

# GDataSet

P. Baillehache

September 12, 2020

## Contents

<b>1</b>	<b>Interface</b>	<b>2</b>
<b>2</b>	<b>Code</b>	<b>13</b>
2.1	gdataset.c . . . . .	13
2.2	gdataset-inline.c . . . . .	43
<b>3</b>	<b>Makefile</b>	<b>51</b>
<b>4</b>	<b>Dataset configuration file</b>	<b>51</b>
4.1	VecFloat . . . . .	51
4.2	Pair of GenBrush . . . . .	53
<b>5</b>	<b>Unit tests</b>	<b>53</b>
<b>6</b>	<b>Unit test output</b>	<b>64</b>

## Introduction

GDataSet is a C library to manipulate generic data sets.

It offers the following functionalities:

- loading a data set from its description file
- splitting the data set into user defined categories (e.g. training, validation, test)
- shuffling the data set

- looping through the samples of the data set.
- centering on the mean, normalizing, getting the covariance of two variables, getting the covariance matrix for dataset of type VecFloat

It provides an unique interface to several implementation supporting various types of dataset. Supported types are: VecFloat and pair of GenBrush (img/mask).

The GDataSet library uses the PBErr, GSet, PBJson, PBMath and PBFileSys libraries.

## 1 Interface

```
// ===== GDATASET_H =====

#ifndef GDATASET_H
#define GDATASET_H

// ===== Include =====

#include <stdlib.h>
#include <stdio.h>
#include <stdbool.h>
#include <execinfo.h>
#include <errno.h>
#include <string.h>
#include "pberr.h"
#include "gset.h"
#include "pbmath.h"
#include "pbjson.h"
#include "pbfilesys.h"
#include "neuronet.h"

// Define locally the needed types and functions for libraries that were
// not included to allow the user to include only what's needed for her
// application
#ifndef GENBRUSH_H
typedef struct GenBrush GenBrush;
typedef enum GBScaleMethod {GBScaleMethod_Default} GBScaleMethod;
GenBrush* GBCreateFromFile(const char* const fileName);
GenBrush* GBScale(const GenBrush* const that,
    const VecShort2D* const dim, const GBScaleMethod scaleMethod);
void GBFree(GenBrush** that);
VecShort2D* GBDim(const GenBrush* const that);
void _GDSEnBrushPairRemoveAllSample();
void _GDSEnBrushPairAddSample();
#endif

// ===== Define =====

typedef enum GDataSetType {
    GDataSetType_VecFloat, GDataSetType_GenBrushPair
} GDataSetType;
```

```

// ===== Data structures =====

typedef struct GDataSet {
    // Name of the data set
    char* _name;
    // Description of the data set
    char* _desc;
    // Type of set
    GDataSetType _type;
    // Nb of samples
    int _nbSample;
    // Set of samples
    GSet _samples;
    // Dimensions of each sample, they must have all the same dimension
    // e.g.:
    // if samples are VecFloat<3> then _dim = VecShort<1>[3]
    // if samples are GenBrush then _dim = VecShort<2>[width, height]
    VecShort* _sampleDim;
    short _nbInputs;
    short _nbOutputs;
    // Splitting of samples
    VecShort* _split;
    // Sets of splitted samples
    GSet* _categories;
    // Iterators on the sets of splitted samples
    GSetIterForward* _iterators;
} GDataSet;

typedef struct GDataSetVecFloat {
    // Generic GDataSet
    GDataSet _dataSet;
} GDataSetVecFloat;

typedef struct GDataSetGenBrushPair {
    // Generic GDataSet
    GDataSet _dataSet;
    // Format of images
    char* _format;
    // Dimensions of images
    VecShort2D _dim;
    // Nb of mask per img
    int _nbMask;
    // Path to the config file of the data set
    char* _cfgFilePath;
} GDataSetGenBrushPair;

#define GDS_NBMAXMASK 100
typedef struct GDSFilePathPair {
    char* _path[1 + GDS_NBMAXMASK];
} GDSFilePathPair;

typedef struct GDSGenBrushPair {
    GenBrush* _img;
    GenBrush* _mask[GDS_NBMAXMASK];
} GDSGenBrushPair;

typedef struct GDSVecFloatCSVImporter {
    // Size (nb of lines) of the header
    unsigned int _sizeHeader;
    // Separator
    char _sep;
}

```

```

    // Number of column in CSV
    unsigned int _nbCol;
    // Size of the resulting sample
    unsigned int _sizeSample;
    // Field converter function
    void (*_converter)(
        int col,
        char* val,
        VecFloat* sample);
} GDSVecFloatCSVImporter;

// ===== Functions declaration =====

// Create a new GDataSet of type 'type'
GDataSet GDataSetCreateStatic(GDataSetType type);

// Free the memory used by a GDataSet
void GDataSetFreeStatic(GDataSet* const that);

// Load the GDataSet 'that' from the stream 'stream'
// Return true if the GDataSet could be loaded, false else
bool GDataSetLoad(GDataSet* that, FILE* const stream);
bool _GDSLoad(GDataSet* that, FILE* const stream);

// Function which decode from JSON encoding 'json' to 'that'
bool GDataSetDecodeAsJSON(GDataSet* that, const JSONNode* const json);

// Create a new GDataSetVecFloat defined by the file at 'cfgFilePath'
GDataSetVecFloat GDataSetVecFloatCreateStaticFromFile(
    const char* const cfgFilePath);

// Reset the categories of the GDataSet 'that' to one unshuffled
// category
void GDSResetCategories(GDataSet* const that);

// Function which decode from JSON encoding 'json' to 'that'
bool GDataSetVecFloatDecodeAsJSON(GDataSetVecFloat* that,
    const JSONNode* const json);

// Function which return the JSON encoding of 'that'
JSONNode* GDataSetVecFloatEncodeAsJSON(
    const GDataSetVecFloat* const that);

// Function which return the JSON encoding of the category 'iCat'
// of 'that'
JSONNode* GDataSetVecFloatEncodeCategoryAsJSON(
    const GDataSetVecFloat* const that,
    const unsigned int iCat);

// Function which decode from JSON encoding 'json' to 'that'
bool GDataSetGenBrushPairDecodeAsJSON(GDataSetGenBrushPair* that,
    const JSONNode* const json);

// Free the memory used by a GDataSetVecFloat
void GDataSetVecFloatFreeStatic(GDataSetVecFloat* const that);

// Create a new GDataSetGenBrushPair defined by the file at 'cfgFilePath'
GDataSetGenBrushPair GDataSetGenBrushPairCreateStaticFromFile(
    const char* const cfgFilePath);

// Free the memory used by a GDataSetGenBrushPair
void GDataSetGenBrushPairFreeStatic(GDataSetGenBrushPair* const that);

```

```

// Get the total number of samples in the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
long _GDSGetSize(const GDataSet* const that);

// Get the number of input values in one sample of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
short _GDSGetNbInputs(const GDataSet* const that);

// Get the number of output values in one sample of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
short _GDSGetNbOutputs(const GDataSet* const that);

// Set the number of input values in one sample of the GDataSet 'that' to 'nb'
#if BUILDMODE != 0
static inline
#endif
void _GDSSetNbInputs(GDataSet* const that, const short nb);

// Set the number of output values in one sample of the GDataSet 'that' to 'nb'
#if BUILDMODE != 0
static inline
#endif
void _GDSSetNbOutputs(GDataSet* const that, const short nb);

// Get the number of masks in the GDataSet 'that'
int _GDSGetNbMask(const GDataSet* const that);

// Get the number of masks in the GDataSetGenBrushPair 'that'
#if BUILDMODE != 0
static inline
#endif
int GDSGetNbMaskGenBrushPair(const GDataSetGenBrushPair* const that);

// Get the total number of samples in the GDataSet 'that' for the
// category 'iCat'. Return 0 if the category doesn't exists
#if BUILDMODE != 0
static inline
#endif
long _GDSGetSizeCat(const GDataSet* const that, const long iCat);

// Split the samples of the GDataSet 'that' into several categories
// defined by 'cat'. The dimension of 'cat' gives the number of
// categories and the value for each dimension of 'cat' gives the
// number of samples in the corresponding category. For example <3,4>
// would mean 2 categories with 3 samples in the first one and 4
// samples in the second one. There must be at least as many samples
// in the data set as the sum of samples in 'cat'.
// Each category must have at least one sample.
// If 'that' was already splitted the previous splitting is discarded.
void _GDSSplit(GDataSet* const that, const VecShort* const cat);

// Unsplit the GDataSet 'that', i.e. after calling GDataSetUnsplit 'that'
// has only one category containing all the samples
#if BUILDMODE != 0
static inline

```

```

#endif
void _GDSUnsplit(GDataSet* const that);

// Shuffle the samples of the category 'iCat' of the GDataSet 'that'.
// Reset the iterator of the category
#if BUILDMODE != 0
static inline
#endif
void _GDSShuffle(GDataSet* const that, const long iCat);

// Shuffle the samples of all the categories of the GDataSet 'that'.
// Reset the iterator of the categories
#if BUILDMODE != 0
static inline
#endif
void _GDSShuffleAll(GDataSet* const that);

// Get the name of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
const char* _GDSName(const GDataSet* const that);

// Get the description of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
const char* _GDSDesc(const GDataSet* const that);

// Get the type of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
GDataSetType _GDSGetType(const GDataSet* const that);

// Get the number of categories of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
long _GDSGetNbCat(const GDataSet* const that);

// If there is a next sample move to the next sample of the category
// 'iCat' and return true, else return false
#if BUILDMODE != 0
static inline
#endif
bool _GDSStepSample(const GDataSet* const that, const long iCat);

// Reset the iterator on category 'iCat' of the GDataSet 'that', i.e.
// the next call to GDataSetGetNextSample will give the first sample of
// the category 'iCat'
#if BUILDMODE != 0
static inline
#endif
void _GDSReset(GDataSet* const that, const long iCat);

// Reset the iterator on all categories of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
void _GDSResetAll(GDataSet* const that);

```

```

// Get the current sample in the category 'iCat' of the GDataSet 'that'
void* _GDSGetSample(
    const GDataSet* const that, const int iCat);
VecFloat* GDSGetSampleVecFloat(
    const GDataSetVecFloat* const that, const int iCat);
GDSGenBrushPair* GDSGetSampleGenBrushPair(
    const GDataSetGenBrushPair* const that, const int iCat);

// Get the inputs of the current sample in the category 'iCat' of
// the GDataSet 'that'
VecFloat* GDSGetSampleInputsVecFloat(
    const GDataSetVecFloat* const that, const int iCat);

// Get the outputs of the current sample in the category 'iCat' of
// the GDataSet 'that'
VecFloat* GDSGetSampleOutputsVecFloat(
    const GDataSetVecFloat* const that, const int iCat);

// Release the memory used by the FilePathPair 'that'
void GDSFilePathPairFree(GDSFilePathPair** const that);
#ifdef GENBRUSH_H
// Release the memory used by the GenBrushPair 'that'
void GDSGenBrushPairFree(GDSGenBrushPair** const that);
#endif

// Get the dimensions of the samples of GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
const VecShort* _GDSSampleDim(const GDataSet* const that);

// Get the samples of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
const GSet* _GDSSamples(const GDataSet* const that);
#if BUILDMODE != 0
static inline
#endif
const GSetVecFloat* _GDSVecFloatSamples(
    const GDataSetVecFloat* const that);
#if BUILDMODE != 0
static inline
#endif
const GSet* _GDSGenBrushPairSamples(
    const GDataSetGenBrushPair* const that);

// Center the GDataSet 'that' on its mean
void GDSMeanCenter(GDataSetVecFloat* const that);

// Normalize the GDataSet 'that', ie normalize each of its vectors
void GDSNormalize(GDataSetVecFloat* const that);

// Get the mean of the GDataSet 'that'
VecFloat* GDSGetMean(const GDataSetVecFloat* const that);

// Get the max of the GDataSet 'that'
VecFloat* GDSGetMax(const GDataSetVecFloat* const that);

// Get a clone of the GDataSet 'that'
// All the data in the GDataSet are cloned except for the splitting
// categories which are reset to one category made of the original data

```

```

GDataSetVecFloat GDSClone(const GDataSetVecFloat* const that);

// Get the covariance matrix of the GDataSetVecFloat 'that'
MatFloat* GDSGetCovarianceMatrix(const GDataSetVecFloat* const that);

// Get the covariance of the variables at 'indices' in the
// GDataSetVecFloat 'that'
float GDSGetCovariance(const GDataSetVecFloat* const that,
    const VecShort2D* const indices);

// Create a GDataSetVecFloat by importing the CSV file 'csvPath' and
// decoding it with the 'importer'
// Return an empty GDataSetVecFloat if the importation failed
GDataSetVecFloat GDataSetCreateStaticFromCSV(
    const char* const csvPath,
    const GDSVecFloatCSVImporter* const importer);

// Create a CSV importer for a GDataSetVecFloat
GDSVecFloatCSVImporter GDSVecFloatCSVImporterCreateStatic(
    const unsigned int sizeHeader,
    const char sep,
    const unsigned int nbCol,
    const unsigned int sizeSample,
    void (*converter)(
        int col,
        char* val,
        VecFloat* sample));

// Save the GDataSetVecFloat to the stream
// If 'compact' equals true it saves in compact form, else it saves in
// readable form
// Return true upon success else false
bool GDSVecFloatSave(
    const GDataSetVecFloat* const that,
    FILE* const stream,
    const bool compact);

// Save the category 'iCat' of the GDataSetVecFloat to the stream
// If 'compact' equals true it saves in compact form, else it saves in
// readable form
// Return true upon success else false
bool GDSVecFloatSaveCategory(
    const GDataSetVecFloat* const that,
    FILE* const stream,
    const bool compact,
    const int iCat);

// Run the prediction by the NeuraNet 'nn' on each sample of the category
// 'iCat' of the GDataSet 'that'. The index of columns in the samples
// for inputs and outputs are given by 'iInputs' and 'iOutputs'.
// Stop the prediction of samples when the result can't get better
// than 'threshold'
// Return the value of the NeuraNet on the predicted samples, defined
// as sum_samples(||output_sample-output_neuranet||)/nb_sample
// Higher is better, 0.0 is best value
float GDataSetVecFloatEvaluateNN(
    const GDataSetVecFloat* const that,
    const NeuraNet* const nn,
    const int iCat,
    const VecShort* const iInputs,
    const VecShort* const iOutputs,
    const float threshold);

