ParallelKmenasIgnageCompressor

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Chapter 1

Parallel Kmeans Images Compressor

This program compresses images by reducing the number of colors using k-means clustering. It offers enhanced performance through the implementation of several parallelization techniques. By clustering pixels into k color groups, the program reduces the image's color palette, thereby compressing the image while maintaining visual quality.

1.1 Doxygen Documentation

The documentation of the project can be found here.

1.2 Prerequisites

In order to be able to compile and run the program, there are a few programs that need to be installed.

1.2.1 OpenCV C++ Library

A comprehensive library for computer vision and image processing tasks.

You can refer to the official page to download.

1.2.2 Mpicc

A C compiler wrapper for parallel programming with the MPI library.

1.2.3 OpenMP

A C++ API for parallel programming on shared-memory systems.

1.3 Getting Started

To compile the project, navigate to the project root directory in your terminal and run the following command:
```
make
```

Once you have compiled you can execute the main program by:
```
./exe
```

1.4 What to expect

Once the program is started, the following screen appears, through which it is possible to compress a new image or decompress an already compressed image.

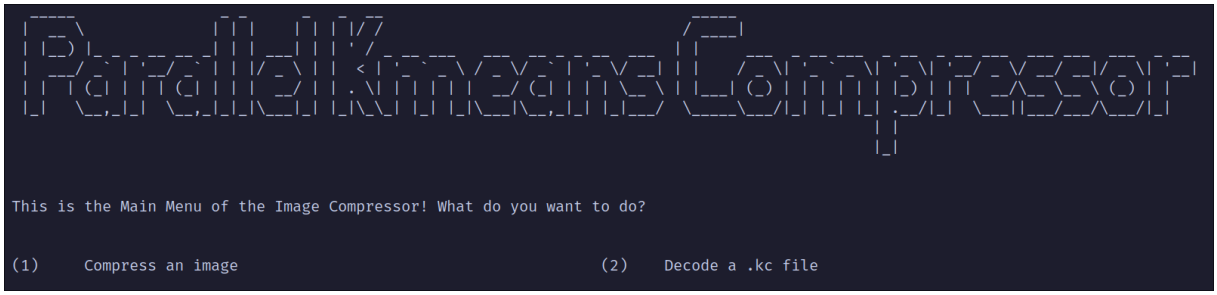

Figure 1.1 alt text

If you choose the "Compress an image" option you can select one type of compressor (sequential, MPI or OpenMP), the type of compression and the path of the original image.

The result image will be created in the output folder and you can rerun `./exe` selecting the decoding function to decode it.

1.5 Project Structure

The project is organized as follows:

1.5.0.1 Folders

- `benchmarkImages`: This folder contains the images used for benchmarking the program. It can be used to test the program's performance.
- `outputs`: This folder contains the compressed images. After installing the program, you may notice that the outputs folder is not present. However, don't worry! It will be automatically created during the first execution of the program.
- `include`: This folder contains the header files of the project. These define the classes and functions that are used in the program.
- `src`: This folder contains the source files of the project. These files contain the implementation of the classes and functions defined in the header files.
- `build`: This folder contains the object files generated during the compilation process.

1.5.0.2 Files and Executables

- `exe`: This is the executable file generated after compiling the project. It is the main program that can be executed to compress or decompress images.
- `Makefile`: This file contains the instructions for compiling the project. It specifies the dependencies and the commands to compile the project.
- `.config`: This file contains the configuration of the program. It is used to store some hyperparameters that can be modified to change the behavior of the program.

1.6 How does it work?

The program compresses images by reducing the number of colors in the image. It does this by clustering the pixels into k color groups using the k-means clustering algorithm. The k-means algorithm is an unsupervised learning algorithm that partitions the data into k clusters based on the similarity of the data points. In the context of image compression, the data points are the pixels of the image, and the clusters are the colors that represent the image.

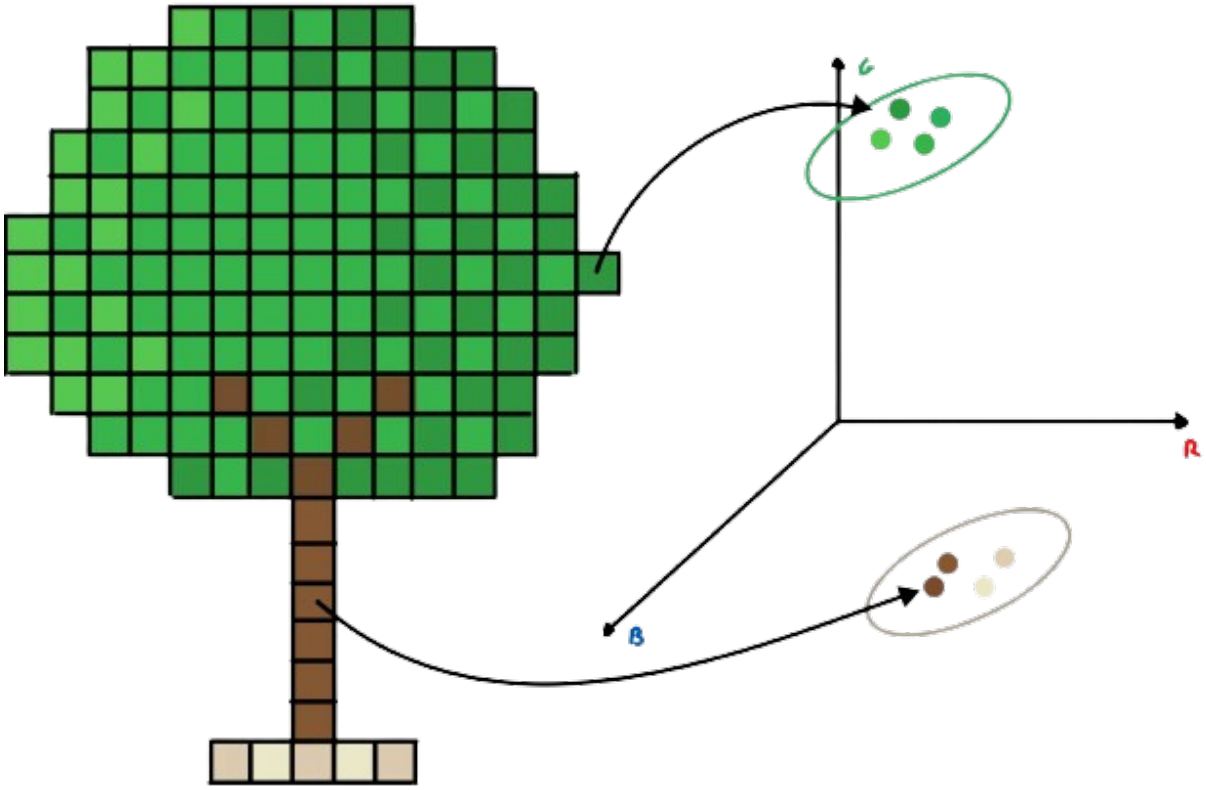

Figure 1.2 tree

The k-means algorithm works as follows:

1. Initialize k centroids randomly.
2. Assign each data point to the nearest centroid.
3. Recompute the centroids based on the data points assigned to them.
4. Repeat steps 2 and 3 until convergence.

The k-means algorithm is an iterative algorithm that converges to a local minimum. The quality of the compression depends on the value of k, the number of clusters. A higher value of k will result in a better representation of the image but will require more memory to store the centroids.

1.7 Parallelization Techniques

The program uses several parallelization techniques to enhance performance. These techniques include:

- **OpenMP**: OpenMP is an API for parallel programming on shared-memory systems. It allows the program to parallelize the computation of the k-means algorithm by distributing the work among multiple threads.
- **MPI**: MPI is a message-passing library for parallel programming on distributed-memory systems. It allows the program to parallelize the computation of the k-means algorithm by distributing the work among multiple processes running on different nodes.

1.8 Benchmarking

The program includes a benchmarking feature that allows you to test the performance of the program on different images. The benchmarking feature measures the time taken to compress an image using different compression techniques and different values of k. The benchmarking results are displayed in a table that shows the time taken to compress the image for each value of k and each compression technique.

1.9 Authors

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Chapter 2

Namespace Index

2.1 Namespace List

Here is a list of all namespaces with brief descriptions:

Chapter 3

Hierarchical Index

3.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 4

Class Index

4.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 5

File Index

5.1 File List

Here is a list of all files with brief descriptions:

Chapter 6

Namespace Documentation

6.1 km Namespace Reference

Main namespace for the project.

Namespaces

- namespace filesUtils

  Provides utility functions for file handling.
- namespace imageUtils

  Provides utility functions for image processing.
- namespace utilsCLI

  Provides utility functions for the command-line interface.

