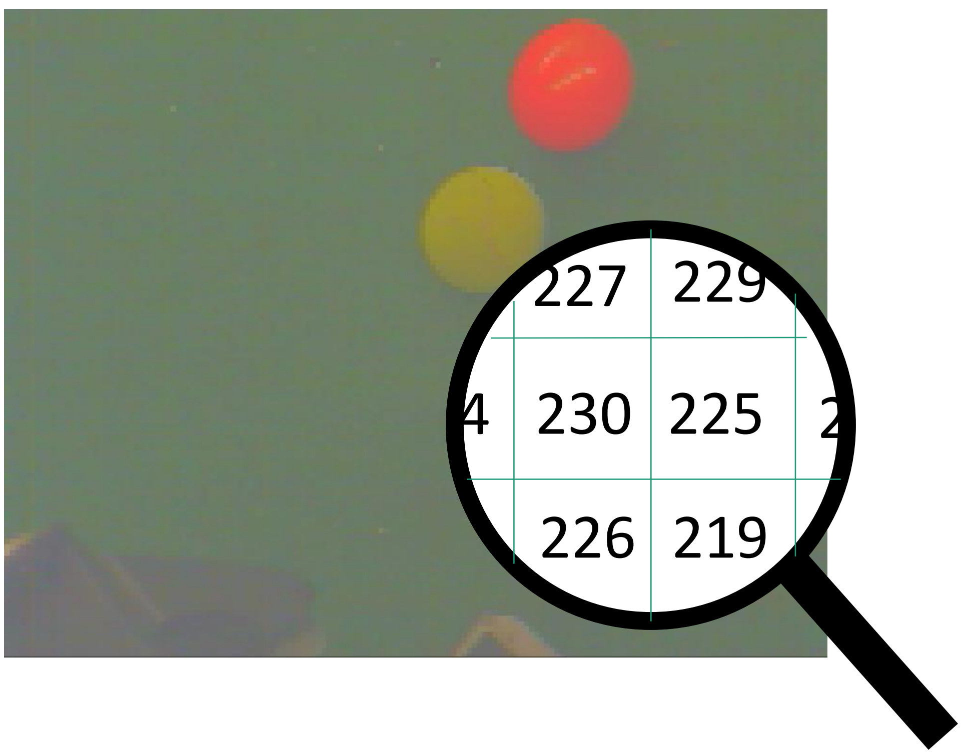
- Good mathematical properties:
  e.g., product of Gaussian distributions forms Gaussian.

- Central limit theorem:
  Expectation of the mean of any random variables converges to Gaussian.

# Gaussian Distribution : Example

## Ball color distribution

Color Image

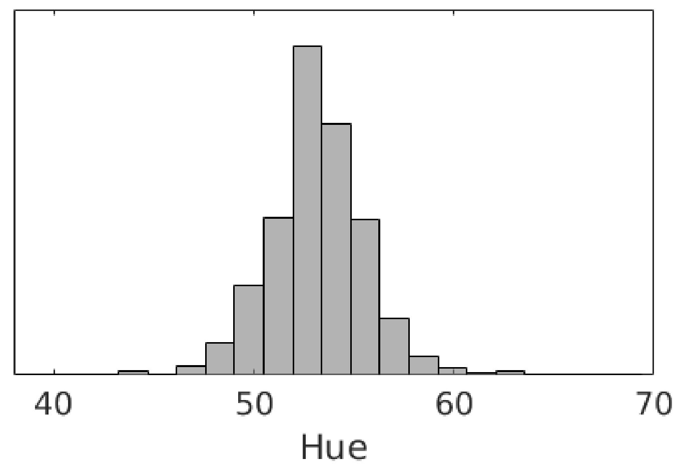



“Yellow”?
“Red”?

