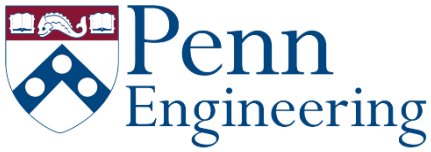
Robotics

Estimation and Learning
with Dan Lee

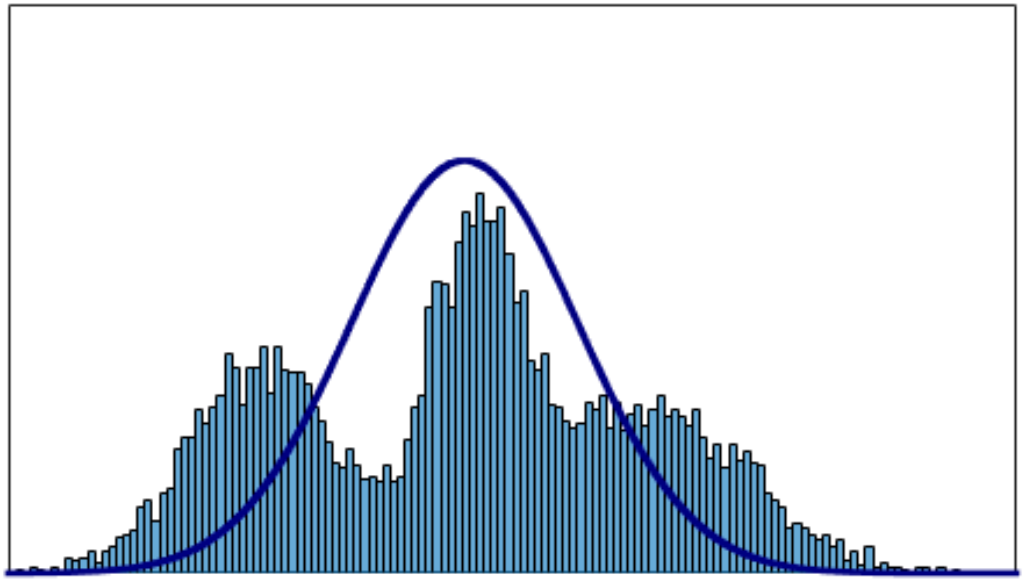
Week 1.
Gaussian Model Learning

1.4.1 Gaussian Mixture Model



Limitations of Single Gaussian

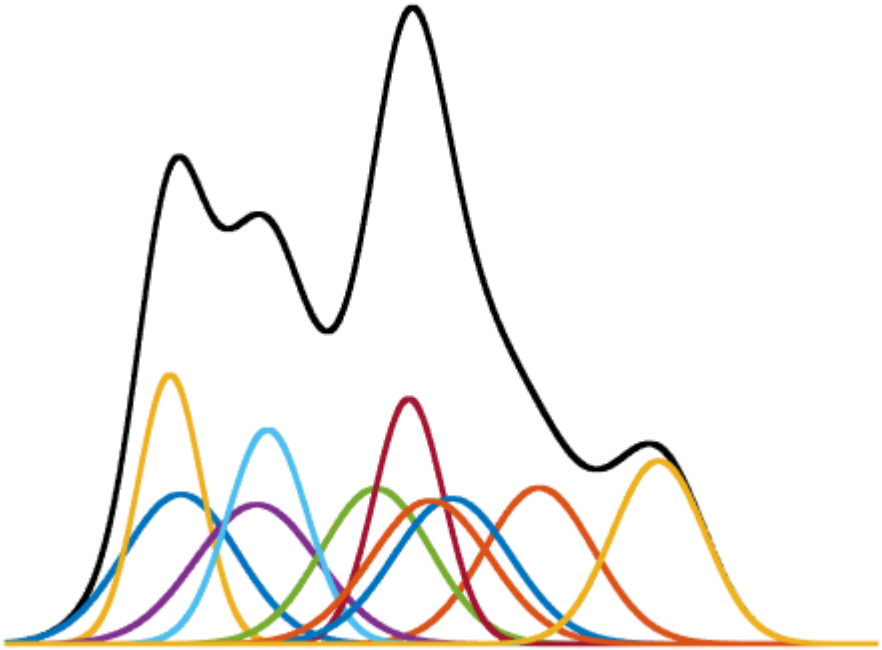
- Single Mode
- Symmetric



Gaussian Mixture Model

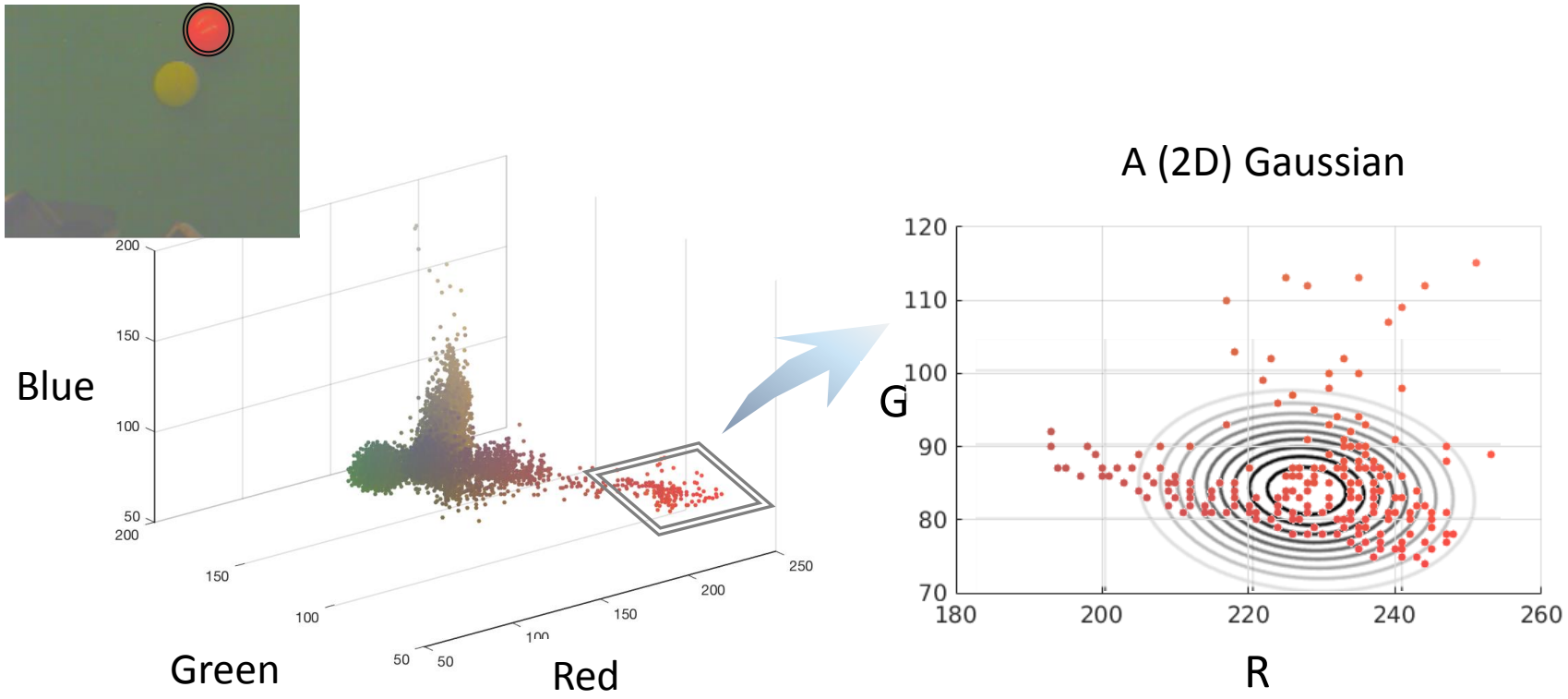
- Mixture (=**Sum**) of Gaussians

傅立叶！



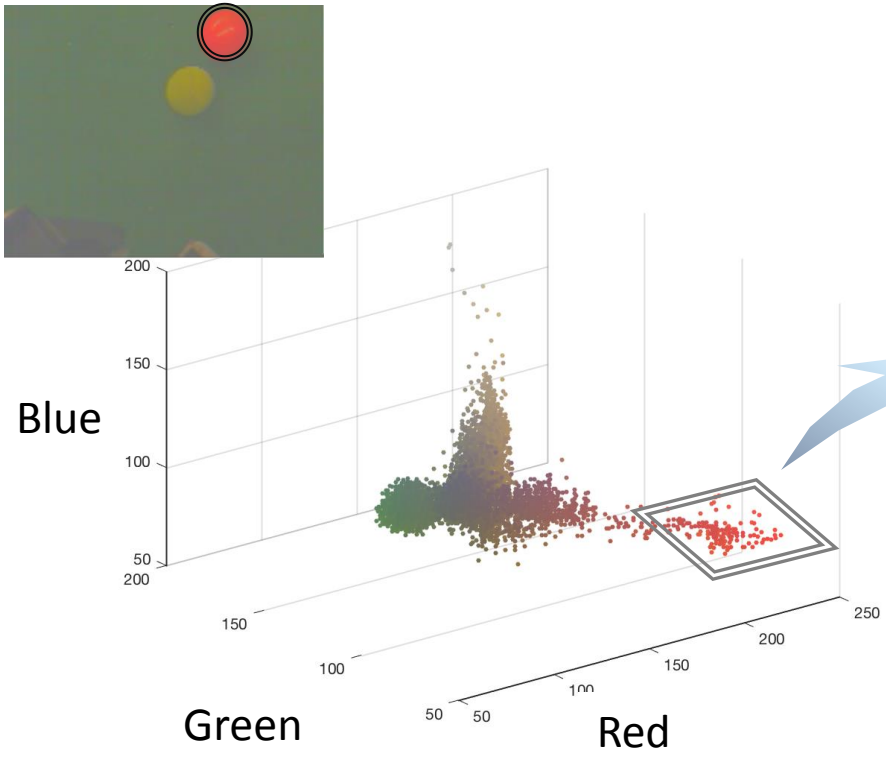
Multi-dimension Distribution: Example

- Ball color in multi-channels