```



```

// Create a new GDataSetVecFloat
GDataSetVecFloat GDataSetVecFloatCreateStatic(void);

// Remove all the samples of the GDataSetVecFloat 'that'
#ifdef BUILDMODE != 0
static inline
#endif
void _GDSVecFloatRemoveAllSample(GDataSetVecFloat* const that);

// Remove all the samples of the GDataSetGenBrushPair 'that'
#ifdef GENBRUSH_H
#ifdef BUILDMODE != 0
static inline
#endif
#endif
void _GDSEnBrushPairRemoveAllSample(GDataSetGenBrushPair* const that);
#endif

// Append 'sample' in the GDataSetVecFloat 'that'
#ifdef BUILDMODE != 0
static inline
#endif
void _GDSVecFloatAddSample(
    GDataSetVecFloat* const that,
    VecFloat* sample);

// Append 'sample' in the GDataSetGenBrush 'that'
#ifdef GENBRUSH_H
#ifdef BUILDMODE != 0
static inline
#endif
#endif
void _GDSEnBrushPairAddSample(
    GDataSetGenBrushPair* const that,
    GDSEnBrushPair* sample);
#endif

// Get the proximity matrix of the samples of category 'iCat' in the
// GDataSetVecFloat 'that'
// M[i,j] = euclidean distance between the i-th sample and the j-th sample
MatFloat* GDSVecFloatGetProxMat(
    const GDataSetVecFloat* that,
    unsigned int iCat);

// Get the nearest (in term of euclidean distance) sample of category
// 'iCat' to 'target' in the GDataSetVecFloat 'that' using the AESA
// nearest neighbour search
// TODO: should use a lookup table to get VecDist(sample, prevCandidate)
// but it's complicated by the fact I'm loosing the index of samples when
// using GSet
// Also, even if using a lookup table, and even if AESA actually reduces
// efficiently the number of VecDist(candidate, target), the cost of
// VecDist() much be hugely bigger than the one of using a lookup table
// to make AESA relevant. It's probably meaningless on a VecFloat,
// maybe more meaningful on a GenBrush ?
// http://citeseerx.ist.psu.edu/viewdoc/download?
// doi=10.1.1.481.2200&rep=rep1&type=pdf
VecFloat* GDSVecFloatNearestNeighbourAESA(
    const GDataSetVecFloat* that,
    const VecFloat* target,
    int iCat);

// Get the nearest (in term of euclidean distance) sample of category

```

```

// 'iCat' to 'target' in the GDataSetVecFloat 'that' using brute force
VecFloat* GDSVecFloatNearestNeighbourBrute(
    const GDataSetVecFloat* that,
        const VecFloat* target,
            int iCat);

// ===== Polymorphism =====

#define GDSRemoveAllSample(DataSet) _Generic(DataSet, \
    GDataSetVecFloat*: _GDSVecFloatRemoveAllSample, \
    GDataSetGenBrushPair*: _GDSGenBrushPairRemoveAllSample, \
    default: PBErrInvalidPolymorphism)(DataSet)

#define GDSAddSample(DataSet, Sample) _Generic(DataSet, \
    GDataSetVecFloat*: _GDSVecFloatAddSample, \
    GDataSetGenBrushPair*: _GDSGenBrushPairAddSample, \
    default: PBErrInvalidPolymorphism)(DataSet, Sample)

#define GDSDesc(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSDesc, \
    const GDataSet*: _GDSDesc, \
    GDataSetVecFloat*: _GDSDesc, \
    const GDataSetVecFloat*: _GDSDesc, \
    GDataSetGenBrushPair*: _GDSDesc, \
    const GDataSetGenBrushPair*: _GDSDesc, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet)

#define GDSGetNbCat(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSGetNbCat, \
    const GDataSet*: _GDSGetNbCat, \
    GDataSetVecFloat*: _GDSGetNbCat, \
    const GDataSetVecFloat*: _GDSGetNbCat, \
    GDataSetGenBrushPair*: _GDSGetNbCat, \
    const GDataSetGenBrushPair*: _GDSGetNbCat, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet)

#define GDSGetSample(DataSet, ICat) _Generic(DataSet, \
    GDataSet*: _GDSGetSample, \
    const GDataSet*: _GDSGetSample, \
    GDataSetVecFloat*: GDSGetSampleVecFloat, \
    const GDataSetVecFloat*: GDSGetSampleVecFloat, \
    GDataSetGenBrushPair*: GDSGetSampleGenBrushPair, \
    const GDataSetGenBrushPair*: GDSGetSampleGenBrushPair, \
    default: PBErrInvalidPolymorphism)(DataSet, ICat)

#define GDSGetSampleInputs(DataSet, ICat) _Generic(DataSet, \
    GDataSetVecFloat*: GDSGetSampleInputsVecFloat, \
    const GDataSetVecFloat*: GDSGetSampleInputsVecFloat, \
    default: PBErrInvalidPolymorphism)(DataSet, ICat)

#define GDSGetSampleOutputs(DataSet, ICat) _Generic(DataSet, \
    GDataSetVecFloat*: GDSGetSampleOutputsVecFloat, \
    const GDataSetVecFloat*: GDSGetSampleOutputsVecFloat, \
    default: PBErrInvalidPolymorphism)(DataSet, ICat)

#define GDSGetSize(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSGetSize, \
    const GDataSet*: _GDSGetSize, \
    GDataSetVecFloat*: _GDSGetSize, \
    const GDataSetVecFloat*: _GDSGetSize, \
    GDataSetGenBrushPair*: _GDSGetSize, \
    const GDataSetGenBrushPair*: _GDSGetSize, \

```

```

    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet)

#define GDSGetSizeCat(DataSet, ICat) _Generic(DataSet, \
    GDataSet*: _GDSGetSizeCat, \
    const GDataSet*: _GDSGetSizeCat, \
    GDataSetVecFloat*: _GDSGetSizeCat, \
    const GDataSetVecFloat*: _GDSGetSizeCat, \
    GDataSetGenBrushPair*: _GDSGetSizeCat, \
    const GDataSetGenBrushPair*: _GDSGetSizeCat, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet, ICat)

#define GDSGetType(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSGetType, \
    const GDataSet*: _GDSGetType, \
    GDataSetVecFloat*: _GDSGetType, \
    const GDataSetVecFloat*: _GDSGetType, \
    GDataSetGenBrushPair*: _GDSGetType, \
    const GDataSetGenBrushPair*: _GDSGetType, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet)

#define GDSName(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSName, \
    const GDataSet*: _GDSName, \
    GDataSetVecFloat*: _GDSName, \
    const GDataSetVecFloat*: _GDSName, \
    GDataSetGenBrushPair*: _GDSName, \
    const GDataSetGenBrushPair*: _GDSName, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet)

#define GDSGetNbMask(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSGetNbMask, \
    const GDataSet*: _GDSGetNbMask, \
    GDataSetGenBrushPair*: GDSGetNbMaskGenBrushPair, \
    const GDataSetGenBrushPair*: GDSGetNbMaskGenBrushPair, \
    default: PBErrInvalidPolymorphism)(DataSet)

#define GDSReset(DataSet, ICat) _Generic(DataSet, \
    GDataSet*: _GDSReset, \
    const GDataSet*: _GDSReset, \
    GDataSetVecFloat*: _GDSReset, \
    const GDataSetVecFloat*: _GDSReset, \
    GDataSetGenBrushPair*: _GDSReset, \
    const GDataSetGenBrushPair*: _GDSReset, \
    default: PBErrInvalidPolymorphism)((GDataSet*)DataSet, ICat)

#define GDSResetAll(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSResetAll, \
    const GDataSet*: _GDSResetAll, \
    GDataSetVecFloat*: _GDSResetAll, \
    const GDataSetVecFloat*: _GDSResetAll, \
    GDataSetGenBrushPair*: _GDSResetAll, \
    const GDataSetGenBrushPair*: _GDSResetAll, \
    default: PBErrInvalidPolymorphism)((GDataSet*)DataSet)

#define GDSSampleDim(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSSampleDim, \
    const GDataSet*: _GDSSampleDim, \
    GDataSetVecFloat*: _GDSSampleDim, \
    const GDataSetVecFloat*: _GDSSampleDim, \
    GDataSetGenBrushPair*: _GDSSampleDim, \
    const GDataSetGenBrushPair*: _GDSSampleDim, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet)

```

```

#define GDSShuffle(DataSet, ICat) _Generic(DataSet, \
    GDataSet*: _GDSShuffle, \
    GDataSetVecFloat*: _GDSShuffle, \
    GDataSetGenBrushPair*: _GDSShuffle, \
    default: PBErrInvalidPolymorphism)((GDataSet*)DataSet, ICat)

#define GDSShuffleAll(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSShuffleAll, \
    GDataSetVecFloat*: _GDSShuffleAll, \
    GDataSetGenBrushPair*: _GDSShuffleAll, \
    default: PBErrInvalidPolymorphism)((GDataSet*)DataSet)

#define GDSSplit(DataSet, Cat) _Generic(DataSet, \
    GDataSet*: _GDSSplit, \
    GDataSetVecFloat*: _GDSSplit, \
    GDataSetGenBrushPair*: _GDSSplit, \
    default: PBErrInvalidPolymorphism)((GDataSet*)DataSet, Cat)

#define GDSStepSample(DataSet, ICat) _Generic(DataSet, \
    GDataSet*: _GDSStepSample, \
    const GDataSet*: _GDSStepSample, \
    GDataSetVecFloat*: _GDSStepSample, \
    const GDataSetVecFloat*: _GDSStepSample, \
    GDataSetGenBrushPair*: _GDSStepSample, \
    const GDataSetGenBrushPair*: _GDSStepSample, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet, ICat)

#define GDSUnsplit(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSUnsplit, \
    GDataSetVecFloat*: _GDSUnsplit, \
    GDataSetGenBrushPair*: _GDSUnsplit, \
    default: PBErrInvalidPolymorphism)((GDataSet*)DataSet)

#define GDSSamples(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSSamples, \
    const GDataSet*: _GDSSamples, \
    GDataSetVecFloat*: _GDSVecFloatSamples, \
    const GDataSetVecFloat*: _GDSVecFloatSamples, \
    GDataSetGenBrushPair*: _GDSGenBrushPairSamples, \
    const GDataSetGenBrushPair*: _GDSGenBrushPairSamples, \
    default: PBErrInvalidPolymorphism)(DataSet)

#define GDSSave(DataSet, Stream, Compact) _Generic(DataSet, \
    GDataSetVecFloat*: GDSVecFloatSave, \
    const GDataSetVecFloat*: GDSVecFloatSave, \
    default: PBErrInvalidPolymorphism)(DataSet, Stream, Compact)

#define GDSEvaluateNN(GDS, NN, Cat, Inputs, Outputs, Threshold) \
    _Generic(GDS, \
    GDataSetVecFloat*: GDataSetVecFloatEvaluateNN, \
    const GDataSetVecFloat*: GDataSetVecFloatEvaluateNN, \
    default: PBErrInvalidPolymorphism)( \
        GDS, NN, Cat, Inputs, Outputs, Threshold)

#define GDSLoad(DataSet, FP) _Generic(DataSet, \
    GDataSet*: GDataSetLoad, \
    GDataSetVecFloat*: _GDSLoad, \
    GDataSetGenBrushPair*: _GDSLoad, \
    default: PBErrInvalidPolymorphism)((GDataSet*)DataSet, FP)

#define GDSGetProxMat(DataSet, Cat) _Generic(DataSet, \

```

```

GDataSetVecFloat*: GDSVecFloatGetProxMat, \
const GDataSetVecFloat*: GDSVecFloatGetProxMat, \
default: PBErrInvalidPolymorphism)(DataSet, Cat)

#define GDSNearestNeighbour(DataSet, Target, ICat) \
_Generic(DataSet, \
    GDataSetVecFloat*: GDSVecFloatNearestNeighbourBrute, \
    const GDataSetVecFloat*: GDSVecFloatNearestNeighbourBrute, \
    default: PBErrInvalidPolymorphism)(DataSet, Target, ICat)

#define GDSGetNbInputs(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSGetNbInputs, \
    const GDataSet*: _GDSGetNbInputs, \
    GDataSetVecFloat*: _GDSGetNbInputs, \
    const GDataSetVecFloat*: _GDSGetNbInputs, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet)

#define GDSGetNbOutputs(DataSet) _Generic(DataSet, \
    GDataSet*: _GDSGetNbOutputs, \
    const GDataSet*: _GDSGetNbOutputs, \
    GDataSetVecFloat*: _GDSGetNbOutputs, \
    const GDataSetVecFloat*: _GDSGetNbOutputs, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet)

#define GDSSetNbInputs(DataSet, Nb) _Generic(DataSet, \
    GDataSet*: _GDSSetNbInputs, \
    const GDataSet*: _GDSSetNbInputs, \
    GDataSetVecFloat*: _GDSSetNbInputs, \
    const GDataSetVecFloat*: _GDSSetNbInputs, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet, Nb)

#define GDSSetNbOutputs(DataSet, Nb) _Generic(DataSet, \
    GDataSet*: _GDSSetNbOutputs, \
    const GDataSet*: _GDSSetNbOutputs, \
    GDataSetVecFloat*: _GDSSetNbOutputs, \
    const GDataSetVecFloat*: _GDSSetNbOutputs, \
    default: PBErrInvalidPolymorphism)((const GDataSet*)DataSet, Nb)

// ===== static inliner =====

#if BUILDMODE != 0
#include "gdataset-inline.c"
#endif

#endif

```

## 2 Code

### 2.1 gdataset.c

```

// ===== GDATASET_C =====

// ===== Include =====

#include "gdataset.h"
#if BUILDMODE == 0
#include "gdataset-inline.c"
#endif

```

```

// ===== Functions implementation =====

// Create a new GDataSet of type 'type'
GDataSet GDataSetCreateStatic(GDataSetType type) {
    // Declare the new GDataSet
    GDataSet that;
    // Set the properties
    that._name = NULL;
    that._desc = NULL;
    that._type = type;
    that._nbSample = 0;
    that._nbInputs = 0;
    that._nbOutputs = 0;
    that._samples = GSetCreateStatic();
    that._sampleDim = NULL;
    that._split = NULL;
    that._categories = NULL;
    that._iterators = NULL;
    // Return the new GDataSet
    return that;
}

// Load the GDataSet 'that' from the stream 'stream'
// Return true if the GDataSet could be loaded, false else
bool GDataSetLoad(GDataSet* that, FILE* const stream) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (stream == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'stream' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    // Load the whole encoded data
    JSONNode* json = JSONCreate();
    if (!JSONLoad(json, stream)) {
        return false;
    }
    // Decode the JSON
    if (!GDataSetDecodeAsJSON(that, json)) {
        return false;
    }
    // Free memory
    JSONFree(&json);
    // Return the success code
    return true;
}

bool _GDSLoad(GDataSet* that, FILE* const stream) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (stream == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'stream' is null");
        }
    #endif
}

```

```

        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    // Load the whole encoded data
    JSONNode* json = JSONCreate();
    if (!JSONLoad(json, stream)) {
        return false;
    }
    // Decode the JSON
    GDataSet dataset = GDataSetCreateStatic(0);
    if (!GDataSetDecodeAsJSON(&dataset, json)) {
        return false;
    }
    if (GDSGetType(&dataset) != GDSGetType(that)) {
        return false;
    } else {
        *that = dataset;
    }
    // Decode the samples according to the type of dataset
    switch(GDSGetType(that)) {
        case GDataSetType_VecFloat:
            if (!GDataSetVecFloatDecodeAsJSON((GDataSetVecFloat*)that, json)) {
                return false;
            }
            break;
        case GDataSetType_GenBrushPair:
            if (!GDataSetGenBrushPairDecodeAsJSON(
                (GDataSetGenBrushPair*)that, json)) {
                return false;
            }
            break;
        default:
            return false;
    }
    // Free memory
    JSONFree(&json);
    // Return the success code
    return true;
}

// Function which decode from JSON encoding 'json' to 'that'
bool GDataSetDecodeAsJSON(GDataSet* that, const JSONNode* const json) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        PBMathErr->_type = PBErrTypeNullPointer;
        sprintf(PBMathErr->_msg, "'that' is null");
        PBErrCatch(PBMathErr);
    }
    if (json == NULL) {
        PBMathErr->_type = PBErrTypeNullPointer;
        sprintf(PBMathErr->_msg, "'json' is null");
        PBErrCatch(PBMathErr);
    }
#endif
    // Free memory
    GDataSetFreeStatic(that);
    // Decode dataSetType
    JSONNode* prop = JSONProperty(json, "dataSetType");
    if (prop == NULL) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg,
            "Invalid description file (dataSetType missing)");
    }
}

