BNPlib **for density estimation:**

A nonparametric C++ library
(part 3)

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https://github.com/poliprojects/BNPlib

Title

Applications

Cluster estimation

```
unsigned int cluster_estimate();
```

$$\hat{k} = \arg\min_k \left\| D^{(k)} - \bar{D} \right\|_F^2 = \arg\min_k \sum_{i,j} \left(D_{ij}^{(k)} - \bar{D}_{ij} \right)^2$$

Density estimation
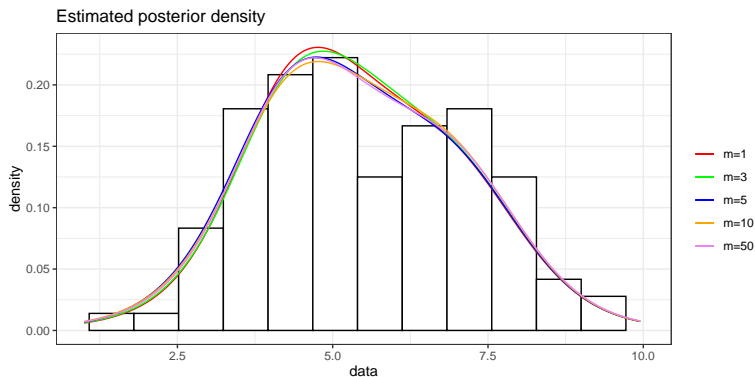
```
void eval_density(const std::vector<double> grid);
```

$$\hat{f}^{(k)}(x) \ = \ \sum_j \frac{n_j^{(k)}}{M+n} f\left(x|\phi_j^{(k)}\right) \ + \ \frac{M}{M+n} m(x)$$

$$\hat{m}(x) = \frac{1}{m} \sum_{h=0}^{m-1} f\left(x|\phi_h\right)$$

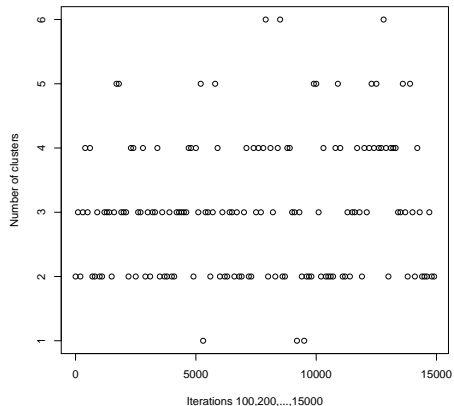$$\implies \hat{f}(x) = \frac{1}{K} \sum_k \hat{f}^{(k)}(x)$$

Results

Auxiliary parameters
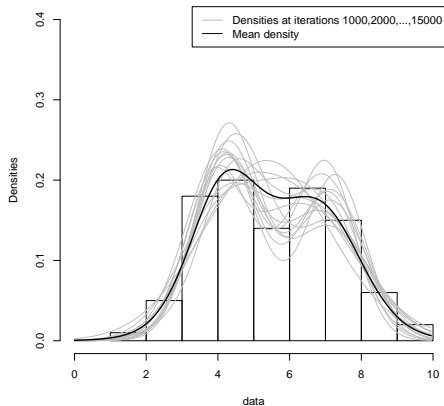

Estimated posterior density

Oscillations

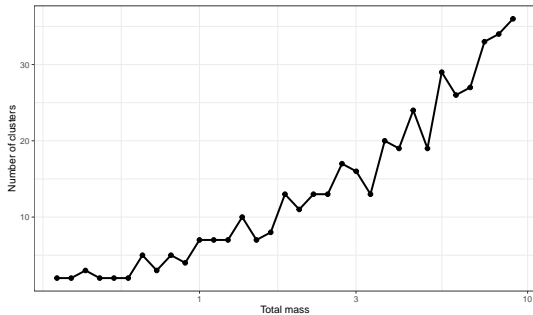**Number of clusters at single iterations**