# Gaussian Distribution : Example

## Ball color distribution

Color Image



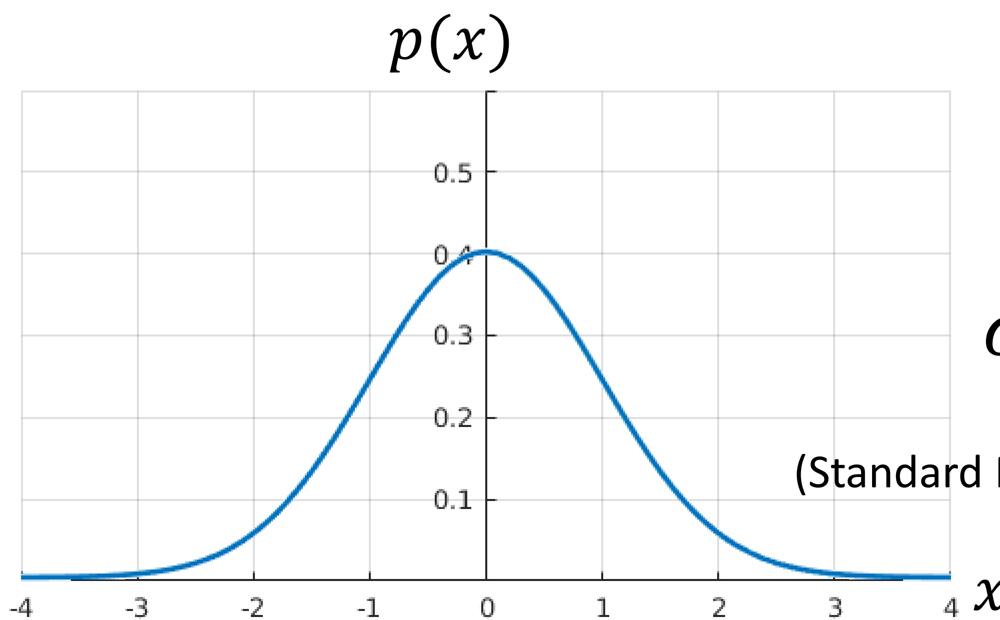
# Gaussian Distribution (1D)

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

| | |
|---|---|
| $x$ | Variable |
| $\mu$ | Mean |
| $\sigma^2$ | Variance |
| $\sigma$ | Standard deviation |

# Gaussian Distribution (1D)

$$p(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$



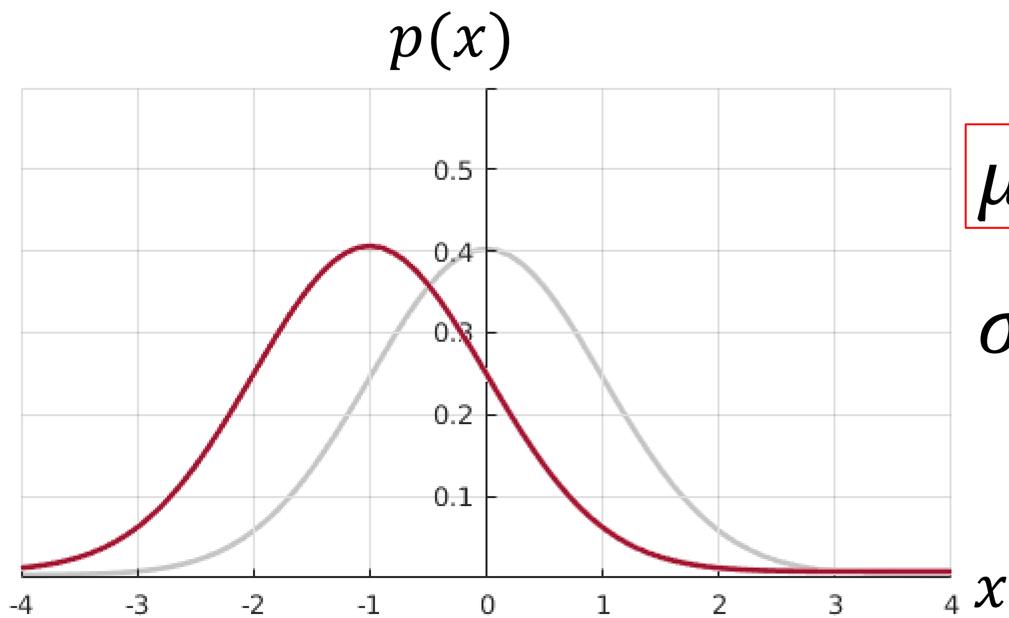

$$\mu = 0$$

$$\sigma^2 = 1$$

(Standard Normal Distribution)

