

# GDataSet

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## 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);
#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;
    // 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 _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 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. Samples are allocated // randomly to the categories.
// 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);

// 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 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 'inputs' and 'outputs'.
// input values in [-1,1] and output values in [-1,1]
// Stop the prediction of samples when the result can't get better
// than 'threhsold'
// 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 long iCat,
    const VecShort* const iInputs,
    const VecShort* const iOutputs,
    const float threshold);

// Create a new GDataSetVecFloat
GDataSetVecFloat GDataSetVecFloatCreateStatic();

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

#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 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)((const 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, \
    GDataSetVecFloat*: _GDSLoad, \
    GDataSetGenBrushPair*: _GDSLoad, \
    default: PBErrInvalidPolymorphism)((GDataSet*)DataSet, FP)

// ===== 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._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 _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");
            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));
// 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) {
#ifdef 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. Samples are allocated // randomly to the categories.
// 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);
    }
    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);
    // Shuffle the samples
    GSetShuffle(&(amp;that->_samples));
    // Declare an iterator on the samples
    GSetIterForward iter = GSetIterForwardCreateStatic(&(amp;that->_samples));
    // Loop on categories
    for (long iCat = nbCat; iCat--;) {
        // Get the nb of samples for this category
        long nbSample = VecGet(cat, iCat);
        // Loop on the sample
        for (long iSample = nbSample; iSample-- && GSetIterStep(&iter);) {
            // Get the next sample
            void* sample = GSetIterGet(&iter);
            // Add the sample to the category
            GSetAppend(that->_categories + iCat, sample);
        }
    }
    // 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) {
#ifdef 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);
}

GDSGenBrushPair* GDSGetSampleGenBrushPair(
    const GDataSetGenBrushPair* const that, const int iCat) {
#ifdef 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) {
    #if 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) {
    #if 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 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) {
    #if 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) {
    #if 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) {
#ifdef 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", GDSGetSize(that));
    JSONAddProp(json, "nbSample", 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) {
#ifdef 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));
    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) {
#ifdef BUILDMODE == 0
    if (that == NULL) {
        GDataSetErr->_type = PBErrTypeNullPointer;

```

```

        sprintf(GDataSetErr->_msg, "'that' is null");
        PBErCatch(GDataSetErr);
    }
    if (stream == NULL) {
        GDataSetErr->_type = PBErTypeNullPointer;
        sprintf(GDataSetErr->_msg, "'stream' is null");
        PBErCatch(GDataSetErr);
    }
#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 = PBErTypeNullPointer;
        sprintf(GDataSetErr->_msg, "'that' is null");
        PBErCatch(GDataSetErr);
    }
    if (stream == NULL) {
        GDataSetErr->_type = PBErTypeNullPointer;
        sprintf(GDataSetErr->_msg, "'stream' is null");
        PBErCatch(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 'inputs' and 'outputs'.
// input values in [-1,1] and output values in [-1,1]
// Stop the prediction of samples when the result can't get better
// than 'threhsold'

```

```

// 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 long 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() {
    // Declare the result GDataSetVecFloat

```

```

GDataSetVecFloat that;

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

// Return the dataset
return that;
}

```

## 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 = PErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PErrCatch(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 = PErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PErrCatch(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 = PErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PErrCatch(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 = PErrTypeNullPointer;
            sprintf(PBImgAnalysisErr->_msg, "'that' is null");
            PErrCatch(PBImgAnalysisErr);
        }
    #endif
}

```

```

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

```

### 3 Makefile

```

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

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)/3

```

## 4 Dataset configuration file

### 4.1 VecFloat

testGDataSetVecFloat.json:

```

{
  "dataSet": "testGDataSet",
  "dataSetType": "0",
  "desc": "UnitTestGDataSetCreateFree",
  "dim": {
    "_dim": "1",
    "_val": ["2"]
  },
  "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",
  "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"]
  },
  "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"
    ]
  },
  "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");
    }
}