```

```

    return false;
}
JSONNode* val = JSONValue(prop, 0);
// Create the new data set
*that = GDataSetCreateStatic(atoi(JSONLabel(val)));
// Decode dataSet
prop = JSONProperty(json, "dataSet");
if (prop == NULL) {
    GDataSetErr->_type = PBErrTypeInvalidData;
    sprintf(GDataSetErr->_msg,
        "Invalid description file (dataSet missing)");
    return false;
}
val = JSONValue(prop, 0);
that->_name = PBErrMalloc(GDataSetErr,
    sizeof(char) * (strlen(JSONLabel(val)) + 1));
strcpy(that->_name, JSONLabel(val));
// Decode desc
prop = JSONProperty(json, "desc");
if (prop == NULL) {
    GDataSetErr->_type = PBErrTypeInvalidData;
    sprintf(GDataSetErr->_msg,
        "Invalid description file (desc missing)");
    return false;
}
val = JSONValue(prop, 0);
that->_desc = PBErrMalloc(GDataSetErr,
    sizeof(char) * (strlen(JSONLabel(val)) + 1));
strcpy(that->_desc, JSONLabel(val));
// Decode dim
prop = JSONProperty(json, "dim");
if (prop == NULL) {
    GDataSetErr->_type = PBErrTypeInvalidData;
    sprintf(GDataSetErr->_msg,
        "Invalid description file (dim missing)");
    return false;
}
that->_sampleDim = NULL;
VecDecodeAsJSON(&(that->_sampleDim), prop);
// Decode nbSample
prop = JSONProperty(json, "nbSample");
if (prop == NULL) {
    GDataSetErr->_type = PBErrTypeInvalidData;
    sprintf(GDataSetErr->_msg,
        "Invalid description file (nbSample missing)");
    return false;
}
val = JSONValue(prop, 0);
that->_nbSample = atoi(JSONLabel(val));
// Decode nbInputs
prop = JSONProperty(json, "nbInputs");
if (prop == NULL) {
    GDataSetErr->_type = PBErrTypeInvalidData;
    sprintf(GDataSetErr->_msg,
        "Invalid description file (nbInputs missing)");
    return false;
}
val = JSONValue(prop, 0);
that->_nbInputs = atoi(JSONLabel(val));
// Decode nbOutputs
prop = JSONProperty(json, "nbOutputs");
if (prop == NULL) {

```



```

        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg,
            "Invalid description file (nbOutputs missing)");
        return false;
    }
    val = JSONValue(prop, 0);
    that->_nbOutputs = atoi(JSONLabel(val));
    // Return the success code
    return true;
}

// Free the memory used by a GDataSet
void GDataSetFreeStatic(GDataSet* const that) {
    if (that == NULL)
        return;
    // Free memory
    if (that->_name)
        free(that->_name);
    if (that->_desc)
        free(that->_desc);
    for (int iCat = GDSGetNbCat(that); iCat--;) {
        GSetFlush(that->_categories + iCat);
    }
    if (that->_categories)
        free(that->_categories);
    if (that->_iterators)
        free(that->_iterators);
    if (that->_split)
        VecFree(&(that->_split));
    if (that->_sampleDim)
        VecFree(&(that->_sampleDim));
}

// Create a new GDataSetVecFloat defined by the file at 'cfgFilePath'
GDataSetVecFloat GDataSetVecFloatCreateStaticFromFile(
    const char* const cfgFilePath) {
    #if BUILDMODE == 0
        if (cfgFilePath == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'cfgFilePath' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    // Declare the new GDataSetVecFloat
    GDataSetVecFloat that;
    *(GDataSet*)&that = GDataSetCreateStatic(GDataSetType_VecFloat);
    // Open the file
    FILE* stream = fopen(cfgFilePath, "r");
    // If the description file doesn't exist
    if (stream == NULL) {
        GDataSetErr->_type = PBErrTypeInvalidArg;
        sprintf(GDataSetErr->_msg, "Can't open the configuration file %s",
            cfgFilePath);
        PBErrCatch(GDataSetErr);
    }
    // Load the whole encoded data
    JSONNode* json = JSONCreate();
    if (!JSONLoad(json, stream)) {
        printf("%s\n", GDataSetErr->_msg);
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Can't load the configuration file");
        PBErrCatch(GDataSetErr);
    }
}

```

```

    }
    // Decode the JSON data for the generic GDataSet
    if (!GDataSetDecodeAsJSON((GDataSet*)&that, json)) {
        printf("%s\n", GDataSetErr->_msg);
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Can't decode the configuration file");
        PBErrCatch(GDataSetErr);
    }
    // Check the type
    if (GDSGetType(&that) != GDataSetType_VecFloat) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Invalid type");
        PBErrCatch(GDataSetErr);
    }
    // Check the samples' dimension
    if (VecGetDim(GDSSampleDim(&that)) != 1) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Invalid sample dimension");
        PBErrCatch(GDataSetErr);
    }
    // Decode the properties of the GDataSetVecFloat
    if (!GDataSetVecFloatDecodeAsJSON(&that, json)) {
        printf("%s\n", GDataSetErr->_msg);
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Can't decode the configuration file");
        PBErrCatch(GDataSetErr);
    }
    // Free memory
    JSONFree(&json);
    fclose(stream);
    // Return the new GDataSetVecFloat
    return that;
}

// Function which decode from JSON encoding 'json' to 'that'
bool GDataSetVecFloatDecodeAsJSON(GDataSetVecFloat* that,
    const JSONNode* const json) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        PBMathErr->_type = PBErrTypeNullPointer;
        sprintf(PBMathErr->_msg, "'that' is null");
        PBErrCatch(PBMathErr);
    }
    if (json == NULL) {
        PBMathErr->_type = PBErrTypeNullPointer;
        sprintf(PBMathErr->_msg, "'json' is null");
        PBErrCatch(PBMathErr);
    }
#endif
    // Load the samples
    JSONNode* prop = JSONProperty(json, "samples");
    if (prop == NULL) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg,
            "Invalid description file (samples missing)");
        return false;
    }
    if (JSONGetNbValue(prop) != that->_dataSet._nbSample) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg,
            "Invalid description file (samples's number != nbSample)");
        return false;
    }

```

```

    }
    that->_dataSet._samples = GSetCreateStatic();
    for (int iSample = 0; iSample < GDSGetSize(that); ++iSample) {
        JSONNode* val = JSONValue(prop, iSample);
        VecFloat* v = NULL;
        VecDecodeAsJSON(&v, val);
        GSetAppend((GSet*)GDSSamples(that), v);
    }
    // Create the initial category
    GDSResetCategories((GDataSet*)that);
    // Return the success code
    return true;
}

// Reset the categories of the GDataSet 'that' to one unshuffled
// category
void GDSResetCategories(GDataSet* const that) {
    #if BUILDMODE == 0
        if (that == NULL) {
            PBMathErr->_type = PBErrTypeNullPointer;
            sprintf(PBMathErr->_msg, "'that' is null");
            PBErrCatch(PBMathErr);
        }
    #endif
    if (that->_split)
        VecFree(&(that->_split));
    that->_split = VecShortCreate(1);
    VecSet(that->_split, 0, GDSGetSize(that));
    if (that->_categories) {
        for (int iCat = GDSGetNbCat(that); iCat--;) {
            GSetFlush(that->_categories + iCat);
        }
        free(that->_categories);
    }
    if (that->_iterators)
        free(that->_iterators);
    that->_categories = GSetCreate();
    GSetIterForward iter = GSetIterForwardCreateStatic(GDSSamples(that));
    if (GDSGetSize(that) > 0) {
        do {
            void* sample = GSetIterGet(&iter);
            GSetAppend(that->_categories, sample);
        } while (GSetIterStep(&iter));
    }
    that->_iterators = PBErrMalloc(GDataSetErr, sizeof(GSetIterForward));
    that->_iterators[0] = GSetIterForwardCreateStatic(that->_categories);
}

// Free the memory used by a GDataSetVecFloat
void GDataSetVecFloatFreeStatic(GDataSetVecFloat* const that) {
    if (that == NULL)
        return;
    // Free memory
    while (GSetNbElem(&(((GDataSet*)that)->_samples)) > 0) {
        VecFloat* sample = GSetPop(&(((GDataSet*)that)->_samples));
        VecFree(&sample);
    }
    GDataSetFreeStatic((GDataSet*)that);
}

// Create a new GDataSetGenBrushPair defined by the file at 'cfgFilePath'
// The random generator must have been initialized before calling

```

```

// this function
GDataSetGenBrushPair GDataSetGenBrushPairCreateStaticFromFile(
    const char* const cfgFilePath) {
    #if BUILDMODE == 0
        if (cfgFilePath == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'cfgFilePath' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    // Declare the new GDataSetVecFloat
    GDataSetGenBrushPair that;
    *(GDataSet*)&that = GDataSetCreateStatic(GDataSetType_GenBrushPair);
    // Copy the file path
    that._cfgFilePath = PBErrMalloc(GDataSetErr, strlen(cfgFilePath) + 1);
    strcpy(that._cfgFilePath, cfgFilePath);
    // Open the file
    FILE* stream = fopen(cfgFilePath, "r");
    // If the description file doesn't exist
    if (stream == NULL) {
        GDataSetErr->_type = PBErrTypeInvalidArg;
        sprintf(GDataSetErr->_msg, "Can't open the configuration file %s",
            cfgFilePath);
        PBErrCatch(GDataSetErr);
    }
    // Load the whole encoded data
    JSONNode* json = JSONCreate();
    if (!JSONLoad(json, stream)) {
        printf("%s\n", GDataSetErr->_msg);
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Can't load the configuration file");
        PBErrCatch(GDataSetErr);
    }
    // Decode the JSON data for the generic GDataSet
    if (!GDataSetDecodeAsJSON((GDataSet*)&that, json)) {
        printf("%s\n", GDataSetErr->_msg);
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Can't decode the configuration file");
        PBErrCatch(GDataSetErr);
    }
    // Check the type
    if (GDSGetType(&that) != GDataSetType_GenBrushPair) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Invalid type");
        PBErrCatch(GDataSetErr);
    }
    // Check the samples' dimension
    if (VecGetDim(GDSSampleDim(&that)) != 2) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Invalid sample dimension (%ld=2)",
            VecGetDim(GDSSampleDim(&that)));
        PBErrCatch(GDataSetErr);
    }
    // Decode the properties of the GDataSetGenBrushPair
    if (!GDataSetGenBrushPairDecodeAsJSON(&that, json)) {
        printf("%s\n", GDataSetErr->_msg);
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg, "Can't decode the configuration file");
        PBErrCatch(GDataSetErr);
    }
    // Free memory
    JSONFree(&json);
}

```

```

    fclose(stream);
    // Return the new GDataSetGenBrushPair
    return that;
}

// Function which decode from JSON encoding 'json' to 'that'
bool GDataSetGenBrushPairDecodeAsJSON(GDataSetGenBrushPair* that,
    const JSONNode* const json) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        PBMathErr->_type = PBErrTypeNullPointer;
        sprintf(PBMathErr->_msg, "'that' is null");
        PBErrCatch(PBMathErr);
    }
    if (json == NULL) {
        PBMathErr->_type = PBErrTypeNullPointer;
        sprintf(PBMathErr->_msg, "'json' is null");
        PBErrCatch(PBMathErr);
    }
#endif
    // Get the nb of mask
    JSONNode* prop = JSONProperty(json, "nbMask");
    if (prop == NULL) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg,
            "Invalid description file (nbMask missing)");
        PBErrCatch(GDataSetErr);
    }
    that->_nbMask = atoi(JSONLblVal(prop));
    if (that->_nbMask >= GDS_NBMAXMASK) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg,
            "Invalid description file (invalid nbMask %d>=%d)",
            that->_nbMask, GDS_NBMAXMASK);
        PBErrCatch(GDataSetErr);
    }
    // Load the samples
    prop = JSONProperty(json, "samples");
    if (prop == NULL) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg,
            "Invalid description file (samples missing)");
        PBErrCatch(GDataSetErr);
    }
    if (JSONGetNbValue(prop) != GDSGetSize(that)) {
        GDataSetErr->_type = PBErrTypeInvalidData;
        sprintf(GDataSetErr->_msg,
            "Invalid description file (samples's number != nbSample)");
        PBErrCatch(GDataSetErr);
    }
    that->_dataSet._samples = GSetCreateStatic();
    for (int iSample = 0; iSample < GDSGetSize(that); ++iSample) {
        JSONNode* val = JSONValue(prop, iSample);
        // Allocate memory for the pair image/mask
        GDSFilePathPair* pair = PBErrMalloc(GDataSetErr,
            sizeof(GDSFilePathPair));
        pair->_path[0] = NULL;
        for (int iMask = GDS_NBMAXMASK; iMask--;)
            pair->_path[1 + iMask] = NULL;
        // Decode img
        JSONNode* subProp = JSONProperty(val, "img");
        if (subProp == NULL) {

```

```

    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg,
        "Invalid description file (samples.img missing)");
    PBErrCatch(GDataSetErr);
}
JSONNode* subVal = JSONValue(subProp, 0);
pair->_path[0] = PBErrMalloc(GDataSetErr,
    sizeof(char) * (strlen(JSONLabel(subVal)) + 1));
strcpy(pair->_path[0], JSONLabel(subVal));
// Decode mask
subProp = JSONProperty(val, "mask");
if (subProp == NULL) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg,
        "Invalid description file (samples.mask missing)");
    PBErrCatch(GDataSetErr);
}
for (int iMask = 0; iMask < that->_nbMask; ++iMask) {
    subVal = JSONValue(subProp, iMask);
    pair->_path[1 + iMask] = PBErrMalloc(GDataSetErr,
        sizeof(char) * (strlen(JSONLabel(subVal)) + 1));
    strcpy(pair->_path[1 + iMask], JSONLabel(subVal));
}
// Add the pair to the samples
GSetAppend((GSet*)GDSSamples(that), pair);
}
// Create the initial category
GDSResetCategories((GDataSet*)that);
// Return the new GDataSetVecFloat
return that;
}

// Free the memory used by a GDataSetGenBrushPair
void GDataSetGenBrushPairFreeStatic(GDataSetGenBrushPair* const that) {
    if (that == NULL)
        return;
    // Free memory
    GDataSetFreeStatic((GDataSet*)that);
    if (that->_cfgFilePath)
        free(that->_cfgFilePath);
    while (GSetNbElem(&((GDataSet*)that)->_samples) > 0) {
        GDSFilePathPair* sample = GSetPop(&((GDataSet*)that)->_samples);
        GDSFilePathPairFree(&sample);
    }
}

// Split the samples of the GDataSet 'that' into several categories
// defined by 'cat'. The dimension of 'cat' gives the number of
// categories and the value for each dimension of 'cat' gives the
// number of samples in the corresponding category. For example <3,4>
// would mean 2 categories with 3 samples in the first one and 4
// samples in the second one. There must be at least as many samples
// in the data set as the sum of samples in 'cat'.
// Each category must have at least one sample.
// If 'that' was already splitted the previous splitting is discarded.
void _GDSSplit(GDataSet* const that, const VecShort* const cat) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
}