# Gaussian Distribution (1D)

$$p(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{(x+1)^2}{2}}$$



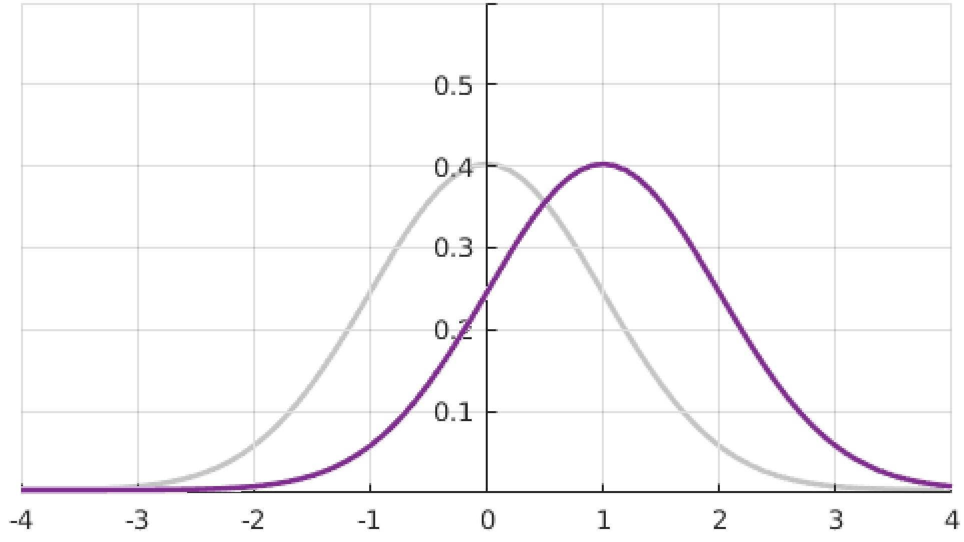

$\boxed{\mu = -1}$

$\sigma^2 = 1$

# Gaussian Distribution (1D)

$$p(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{(x-1)^2}{2}}$$

$p(x)$



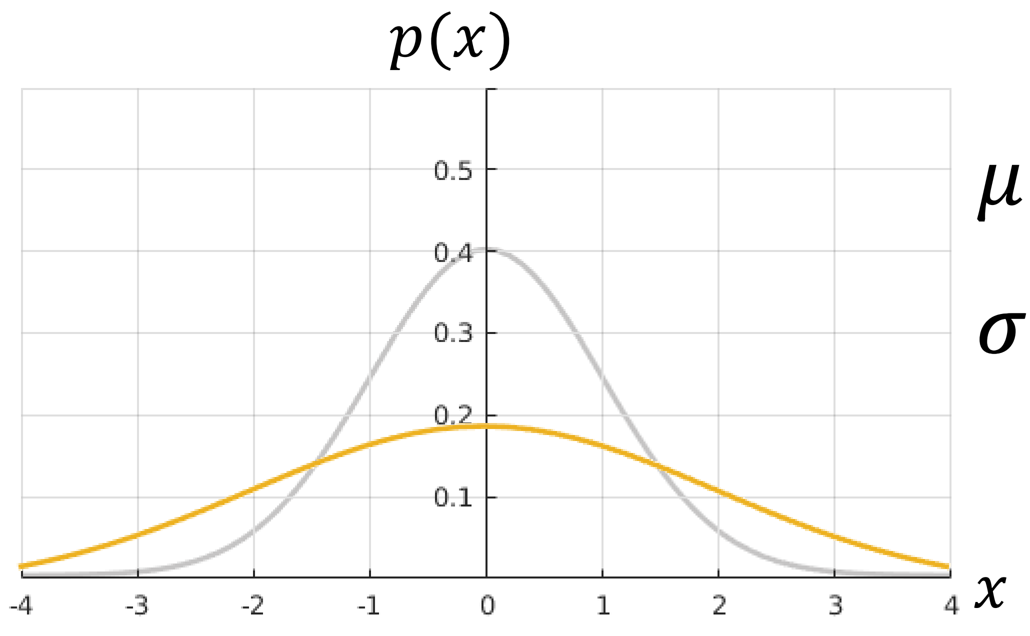

$x$