Classes

- class ConfigReader

  Reads and stores configuration values from a file.
- class KMeansBase

  Base class for K-means clustering algorithm.
- class KMeansCUDA

  Represents the K-means clustering algorithm using CUDA.
- class KMeansMPI

  Represents the K-means clustering algorithm using MPI.
- class KMeansOMP

  Represents the K-means clustering algorithm using OpenMP.
- class KMeansSequential

  Represents the K-means clustering algorithm.
- class Performance

  Represents the performance evaluation.
- class Point

  Represents a point in a feature space.

6.1.1 Detailed Description

Main namespace for the project.

The `km` namespace encapsulates various functionalities related to data clustering, file manipulation, and image processing. It is designed to organize core utilities and algorithms used across different modules of the project.

6.2 km::filesUtils Namespace Reference

Provides utility functions for file handling.

Functions

- auto createOutputDirectories () -> void

  Creates output directories.
- auto writeBinaryFile (std::string &outputPath, int &width, int &height, int &k, std::vector< Point > points, std::vector< Point > centroids) -> void

  Writes data to a binary file.
- auto isCorrectExtension (const std::filesystem::path &filePath, const std::string &correctExtension) -> bool

  Checks if a file has the correct extension.
- auto createDecodingMenu (std::filesystem::path &decodeDir, std::vector< std::filesystem::path > &imageNames) -> void

  Creates a decoding menu.
- auto readBinaryFile (std::string &path, cv::Mat &imageCompressed) -> int

  Reads a binary file and reconstructs the compressed image.

6.2.1 Detailed Description

Provides utility functions for file handling.

6.2.2 Function Documentation

6.2.2.1 createDecodingMenu()

```
auto km::filesUtils::createDecodingMenu (
            std::filesystem::path & decodeDir,
            std::vector< std::filesystem::path > & imageNames ) -> void
```

Creates a decoding menu.

Parameters

decodeDir	Directory for decoding
imageNames	Vector of image names

6.2.2.2 createOutputDirectories()

```
auto km::filesUtils::createOutputDirectories ( ) -> void
```

Creates output directories.

6.2.2.3 isCorrectExtension()

```
auto km::filesUtils::isCorrectExtension (
            const std::filesystem::path & filePath,
            const std::string & correctExtension ) -> bool
```

Checks if a file has the correct extension.

Parameters

filePath	Path of the file
correctExtension	Correct extension to check

Returns

True if the file has the correct extension, false otherwise

6.2.2.4 readBinaryFile()

```
auto km::filesUtils::readBinaryFile (
            std::string & path,
            cv::Mat & imageCompressed ) -> int
```

Reads a binary file and reconstructs the compressed image.

Parameters

path	Path of the binary file
imageCompressed	Compressed image matrix

Returns

Number of clusters

6.2.2.5 writeBinaryFile()

```
auto km::filesUtils::writeBinaryFile (
            std::string & outputPath,
            int & width,
            int & height,
            int & k,
```

```
            std::vector< Point > points,
            std::vector< Point > centroids ) -> void
```

Writes data to a binary file.

Parameters

outputPath	Path of the output file
width	Width of the image
height	Height of the image
k	Number of clusters
points	Vector of points
centroids	Vector of centroids

6.3 km::imageUtils Namespace Reference

Provides utility functions for image processing.

Functions

- void preprocessing (cv::Mat &image, int &typeCompressionChoice)

  Performs preprocessing on an image.
- void defineKValue (int &k, int levelsColorsChoice, std::set< std::vector< unsigned char > > &different_↩ colors)

  Defines the value of K based on the color levels choice.
- void pointsFromImage (cv::Mat &image, std::vector< Point > &points, std::set< std::vector< unsigned char > > &different_colors)

  Extracts points from an image.

6.3.1 Detailed Description

Provides utility functions for image processing.

6.3.2 Function Documentation

6.3.2.1 defineKValue()

```
void km::imageUtils::defineKValue (
            int & k,
            int levelsColorsChoice,
            std::set< std::vector< unsigned char > > & different_colors )
```

Defines the value of K based on the color levels choice.

Parameters

k	Value of K
levelsColorsChoice	Levels of colors choice
different_colors	Set of different colors in the image

6.3.2.2 pointsFromImage()

```
void km::imageUtils::pointsFromImage (
            cv::Mat & image,
            std::vector< Point > & points,
            std::set< std::vector< unsigned char > > & different_colors )
```

Extracts points from an image.

Parameters

image	Input image
points	Vector of points
different_colors	Set of different colors in the image

6.3.2.3 preprocessing()

```
void km::imageUtils::preprocessing (
            cv::Mat & image,
            int & typeCompressionChoice )
```

Performs preprocessing on an image.

Parameters

image	Input image
typeCompressionChoice	Type of compression choice

6.4 km::utilsCLI Namespace Reference

Provides utility functions for the command-line interface.

Functions

- void sequentialEncoderHeader ()

  Displays the header for the sequential encoder.
- void mpiEncoderHeader ()

  Displays the header for the MPI encoder.
- void ompEncoderHeader ()

  Displays the header for the OpenMP encoder.
- void mainMenuHeader ()

  Displays the main menu header.
- void decoderHeader ()

  Displays the decoder header.
- void workDone ()

  Displays the work done message.

- void compressionChoices (int &levelsColorsChoice, int &typeCompressionChoice, std::string &outputPath, cv::Mat &image, int executionStandard)

  Handles the compression choices.
- void printCompressionInformations (int &originalWidth, int &originalHeight, int &width, int &height, int &k, size_t &different_colors_size)

  Prints the compression information.
- void displayDecodingMenu (std::string &path, std::vector< std::filesystem::path > &imageNames, std::filesystem::path &decodeDir)

  Displays the decoding menu.

6.4.1 Detailed Description

Provides utility functions for the command-line interface.

6.4.2 Function Documentation

6.4.2.1 compressionChoices()

```
void km::utilsCLI::compressionChoices (
            int & levelsColorsChoice,
            int & typeCompressionChoice,
            std::string & outputPath,
            cv::Mat & image,
            int executionStandard )
```

Handles the compression choices.

Parameters

levelsColorsChoice	Choice of color levels
typeCompressionChoice	Choice of compression type
outputPath	Output path
image	Input image
executionStandard	Execution standard

6.4.2.2 decoderHeader()

```
void km::utilsCLI::decoderHeader ( )
```

Displays the decoder header.

6.4.2.3 displayDecodingMenu()

```
void km::utilsCLI::displayDecodingMenu (
            std::string & path,
            std::vector< std::filesystem::path > & imageNames,
            std::filesystem::path & decodeDir )
```

Displays the decoding menu.

Parameters

path	Path of the directory containing the compressed images
imageNames	Vector of image names
decodeDir	Path of the decoding directory

6.4.2.4 mainMenuHeader()

```
void km::utilsCLI::mainMenuHeader ( )
```

Displays the main menu header.

6.4.2.5 mpiEncoderHeader()

```
void km::utilsCLI::mpiEncoderHeader ( )
```

Displays the header for the MPI encoder.

6.4.2.6 ompEncoderHeader()

```
void km::utilsCLI::ompEncoderHeader ( )
```

Displays the header for the OpenMP encoder.

6.4.2.7 printCompressionInformations()

```
void km::utilsCLI::printCompressionInformations (
            int & originalWidth,
            int & originalHeight,
            int & width,
            int & height,
            int & k,
            size_t & different_colors_size )
```

Prints the compression information.

Parameters

originalWidth	Original width of the image
originalHeight	Original height of the image
width	Width of the compressed image
height	Height of the compressed image
k	Number of clusters
different_colors_size	Number of different colors

6.4.2.8 sequentialEncoderHeader()

```
void km::utilsCLI::sequentialEncoderHeader ( )
```

Displays the header for the sequential encoder.

6.4.2.9 workDone()

```
void km::utilsCLI::workDone ( )
```

Displays the work done message.