```

```

long nb = 0;
for (long iCat = VecGetDim(cat); iCat--;)
    nb += VecGet(cat, iCat);
if (nb > GDSGetSize(that)) {
    GDataSetErr->_type = PBErrTypeInvalidArg;
    sprintf(PBImgAnalysisErr->_msg,
        "Not enough samples for the requested splitting (%ld<%ld)",
        nb, GDSGetSize(that));
    PBErrCatch(PBImgAnalysisErr);
}
#endif
// Free the current splitting if necessary
if (that->_categories != NULL) {
    if (that->_split != NULL) {
        for (int iCat = GDSGetNbCat(that); iCat--;) {
            GSetFlush(that->_categories + iCat);
        }
        free(that->_categories);
    }
    if (that->_iterators)
        free(that->_iterators);
    VecFree(&(that->_split));
    // Get the number of categories
    long nbCat = VecGetDim(cat);
    // Allocate memory for the categories
    that->_categories = PBErrMalloc(GDataSetErr, sizeof(GSet) * nbCat);
    for (long iCat = nbCat; iCat--;) {
        that->_categories[iCat] = GSetCreateStatic();
    }
    // Copy the splitting
    that->_split = VecClone(cat);
    // Declare an iterator on the samples
    GSetIterForward iter = GSetIterForwardCreateStatic(&(that->_samples));
    // Loop on categories
    for (long iCat = 0; iCat < nbCat; ++iCat) {
        // Get the nb of samples for this category
        long nbSample = VecGet(cat, iCat);
        // Loop on the sample
        for (long iSample = 0; iSample < nbSample; ++iSample) {
            // Get the sample
            void* sample = GSetIterGet(&iter);
            // Add the sample to the category
            GSetAppend(that->_categories + iCat, sample);
            // Move to the next sample
            GSetIterStep(&iter);
        }
    }
    // Allocate memory for the iterators
    that->_iterators = PBErrMalloc(GDataSetErr,
        sizeof(GSetIterForward) * nbCat);
    for (long iCat = nbCat; iCat--;) {
        that->_iterators[iCat] =
            GSetIterForwardCreateStatic(that->_categories + iCat);
    }
}

// Get the current sample in the category 'iCat' of the GDataSet 'that'
void* _GDSGetSample(
    const GDataSet* const that, const int iCat) {
    // Call the appropriate function according to the type
    switch (GDSGetType(that)) {

```

```

        case GDataSetType_VecFloat:
            return GDSGetSampleVecFloat((GDataSetVecFloat*)that, iCat);
            break;
        case GDataSetType_GenBrushPair:
            return GDSGetSampleGenBrushPair((GDataSetGenBrushPair*)that, iCat);
            break;
        default:
            return NULL;
            break;
    }
}

// Get the number of masks in the GDataSet 'that'
int _GDSGetNbMask(const GDataSet* const that) {
    // Call the appropriate function according to the type
    switch (GDSGetType(that)) {
        case GDataSetType_GenBrushPair:
            return GDSGetNbMaskGenBrushPair((GDataSetGenBrushPair*)that);
            break;
        default:
            return 0;
            break;
    }
}

VecFloat* GDSGetSampleVecFloat(
    const GDataSetVecFloat* const that, const int iCat) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (iCat < 0 || iCat >= GDSGetNbCat(that)) {
            GDataSetErr->_type = PBErrTypeInvalidArg;
            sprintf(PBImgAnalysisErr->_msg, "'iCat' is invalid (0<=%d<%ld)",
                iCat, GDSGetNbCat(that));
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    VecFloat* sample = GSetIterGet(((GDataSet*)that)->_iterators + iCat);
    return VecClone(sample);
}

// Get the inputs of the current sample in the category 'iCat' of
// the GDataSet 'that'
VecFloat* GDSGetSampleInputsVecFloat(
    const GDataSetVecFloat* const that, const int iCat) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (iCat < 0 || iCat >= GDSGetNbCat(that)) {
            GDataSetErr->_type = PBErrTypeInvalidArg;
            sprintf(PBImgAnalysisErr->_msg, "'iCat' is invalid (0<=%d<%ld)",
                iCat, GDSGetNbCat(that));
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    VecFloat* sample = GSetIterGet(((GDataSet*)that)->_iterators + iCat);
}

```



```

VecFloat* inputs = VecFloatCreate(GDSGetNbInputs(that));
for (short i = GDSGetNbInputs(that); i--;) {
    VecSet(inputs, i, VecGet(sample, i));
}
return inputs;
}

// Get the outputs of the current sample in the category 'iCat' of
// the GDataSet 'that'
VecFloat* GDSGetSampleOutputsVecFloat(
    const GDataSetVecFloat* const that, const int iCat) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (iCat < 0 || iCat >= GDSGetNbCat(that)) {
            GDataSetErr->_type = PBErrTypeInvalidArg;
            sprintf(PBImgAnalysisErr->_msg, "'iCat' is invalid (0<=%d<=%ld)",
                iCat, GDSGetNbCat(that));
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    VecFloat* sample = GSetIterGet(((GDataSet*)that)->_iterators + iCat);
    VecFloat* outputs = VecFloatCreate(GDSGetNbOutputs(that));
    for (short i = GDSGetNbOutputs(that); i--;) {
        VecSet(outputs, i, VecGet(sample, i + GDSGetNbInputs(that)));
    }
    return outputs;
}

GDSGenBrushPair* GDSGetSampleGenBrushPair(
    const GDataSetGenBrushPair* const that, const int iCat) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (iCat < 0 || iCat >= GDSGetNbCat(that)) {
            GDataSetErr->_type = PBErrTypeInvalidArg;
            sprintf(PBImgAnalysisErr->_msg, "'iCat' is invalid (0<=%d<=%ld)",
                iCat, GDSGetNbCat(that));
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    GDSFilePathPair* pairFile =
        GSetIterGet(((GDataSet*)that)->_iterators + iCat);
    GDSGenBrushPair* pairSample = PBErrMalloc(GDataSetErr,
        sizeof(GDSGenBrushPair));
    for (int iMask = 0; iMask < GDS_NBMAXMASK; ++iMask)
        pairSample->_mask[iMask] = NULL;
    char* root = PBFSGetRootPath(that->_cfgFilePath);
    char* path = PBFSJoinPath(root, pairFile->_path[0]);
    GenBrush* gb = GBCreateFromFile(path);
    // Rescale the sample if needed to always provide to the user
    // the dimensions defined in the configuration file of the data set
    if (gb != NULL && !VecIsEqual(GBDim(gb), GDSSampleDim(that))) {
        pairSample->_img = GBScale(gb,
            (const VecShort2D*)GDSSampleDim(that), GBScaleMethod_Default);
        GBFree(&gb);
    }
}

```

```

    } else {
        pairSample->_img = gb;
    }
    free(path);
    for (int iMask = 0; iMask < GDSGetNbMask(that); ++iMask) {
        path = PBFSJoinPath(root, pairFile->_path[1 + iMask]);
        gb = GBCreateFromFile(path);
        if (gb != NULL && !VecIsEqual(GBDim(gb), GDSSampleDim(that))) {
            pairSample->_mask[iMask] = GBScale(gb,
                (const VecShort2D*)GDSSampleDim(that), GBScaleMethod_Default);
            GBFree(&gb);
        } else {
            pairSample->_mask[iMask] = gb;
        }
        free(path);
    }
    free(root);
    return pairSample;
}

// Release the memory used by the FilePathPair 'that'
void GDSFilePathPairFree(GDSFilePathPair** const that) {
    if (that == NULL || *that == NULL)
        return;
    for (int iMask = GDS_NBMAXMASK + 1; iMask--;)
        if ((*that)->_path[iMask] != NULL)
            free((*that)->_path[iMask]);
    free(*that);
    *that = NULL;
}

// Release the memory used by the GenBrushPair 'that'
void GDSGenBrushPairFree(GDSGenBrushPair** const that) {
    if (that == NULL || *that == NULL)
        return;
    GBFree(&((*that)->_img));
    for (int iMask = GDS_NBMAXMASK; iMask--;)
        GBFree(&((*that)->_mask[iMask]));
    free(*that);
    *that = NULL;
}

// Center the GDataSet 'that' on its mean
void GDSMeanCenter(GDataSetVecFloat* const that) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    // Get the mean of the dataset
    VecFloat* mean = GDSGetMean(that);
    // Translate all the data by the mean of the data set
    if (GDSGetSize(that) > 0) {
        GSetIterForward iter = GSetIterForwardCreateStatic(GDSSamples(that));
        do {
            VecFloat* sample = GSetIterGet(&iter);
            VecOp(sample, 1.0, mean, -1.0);
        } while (GSetIterStep(&iter));
    }
    // Free memory

```

```

    VecFree(&mean);
}

// Normalize the GDataSet 'that', ie normalize each of its vectors
void GDSNormalize(GDataSetVecFloat* const that) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    // Normalize all the data of the data set
    if (GDSGetSize(that) > 0) {
        GSetIterForward iter = GSetIterForwardCreateStatic(GDSSamples(that));
        do {
            VecFloat* sample = GSetIterGet(&iter);
            VecNormalise(sample);
        } while (GSetIterStep(&iter));
    }
}

// Get the mean of the GDataSet 'that'
VecFloat* GDSGetMean(const GDataSetVecFloat* const that) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    // Get the dimension of the samples
    const VecShort* dim = GDSSampleDim(that);
    // Create a vector to calculate the mean
    VecFloat* mean = VecFloatCreate(VecGet(dim, 0));
    // Calculate the mean
    if (GDSGetSize(that) > 0) {
        GSetIterForward iter =
            GSetIterForwardCreateStatic(GDSSamples(that));
        do {
            VecFloat* v = GSetIterGet(&iter);
            VecOp(mean, 1.0, v, 1.0);
        } while(GSetIterStep(&iter));
        VecScale(mean, 1.0 / (float)GDSGetSize(that));
    }
    // Return the result
    return mean;
}

// Get the max of the GDataSet 'that'
VecFloat* GDSGetMax(const GDataSetVecFloat* const that) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    // Get the dimension of the samples
    const VecShort* dim = GDSSampleDim(that);
    // Create a vector to calculate the max
    int d = VecGet(dim, 0);

```

```

VecFloat* max = VecFloatCreate(d);
// Calculate the mx
if (GDSGetSize(that) > 0) {
    GSetIterForward iter =
        GSetIterForwardCreateStatic(GDSSamples(that));
    VecFloat* v = GSetIterGet(&iter);
    VecCopy(max, v);
    do {
        v = GSetIterGet(&iter);
        for (int i = d; i--;)
            if (VecGet(max, i) < VecGet(v, i))
                VecSet(max, i, VecGet(v, i));
    } while(GSetIterStep(&iter));
}
// Return the result
return max;
}

// Get a clone of the GDataSet 'that'
// All the data in the GDataSet are cloned except for the splitting
// categories which are reset to one category made of the original data
GDataSetVecFloat GDSClone(const GDataSetVecFloat* const that) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    // Declare the result dataset
    GDataSetVecFloat dataset;
    // Create a pointer to the GDataSet for convenience
    GDataSet* tho = &(dataset._dataSet);
    // Clone or initialize the properties
    tho->_name = PBErrMalloc(GDataSetErr,
        sizeof(char) * (1 + strlen(that->_dataSet._name)));
    strcpy(tho->_name, that->_dataSet._name);
    tho->_desc = PBErrMalloc(GDataSetErr,
        sizeof(char) * (1 + strlen(that->_dataSet._desc)));
    strcpy(tho->_desc, that->_dataSet._desc);
    tho->_type = that->_dataSet._type;
    tho->_nbSample = that->_dataSet._nbSample;
    tho->_sampleDim = VecClone(that->_dataSet._sampleDim);
    tho->_samples = GSetCreateStatic();
    if (GDSGetSize(that) > 0) {
        GSetIterForward iter = GSetIterForwardCreateStatic(GDSSamples(that));
        do {
            VecFloat* v = GSetIterGet(&iter);
            GSetAppend(&(tho->_samples), VecClone(v));
        } while (GSetIterStep(&iter));
    }
    tho->_split = NULL;
    tho->_categories = NULL;
    tho->_iterators = NULL;
    tho->_split = VecShortCreate(1);
    VecSet(tho->_split, 0, tho->_nbSample);
    tho->_categories = PBErrMalloc(GDataSetErr, sizeof(GSet));
    tho->_categories[0] = GSetCreateStatic();
    if (GDSGetSize(that) > 0) {
        GSetIterForward iter =
            GSetIterForwardCreateStatic(&(tho->_samples));
        do {

```

```

        void* sample = GSetIterGet(&iter);
        GSetAppend(tho->_categories, sample);
    } while (GSetIterStep(&iter));
}
tho->_iterators =
    PBErrMalloc(GDataSetErr, sizeof(GSetIterForward));
tho->_iterators[0] =
    GSetIterForwardCreateStatic(tho->_categories);
// Return the result dataset
return dataset;
}

// Get the covariance matrix of the GDataSetVecFloat 'that'
MatFloat* GDSGetCovarianceMatrix(const GDataSetVecFloat* const that) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    // Get the dimension of the samples
    const VecShort* dim = GDSSampleDim(that);
    // Allocate memory for the covariance matrix;
    VecShort2D dimMat = VecShortCreateStatic2D();
    VecSet(&dimMat, 0, VecGet(dim, 0));
    VecSet(&dimMat, 1, VecGet(dim, 0));
    MatFloat* res = MatFloatCreate(&dimMat);
    // Loop on the matrix to set the covariances
    VecShort2D i = VecShortCreateStatic2D();
    do {
        // The matrix is symmetric, avoid calculating twice the same value
        if (VecGet(&i, 0) > VecGet(&i, 1)) {
            VecShort2D j = VecShortCreateStatic2D();
            VecSet(&j, 0, VecGet(&i, 1));
            VecSet(&j, 1, VecGet(&i, 0));
            MatSet(res, &i, MatGet(res, &j));
        } else {
            float covar = GDSGetCovariance(that, &i);
            MatSet(res, &i, covar);
        }
    } while(VecStep(&i, &dimMat));
    // Return the covariance matrix
    return res;
}

// Get the covariance of the variables at 'indices' in the
// GDataSetVecFloat 'that'
float GDSGetCovariance(const GDataSetVecFloat* const that,
    const VecShort2D* const indices) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (indices == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'indices' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
}

```

```

// Declare a variable to memorize the result
float res = 0.0;
if (GDSGetSize(that) > 0) {
    // Get the means of the dataset
    VecFloat* means = GDSGetMean(that);
    // Calculate the covariance
    GSetIterForward iter = GSetIterForwardCreateStatic(GDSSamples(that));
    do {
        VecFloat* sample = GSetIterGet(&iter);
        res += (VecGet(sample, VecGet(indices, 0)) -
                VecGet(means, VecGet(indices, 0))) *
                (VecGet(sample, VecGet(indices, 1)) -
                VecGet(means, VecGet(indices, 1)));
    } while (GSetIterStep(&iter));
    res /= (float)GDSGetSize(that);
    // Free memory
    VecFree(&means);
}
// Return the covariance
return res;
}

// Create a GDataSetVecFloat by importing the CSV file 'csvPath' and
// decoding it with the 'importer'
// Return an empty GDataSetVecFloat if the importation failed
GDataSetVecFloat GDataSetCreateStaticFromCSV(
    const char* const csvPath,
    const GDSVecFloatCSVImporter* const importer) {
#ifdef BUILDMODE == 0
    if (csvPath == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'csvPath' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (importer == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'importer' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    // Declare the result GDataSetVecFloat
    GDataSetVecFloat dataset;
    GDataSet* that = (GDataSet*)&dataset;
    *that = GDataSetCreateStatic(GDataSetType_VecFloat);

    // Initialise the properties
    that->_name = strdup(csvPath);
    that->_desc = strdup(csvPath);
    that->_sampleDim = VecShortCreate(1);
    VecSet(that->_sampleDim, 0, importer->_sizeSample);
    that->_samples = GSetCreateStatic();

    // Open the csv file
    FILE* csvFile = fopen(csvPath, "r");

    // If we could open the file
    if (csvFile != NULL) {

        // Skip the header
        unsigned int nbSkip = 0;
        while (nbSkip < importer->_sizeHeader &&
                !feof(csvFile)) {