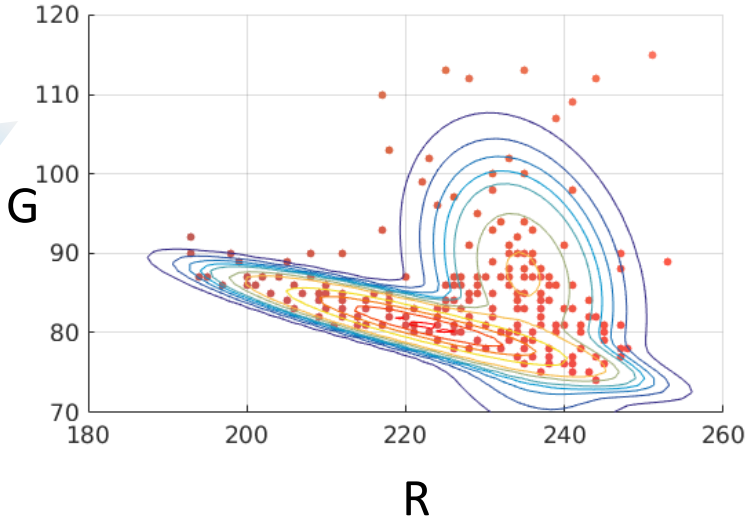


Multi-dimension Distribution: Example

- Ball color in multi-channels



A Mixture of Two Gaussians



Gaussian Mixture Model

- Mixture of Gaussians

$$p(\mathbf{x}) = \sum_{k=1}^{K} w_k g_k(\mathbf{x}|\boldsymbol{\mu}_k, \Sigma_k)$$

g_k: Gaussian with $\boldsymbol{\mu}_k$ and Σ_k

w_k: mixing coefficient (weight, a prior) $\quad w_k > 0, \sum_{k=1}^{K} w_k = 1$

Using GMM

Flexibility

Parameters ↑ 

- No analytic solution
- Overfitting

$$\boldsymbol{\mu} = \{\boldsymbol{\mu}_1, \boldsymbol{\mu}_2, \dots, \boldsymbol{\mu}_K\}$$

$$\Sigma = \{\Sigma_1, \Sigma_2, \dots, \Sigma_K\}$$

$$\boldsymbol{w} = \{w_1, w_2, \dots, w_K\}$$

K: Number of Components

Using GMM

Flexibility

Parameters ↑ 

- No analytic solution
- Overfitting

$$\boldsymbol{\mu} = \{\boldsymbol{\mu}_1, \boldsymbol{\mu}_2, \ldots, \boldsymbol{\mu}_K\}$$

$$\Sigma = \{\Sigma_1, \Sigma_2, \ldots, \Sigma_K\}$$

$$\boldsymbol{w} = w = 1/K$$

K: given number of Components