Chapter 7

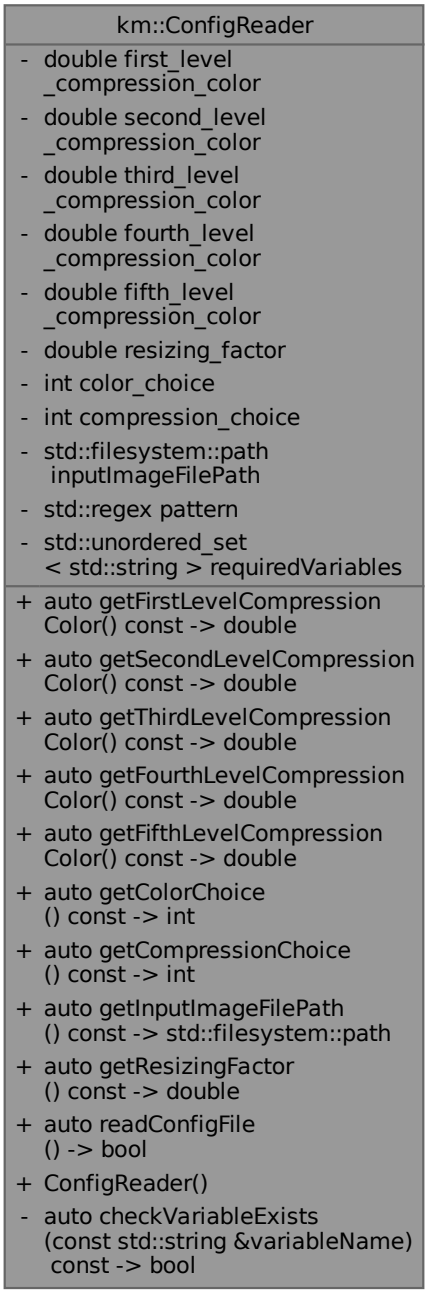
Class Documentation

7.1 km::ConfigReader Class Reference

Reads and stores configuration values from a file.

`#include <configReader.hpp>`

Collaboration diagram for km::ConfigReader:



Public Member Functions

- auto getFirstLevelCompressionColor () const -> double

  Gets the first level compression color value.
- auto getSecondLevelCompressionColor () const -> double

  Gets the second level compression color value.
- auto getThirdLevelCompressionColor () const -> double

Gets the third level compression color value.

- auto getFourthLevelCompressionColor () const -> double

  Gets the fourth level compression color value.
- auto getFifthLevelCompressionColor () const -> double

  Gets the fifth level compression color value.
- auto getColorChoice () const -> int

  Gets the color choice.
- auto getCompressionChoice () const -> int

  Gets the compression choice.
- auto getInputImageFilePath () const -> std::filesystem::path

  Gets the input image file path.
- auto getResizingFactor () const -> double

  Gets the resizing factor.
- auto readConfigFile () -> bool

  Reads the configuration file.
- ConfigReader ()

Private Member Functions

- auto checkVariableExists (const std::string &variableName) const -> bool

Private Attributes

- double first_level_compression_color = 0.

  First level compression color value.
- double second_level_compression_color = 0.

  Second level compression color value.
- double third_level_compression_color = 0.

  Third level compression color value.
- double fourth_level_compression_color = 0.

  Fourth level compression color value.
- double fifth_level_compression_color = 0.

  Fifth level compression color value.
- double resizing_factor = 0.

  Resizing factor.
- int color_choice = 0

  Color choice.
- int compression_choice = 0

  Compression choice.
- std::filesystem::path inputImageFilePath

  Input image file path.
- std::regex pattern

  Regular expression pattern.
- std::unordered_set< std::string > requiredVariables = {}

  Set of required variables.

7.1.1 Detailed Description

Reads and stores configuration values from a file.

7.1.2 Constructor & Destructor Documentation

7.1.2.1 ConfigReader()

```
km::ConfigReader::ConfigReader ( )
```

7.1.3 Member Function Documentation

7.1.3.1 checkVariableExists()

```
auto km::ConfigReader::checkVariableExists (
            const std::string & variableName ) const -> bool  [private]
```

7.1.3.2 getColorChoice()

```
auto km::ConfigReader::getColorChoice ( ) const -> int
```

Gets the color choice.

Returns

Color choice

7.1.3.3 getCompressionChoice()

```
auto km::ConfigReader::getCompressionChoice ( ) const -> int
```

Gets the compression choice.

Returns

Compression choice

7.1.3.4 getFifthLevelCompressionColor()

```
auto km::ConfigReader::getFifthLevelCompressionColor ( ) const -> double
```

Gets the fifth level compression color value.

Returns

Fifth level compression color value

7.1.3.5 getFirstLevelCompressionColor()

```
auto km::ConfigReader::getFirstLevelCompressionColor ( ) const -> double
```

Gets the first level compression color value.

Returns

First level compression color value

7.1.3.6 getFourthLevelCompressionColor()

```
auto km::ConfigReader::getFourthLevelCompressionColor ( ) const -> double
```

Gets the fourth level compression color value.

Returns

Fourth level compression color value

7.1.3.7 getInputImageFilePath()

```
auto km::ConfigReader::getInputImageFilePath ( ) const -> std::filesystem::path
```

Gets the input image file path.

Returns

Input image file path

7.1.3.8 getResizingFactor()

```
auto km::ConfigReader::getResizingFactor ( ) const -> double
```

Gets the resizing factor.

Returns

Resizing factor

7.1.3.9 getSecondLevelCompressionColor()

```
auto km::ConfigReader::getSecondLevelCompressionColor ( ) const -> double
```

Gets the second level compression color value.

Returns

Second level compression color value

7.1.3.10 getThirdLevelCompressionColor()

```
auto km::ConfigReader::getThirdLevelCompressionColor ( ) const -> double
```

Gets the third level compression color value.

Returns

Third level compression color value

7.1.3.11 readConfigFile()

```
auto km::ConfigReader::readConfigFile ( ) -> bool
```

Reads the configuration file.

Returns

True if the configuration file is read successfully, false otherwise

7.1.4 Member Data Documentation

7.1.4.1 color_choice

```
int km::ConfigReader::color_choice = 0  [private]
```

Color choice.

7.1.4.2 compression_choice

```
int km::ConfigReader::compression_choice = 0  [private]
```

Compression choice.

7.1.4.3 fifth_level_compression_color

```
double km::ConfigReader::fifth_level_compression_color = 0.  [private]
```

Fifth level compression color value.

7.1.4.4 first_level_compression_color

```
double km::ConfigReader::first_level_compression_color = 0.  [private]
```

First level compression color value.

7.1.4.5 fourth_level_compression_color

```
double km::ConfigReader::fourth_level_compression_color = 0.  [private]
```

Fourth level compression color value.

7.1.4.6 inputImageFilePath

```
std::filesystem::path km::ConfigReader::inputImageFilePath  [private]
```

Input image file path.

7.1.4.7 pattern

```
std::regex km::ConfigReader::pattern  [private]
```

Regular expression pattern.

7.1.4.8 requiredVariables

```
std::unordered_set<std::string> km::ConfigReader::requiredVariables = {}  [private]
```

Set of required variables.

7.1.4.9 resizing_factor

```
double km::ConfigReader::resizing_factor = 0.  [private]
```

Resizing factor.

7.1.4.10 second_level_compression_color

```
double km::ConfigReader::second_level_compression_color = 0.  [private]
```

Second level compression color value.

7.1.4.11 third_level_compression_color

```
double km::ConfigReader::third_level_compression_color = 0.  [private]
```

Third level compression color value.

The documentation for this class was generated from the following file:

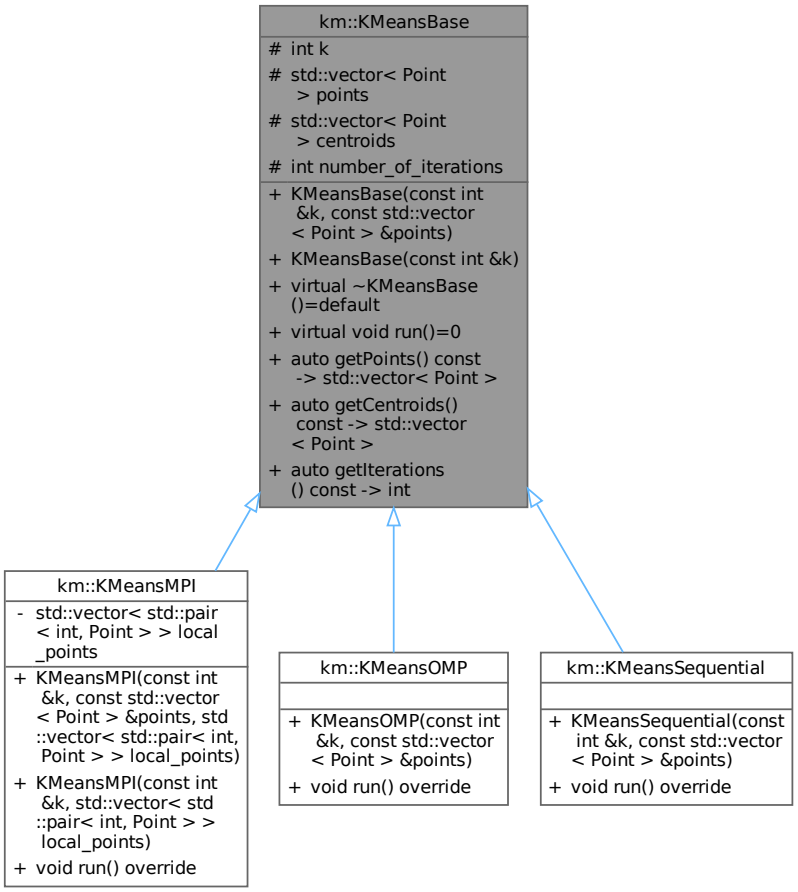
- include/configReader.hpp

7.2 km::KMeansBase Class Reference

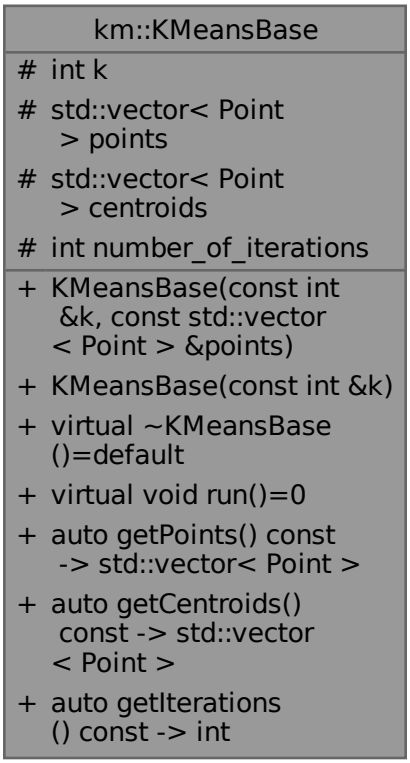
Base class for K-means clustering algorithm.

`#include <kMeansBase.hpp>`

Inheritance diagram for km::KMeansBase:



Collaboration diagram for km::KMeansBase:



Public Member Functions

- KMeansBase (const int &k, const std::vector< Point > &points)

  Constructor for KMeansBase.
- KMeansBase (const int &k)

  Constructs a KMeansBase object only with the specified number of clusters.
- virtual ~KMeansBase ()=default

  Virtual destructor for KMeansBase.
- virtual void run ()=0

  Runs the K-means clustering algorithm.
- auto getPoints () const -> std::vector< Point >

  Gets the poinots.
- auto getCentroids () const -> std::vector< Point >

  Gets the centroids.
- auto getIterations () const -> int

  Gets the number of iterations.

Protected Attributes

- int k

  Number of clusters.
- std::vector< Point > points

  Vector of points.
- std::vector< Point > centroids

  Vector of centroids.
- int number_of_iterations

  Number of iterations.

7.2.1 Detailed Description

Base class for K-means clustering algorithm.

7.2.2 Constructor & Destructor Documentation

7.2.2.1 KMeansBase() [1/2]

```
km::KMeansBase::KMeansBase (
            const int & k,
            const std::vector< Point > & points )
```

Constructor for KMeansBase.

Parameters

k	Number of clusters
points	Vector of points

7.2.2.2 KMeansBase() [2/2]

```
km::KMeansBase::KMeansBase (
            const int & k )
```

Constructs a KMeansBase object only with the specified number of clusters.

Parameters

k	The number of clusters.

7.2.2.3 ~KMeansBase()

```
virtual km::KMeansBase::~KMeansBase ( )  [virtual], [default]
```

Virtual destructor for KMeansBase.

7.2.3 Member Function Documentation

7.2.3.1 getCentroids()

```
auto km::KMeansBase::getCentroids ( ) const -> std::vector< Point >
```

Gets the centroids.

Returns

Vector of centroids

7.2.3.2 getIterations()

```
auto km::KMeansBase::getIterations ( ) const -> int
```

Gets the number of iterations.

Returns

Number of iterations

7.2.3.3 getPoints()

```
auto km::KMeansBase::getPoints ( ) const -> std::vector< Point >
```

Gets the poinots.

Returns

Vector of points

7.2.3.4 run()

```
virtual void km::KMeansBase::run ( )  [pure virtual]
```

Runs the K-means clustering algorithm.

Implemented in km::KMeansMPI, km::KMeansOMP, and km::KMeansSequential.

7.2.4 Member Data Documentation

7.2.4.1 centroids

```
std::vector<Point> km::KMeansBase::centroids  [protected]
```

Vector of centroids.

7.2.4.2 k

```
int km::KMeansBase::k  [protected]
```

Number of clusters.

7.2.4.3 number_of_iterations

```
int km::KMeansBase::number_of_iterations  [protected]
```

Number of iterations.

7.2.4.4 points

```
std::vector<Point> km::KMeansBase::points  [protected]
```

Vector of points.

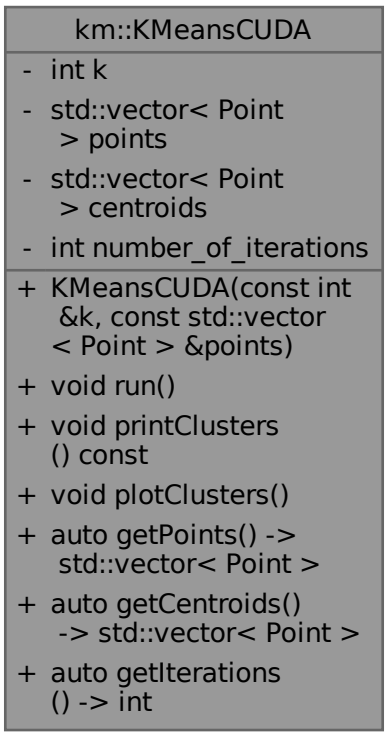
The documentation for this class was generated from the following file:

- include/kMeansBase.hpp

7.3 km::KMeansCUDA Class Reference

Represents the K-means clustering algorithm using CUDA.

Collaboration diagram for km::KMeansCUDA:



Public Member Functions

- KMeansCUDA (const int &k, const std::vector< Point > &points)
  Constructor for KMeans.
- void run ()
  Runs the K-means clustering algorithm using CUDA.
- void printClusters () const
  Prints the clusters.
- void plotClusters ()
  Plots the clusters.
- auto getPoints () -> std::vector< Point >
  Gets the points.
- auto getCentroids () -> std::vector< Point >
  Gets the centroids.
- auto getIterations () -> int
  Gets the number of iterations.

Private Attributes

- int k
  Number of clusters.
- std::vector< Point > points
  Vector of points.
- std::vector< Point > centroids
  Vector of centroids.
- int number_of_iterations
  Number of iterations.

7.3.1 Detailed Description

Represents the K-means clustering algorithm using CUDA.

7.3.2 Constructor & Destructor Documentation

7.3.2.1 KMeansCUDA()

```
km::KMeansCUDA::KMeansCUDA (
            const int & k,
            const std::vector< Point > & points )
```

Constructor for KMeans.

Parameters

k	Number of clusters
points	Vector of points

7.3.3 Member Function Documentation

7.3.3.1 getCentroids()

```
auto km::KMeansCUDA::getCentroids ( ) -> std::vector< Point >
```

Gets the centroids.

Returns

Vector of centroids

7.3.3.2 getIterations()

```
auto km::KMeansCUDA::getIterations ( ) -> int
```

Gets the number of iterations.

Returns

Number of iterations

7.3.3.3 getPoints()

```
auto km::KMeansCUDA::getPoints ( ) -> std::vector< Point >
```

Gets the points.

Returns

Vector of points

7.3.3.4 plotClusters()

```
void km::KMeansCUDA::plotClusters ( )
```

Plots the clusters.

7.3.3.5 printClusters()

```
void km::KMeansCUDA::printClusters ( ) const
```

Prints the clusters.

7.3.3.6 run()

```
void km::KMeansCUDA::run ( )
```

Runs the K-means clustering algorithm using CUDA.

7.3.4 Member Data Documentation

7.3.4.1 centroids

```
std::vector<Point> km::KMeansCUDA::centroids  [private]
```

Vector of centroids.

7.3.4.2 k

```
int km::KMeansCUDA::k  [private]
```

Number of clusters.

7.3.4.3 number_of_iterations

```
int km::KMeansCUDA::number_of_iterations  [private]
```

Number of iterations.

7.3.4.4 points

```
std::vector<Point> km::KMeansCUDA::points  [private]
```

Vector of points.

