Accelerating your Python Code
With PyCuda and GMMs

Varun Nayyar

27/07/18

Outline

Me = Math Major + Script Kiddy (Manage Expectations)

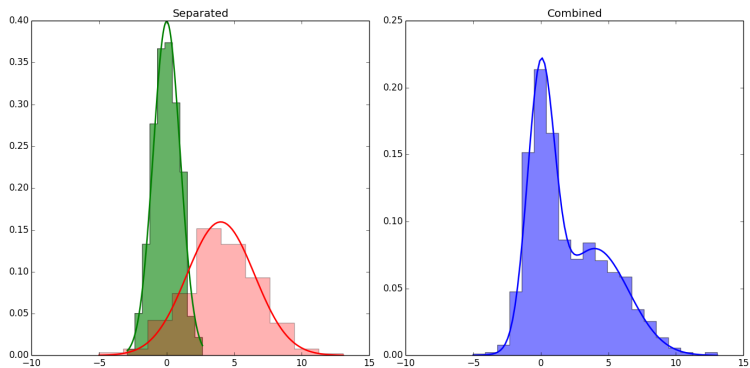## What to Expect

- Some Math
- Iterative Process I went through
- Thinking with CUDA and Basic Syntax
- How to use PyCUDA to avoid complicated work

What NOT to Expect

- How PyCUDA does it's magic
- Intermediate/Advanced CUDA

Gaussian Mixture Models d=1, K=2

Gaussian Mixture Models (GMMs)

K-means++

Gaussian Mixture Models are a class of models that assume the data points are generated by a finite number of gaussian (or normal) distributions

$$f(\mathbf{x}|\boldsymbol{\pi}, \boldsymbol{\mu}, \boldsymbol{\Sigma}) = \sum_{k=1}^{K} \pi_k \mathcal{N}(\mathbf{x}|\mu_k, \Sigma_k)$$

$$l(\mu, \Sigma, \mathbf{x}) = \sum_{i=1}^{N} \ln \left(\sum_{k=1}^{K} \pi_k \mathcal{N}(x_i|\mu_k, \Sigma_k) \right)$$

with K mixtures and the weights π_k giving the prior probability of mixture component k (and sum to 1).

- Very straightforward

Need for speed

- GMM likelihood formula doesn't decompose into a mathematically simpler form
- Number of flops are of the order of $O(NKd)$, in my case, $N = 100{,}000$, $K = 8$, $d = 13$.
- I needed to evaluate the likelihood 100,000 times for a fixed dataset while the parameters were varied.