```

```

    char buffer;
    buffer = fgetc(csvFile);
    if (buffer == '\n')
        ++nbSkip;
}

// Load the samples line by line
while (!feof(csvFile)) {

    // Allocate memory for a new sample
    VecFloat* sample = VecFloatCreate(importer->_sizeSample);

    // Decode each column
    for (unsigned int iCol = 0;
        iCol < importer->_nbCol && !feof(csvFile); ++iCol) {

        // Read the value
        char buffer[1024];
        unsigned int iChar = 0;
        do {
            buffer[iChar] = fgetc(csvFile);
        } while (buffer[iChar] != importer->_sep &&
            buffer[iChar] != '\n' &&
            ++iChar && iChar < sizeof(buffer) && !feof(csvFile));
        buffer[iChar] = '\0';

        // Decode the value and set it into the sample
        if (importer->_converter != NULL) {
            importer->_converter(iCol, buffer, sample);
        } else {
            VecSet(sample, iCol, atof(buffer));
        }
    }

    // If we haven't reached the end of the file
    if (!feof(csvFile)) {

        // Add the sample to the dataset
        GSetAppend((GSet*)GDSSamples(that), sample);

        // Else, we are at the end of the file
    } else {

        // Free the memory
        VecFree(&sample);
    }
}

// Update the number of samples
that->_nbSample = GSetNbElem(GDSSamples(that));

// Close the csv file
fclose(csvFile);
}

// Initialise the categories
GDSResetCategories(that);

// Return the dataset
return dataset;
}

// Create a CSV importer for a GDataSetVecFloat

```

```

GDSVecFloatCSVImporter GDSVecFloatCSVImporterCreateStatic(
    const unsigned int sizeHeader,
        const char sep,
    const unsigned int nbCol,
    const unsigned int sizeSample,
        void (*converter)(
            int col,
            char* val,
            VecFloat* sample)) {
    GDSVecFloatCSVImporter importer = {
        ._sizeHeader=sizeHeader,
        ._sep=sep,
        ._nbCol=nbCol,
        ._sizeSample=sizeSample,
        ._converter=converter
    };
    return importer;
}

// Function which return the JSON encoding of 'that'
JSONNode* GDataSetVecFloatEncodeAsJSON(
    const GDataSetVecFloat* const that) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PErrCatch(PBImgAnalysisErr);
        }
    #endif
    // Create the JSON structure
    JSONNode* json = JSONCreate();

    // Declare a buffer to convert value into string
    char val[100];

    // Encode the properties
    JSONAddProp(json, "dataSet", that->_dataSet._name);
    sprintf(val, "%d", that->_dataSet._type);
    JSONAddProp(json, "dataSetType", val);
    JSONAddProp(json, "desc", that->_dataSet._desc);
    sprintf(val, "%ld", GDSGetSize(that));
    JSONAddProp(json, "nbSample", val);
    sprintf(val, "%d", GDSGetNbInputs(that));
    JSONAddProp(json, "nbInputs", val);
    sprintf(val, "%d", GDSGetNbOutputs(that));
    JSONAddProp(json, "nbOutputs", val);
    JSONAddProp(json, "dim", VecEncodeAsJSON(that->_dataSet._sampleDim));
    JSONArrayStruct samples = JSONArrayStructCreateStatic();
    GSetIterForward iter = GSetIterForwardCreateStatic(GDSSamples(that));
    do {
        VecFloat* sample = GSetIterGet(&iter);
        JSONArrayStructAdd(&samples,
            VecEncodeAsJSON(sample));
    } while (GSetIterStep(&iter));
    JSONAddProp(json, "samples", &samples);
    JSONArrayStructFlush(&samples);

    // Return the created JSON
    return json;
}

// Function which return the JSON encoding of the category 'iCat'

```



```

// of 'that'
JSONNode* GDataSetVecFloatEncodeCategoryAsJSON(
    const GDataSetVecFloat* const that,
    const unsigned int iCat) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    // Create the JSON structure
    JSONNode* json = JSONCreate();

    // Declare a buffer to convert value into string
    char val[100];

    // Encode the properties
    JSONAddProp(json, "dataSet", that->_dataSet._name);
    sprintf(val, "%d", that->_dataSet._type);
    JSONAddProp(json, "dataSetType", val);
    JSONAddProp(json, "desc", that->_dataSet._desc);
    sprintf(val, "%ld", GDSGetSizeCat(that, iCat));
    JSONAddProp(json, "nbSample", val);
    JSONAddProp(json, "dim", VecEncodeAsJSON(that->_dataSet._sampleDim));
    sprintf(val, "%d", GDSGetNbInputs(that));
    JSONAddProp(json, "nbInputs", val);
    sprintf(val, "%d", GDSGetNbOutputs(that));
    JSONAddProp(json, "nbOutputs", val);
    JSONArrayStruct samples = JSONArrayStructCreateStatic();
    GDSReset(that, iCat);
    do {
        VecFloat* sample = GDSGetSample(that, iCat);
        JSONArrayStructAdd(&samples,
            VecEncodeAsJSON(sample));
        VecFree(&sample);
    } while (GDSStepSample(that, iCat));
    JSONAddProp(json, "samples", &samples);
    JSONArrayStructFlush(&samples);

    // Return the created JSON
    return json;
}

// Save the GDataSetVecFloat to the stream
// If 'compact' equals true it saves in compact form, else it saves in
// readable form
// Return true upon success else false
bool GDSVecFloatSave(
    const GDataSetVecFloat* const that,
    FILE* const stream,
    const bool compact) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(GDataSetErr->_msg, "'that' is null");
            PBErrCatch(GDataSetErr);
        }
        if (stream == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(GDataSetErr->_msg, "'stream' is null");
            PBErrCatch(GDataSetErr);
        }
    #endif
}

```

```

    }
#endif
    // Get the JSON encoding
    JSONNode* json = GDataSetVecFloatEncodeAsJSON(that);
    // Save the JSON
    if (!JSONSave(json, stream, compact)) {
        return false;
    }
    // Free memory
    JSONFree(&json);
    // Return success code
    return true;
}

// Save the category 'iCat' of the GDataSetVecFloat to the stream
// If 'compact' equals true it saves in compact form, else it saves in
// readable form
// Return true upon success else false
bool GDSVecFloatSaveCategory(
    const GDataSetVecFloat* const that,
        FILE* const stream,
        const bool compact,
        const int iCat) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(GDataSetErr->_msg, "'that' is null");
            PBErrCatch(GDataSetErr);
        }
        if (stream == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(GDataSetErr->_msg, "'stream' is null");
            PBErrCatch(GDataSetErr);
        }
    }
#endif
    // Get the JSON encoding
    JSONNode* json = GDataSetVecFloatEncodeCategoryAsJSON(
        that,
        iCat);
    // Save the JSON
    if (!JSONSave(json, stream, compact)) {
        return false;
    }
    // Free memory
    JSONFree(&json);
    // Return success code
    return true;
}

// Run the prediction by the NeuraNet 'nn' on each sample of the category
// 'iCat' of the GDataSet 'that'. The index of columns in the samples
// for inputs and outputs are given by 'iInputs' and 'iOutputs'.
// Stop the prediction of samples when the result can't get better
// than 'threshold'
// Return the value of the NeuraNet on the predicted samples, defined
// as sum_samples(||output_sample-output_neuranet||)/nb_sample
// Higher is better, 0.0 is best value
float GDataSetVecFloatEvaluateNN(
    const GDataSetVecFloat* const that,
    const NeuraNet* const nn,
    const int iCat,
    const VecShort* const iInputs,

```

```

    const VecShort* const iOutputs,
    const float threshold) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(GDataSetErr->_msg, "'that' is null");
        PBErrCatch(GDataSetErr);
    }
    if (nn == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(GDataSetErr->_msg, "'nn' is null");
        PBErrCatch(GDataSetErr);
    }
    if (iInputs == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(GDataSetErr->_msg, "'iInputs' is null");
        PBErrCatch(GDataSetErr);
    }
    if (iOutputs == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(GDataSetErr->_msg, "'iOutputs' is null");
        PBErrCatch(GDataSetErr);
    }
    if (VecGetDim(iInputs) != NNGetNbInput(nn)) {
        GDataSetErr->_type = PBErrTypeInvalidArg;
        sprintf(GDataSetErr->_msg,
            "Dim of 'iInputs' is invalid (%ld==%d)",
            VecGetDim(iInputs),
            NNGetNbInput(nn));
        PBErrCatch(GDataSetErr);
    }
    if (VecGetDim(iOutputs) != NNGetNbOutput(nn)) {
        GDataSetErr->_type = PBErrTypeInvalidArg;
        sprintf(GDataSetErr->_msg,
            "Dim of 'iOutputs' is invalid (%ld==%d)",
            VecGetDim(iOutputs),
            NNGetNbOutput(nn));
        PBErrCatch(GDataSetErr);
    }
}
#endif

// Declare a variable to memorize the result
float value = 0.0;

// Declare a variable to memorize the nb of predicted samples
long nbPredSample = 0;

// Declare a variable to manage the threshold
bool flag = true;

// Declare variables for the input and output of the NeuraNet and
// for the correct output of the NeuraNet
VecFloat* inputNN = VecFloatCreate(NNGetNbInput(nn));
VecFloat* outputNN = VecFloatCreate(NNGetNbOutput(nn));
VecFloat* outputSample = VecFloatCreate(NNGetNbOutput(nn));

// Reset the iterator on samples
GDSReset(that, iCat);

// Loop on the samples of the requested category
do {
    // Get a clone of the sample

```

```

VecFloat* sample = GDSGetSample(that, iCat);

// Create the input of the NeuraNet from the sample
for (int iInput = NNGetNbInput(nn); iInput--;) {
    VecSet(inputNN, iInput,
        VecGet(sample, VecGet(iInputs, iInput)));
}

// Run the prediction
NNEval(nn, inputNN, outputNN);

// Create the correct output of the NeuraNet from the sample
for (int iOutput = NNGetNbOutput(nn); iOutput--;) {
    VecSet(outputSample, iOutput,
        VecGet(sample, VecGet(iOutputs, iOutput)));
}

// Calculate the value on this sample
VecFloat* diff = VecGetOp(outputNN, 1.0, outputSample, -1.0);
float sampleValue = VecNorm(diff);
VecFree(&diff);

// Update the total value
value += sampleValue;

// Check against the threshold
float bestPossible = -1.0 * value / (float)GDSGetSizeCat(that, iCat);
if (bestPossible <= threshold) {
    flag = false;
}

// Free memory
VecFree(&sample);

// Increment the nb of predicted samples
++nbPredSample;
} while (flag && GDSStepSample(that, iCat));

// Update the total value
value /= (float)nbPredSample;

// Free memory
VecFree(&inputNN);
VecFree(&outputNN);
VecFree(&outputSample);

// Return the value of the NeuraNet on the samples
return value * -1.0;
}

// Create a new GDataSetVecFloat
GDataSetVecFloat GDataSetVecFloatCreateStatic(void) {
    // Declare the result GDataSetVecFloat
    GDataSetVecFloat that;

    // Initialise properties
    that._dataSet = GDataSetCreateStatic(GDataSetType_VecFloat);

    // Return the dataset
    return that;
}

```

```

// Get the proximity matrix of the samples of category 'iCat' in the
// GDataSetVecFloat 'that'
// M[i,j] = euclidean distance between the i-th sample and the j-th sample
MatFloat* GDSVecFloatGetProxMat(
    const GDataSetVecFloat* that,
    unsigned int iCat) {

#ifdef BUILDMODE == 0

    if (that == NULL) {

        GDataSetErr->_type = PErrTypeNullPointer;
        sprintf(
            GDataSetErr->_msg,
            "'that' is null");
        PErrCatch(GDataSetErr);

    }

#endif

    // Allocate memory for the result matrix
    long nbSamples =
        GDSGetSizeCat(
            that,
            iCat);
    VecShort2D v = VecShortCreateStatic2D();
    VecSet(
        &v,
        0,
        nbSamples);
    VecSet(
        &v,
        1,
        nbSamples);
    MatFloat* proxMat = MatFloatCreate(&v);

    // Declare another vector used to manipulate the matrix
    VecShort2D w = VecShortCreateStatic2D();

    // Declare two variables to memorize the indices of samples
    long iSample = 0;
    long jSample = 0;

    // Loop on the samples of the category
    GDSReset(
        that,
        iCat);
    bool flagStepI = true;
    bool flagStepJ = true;
    do {

        // Get the sample
        VecFloat* sampleI = GSetIterGet(((GDataSet*)that)->_iterators + iCat);

        // Update the index to manipulate the matrix
        VecSet(
            &v,
            0,
            iSample);
        VecSet(

```

```

        &w,
        1,
        iSample);

// Create a temporary iterator to loop on the following sample
GSetIterForward iterJ = ((GDataSet*)that)->_iterators[iCat];
jSample = iSample;

// Loop on the following samples
do {

    // Get the following sample
    VecFloat* sampleJ = GSetIterGet(&iterJ);

    // Get the distance between the sample and the following sample
    float dist = 0.0;
    if (iSample != jSample) {

        dist =
            VecDist(
                sampleI,
                sampleJ);

    }

    // Update the index to manipulate the matrix
    VecSet(
        &v,
        1,
        jSample);
    VecSet(
        &w,
        0,
        jSample);

    // Update the proximity matrix
    MatSet(
        proxMat,
        &v,
        dist);
    MatSet(
        proxMat,
        &w,
        dist);

    // Step to the next following sample
    flagStepJ = GSetIterStep(&iterJ);
    ++jSample;

} while (flagStepJ);

// Step to the next sample
flagStepI =
    GDSStepSample(
        that,
        iCat);
++iSample;

} while (flagStepI);

// Return the proximity matrix
return proxMat;

```

```

}

// Get the nearest (in term of euclidean distance) sample of category
// 'iCat' to 'target' in the GDataSetVecFloat 'that' using the AESA
// nearest neighbour search
// TODO: should use a lookup table to get VecDist(sample, prevCandidate)
// but it's complicated by the fact I'm loosing the index of samples when
// using GSet
// Also, even if using a lookup table, and even if AESA actually reduces
// efficiently the number of VecDist(candidate, target), the cost of
// VecDist() much be hugely bigger than the one of using a lookup table
// to make AESA relevant. It's probably meaningless on a VecFloat,
// maybe more meaningful on a GenBrush ?
// http://citeseerx.ist.psu.edu/viewdoc/download?
// doi=10.1.1.481.2200&rep=rep1&type=pdf
VecFloat* GDSVecFloatNearestNeighbourAESA(
    const GDataSetVecFloat* that,
    const VecFloat* target,
    int iCat) {

#ifdef BUILDMODE == 0

    if (that == NULL) {

        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(
            GDataSetErr->_msg,
            "'that' is null");
        PBErrCatch(GDataSetErr);

    }

    if (target == NULL) {

        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(
            GDataSetErr->_msg,
            "'target' is null");
        PBErrCatch(GDataSetErr);

    }

#endif

    // Declare the pointer to the result sample
    VecFloat* nearestNeighbour = NULL;

    // Declare a variable to store the best distance
    float bestDist = -1.0;

    // Create the set of examined samples
    GSet done = GSetCreateStatic();

    // Create the set of not yet examined samples
    GSet todo = GSetCreateStatic();
    GDSReset(
        that,
        iCat);
    bool flagStep = true;
    do {