The documentation for this class was generated from the following file:

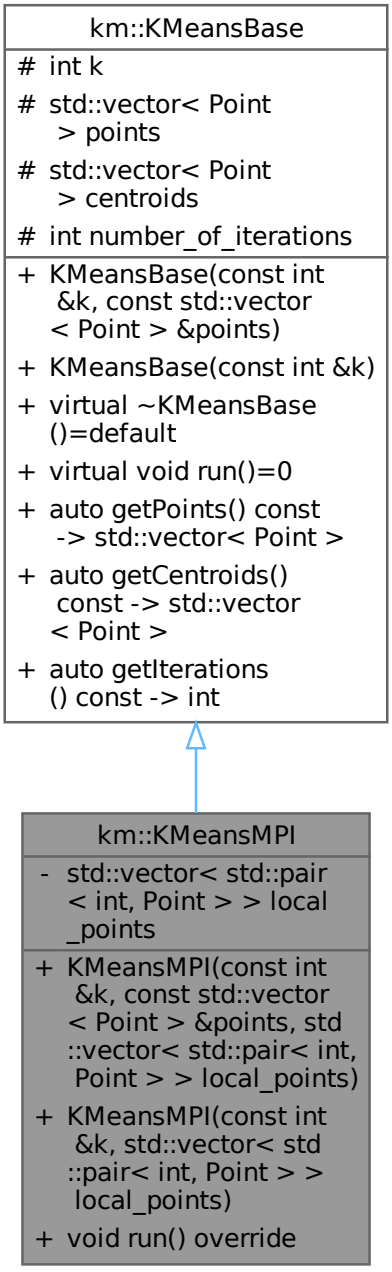
- include/kMeansCUDA.cuh

7.4 km::KMeansMPI Class Reference

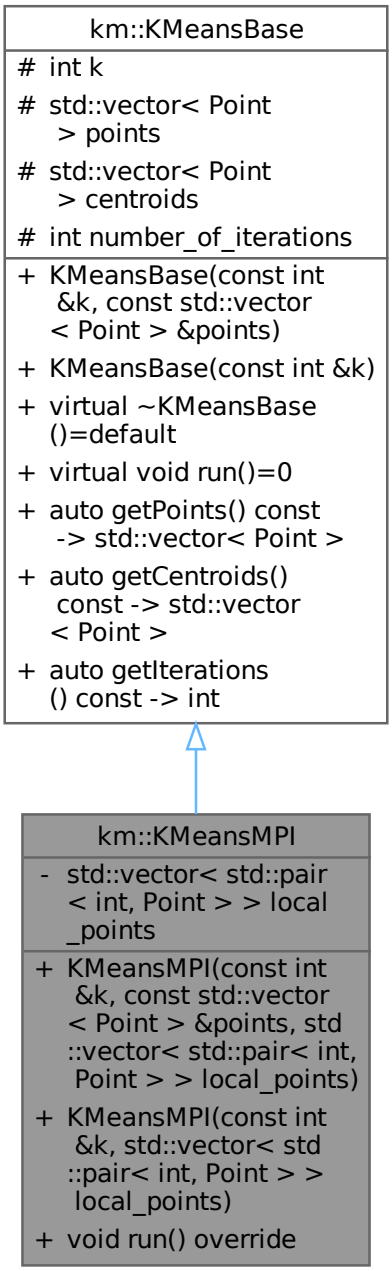
Represents the K-means clustering algorithm using MPI.

`#include <kMeansMPI.hpp>`

Inheritance diagram for km::KMeansMPI:



Collaboration diagram for km::KMeansMPI:



Public Member Functions

- KMeansMPI (const int &k, const std::vector< Point > &points, std::vector< std::pair< int, Point > > local_points)

  Constructor for KMeansMPI.
- KMeansMPI (const int &k, std::vector< std::pair< int, Point > > local_points)

  Constructor for KMeansMPI.

- void run () override

  Runs the K-means clustering algorithm using MPI.

Public Member Functions inherited from km::KMeansBase

- KMeansBase (const int &k, const std::vector< Point > &points)

  Constructor for KMeansBase.
- KMeansBase (const int &k)

  Constructs a KMeansBase object only with the specified number of clusters.
- virtual ~KMeansBase ()=default

  Virtual destructor for KMeansBase.
- auto getPoints () const -> std::vector< Point >

  Gets the poinots.
- auto getCentroids () const -> std::vector< Point >

  Gets the centroids.
- auto getIterations () const -> int

  Gets the number of iterations.

Private Attributes

- std::vector< std::pair< int, Point > > local_points

  Vector of local points.

Additional Inherited Members

Protected Attributes inherited from km::KMeansBase

- int k

  Number of clusters.
- std::vector< Point > points

  Vector of points.
- std::vector< Point > centroids

  Vector of centroids.
- int number_of_iterations

  Number of iterations.

7.4.1 Detailed Description

Represents the K-means clustering algorithm using MPI.

7.4.2 Constructor & Destructor Documentation

7.4.2.1 KMeansMPI() [1/2]

```
km::KMeansMPI::KMeansMPI (
            const int & k,
            const std::vector< Point > & points,
            std::vector< std::pair< int, Point > > local_points )
```

Constructor for KMeansMPI.

Parameters

k	Number of clusters
points	Vector of points

7.4.2.2 KMeansMPI() [2/2]

```
km::KMeansMPI::KMeansMPI (
            const int & k,
            std::vector< std::pair< int, Point > > local_points )
```

Constructor for KMeansMPI.

Parameters

k	Number of clusters

7.4.3 Member Function Documentation

7.4.3.1 run()

```
void km::KMeansMPI::run ( )  [override], [virtual]
```

Runs the K-means clustering algorithm using MPI.

Implements km::KMeansBase.

7.4.4 Member Data Documentation

7.4.4.1 local_points

```
std::vector<std::pair<int, Point> > km::KMeansMPI::local_points  [private]
```

Vector of local points.

The documentation for this class was generated from the following file:

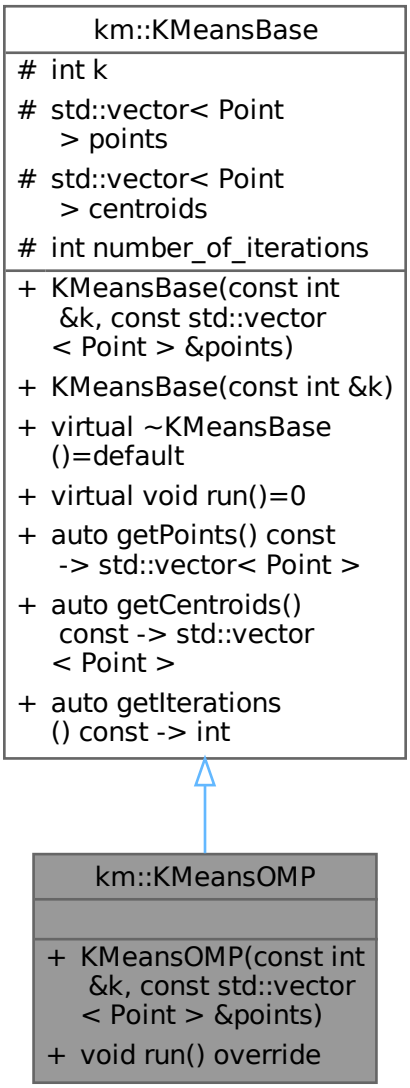
- include/kMeansMPI.hpp

7.5 km::KMeansOMP Class Reference

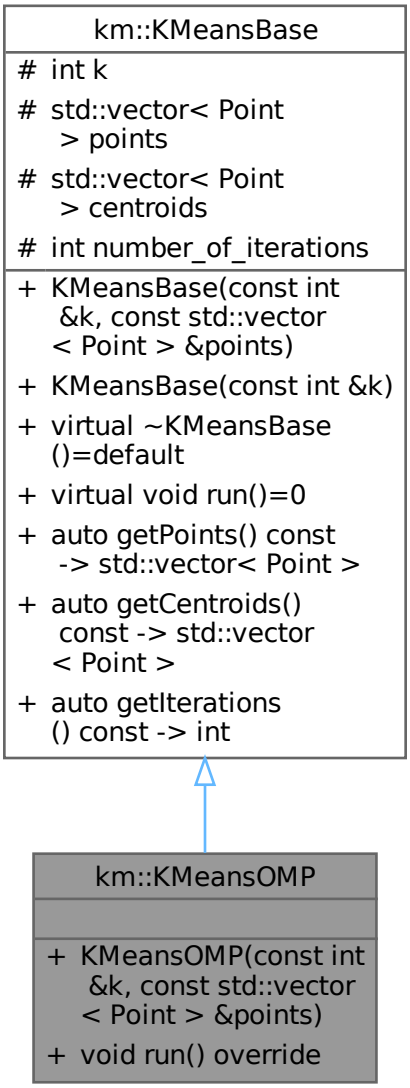
Represents the K-means clustering algorithm using OpenMP.