$\boxed{\mu = 1}$

$\sigma^2 = 1$

# Gaussian Distribution (1D)

$$p(x) = \frac{1}{2\sqrt{\pi}} e^{-\frac{x^2}{4}}$$

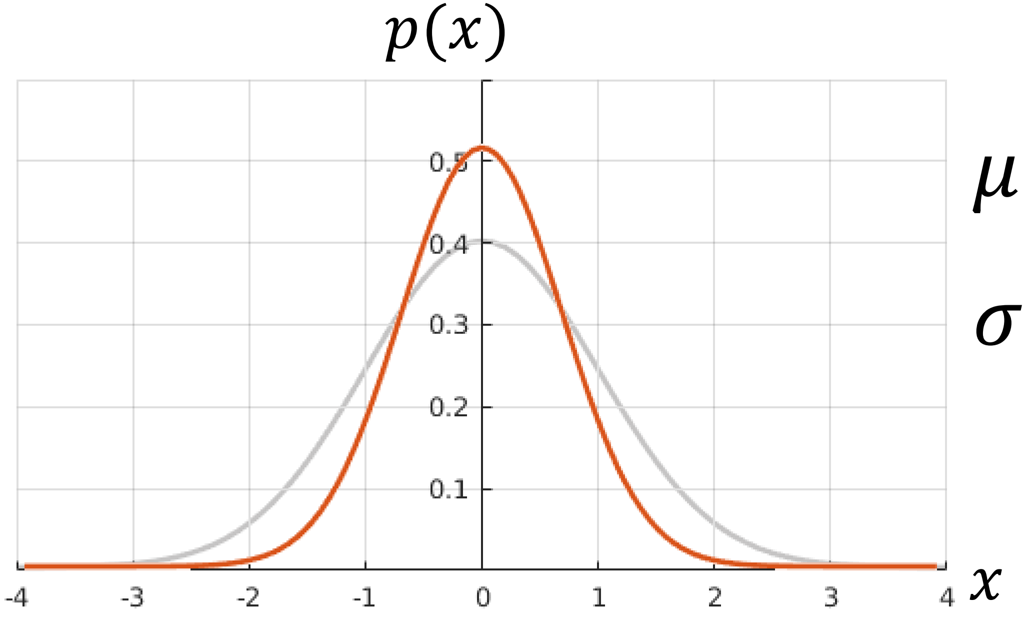



$\mu = 0$

$\sigma^2 = 2$

# Gaussian Distribution (1D)

$$p(x) = \frac{1}{\sqrt{1.4\pi}} e^{-\frac{x^2}{1.4}}$$

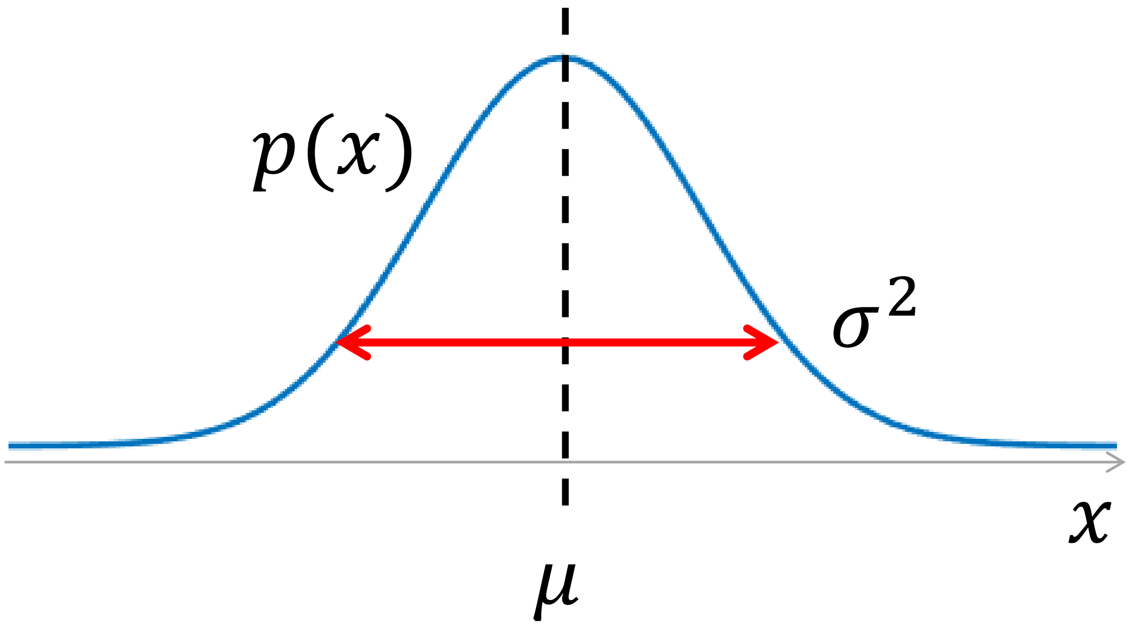



$\mu = 0$

$\sigma^2 = 0.7$