```

```

VecFloat* sample = GSetIterGet(((GDataSet*)that)->_iterators + iCat);
GSetAppend(
    &todo,
    sample);
flagStep =
    GDSStepSample(
        that,
        iCat);

} while(flagStep);

// Declare the pointer to the candidate sample and initialise it
// to the first sample not yet examined
VecFloat* candidate = GSetPop(&todo);

// While there is a candidate to examined
while(candidate != NULL) {

    // Get the distance from the candidate to the target
    float distCandidate =
        VecDist(
            candidate,
            target);

    // Add the candidate to the set of examined samples sorted on
    // their distance to the target
    GSetAddSort(
        &done,
        candidate,
        distCandidate);

    // If there is no current best or the distance is less than the
    // current best
    if (
        bestDist < 0.0 ||
        distCandidate < bestDist) {

        // Update the current best
        bestDist = distCandidate;
        nearestNeighbour = candidate;

    }

    // Create a temporary set to update the lower bound
    GSet update = GSetCreateStatic();

    // For each sample not yet examined
    while(GSetNbElem(&todo) > 0) {

        // Get the sample
        VecFloat* sample = GSetPop(&todo);

        // Get the lower bound of the sample
        float lowerBound = 0.0;
        GSetIterForward iter = GSetIterForwardCreateStatic(&done);
        do {

            VecFloat* prevCandidate = GSetIterGet(&iter);
            const GSetElem* elem = GSetIterGetElem(&iter);
            float l =
                GSetElemGetSortVal(elem) -
                VecDist(

```



```

        sample,
        prevCandidate);
    if (l > lowerBound) {

        lowerBound = l;

    }

} while(
    GSetIterStep(&iter) &&
    lowerBound < bestDist);

// Add the sample to the updated set if its lower bound is below
// the current best distance
if (lowerBound < bestDist) {

    GSetAddSort(
        &update,
        sample,
        lowerBound);

}

}

// Swap the todo and update sets
todo = update;

// Get the next candidate as the one with lowest bound in the list of
// not yet examined samples
candidate = GSetPop(&todo);

}

// Free memory
GSetFlush(&done);

// Return the nearest neighbour
return nearestNeighbour;

}

// Get the nearest (in term of euclidean distance) sample of category
// 'iCat' to 'target' in the GDataSetVecFloat 'that' using brute force
VecFloat* GDSVecFloatNearestNeighbourBrute(
    const GDataSetVecFloat* that,
    const VecFloat* target,
    int iCat) {

#ifdef BUILDMODE == 0

    if (that == NULL) {

        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(
            GDataSetErr->_msg,
            "'that' is null");
        PBErrCatch(GDataSetErr);

    }

    if (target == NULL) {

```

```

    GDataSetErr->_type = PBErrTypeNullPointer;
    sprintf(
        GDataSetErr->_msg,
        "'target' is null");
    PBErrCatch(GDataSetErr);

}

#endif

// Declare the pointer to the result
VecFloat* nearest = NULL;

// Declare a variable to memorize the best distance
float bestDist = 0.0;

// Loop on samples
do {

    // Get the sample
    VecFloat* sample =
        GDSGetSample(
            that,
            iCat);

    // Get the distance to the target
    float dist =
        VecDist(
            target,
            sample);

    // If there is no nearest yet or the distance is better
    if (
        nearest == NULL ||
        dist < bestDist) {

        // Free memory used by the copy of the current best sample
        VecFree(&nearest);

        // Update the nearest sample
        bestDist = dist;
        nearest = sample;

    // Else, it is farther than the current best
    } else {

        // Free memory used by the copy of the sample
        VecFree(&sample);

    }

} while(GDSStepSample(that, iCat));

// Return the result
return nearest;

}

```

## 2.2 gdataset-inline.c

```
// ===== GDATASET_static inline.C =====

// ===== Functions implementation =====

// Get the total number of samples in the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
long _GDSGetSize(const GDataSet* const that) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    return that->_nbSample;
}

// Get the total number of samples in the GDataSet 'that' for the
// category 'iCat'. Return 0 if the category doesn't exists
#if BUILDMODE != 0
static inline
#endif
long _GDSGetSizeCat(const GDataSet* const that, const long iCat) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (that->_split == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that->_split' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (iCat < 0 || iCat >= GDSGetNbCat(that)) {
            GDataSetErr->_type = PBErrTypeInvalidArg;
            sprintf(PBImgAnalysisErr->_msg, "'iCat' is invalid (0<=%ld<%ld)",
                iCat, GDSGetNbCat(that));
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    return (that->_split ? VecGet(that->_split, iCat) : 0);
}

// Unsplit the GDataSet 'that', i.e. after calling GDataSetUnsplit 'that'
// has only one category containing all the samples
#if BUILDMODE != 0
static inline
#endif
void _GDSUnsplit(GDataSet* const that) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    // Unsplitting is equivalent to splitting in one category with all the
```

```

    // samples
    VecShort* split = VecShortCreate(1);
    VecSet(split, 0, GDSGetSize(that));
    GDSSplit(that, split);
    VecFree(&split);
}

// Shuffle the samples of the category 'iCat' of the GDataSet 'that'.
// Reset the iterator of the category
#if BUILDMODE != 0
static inline
#endif
void _GDSShuffle(GDataSet* const that, const long iCat) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (that->_categories == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that->_categories' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
        if (iCat < 0 || iCat >= GDSGetNbCat(that)) {
            GDataSetErr->_type = PBErrTypeInvalidArg;
            sprintf(PBImgAnalysisErr->_msg, "'iCat' is invalid (0<=%ld<=%ld)",
                    iCat, GDSGetNbCat(that));
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    // Shuffle the GSet of the category
    if (that->_categories)
        GSetShuffle(that->_categories + iCat);
    // Reset the iterator
    GDSReset(that, iCat);
}

// Shuffle the samples of all the categories of the GDataSet 'that'.
// Reset the iterator of the categories
#if BUILDMODE != 0
static inline
#endif
void _GDSShuffleAll(GDataSet* const that) {
    #if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PBErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PBErrCatch(PBImgAnalysisErr);
        }
    #endif
    // Loop on categories
    for (int iCat = GDSGetNbCat(that); iCat--;)
        // Shuffle the category
        GDSShuffle(that, iCat);
}

// Get the name of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
const char* _GDSName(const GDataSet* const that) {

```

```

#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    return that->_name;
}

// Get the description of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
const char* _GDSDesc(const GDataSet* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    return that->_desc;
}

// Get the type of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
GDataSetType _GDSGetType(const GDataSet* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    return that->_type;
}

// Get the number of categories of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
long _GDSGetNbCat(const GDataSet* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    return (that->_split ? VecGetDim(that->_split) : 0);
}

// If there is a next sample move to the next sample of the category
// 'iCat' and return true, else return false
#if BUILDMODE != 0
static inline
#endif
bool _GDSStepSample(const GDataSet* const that, const long iCat) {
#if BUILDMODE == 0

```

```

    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (that->_iterators == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that->_iterators' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (iCat < 0 || iCat >= GDSGetNbCat(that)) {
        GDataSetErr->_type = PBErrTypeInvalidArg;
        sprintf(PBImgAnalysisErr->_msg, "'iCat' is invalid (0<=%ld<%ld)",
            iCat, GDSGetNbCat(that));
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    return (that->_iterators ?
        GSetIterStep(that->_iterators + iCat) : false);
}

// Reset the iterator on category 'iCat' of the GDataSet 'that', i.e.
// the next call to GDataSetGetNextSample will give the first sample of
// the category 'iCat'
#if BUILDMODE != 0
static inline
#endif
void _GDSReset(GDataSet* const that, const long iCat) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (that->_iterators == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that->_iterators' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (iCat < 0 || iCat >= GDSGetNbCat(that)) {
        GDataSetErr->_type = PBErrTypeInvalidArg;
        sprintf(PBImgAnalysisErr->_msg, "'iCat' is invalid (0<=%ld<%ld)",
            iCat, GDSGetNbCat(that));
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    if (that->_iterators)
        GSetIterReset(that->_iterators + iCat);
}

// Reset the iterator on all categories of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
void _GDSResetAll(GDataSet* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
}

```

```

    // Loop on categories
    for (int iCat = GDSGetNbCat(that); iCat--;)
        // Shuffle the category
        GDSReset(that, iCat);
}

// Get the dimensions of the samples of GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
const VecShort* _GDSSampleDim(const GDataSet* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PErrCatch(PBImgAnalysisErr);
    }
#endif
    return that->_sampleDim;
}

// Get the number of masks in the GDataSetGenBrushPair 'that'
#if BUILDMODE != 0
static inline
#endif
int GDSGetNbMaskGenBrushPair(const GDataSetGenBrushPair* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PErrCatch(PBImgAnalysisErr);
    }
#endif
    return that->_nbMask;
}

// Get the samples of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
const GSet* _GDSSamples(const GDataSet* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PErrCatch(PBImgAnalysisErr);
    }
#endif
    return &(that->_samples);
}

#if BUILDMODE != 0
static inline
#endif
const GSetVecFloat* _GDSVecFloatSamples(
    const GDataSetVecFloat* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PErrCatch(PBImgAnalysisErr);
    }
#endif
}

```

```

    return (GSetVecFloat*)&(that->_dataSet._samples);
}
#endif BUILDMODE != 0
static inline
#endif
const GSet* _GDSEnBrushPairSamples(
    const GDataSetGenBrushPair* const that) {
    if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PErrCatch(PBImgAnalysisErr);
        }
    #endif
    return &(that->_dataSet._samples);
}

// Remove all the samples of the GDataSetVecFloat 'that'
#if BUILDMODE != 0
static inline
#endif
void _GDSVecFloatRemoveAllSample(GDataSetVecFloat* const that) {
    if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PErrCatch(PBImgAnalysisErr);
        }
    #endif
    while (GSetNbElem(GDSSamples(that)) > 0) {
        VecFloat* sample = GSetPop((GSet*)GDSSamples(that));
        VecFree(&sample);
    }
    that->_dataSet._nbSample = 0;
    GDSUnsplit(that);
}

// Remove all the samples of the GDataSetGenBrushPair 'that'
#ifdef GENBRUSH_H
#if BUILDMODE != 0
static inline
#endif
void _GDSEnBrushPairRemoveAllSample(GDataSetGenBrushPair* const that) {
    if BUILDMODE == 0
        if (that == NULL) {
            GDataSetErr->_type = PErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PErrCatch(PBImgAnalysisErr);
        }
    #endif
    while (GSetNbElem(GDSSamples(that)) > 0) {
        GDSEnBrushPair* sample = GSetPop((GSet*)GDSSamples(that));
        GDSEnBrushPairFree(&sample);
    }
    that->_dataSet._nbSample = 0;
    GDSUnsplit(that);
}
#endif

// Append 'sample' in the GDataSetVecFloat 'that'
#if BUILDMODE != 0
static inline

```



```

#endif
void _GDSVecFloatAddSample(
    GDataSetVecFloat* const that,
    VecFloat* sample) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (sample == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'sample' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (VecGetDim(sample) != VecGet(GDSSampleDim(that), 0)) {
        GDataSetErr->_type = PBErrTypeInvalidArg;
        sprintf(PBImgAnalysisErr->_msg,
            "'sample' has invalid dimensions (%ld!=%ld)",
            VecGetDim(sample), VecGet(GDSSampleDim(that), 0));
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    GSetAppend((GSet*)GDSSamples(that), sample);
    that->_dataSet._nbSample += 1;
}

// Append 'sample' in the GDataSetGenBrush 'that'
#ifdef GENBRUSH_H
#ifdef BUILDMODE != 0
static inline
#endif
void _GDSGenBrushPairAddSample(
    GDataSetGenBrushPair* const that,
    GDSGenBrushPair* sample) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (sample == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'sample' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
    if (VecIsEqual(GBDim(sample), GDSSampleDim(&dataset)) == FALSE) {
        GDataSetErr->_type = PBErrTypeInvalidArg;
        sprintf(PBImgAnalysisErr->_msg,
            "'sample' has invalid dimensions ((%ld,%ld)!=(%ld,%ld))",
            VecGet(GBDim(sample), 0),
            VecGet(GBDim(sample), 1),
            VecGet(GDSSampleDim(&dataset), 0),
            VecGet(GDSSampleDim(&dataset), 1));
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    GSetAppend((GSet*)GDSSamples(that), sample);
    that->_dataSet._nbSample += 1;
}
#endif

```

```

// Get the number of input values in one sample of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
short _GDSGetNbInputs(const GDataSet* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    return that->_nbInputs;
}

// Get the number of output values in one sample of the GDataSet 'that'
#if BUILDMODE != 0
static inline
#endif
short _GDSGetNbOutputs(const GDataSet* const that) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    return that->_nbOutputs;
}

// Set the number of input values in one sample of the GDataSet 'that' to 'nb'
#if BUILDMODE != 0
static inline
#endif
void _GDSSetNbInputs(GDataSet* const that, const short nb) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    that->_nbInputs = nb;
}

// Set the number of output values in one sample of the GDataSet 'that' to 'nb'
#if BUILDMODE != 0
static inline
#endif
void _GDSSetNbOutputs(GDataSet* const that, const short nb) {
#if BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;
        sprintf(PBImgAnalysisErr->_msg, "'that' is null");
        PBErrCatch(PBImgAnalysisErr);
    }
#endif
    that->_nbOutputs = nb;
}

```

## 3 Makefile

```
# Build mode
# 0: development (max safety, no optimisation)
# 1: release (min safety, optimisation)
# 2: fast and furious (no safety, optimisation)
BUILD_MODE?=0

all: pbmake_wget main

# Automatic installation of the repository PBMake in the parent folder
pbmake_wget:
if [ ! -d ../PBMake ]; then wget https://github.com/BayashiPascal/PBMake/archive/master.zip; unzip master.zip; rm -f

# Makefile definitions
MAKEFILE_INC=../PBMake/Makefile.inc
include $(MAKEFILE_INC)

# Rules to make the executable
repo=gdataset
$(repo)_EXENAME: \
$(repo)_EXENAME.o \
$(repo)_EXE_DEP \
$(repo)_DEP
$(COMPILER) 'echo "$(repo)_EXE_DEP" "$(repo)_EXENAME.o" | tr ' ' '\n' | sort -u' $(LINK_ARG) $(repo)_LINK_ARG

$(repo)_EXENAME.o: \
$(repo)_DIR/$(repo)_EXENAME.c \
$(repo)_INC_H_EXE \
$(repo)_EXE_DEP
$(COMPILER) $(BUILD_ARG) $(repo)_BUILD_ARG 'echo "$(repo)_INC_DIR" | tr ' ' '\n' | sort -u' -c $(repo)_DIR/
```