`#include <kMeansOMP.hpp>`

Inheritance diagram for km::KMeansOMP:



Collaboration diagram for km::KMeansOMP:



Public Member Functions

- KMeansOMP (const int &k, const std::vector< Point > &points)

  Constructor for KMeansOMP.
- void run () override

  Runs the K-means clustering algorithm using OpenMP.

Public Member Functions inherited from km::KMeansBase

- KMeansBase (const int &k, const std::vector< Point > &points)

Constructor for KMeansBase.

- KMeansBase (const int &k)

  Constructs a KMeansBase object only with the specified number of clusters.
- virtual ~KMeansBase ()=default

  Virtual destructor for KMeansBase.
- auto getPoints () const -> std::vector< Point >

  Gets the poinots.
- auto getCentroids () const -> std::vector< Point >

  Gets the centroids.
- auto getIterations () const -> int

  Gets the number of iterations.

Additional Inherited Members

Protected Attributes inherited from km::KMeansBase

- int k

  Number of clusters.
- std::vector< Point > points

  Vector of points.
- std::vector< Point > centroids

  Vector of centroids.
- int number_of_iterations

  Number of iterations.

7.5.1 Detailed Description

Represents the K-means clustering algorithm using OpenMP.

7.5.2 Constructor & Destructor Documentation

7.5.2.1 KMeansOMP()

```
km::KMeansOMP::KMeansOMP (
            const int & k,
            const std::vector< Point > & points )
```

Constructor for KMeansOMP.

Parameters

k	Number of clusters
points	Vector of points

7.5.3 Member Function Documentation

7.5.3.1 run()

```
void km::KMeansOMP::run ( )  [override], [virtual]
```

Runs the K-means clustering algorithm using OpenMP.

Implements km::KMeansBase.

The documentation for this class was generated from the following file:

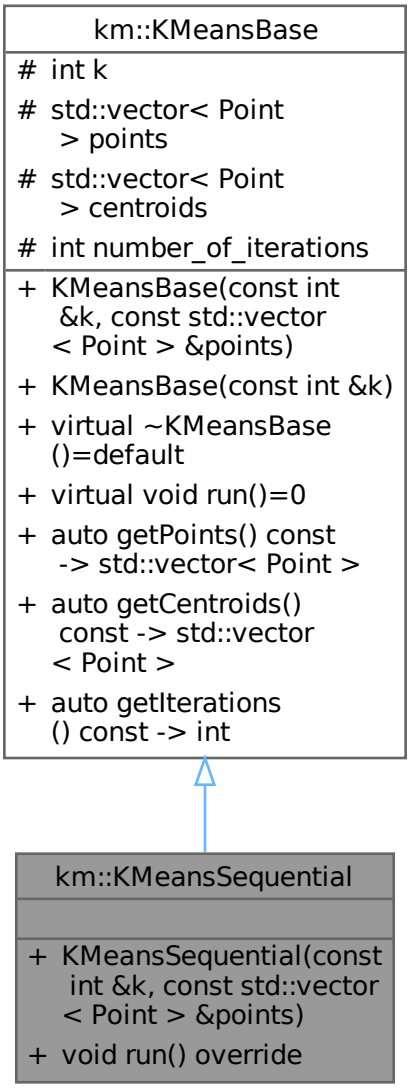
- include/kMeansOMP.hpp

7.6 km::KMeansSequential Class Reference

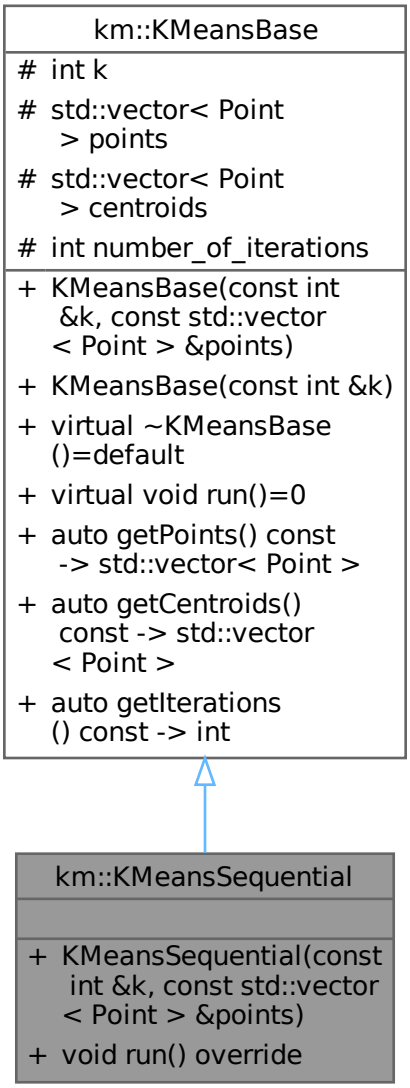
Represents the K-means clustering algorithm.

```
#include <kMeansSequential.hpp>
```

Inheritance diagram for km::KMeansSequential:



Collaboration diagram for km::KMeansSequential:



Public Member Functions

- KMeansSequential (const int &k, const std::vector< Point > &points)

  Constructor for KMeansSequential.
- void run () override

  Runs the K-means clustering algorithm.

Public Member Functions inherited from km::KMeansBase

- KMeansBase (const int &k, const std::vector< Point > &points)

Constructor for KMeansBase.

- KMeansBase (const int &k)

  Constructs a KMeansBase object only with the specified number of clusters.
- virtual ~KMeansBase ()=default

  Virtual destructor for KMeansBase.
- auto getPoints () const -> std::vector< Point >

  Gets the poinots.
- auto getCentroids () const -> std::vector< Point >

  Gets the centroids.
- auto getIterations () const -> int

  Gets the number of iterations.

Additional Inherited Members

Protected Attributes inherited from km::KMeansBase

- int k

  Number of clusters.
- std::vector< Point > points

  Vector of points.
- std::vector< Point > centroids

  Vector of centroids.
- int number_of_iterations

  Number of iterations.

7.6.1 Detailed Description

Represents the K-means clustering algorithm.

7.6.2 Constructor & Destructor Documentation

7.6.2.1 KMeansSequential()

```
km::KMeansSequential::KMeansSequential (
            const int & k,
            const std::vector< Point > & points )
```

Constructor for KMeansSequential.

Parameters

k	Number of clusters
points	Vector of points

7.6.3 Member Function Documentation

7.6.3.1 run()

```
void km::KMeansSequential::run ( )  [override], [virtual]
```

Runs the K-means clustering algorithm.

Implements km::KMeansBase.

The documentation for this class was generated from the following file:

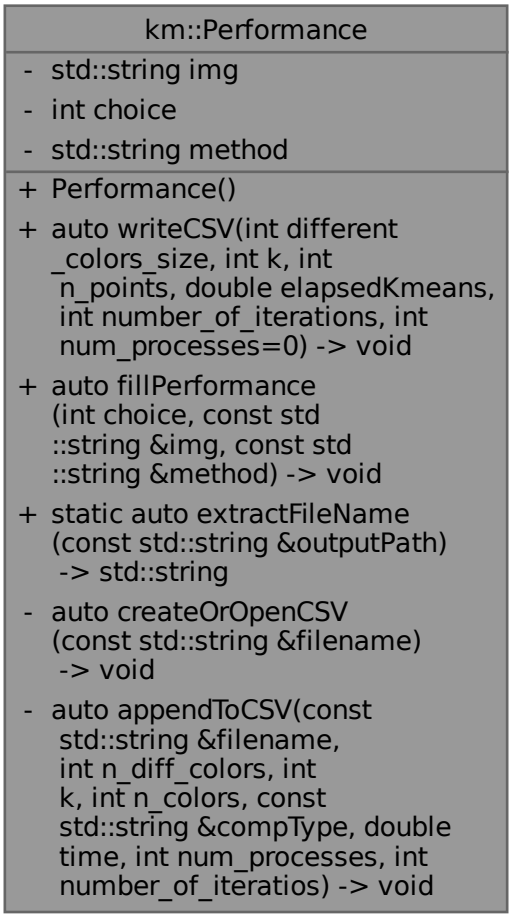
- include/kMeansSequential.hpp

7.7 km::Performance Class Reference

Represents the performance evaluation.

```
#include <performanceEvaluation.hpp>
```

Collaboration diagram for km::Performance:



Public Member Functions

- Performance ()

  Default constructor.
- auto writeCSV (int different_colors_size, int k, int n_points, double elapsedKmeans, int number_of_iterations, int num_processes=0) -> void

  Writes performance data to a CSV file.
- auto fillPerformance (int choice, const std::string &img, const std::string &method) -> void

  Fills the performance data.