# Gaussian Distribution (1D)

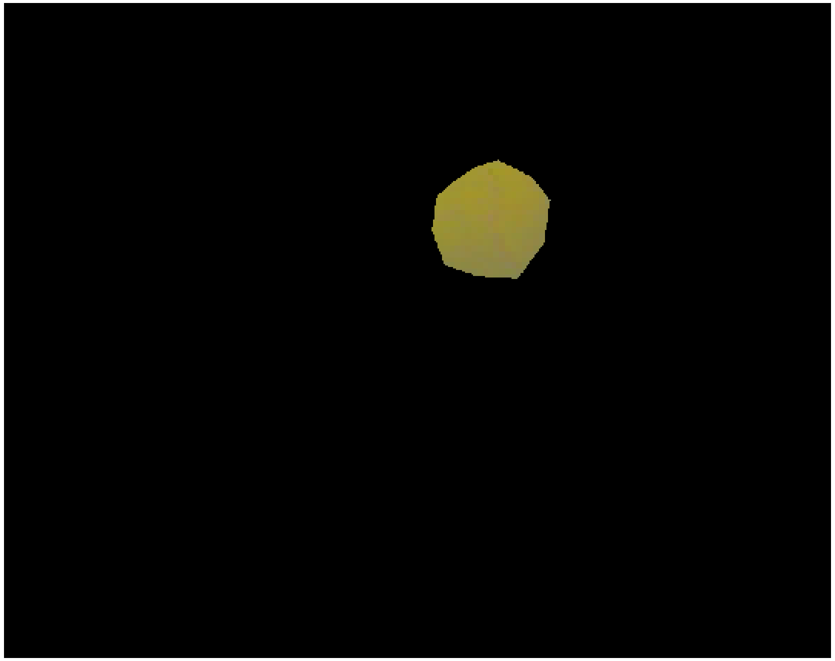
$$p(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left\{-\frac{(x-\mu)^2}{2\sigma^2}\right\}$$

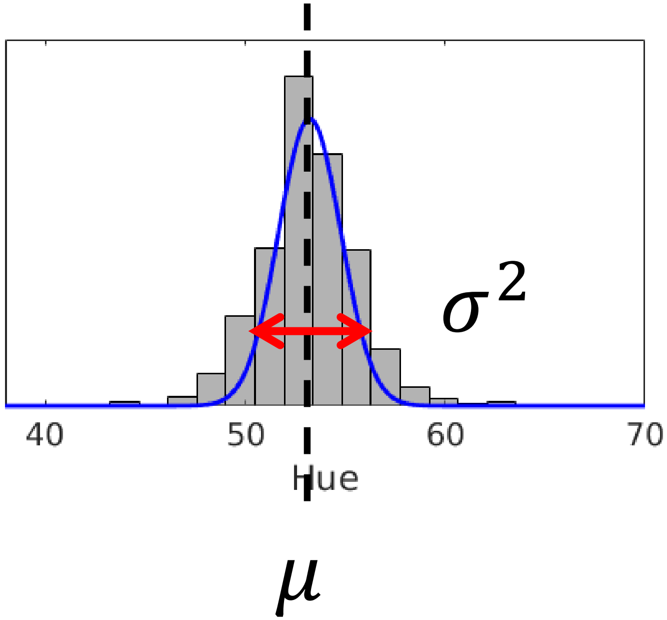


# Gaussian Distribution : Example

## Ball color distribution

Color Image





# Acknowledgement

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