## 4 Dataset configuration file

### 4.1 VecFloat

testGDataSetVecFloat.json:

```
{
  "dataSet": "testGDataSet",
  "dataSetType": "0",
  "desc": "UnitTestGDataSetCreateFree",
  "dim": {
    "_dim": "1",
    "_val": ["2"]
  },
  "nbInputs": "1",
  "nbOutputs": "1",
  "nbSample": "3",
  "samples": [
    {
      "_dim": "2",
      "_val": ["0.0", "1.0"]
    },
    {
      "_dim": "2",
      "_val": ["2.0", "3.0"]
    }
  ]
}
```

```

    },
    {
      "_dim": "2",
      "_val": ["4.0", "5.0"]
    }
  ]
}

```

testGDataSetVecFloatCovariance.json:

```

{
  "dataSet": "testGDataSet",
  "dataSetType": "0",
  "desc": "UnitTestGDataSetVecFloatCovariance",
  "dim": {
    "_dim": "1",
    "_val": ["3"]
  },
  "nbSample": "3",
  "nbInputs": "2",
  "nbOutputs": "1",
  "samples": [
    {
      "_dim": "3",
      "_val": ["1.0", "2.0", "3.0"]
    },
    {
      "_dim": "3",
      "_val": ["6.0", "5.0", "4.0"]
    },
    {
      "_dim": "3",
      "_val": ["7.0", "8.0", "9.0"]
    }
  ]
}

```

testGDataSetVecFloat.json:

```

{
  "dataSet": "testGDataSet",
  "dataSetType": "0",
  "desc": "UnitTestGDataSetVecFloatNormalize",
  "dim": {
    "_dim": "1",
    "_val": ["3"]
  },
  "nbInputs": "2",
  "nbOutputs": "1",
  "nbSample": "3",
  "samples": [
    {
      "_dim": "3",
      "_val": ["1.0", "2.0", "3.0"]
    },
    {
      "_dim": "3",
      "_val": ["6.0", "5.0", "4.0"]
    },
    {
      "_dim": "3",
      "_val": ["7.0", "8.0", "9.0"]
    }
  ]
}

```

```

    }
  ]
}

```

## 4.2 Pair of GenBrush

```

{
  "dataSet": "dataset-002-001",
  "dataSetType": "1",
  "desc": "unitTest",
  "dim": {
    "_dim": "2",
    "_val": [
      "10",
      "20"
    ]
  },
  "nbInputs": "2",
  "nbOutputs": "1",
  "format": "tga",
  "nbMask": "2",
  "nbSample": "3",
  "samples": [
    {
      "img": "img000.tga",
      "mask": [
        "mask000-000.tga",
        "mask000-001.tga"
      ]
    },
    {
      "img": "img001.tga",
      "mask": [
        "mask001-000.tga",
        "mask001-001.tga"
      ]
    },
    {
      "img": "img002.tga",
      "mask": [
        "mask002-000.tga",
        "mask002-001.tga"
      ]
    }
  ]
}

```

## 5 Unit tests

```

#include <stdlib.h>
#include <stdlib.h>
#include <stdio.h>
#include <time.h>
#include <string.h>
#include <math.h>
#include "genbrush.h"
#include "gdataset.h"

```

```

void UnitTestGDataSetVecFloatCreateFreeClone() {
    srand(1);
    char* cfgFilePath = "testGDataSetVecFloat.json";
    GDataSetVecFloat gdataset =
        GDataSetVecFloatCreateStaticFromFile(cfgFilePath);
    GDataSet* g = (GDataSet*)&gdataset;
    if (GSetGet(g->_categories, 0) != GSetGet(&(g->_samples), 0) ||
        GSetGet(g->_categories, 1) != GSetGet(&(g->_samples), 1) ||
        GSetGet(g->_categories, 2) != GSetGet(&(g->_samples), 2)) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDataSetCreateStatic failed");
        PBErrCatch(GDataSetErr);
    }
    GDataSetVecFloat clone = GDSClone(&gdataset);
    GDataSet* f = (GDataSet*)&clone;
    if (GSetGet(f->_categories, 0) != GSetGet(&(f->_samples), 0) ||
        GSetGet(f->_categories, 1) != GSetGet(&(f->_samples), 1) ||
        GSetGet(f->_categories, 2) != GSetGet(&(f->_samples), 2)) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSClone failed");
        PBErrCatch(GDataSetErr);
    }

    GDataSetVecFloatFreeStatic(&clone);
    GDataSetVecFloatFreeStatic(&gdataset);
    printf("UnitTestGDataSetVecFloatCreateFreeClone OK\n");
}

void UnitTestGDataSetVecFloatGet() {
    srand(1);
    char* cfgFilePath = "testGDataSetVecFloat.json";
    GDataSetVecFloat gdataset =
        GDataSetVecFloatCreateStaticFromFile(cfgFilePath);
    if (strcmp(GDSDesc(&gdataset), "UnitTestGDataSetCreateFree") != 0) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSDesc failed");
        PBErrCatch(GDataSetErr);
    }
    if (strcmp(GDSName(&gdataset), "testGDataSet") != 0) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSName failed");
        PBErrCatch(GDataSetErr);
    }
    if (GDSGetType(&gdataset) != GDataSetType_VecFloat) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSGetType failed");
        PBErrCatch(GDataSetErr);
    }
    if (GDSGetNbCat(&gdataset) != 1) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSGetNbCat failed");
        PBErrCatch(GDataSetErr);
    }
    if (GDSGetSize(&gdataset) != 3) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSGetSize failed");
        PBErrCatch(GDataSetErr);
    }
    if (GDSGetSizeCat(&gdataset, 0) != 3) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSGetSizeCat failed");
        PBErrCatch(GDataSetErr);
    }
}

```

```

}
if ((GSet*)GDSSamples(&gdataset) != &(gdataset._dataSet._samples)) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSSamples failed");
    PBErrCatch(GDataSetErr);
}
VecShort* dim = VecShortCreate(1);
VecSet(dim, 0, 2);
if (VecIsEqual(GDSSampleDim(&gdataset), dim) != true) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSSampleDim failed");
    PBErrCatch(GDataSetErr);
}
VecFree(&dim);
VecFloat* mean = GDSGetMean(&gdataset);
VecFloat2D checkMean = VecFloatCreateStatic2D();
VecSet(&checkMean, 0, 2.0);
VecSet(&checkMean, 1, 3.0);
if (!VecIsEqual(mean, &checkMean)) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSGetMean failed");
    PBErrCatch(GDataSetErr);
}
VecFree(&mean);
VecFloat* max = GDSGetMax(&gdataset);
VecFloat2D checkMax = VecFloatCreateStatic2D();
VecSet(&checkMax, 0, 4.0);
VecSet(&checkMax, 1, 5.0);
if (!VecIsEqual(max, &checkMax)) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSGetMax failed");
    PBErrCatch(GDataSetErr);
}
VecFree(&max);
GDSMeanCenter(&gdataset);
VecFloat2D checkMeanCenter[3];
for (int i = 0; i < GDSGetSize(&gdataset); ++i) {
    checkMeanCenter[i] = VecFloatCreateStatic2D();
    VecSet(checkMeanCenter + i, 0, -2.0 + (float)i * 2.0);
    VecSet(checkMeanCenter + i, 1, -2.0 + (float)i * 2.0);
}
GSetIterForward iter = GSetIterForwardCreateStatic(
    GDSSamples(&gdataset));
int i = 0;
do {
    VecFloat* sample = GSetIterGet(&iter);
    if (!VecIsEqual(sample, checkMeanCenter + i)) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSMeanCenter failed");
        PBErrCatch(GDataSetErr);
    }
} while (GSetIterStep(&iter) && ++i);

GDataSetVecFloatFreeStatic(&gdataset);
printf("UnitTestGDataSetVecFloatGet OK\n");
}

void UnitTestGDataSetVecFloatSplitUnsplit() {
    srandom(1);
    char* cfgFilePath = "testGDataSetVecFloat.json";
    GDataSetVecFloat gdataset =
        GDataSetVecFloatCreateStaticFromFile(cfgFilePath);

```

```

VecShort* split = VecShortCreate(2);
VecSet(split, 0, 1);
VecSet(split, 1, 2);
GDSSplit(&gdataset, split);
if (GDSGetNbCat(&gdataset) != 2) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSSplit failed");
    PBErrCatch(GDataSetErr);
}
if (GDSGetSizeCat(&gdataset, 0) != 1 ||
    GDSGetSizeCat(&gdataset, 1) != 2) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSSplit failed");
    PBErrCatch(GDataSetErr);
}
if (GDSGetSizeCat(&gdataset, 0) != GSetNbElem(gdataset._dataSet._categories) ||
    GDSGetSizeCat(&gdataset, 1) != GSetNbElem(gdataset._dataSet._categories + 1)) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSSplit failed");
    PBErrCatch(GDataSetErr);
}
GDSUnsplit(&gdataset);
if (GDSGetNbCat(&gdataset) != 1) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSUnsplit failed");
    PBErrCatch(GDataSetErr);
}
VecFree(&split);
GDataSetVecFloatFreeStatic(&gdataset);
printf("UnitTestGDataSetVecFloatSplitUnsplit OK\n");
}

void UnitTestGDataSetVecFloatShuffle() {
    srand(1);
    char* cfgFilePath = "testGDataSetVecFloat.json";
    GDataSetVecFloat gdataset =
        GDataSetVecFloatCreateStaticFromFile(cfgFilePath);
    GDSShuffle(&gdataset, 0);
    GDataSet* g = (GDataSet*)(&gdataset);
    if (GSetGet(g->_categories, 0) != GSetGet(&(g->_samples), 1)/* ||
        GSetGet(g->_categories, 1) != GSetGet(&(g->_samples), 0) ||
        GSetGet(g->_categories, 2) != GSetGet(&(g->_samples), 1)*/) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSShuffle failed");
        PBErrCatch(GDataSetErr);
    }
    GDataSetVecFloatFreeStatic(&gdataset);
    printf("UnitTestGDataSetVecFloatShuffle OK\n");
}

void UnitTestGDataSetVecFloatStepSampleGetSample() {
    srand(1);
    char* cfgFilePath = "testGDataSetVecFloat.json";
    GDataSetVecFloat gdataset =
        GDataSetVecFloatCreateStaticFromFile(cfgFilePath);
    int iSample = 0;
    float check[6] = {0.0, 1.0, 2.0, 3.0, 4.0, 5.0};
    do {
        VecFloat* sample = GDSGetSample(&gdataset, 0);
        if (ISEQUALF(VecGet(sample, 0), check[iSample * 2]) == false ||
            ISEQUALF(VecGet(sample, 1), check[iSample * 2 + 1]) == false) {
            GDataSetErr->_type = PBErrTypeUnitTestFailed;
        }
    } while (1);
}

```



```

        sprintf(GDataSetErr->_msg, "GDSGetSample failed");
        PBErrCatch(GDataSetErr);
    }
    VecFree(&sample);
    VecFloat* inputs = GDSGetSampleInputs(&gdataset, 0);
    VecFloat* outputs = GDSGetSampleOutputs(&gdataset, 0);
    if (ISEQUALF(VecGet(inputs, 0), check[iSample * 2]) == false) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSGetSampleInputs failed");
        PBErrCatch(GDataSetErr);
    }
    if (ISEQUALF(VecGet(outputs, 0), check[iSample * 2 + 1]) == false) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSGetSampleOutputs failed");
        PBErrCatch(GDataSetErr);
    }
    VecFree(&inputs);
    VecFree(&outputs);
    ++iSample;
} while (GDSSStepSample(&gdataset, 0));
GDataSetVecFloatFreeStatic(&gdataset);
printf("UnitTestGDataSetVecFloatStepSampleGetSample OK\n");
}

void UnitTestGDataSetVecFloatCovariance() {
    srandom(1);
    char* cfgFilePath = "testGDataSetVecFloatCovariance.json";
    GDataSetVecFloat gdataset =
        GDataSetVecFloatCreateStaticFromFile(cfgFilePath);
    MatFloat* covariance = GDSGetCovarianceMatrix(&gdataset);
    float v[9] = {
        6.888888, 6.0, 5.111111,
        6.0, 6.0, 6.0,
        5.111111, 6.0, 6.888888};
    VecShort2D i = VecShortCreateStatic2D();
    VecShort2D dim = VecShortCreateStatic2D();
    VecSet(&dim, 0, 3);
    VecSet(&dim, 1, 3);
    int j = 0;
    do {
        if (!ISEQUALF(MatGet(covariance, &i), v[j])) {
            GDataSetErr->_type = PBErrTypeUnitTestFailed;
            sprintf(GDataSetErr->_msg, "GDSGetCovarianceMatrix failed");
            PBErrCatch(GDataSetErr);
        }
        ++j;
    } while (VecStep(&i, &dim));
    MatFree(&covariance);
    GDataSetVecFloatFreeStatic(&gdataset);
    printf("UnitTestGDataSetVecFloatCovariance OK\n");
}

void UnitTestGDataSetVecFloatNormalize() {
    srandom(1);
    char* cfgFilePath = "testGDataSetVecFloatNormalize.json";
    GDataSetVecFloat gdataset =
        GDataSetVecFloatCreateStaticFromFile(cfgFilePath);
    GDSNormalize(&gdataset);
    GSetIterForward iter =
        GSetIterForwardCreateStatic(GDSSamples(&gdataset));
    float check[9] = {
        0.267261, 0.534522, 0.801784,

```

```

        0.683763,0.569803,0.455842,
        0.502571,0.574367,0.646162
    };
    int i = 0;
    do {
        VecFloat* v = GSetIterGet(&iter);
        if (!ISEQUALF(VecGet(v, 0), check[i * 3]) ||
            !ISEQUALF(VecGet(v, 1), check[i * 3 + 1]) ||
            !ISEQUALF(VecGet(v, 2), check[i * 3 + 2])) {
            GDataSetErr->_type = PBErrTypeUnitTestFailed;
            sprintf(GDataSetErr->_msg, "GDSNormalize failed");
            PBErrCatch(GDataSetErr);
        }
        ++i;
    } while(GSetIterStep(&iter));
    GDataSetVecFloatFreeStatic(&gdataset);
    printf("UnitTestGDataSetVecFloatNormalize OK\n");
}

void VecFloatCSVImporter(
    int col,
    char* val,
    VecFloat* sample) {
    if (col == 0) {
        if (*val == 'A') {
            VecSet(sample, col, 10.0);
        } else if (*val == 'B') {
            VecSet(sample, col, 20.0);
        }
    } else {
        VecSet(sample, col, atof(val));
    }
}

void UnitTestGDataSetVecFloatCreateFromCSVSave() {
    char* csvPath = "./unitTestVecFloatCSV.csv";
    GDSVecFloatCSVImporter importer =
        GDSVecFloatCSVImporterCreateStatic(
            1,
            ',',
            3,
            3,
            &VecFloatCSVImporter);
    GDataSetVecFloat dataset =
        GDataSetCreateStaticFromCSV(csvPath, &importer);
    if (GDSGetSize(&dataset) != 3 ||
        GDSGetNbCat(&dataset) != 1) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDataSetCreateStaticFromCSV failed");
        PBErrCatch(GDataSetErr);
    }
    float check[] = {
        10.0,1.0,2.0,
        10.0,3.0,4.0,
        20.0,5.0,6.0};
    for (int iSample = 0; iSample < GDSGetSize(&dataset); ++iSample) {
        for (unsigned int iCol = 0; iCol < importer._nbCol; ++iCol) {
            if (ISEQUALF(check[iSample * importer._nbCol + iCol],
                VecGet(GSetGet(GDSSamples(&dataset), iSample), iCol)) == false) {
                GDataSetErr->_type = PBErrTypeUnitTestFailed;
                sprintf(GDataSetErr->_msg, "GDataSetCreateStaticFromCSV failed");
                PBErrCatch(GDataSetErr);
            }
        }
    }
}