Static Public Member Functions

- static auto extractFileName (const std::string &outputPath) -> std::string

  Extracts the file name from the output path.

Private Member Functions

- auto createOrOpenCSV (const std::string &filename) -> void

  Creates or opens a CSV file.
- auto appendToCSV (const std::string &filename, int n_diff_colors, int k, int n_colors, const std::string &comp↩ Type, double time, int num_processes, int number_of_iteratios) -> void

  Appends performance data to the CSV file.

Private Attributes

- std::string img

  Image name.
- int choice {}

  Choice of performance evaluation.
- std::string method

  Method used.

7.7.1 Detailed Description

Represents the performance evaluation.

7.7.2 Constructor & Destructor Documentation

7.7.2.1 Performance()

```
km::Performance::Performance ( )
```

Default constructor.

7.7.3 Member Function Documentation

7.7.3.1 appendToCSV()

```
auto km::Performance::appendToCSV (
            const std::string & filename,
            int n_diff_colors,
            int k,
            int n_colors,
            const std::string & compType,
            double time,
            int num_processes,
            int number_of_iteratios ) -> void  [private]
```

Appends performance data to the CSV file.

Parameters

filename	Name of the CSV file
n_diff_colors	Number of different colors
k	Number of clusters
n_colors	Number of colors
compType	Compression type
time	Elapsed time
num_processes	Number of processes

7.7.3.2 createOrOpenCSV()

```
auto km::Performance::createOrOpenCSV (
            const std::string & filename ) -> void  [private]
```

Creates or opens a CSV file.

Parameters

filename	Name of the CSV file

7.7.3.3 extractFileName()

```
static auto km::Performance::extractFileName (
            const std::string & outputPath ) -> std::string  [static]
```

Extracts the file name from the output path.

Parameters

outputPath	Output path

Returns

Extracted file name

7.7.3.4 fillPerformance()

```
auto km::Performance::fillPerformance (
            int choice,
            const std::string & img,
            const std::string & method ) -> void
```

Fills the performance data.

Parameters

choice	Choice of performance evaluation
img	Image name
method	Method used

7.7.3.5 writeCSV()

```
auto km::Performance::writeCSV (
            int different_colors_size,
            int k,
            int n_points,
            double elapsedKmeans,
            int number_of_iterations,
            int num_processes = 0 ) -> void
```

Writes performance data to a CSV file.

Parameters

different_colors_size	Number of different colors
k	Number of clusters
n_points	Number of points
elapsedKmeans	Elapsed time for K-means clustering
num_processes	Number of processes (optional, default=0)

7.7.4 Member Data Documentation

7.7.4.1 choice

```
int km::Performance::choice {}  [private]
```

Choice of performance evaluation.

7.7.4.2 img

```
std::string km::Performance::img  [private]
```

Image name.

7.7.4.3 method

```
std::string km::Performance::method  [private]
```

Method used.

The documentation for this class was generated from the following file:

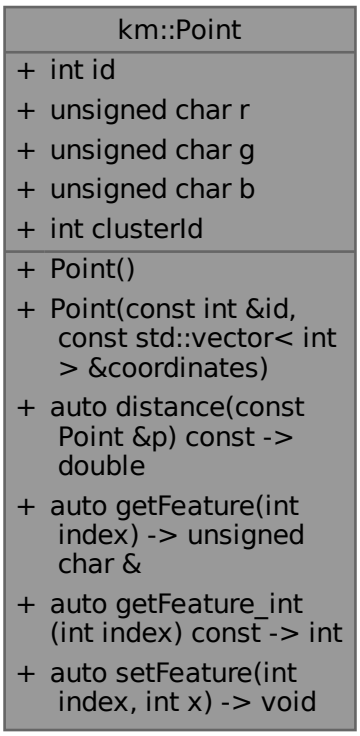
- include/performanceEvaluation.hpp

7.8 km::Point Class Reference

Represents a point in a feature space.

```
#include <point.hpp>
```

Collaboration diagram for km::Point:



Public Member Functions

- Point ()

  Constructor for Point.
- Point (const int &id, const std::vector< int > &coordinates)

  Constructor for Point.
- auto distance (const Point &p) const -> double

  Calculates the distance between this point and another point.
- auto getFeature (int index) -> unsigned char &

  Gets a feature value at the specified index.
- auto getFeature_int (int index) const -> int

  Gets a feature value as an integer at the specified index.
- auto setFeature (int index, int x) -> void

  Sets a feature value at the specified index.

Public Attributes

- int id {0}

  ID of the point.
- unsigned char r {0}

  Red component.
- unsigned char g {0}

  Green component.
- unsigned char b {0}

  Blue component.
- int clusterId {-1}

  ID of the cluster the point belongs to.

7.8.1 Detailed Description

Represents a point in a feature space.

7.8.2 Constructor & Destructor Documentation

7.8.2.1 Point() [1/2]

```
km::Point::Point ( )
```

Constructor for Point.

Parameters

features_size	Number of features

7.8.2.2 Point() [2/2]

```
km::Point::Point (
```

```
            const int & id,
            const std::vector< int > & coordinates )
```

Constructor for Point.

Parameters

id	ID of the point
coordinates	Coordinates of the point

7.8.3 Member Function Documentation

7.8.3.1 distance()

```
auto km::Point::distance (
            const Point & p ) const -> double
```

Calculates the distance between this point and another point.

Parameters

p	Other point

Returns

Distance between the points

7.8.3.2 getFeature()

```
auto km::Point::getFeature (
            int index ) -> unsigned char &
```

Gets a feature value at the specified index.

Parameters

index	Index of the feature

Returns

Feature value

7.8.3.3 getFeature_int()

```
auto km::Point::getFeature_int (
            int index ) const -> int
```

Gets a feature value as an integer at the specified index.

Parameters

index	Index of the feature

Returns

Feature value as an integer

7.8.3.4 setFeature()

```
auto km::Point::setFeature (
            int index,
            int x ) -> void
```

Sets a feature value at the specified index.

Parameters

index	Index of the feature
x	Feature value

7.8.4 Member Data Documentation

7.8.4.1 b

```
unsigned char km::Point::b {0}
```

Blue component.

7.8.4.2 clusterId

```
int km::Point::clusterId {-1}
```

ID of the cluster the point belongs to.

7.8.4.3 g

```
unsigned char km::Point::g {0}
```

Green component.

7.8.4.4 id

```
int km::Point::id {0}
```

ID of the point.

7.8.4.5 r

```
unsigned char km::Point::r {0}
```

Red component.

The documentation for this class was generated from the following file:

- include/point.hpp

Chapter 8

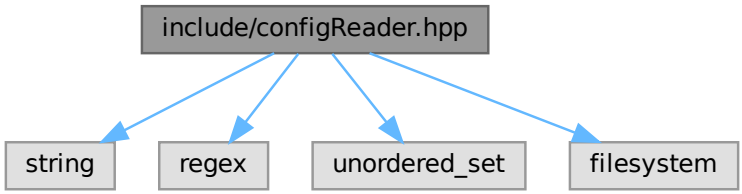
File Documentation

8.1 include/configReader.hpp File Reference

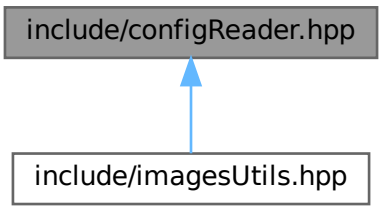
ConfigReader class declaration.

```
#include <string>
#include <regex>
#include <unordered_set>
#include <filesystem>
```

Include dependency graph for configReader.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- class km::ConfigReader

  Reads and stores configuration values from a file.

Namespaces

- namespace km

  Main namespace for the project.

8.1.1 Detailed Description

ConfigReader class declaration.

8.2 configReader.hpp

Go to the documentation of this file.