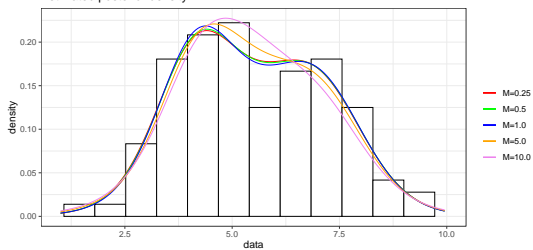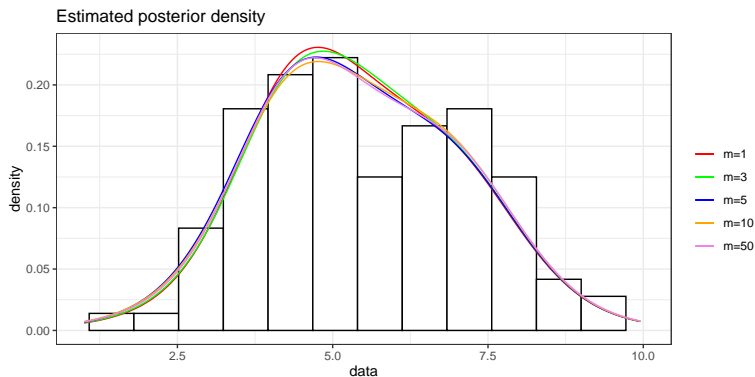**Local density estimates at single iterations**

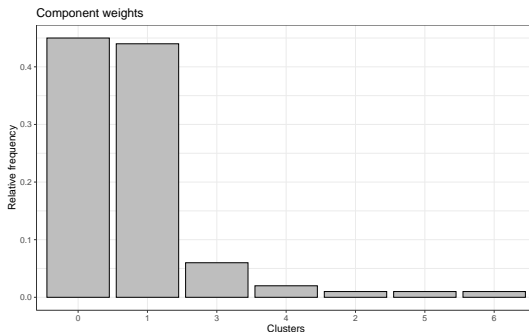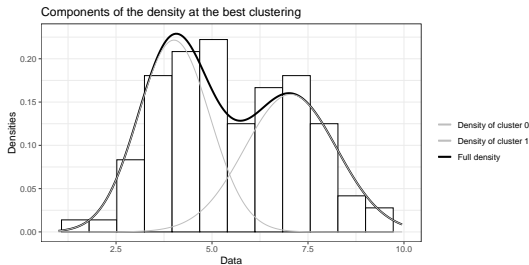# Total mass

Number of clusters as a function of the total mass
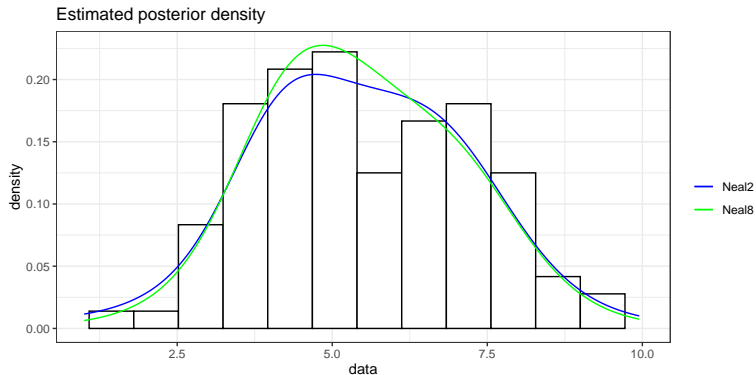

Estimated posterior density

Auxiliary parameters

Estimated posterior density

Density components

Components of the density at the best clustering

Component weights

Neal2 vs Neal8

Estimated posterior density

Bibliography

📕 Muller, Quintana, *Bayesian Nonparametric Data Analysis*

📕 Neal (2000), *Markov Chain Sampling Methods for Dirichlet Process Mixture Models*

📕 Ishwaran, James (2001), *Gibbs Sampling Methods for Stick-Breaking Priors*

📕 Murphy (2007), *Conjugate Bayesian analysis of the Gaussian distribution*

📕 Protocol Buffers: `https://developers.google.com/protocol-buffers/docs/cpptutorial`

📕 Stan: `http://mc-stan.org/math`

📕 Eigen: `https://eigen.tuxfamily.org/dox`

📕 GitHub codes of Mario Beraha and Riccardo Corradin for similar projects

📕 Course material for Bayesian Statistics: `https://beep.metid.polimi.it/web/2019-20-bayesian-statistics-alessandra-guglielmi-/`