

BNPlib for density estimation:

A nonparametric C++ library

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<https://github.com/poliprojects/BNPlib>

Algorithms

Structure: Algorithm<Hierarchy<Hypers>, Hypers, Mixture>

Algorithm <Hierarchy<Hypers>.Mixture>

```
unsigned int maxiter = 20000;  
unsigned int burnin = 5000;  
int num_clusters;  
  
MatrixXd data;  
vector<unsigned int> allocations;  
vector<Hierarchy<Hypers>> unique_values;
```

Neal2 <Hierarchy<Hypers>.Mixture>

```
void initialize() override;  
void sample_allocations() override;  
void sample_unique_values() override;
```

Neal8 <Hierarchy<Hypers>.Mixture>

```
unsigned int n_aux = 3;  
vector<Hierarchy<Hypers>> aux_unique_values;  
void sample_allocations() override;
```

Hierarchies

Template parameter for Algorithm: common interface needed

HierarchyNNIG <Hypers>

```
vector<MatrixXd> state;
shared_ptr<Hypers> hypers;
```

→ state(2, MatrixXd(1,1))

```
VectorXd eval_marg(MatrixXd datum);
VectorXd like(MatrixXd datum);
void sample_given_data(MatrixXd data);
void draw();
vector<double> normal_gamma_update(VectorXd data,
                                   double mu0, double alpha0, double beta0, double lambda0);
```

} → check in Algorithm Constructor if data is univariate

HierarchyDummy <Hypers>

```
vector<MatrixXd> state;
shared_ptr<Hypers> hypers;
```

```
VectorXd eval_marg(MatrixXd datum);
VectorXd like(MatrixXd datum);
void sample_given_data(MatrixXd data);
void draw();
std::vector<Eigen::MatrixXd> dummy_update(MatrixXd data,
                                           VectorXd mu0, MatrixXd lambda0);
```

Hyperparameters

Template parameter for Algorithm (and Hierarchy): common interface needed

HypersFixedNNIG

```
double mu0, lambda, alpha0, beta0;
```

HypersDummy

```
VectorXd mu0;  
MatrixXd lambda0;
```

Mixtures

Template parameter for Algorithm: common interface needed

DirichletMixture

```
double totalmass;
```

```
double const prob_existing_cluster( int card, unsigned int n)
```

```
double const prob_new_cluster( unsigned int n, unsigned int n_unique)
```

PitYorMixture

```
double strength;
```

```
double discount;
```

```
double const prob_existing_cluster( int card, unsigned int n)
```

```
double const prob_new_cluster( unsigned int n, unsigned int n_unique)
```

Factory

To choose the Algorithm at runtime:

```
template<class AbstractProduct, typename... Args>
class Factory{
private:
    std::map<Identifier, Builder> storage;
    //[...]
public:
    static Factory& Instance();
    std::unique_ptr<AbstractProduct> create_object(
        const Identifier &name, Args... args) const;
    void add_builder(const Identifier &name,
        const Builder &builder);
    //[...]
}
```

Protocol Buffers API

- For multivariate data storage
- Model in `output.proto`:

```
message Par_Col {
    repeated double elems = 1;
}
message Param {
    repeated Par_Col par_cols = 1;
}
message UniqueValues {
    repeated Param params = 1;
}
message IterationOutput {
    repeated int32 allocations = 1;
    repeated UniqueValues uniquevalues = 2;
}
message ChainOutput {
    repeated IterationOutput chain = 1;
}
```

Collectors