```

```

    }
}
}
FILE* stream = fopen("./unitTestVecFloatSave.json", "w");
if (GDSSave(&dataset, stream, false) == false) {
    GDataSetErr->_type = PBErrTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDataSetVecFloatSave failed");
    PBErrCatch(GDataSetErr);
}
fclose(stream);
GDataSetVecFloat load =
    GDataSetVecFloatCreateStaticFromFile("./unitTestVecFloatSave.json");
for (int iSample = 0; iSample < GDSGetSize(&dataset); ++iSample) {
    for (unsigned int iCol = 0; iCol < importer._nbCol; ++iCol) {
        if (ISEQUALF(check[iSample * importer._nbCol + iCol],
            VecGet(GSetGet(GDSSamples(&load), iSample), iCol)) == false) {
            GDataSetErr->_type = PBErrTypeUnitTestFailed;
            sprintf(GDataSetErr->_msg, "GDataSetVecFloatSave failed");
            PBErrCatch(GDataSetErr);
        }
    }
}
GDataSetVecFloatFreeStatic(&dataset);
GDataSetVecFloatFreeStatic(&load);
printf("UnitTestGDataSetVecFloatCreateFromCSVSave OK\n");
}

void UnitTestGDataSetVecFloatSaveCategory() {
    char* csvPath = "./unitTestVecFloatCSV.csv";
    GDSVecFloatCSVImporter importer =
        GDSVecFloatCSVImporterCreateStatic(
            1,
            ',',
            3,
            3,
            &VecFloatCSVImporter);
    GDataSetVecFloat dataset =
        GDataSetCreateStaticFromCSV(
            csvPath,
            &importer);
    VecShort2D split = VecShortCreateStatic2D();
    VecSet(&split, 0, 1);
    VecSet(&split, 1, 2);
    GDSSplit(&dataset, (VecShort*)&split);
    FILE* stream = fopen("./unitTestVecFloatSaveCategory.json", "w");
    GDSVecFloatSaveCategory(
        &dataset,
        stream,
        true,
        1);
    fclose(stream);
    GDataSetVecFloat load =
        GDataSetVecFloatCreateStaticFromFile(
            "./unitTestVecFloatSaveCategory.json");
    float check[] = {
        10.0, 3.0, 4.0,
        20.0, 5.0, 6.0};
    for (int iSample = 0; iSample < GDSGetSize(&load); ++iSample) {
        for (unsigned int iCol = 0; iCol < importer._nbCol; ++iCol) {
            if (ISEQUALF(check[iSample * importer._nbCol + iCol],
                VecGet(GSetGet(GDSSamples(&load), iSample), iCol)) == false) {
                GDataSetErr->_type = PBErrTypeUnitTestFailed;
            }
        }
    }
}

```

```

        sprintf(GDataSetErr->_msg, "GDataSetVecFloatSaveCategory failed");
        PBErrCatch(GDataSetErr);
    }
}
}
GDataSetVecFloatFreeStatic(&dataset);
GDataSetVecFloatFreeStatic(&load);
printf("UnitTestGDataSetVecFloatSaveCategory OK\n");
}

void UnitTestGDataSetVecFloatAddRemoveSample() {
    char* cfgFilePath = "testGDataSetVecFloatNormalize.json";
    GDataSetVecFloat dataset =
        GDataSetVecFloatCreateStaticFromFile(cfgFilePath);
    VecShort2D split = VecShortCreateStatic2D();
    VecSet(&split, 0, 1);
    VecSet(&split, 1, 2);
    GDSSplit(&dataset, (VecShort*)&split);
    GDSRemoveAllSample(&dataset);
    if (GDSGetNbCat(&dataset) != 1 ||
        GDSGetSize(&dataset) != 0) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSVecFloatRemoveAllSample failed");
        PBErrCatch(GDataSetErr);
    }
    VecFloat* sample = VecFloatCreate(3);
    GDSAddSample(&dataset, sample);
    if (GDSGetNbCat(&dataset) != 1 ||
        GDSGetSize(&dataset) != 1) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSVecFloatAddSample failed");
        PBErrCatch(GDataSetErr);
    }
    GDataSetVecFloatFreeStatic(&dataset);
    printf("UnitTestGDataSetVecFloatAddRemoveSample OK\n");
}

void UnitTestGDataSetVecFloatProxMatNearestNeighbour() {
    char* cfgFilePath = "testGDataSetVecFloat.json";
    GDataSetVecFloat dataset =
        GDataSetVecFloatCreateStaticFromFile(cfgFilePath);
    MatFloat* proxMat = GDSGetProxMat(&dataset, 0);
    float check[3][3] = {{0.0, 2.828427, 5.656854}, {2.828427, 0.0, 2.828427}, {5.656854, 2.828427, 0.0}};
    VecShort2D v = VecShortCreateStatic2D();
    do {
        if (!ISEQUALF(check[VecGet(&v, 0)][VecGet(&v, 1)],
            MatGet(proxMat, &v))) {
            GDataSetErr->_type = PBErrTypeUnitTestFailed;
            sprintf(GDataSetErr->_msg, "GDSGetProxMat failed");
            PBErrCatch(GDataSetErr);
        }
    } while(VecStep(&v, MatDim(proxMat)));
    VecFloat2D target = VecFloatCreateStatic2D();
    VecSet(&target, 0, 6.0);
    VecSet(&target, 1, 1.5);
    VecFloat* nearest =
        GDSNearestNeighbour(&dataset, (VecFloat*)&target, 0);
    VecFloat2D checkb = VecFloatCreateStatic2D();
    VecSet(&checkb, 0, 4.0);
    VecSet(&checkb, 1, 5.0);
    if (!VecIsEqual(nearest, &checkb)) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
    }
}

```

```

        sprintf(GDataSetErr->_msg, "GDSNearestNeighbour failed");
        PBErrCatch(GDataSetErr);
    }
    VecFree(&nearest);
    MatFree(&proxMat);
    GDataSetVecFloatFreeStatic(&dataset);

    srandom(time(NULL));
    for (int size = 100; size < 10000; size *= 2) {
        dataset = GDataSetVecFloatCreateStatic();
        dataset._dataSet._sampleDim = VecShortCreate(1);
        VecSet(dataset._dataSet._sampleDim, 0, 3);
        for (int iSample = size; iSample--;) {
            VecFloat* sample = VecFloatCreate(3);
            VecSet(sample, 0, (0.5 - rnd()) * 100.0);
            VecSet(sample, 1, (0.5 - rnd()) * 100.0);
            VecSet(sample, 2, (0.5 - rnd()) * 100.0);
            GDSAddSample(&dataset, sample);
        }
        VecShort* split = VecShortCreate(1);
        VecSet(split, 0, size);
        GDSSplit(&dataset, split);
        VecFree(&split);
        float delayAESA = 0.0;
        float delayBruteForce = 0.0;
        for (int iCheck = 10; iCheck--;) {
            VecFloat3D target3d = VecFloatCreateStatic3D();
            VecSet(&target3d, 0, (0.5 - rnd()) * 100.0);
            VecSet(&target3d, 1, (0.5 - rnd()) * 100.0);
            VecSet(&target3d, 2, (0.5 - rnd()) * 100.0);

            GDSResetAll(&dataset);
            clock_t clockBefore = clock();
            VecFloat* checkNearest = GDSVecFloatNearestNeighbourBrute(
                &dataset, (VecFloat*)&target3d, 0);
            clock_t clockAfter = clock();
            delayBruteForce += ((double)(clockAfter - clockBefore)) /
                CLOCKS_PER_SEC * 1000.0;

            clockBefore = clock();
            nearest = GDSVecFloatNearestNeighbourAESA(
                &dataset, (VecFloat*)&target3d, 0);
            clockAfter = clock();
            delayAESA += ((double)(clockAfter - clockBefore)) /
                CLOCKS_PER_SEC * 1000.0;

            if (!VecIsEqual(nearest, checkNearest)) {
                GDataSetErr->_type = PBErrTypeUnitTestFailed;
                sprintf(GDataSetErr->_msg, "GDSNearestNeighbour failed");
                PBErrCatch(GDataSetErr);
            }
            VecFree(&checkNearest);
        }
        printf("size: %d, ratio bruteForce/AESA: %f\n",
            size, delayBruteForce / delayAESA);
        GDataSetVecFloatFreeStatic(&dataset);
    }
    printf("UnitTestGDataSetVecFloatProxMatNearestNeighbour OK\n");
}

void UnitTestGDataSetVecFloat() {
    UnitTestGDataSetVecFloatCreateFreeClone();
}

```

```

    UnitTestGDataSetVecFloatGet();
    UnitTestGDataSetVecFloatSplitUnsplit();
    UnitTestGDataSetVecFloatShuffle();
    UnitTestGDataSetVecFloatStepSampleGetSample();
    UnitTestGDataSetVecFloatCovariance();
    UnitTestGDataSetVecFloatNormalize();
    UnitTestGDataSetVecFloatCreateFromCSVSave();
    UnitTestGDataSetVecFloatSaveCategory();
    UnitTestGDataSetVecFloatAddRemoveSample();
    UnitTestGDataSetVecFloatProxMatNearestNeighbour();
}

void UnitTestGDataSetGenBrushPair() {
    srand(1);
    char* cfgFilePath = "testGDataSetGenBrushPair.json";
    GDataSetGenBrushPair gdataset =
        GDataSetGenBrushPairCreateStaticFromFile(cfgFilePath);
    if (GDSGetNbMask(&gdataset) != 2) {
        GDataSetErr->_type = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSGetSample<GenBrushPair> failed");
        PBErrCatch(GDataSetErr);
    }
    int iCat = 0;
    do {
        GDSGenBrushPair* sample = GDSGetSample(&gdataset, iCat);
        if (VecIsEqual(GBDim(sample->_img),
            GDSSampleDim(&gdataset)) == false ||
            VecIsEqual(GBDim(sample->_mask[0]),
            GDSSampleDim(&gdataset)) == false ||
            VecIsEqual(GBDim(sample->_mask[1]),
            GDSSampleDim(&gdataset)) == false) {
            GDataSetErr->_type = PBErrTypeUnitTestFailed;
            sprintf(GDataSetErr->_msg, "GDSGetSample<GenBrushPair> failed");
            PBErrCatch(GDataSetErr);
        }
        GDSGenBrushPairFree(&sample);
    } while (GDSSStepSample(&gdataset, iCat));
    GDataSetGenBrushPairFreeStatic(&gdataset);
    printf("UnitTestGDataSetGenBrushPair OK\n");
}

void UnitTestSDSIA() {
    srand(1);
    char* cfgFilePath = "../SDSIA/UnitTestOut/002/001/dataset.json";
    GDataSetGenBrushPair gdataset =
        GDataSetGenBrushPairCreateStaticFromFile(cfgFilePath);
    int iCat = 0;
    do {
        GDSGenBrushPair* sample = GDSGetSample(&gdataset, iCat);
        if (VecIsEqual(GBDim(sample->_img),
            GDSSampleDim(&gdataset)) == false ||
            VecIsEqual(GBDim(sample->_mask[0]),
            GDSSampleDim(&gdataset)) == false ||
            VecIsEqual(GBDim(sample->_mask[1]),
            GDSSampleDim(&gdataset)) == false) {
            GDataSetErr->_type = PBErrTypeUnitTestFailed;
            sprintf(GDataSetErr->_msg, "GDSGetSample<GenBrushPair> failed");
            PBErrCatch(GDataSetErr);
        }
        GDSGenBrushPairFree(&sample);
    } while (GDSSStepSample(&gdataset, iCat));
    GDataSetGenBrushPairFreeStatic(&gdataset);
}

```

```

    printf("UnitTestSDSIA OK\n");
}

void UnitTestNNEvalCSVImporter(
    int col,
    char* val,
    VecFloat* sample) {
    if (col == 0) {
        if (*val == 'M') {
            VecSet(sample, 0, 1.0);
            VecSet(sample, 1, 0.0);
            VecSet(sample, 2, 0.0);
        } else if (*val == 'F') {
            VecSet(sample, 0, 0.0);
            VecSet(sample, 1, 1.0);
            VecSet(sample, 2, 0.0);
        } else if (*val == 'I') {
            VecSet(sample, 0, 0.0);
            VecSet(sample, 1, 0.0);
            VecSet(sample, 2, 1.0);
        }
    } else {
        VecSet(sample, col + 2, atof(val));
    }
}

void UnitTestGDataSetNNEval() {
    char* csvPath = "./unitTestNNEval.csv";
    GDSVecFloatCSVImporter importer =
        GDSVecFloatCSVImporterCreateStatic(
            0,
            ' ',
            9,
            11,
            &UnitTestNNEvalCSVImporter);
    GDataSetVecFloat dataset =
        GDataSetCreateStaticFromCSV(csvPath, &importer);
    NeuraNet* nn = NULL;
    FILE* fp = fopen("./unitTestNNEval.json", "r");
    (void)NNLoad(&nn, fp);
    fclose(fp);
    VecShort* inputs = VecShortCreate(10);
    for (int i = 10; i--;)
        VecSet(inputs, i, i);
    VecShort* outputs = VecShortCreate(1);
    VecSet(outputs, 0, 10);
    int iCat = 0;
    float threshold = -1000.0;
    float val = GDSEvaluateNN(
        &dataset,
        nn,
        iCat,
        inputs,
        outputs,
        threshold);
    if (!ISEQUALF(val, -1.672186)) {
        GDataSetErr->_type = PErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSEvaluateNN failed");
        PErrCatch(GDataSetErr);
    }
    VecFree(&inputs);
    VecFree(&outputs);
}

```

```

    NeuraNetFree(&nn);
    GDataSetVecFloatFreeStatic(&dataset);
    printf("UnitTestNNEval OK\n");
}

void UnitTestAll() {
    UnitTestGDataSetVecFloat();
    UnitTestGDataSetGenBrushPair();
    UnitTestGDataSetNNEval();
    UnitTestSDSIA();
}

int main(void) {
    UnitTestAll();

    return 0;
}

```

## 6 Unit test output

```

UnitTestGDataSetVecFloatCreateFreeClone OK
UnitTestGDataSetVecFloatGet OK
UnitTestGDataSetVecFloatSplitUnsplit OK
UnitTestGDataSetVecFloatShuffle OK
UnitTestGDataSetVecFloatStepSampleGetSample OK
UnitTestGDataSetVecFloatCovariance OK
UnitTestGDataSetVecFloatNormalize OK
UnitTestGDataSetVecFloatCreateFromCSVSave OK
UnitTestGDataSetVecFloatSaveCategory OK
UnitTestGDataSetVecFloatAddRemoveSample OK
size: 100, ratio bruteForce/AESA: 0.097640
size: 200, ratio bruteForce/AESA: 0.056180
size: 400, ratio bruteForce/AESA: 0.026662
size: 800, ratio bruteForce/AESA: 0.024791
size: 1600, ratio bruteForce/AESA: 0.005881
size: 3200, ratio bruteForce/AESA: 0.001788
size: 6400, ratio bruteForce/AESA: 0.000696
UnitTestGDataSetVecFloatProxMatNearestNeighbour OK
UnitTestGDataSetGenBrushPair OK
UnitTestNNEval OK
UnitTestSDSIA OK

```