```



```

    PBErCatch(GDataSetErr);
}
if (strcmp(GDSName(&gdataset), "testGDataSet") != 0) {
    GDataSetErr->_type = PBErTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSName failed");
    PBErCatch(GDataSetErr);
}
if (GDSGetType(&gdataset) != GDataSetType_VecFloat) {
    GDataSetErr->_type = PBErTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSGetType failed");
    PBErCatch(GDataSetErr);
}
if (GDSGetNbCat(&gdataset) != 1) {
    GDataSetErr->_type = PBErTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSGetNbCat failed");
    PBErCatch(GDataSetErr);
}
if (GDSGetSize(&gdataset) != 3) {
    GDataSetErr->_type = PBErTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSGetSize failed");
    PBErCatch(GDataSetErr);
}
if (GDSGetSizeCat(&gdataset, 0) != 3) {
    GDataSetErr->_type = PBErTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSGetSizeCat failed");
    PBErCatch(GDataSetErr);
}
if ((GSet*)GDSSamples(&gdataset) != &(gdataset._dataSet._samples)) {
    GDataSetErr->_type = PBErTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSSamples failed");
    PBErCatch(GDataSetErr);
}
VecShort* dim = VecShortCreate(1);
VecSet(dim, 0, 2);
if (VecIsEqual(GDSSampleDim(&gdataset), dim) != true) {
    GDataSetErr->_type = PBErTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSSampleDim failed");
    PBErCatch(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 = PBErTypeUnitTestFailed;
    sprintf(GDataSetErr->_msg, "GDSGetMean failed");
    PBErCatch(GDataSetErr);
}
VecFree(&mean);
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 = PErrTypeUnitTestFailed;
            sprintf(GDataSetErr->_msg, "GDSMeanCenter failed");
            PErrCatch(GDataSetErr);
        }
    } while (GSetIterStep(&iter) && ++i);

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

void UnitTestGDataSetVecFloatSplitUnsplit() {
    srand(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 = PErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSSplit failed");
        PErrCatch(GDataSetErr);
    }
    if (GDSGetSizeCat(&gdataset, 0) != 1 ||
        GDSGetSizeCat(&gdataset, 1) != 2) {
        GDataSetErr->_type = PErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSSplit failed");
        PErrCatch(GDataSetErr);
    }
    GDSUnsplit(&gdataset);
    if (GDSGetNbCat(&gdataset) != 1) {
        GDataSetErr->_type = PErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSUnsplit failed");
        PErrCatch(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 = PErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSShuffle failed");
        PErrCatch(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;
        sprintf(GDataSetErr->_msg, "GDSGetSample failed");
        PBErrCatch(GDataSetErr);
    }
    VecFree(&sample);
    ++iSample;
} while (GDSStepSample(&gdataset, 0));
GDataSetVecFloatFreeStatic(&gdataset);
printf("UnitTestGDataSetVecFloatStepSampleGetSample OK\n");
}

void UnitTestGDataSetVecFloatCovariance() {
    srand(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() {
    srand(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[] = {
        20.0, 5.0, 6.0,
        10.0, 1.0, 2.0};
    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("UnitTestDataSetVecFloatCreateFromCSVSave OK\n");
}

void UnitTestDataSetVecFloat() {
    UnitTestDataSetVecFloatCreateFreeClone();
    UnitTestDataSetVecFloatGet();
    UnitTestDataSetVecFloatSplitUnsplit();
    UnitTestDataSetVecFloatShuffle();
    UnitTestDataSetVecFloatStepSampleGetSample();
    UnitTestDataSetVecFloatCovariance();
    UnitTestDataSetVecFloatNormalize();
    UnitTestDataSetVecFloatCreateFromCSVSave();
    UnitTestDataSetVecFloatSaveCategory();
}

void UnitTestDataSetGenBrushPair() {
    srand(1);
    char* cfgFilePath = "testGDataSetGenBrushPair.json";
    GDataSetGenBrushPair gdataset =
        GDataSetGenBrushPairCreateStaticFromFile(cfgFilePath);
    if (GDSGetNbMask(&gdataset) != 2) {
        GDataSetErr->_type = PErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSGetSample<GenBrushPair> failed");
        PErrCatch(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 = PErrTypeUnitTestFailed;
            sprintf(GDataSetErr->_msg, "GDSGetSample<GenBrushPair> failed");
            PErrCatch(GDataSetErr);
        }
        GDSGenBrushPairFree(&sample);
    } while (GDSSampleDim(&gdataset, iCat));
    GDataSetGenBrushPairFreeStatic(&gdataset);
    printf("UnitTestDataSetGenBrushPair OK\n");
}

void UnitTestSDSIA() {
    srand(1);
    char* cfgFilePath = "../SDSIA/UnitTestDataOut/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 = PErrTypeUnitTestFailed;

```

```

        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";
    GDSEVecFloatCSVImporter 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 = PBErrTypeUnitTestFailed;
        sprintf(GDataSetErr->_msg, "GDSEvaluateNN failed");
        PBErrCatch(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
UnitTestGDataSetVecFloatCreateFromCSVSave OK
UnitTestGDataSetGenBrushPair OK
UnitTestNNEval OK
UnitTestSDSIA OK

```