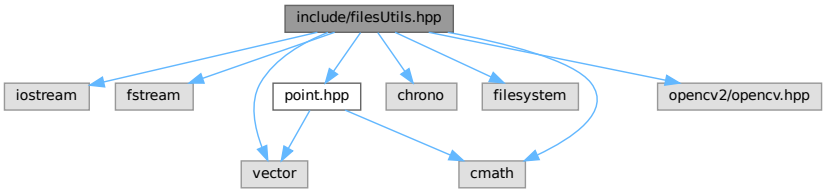
```
00001
00006 #ifndef CONFIG_READER_HPP
00007 #define CONFIG_READER_HPP
00008
00009 #include <string>
00010 #include <regex>
00011 #include <unordered_set>
00012 #include <filesystem>
00013
00014 namespace km
00015 {
00021     class ConfigReader
00022     {
00023     private:
00024         double first_level_compression_color = 0.;
00025         double second_level_compression_color = 0.;
00026         double third_level_compression_color = 0.;
00027         double fourth_level_compression_color = 0.;
00028         double fifth_level_compression_color = 0.;
00029         double resizing_factor = 0.;
00030         int color_choice = 0;
00031         int compression_choice = 0;
00032         std::filesystem::path inputImageFilePath;
00033         std::regex pattern;
00034         std::unordered_set<std::string> requiredVariables = {};
00035
00036         [[nodiscard]] auto checkVariableExists(const std::string &variableName) const -> bool;
00037
00043     public:
00044         [[nodiscard]] auto getFirstLevelCompressionColor() const -> double;
00045
00050         [[nodiscard]] auto getSecondLevelCompressionColor() const -> double;
00051
00056         [[nodiscard]] auto getThirdLevelCompressionColor() const -> double;
00057
00062         [[nodiscard]] auto getFourthLevelCompressionColor() const -> double;
00063
00068         [[nodiscard]] auto getFifthLevelCompressionColor() const -> double;
00069
00074         [[nodiscard]] auto getColorChoice() const -> int;
00075
00080         [[nodiscard]] auto getCompressionChoice() const -> int;
00081
00086         [[nodiscard]] auto getInputImageFilePath() const -> std::filesystem::path;
00087
00092         [[nodiscard]] auto getResizingFactor() const -> double;
00093
00098         [[nodiscard]] auto readConfigFile() -> bool;
00099
00100         ConfigReader();
00101     };
00102 } // namespace km
00103
00104 #endif // CONFIG_READER_HPP
```

8.3 include/filesUtils.hpp File Reference

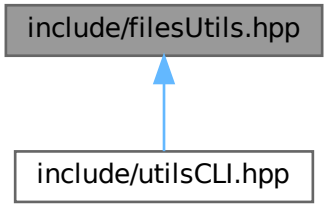
Utility functions for file handling.

```
#include <iostream>
#include <fstream>
#include <vector>
#include <cmath>
#include <chrono>
#include <filesystem>
#include <point.hpp>
#include <opencv2/opencv.hpp>
```

Include dependency graph for filesUtils.hpp:



This graph shows which files directly or indirectly include this file:



Namespaces

- namespace km::filesUtils

  Provides utility functions for file handling.
- namespace km

  Main namespace for the project.

Functions

- auto km::filesUtils::createOutputDirectories () -> void

  Creates output directories.
- auto km::filesUtils::writeBinaryFile (std::string &outputPath, int &width, int &height, int &k, std::vector< Point > points, std::vector< Point > centroids) -> void

  Writes data to a binary file.
- auto km::filesUtils::isCorrectExtension (const std::filesystem::path &filePath, const std::string &correctExtension) -> bool

  Checks if a file has the correct extension.
- auto km::filesUtils::createDecodingMenu (std::filesystem::path &decodeDir, std::vector< std::filesystem::path > &imageNames) -> void

  Creates a decoding menu.
- auto km::filesUtils::readBinaryFile (std::string &path, cv::Mat &imageCompressed) -> int

  Reads a binary file and reconstructs the compressed image.

8.3.1 Detailed Description

Utility functions for file handling.

8.4 filesUtils.hpp

Go to the documentation of this file.

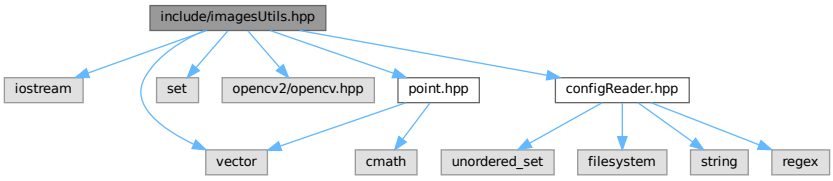
```
00001
00006 #ifndef FILESUTILS_HPP
00007 #define FILESUTILS_HPP
00008
00009 #include <iostream>
00010 #include <fstream>
00011 #include <vector>
00012 #include <cmath>
00013 #include <chrono>
00014 #include <filesystem>
00015 #include <point.hpp>
00016 #include <opencv2/opencv.hpp>
00017
00023 namespace km
00024 {
00025     namespace filesUtils
00026     {
00030         auto createOutputDirectories() -> void;
00031
00041         auto writeBinaryFile(std::string &outputPath, int &width, int &height, int &k,
      std::vector<Point> points, std::vector<Point> centroids) -> void;
00042
00049         auto isCorrectExtension(const std::filesystem::path &filePath, const std::string
      &correctExtension) -> bool;
00050
00056         auto createDecodingMenu(std::filesystem::path &decodeDir, std::vector<std::filesystem::path>
      &imageNames) -> void;
00057
00064         auto readBinaryFile(std::string &path, cv::Mat &imageCompressed) -> int;
00065     };
00066 }
00067
00068 #endif // FILESUTILS_HPP
```

8.5 include/imagesUtils.hpp File Reference

Utility functions for image processing.

```
#include <iostream>
#include <vector>
#include <set>
#include <opencv2/opencv.hpp>
#include <configReader.hpp>
#include <point.hpp>
```

Include dependency graph for imagesUtils.hpp:



Namespaces

- namespace km::imageUtils

  Provides utility functions for image processing.
- namespace km

  Main namespace for the project.

Functions

- void km::imageUtils::preprocessing (cv::Mat &image, int &typeCompressionChoice)

  Performs preprocessing on an image.
- void km::imageUtils::defineKValue (int &k, int levelsColorsChoice, std::set< std::vector< unsigned char > > &different_colors)

  Defines the value of K based on the color levels choice.
- void km::imageUtils::pointsFromImage (cv::Mat &image, std::vector< Point > &points, std::set< std::vector< unsigned char > > &different_colors)

  Extracts points from an image.

8.5.1 Detailed Description

Utility functions for image processing.

8.6 imagesUtils.hpp

Go to the documentation of this file.

```
00001
00006 #ifndef IMAGEUTILS_HPP
00007 #define IMAGEUTILS_HPP
00008
00009 #include <iostream>
00010 #include <vector>
00011 #include <set>
00012 #include <opencv2/opencv.hpp>
00013 #include <configReader.hpp>
00014 #include <point.hpp>
00015
00021 namespace km
00022 {
00023     namespace imageUtils
00024     {
00030         void preprocessing(cv::Mat& image, int& typeCompressionChoice);
00031
00038         void defineKValue(int& k, int levelsColorsChoice, std::set<std::vector<unsigned char»&
      different_colors);
00039
00046         void pointsFromImage(cv::Mat& image, std::vector<Point>& points,
      std::set<std::vector<unsigned char»& different_colors);
00047     };
00048
00049 }
00050
00051 #endif // IMAGEUTILS_HPP
```

8.7 include/kmDocs.hpp File Reference

Documentation for the km namespace.

Namespaces

- namespace km

  Main namespace for the project.

8.7.1 Detailed Description

Documentation for the km namespace.

This file provides comprehensive documentation for the km namespace, which includes utilities for clustering algorithms, file handling, image processing, etc. The km namespace serves as the main container for core functionalities and tools used throughout the project.

8.8 kmDocs.hpp

Go to the documentation of this file.

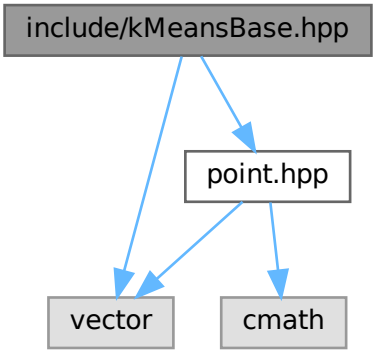
```
00001
00017 namespace km {
00018     // This file is for Doxygen documentation purposes only.
00019 }
```

8.9 include/kMeansBase.hpp File Reference

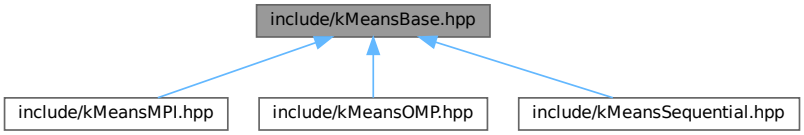
Base class for K-means clustering algorithm.

```
#include <vector>
#include "point.hpp"
```

Include dependency graph for kMeansBase.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- class km::KMeansBase

  Base class for K-means clustering algorithm.

Namespaces

- namespace km

  Main namespace for the project.

8.9.1 Detailed Description

Base class for K-means clustering algorithm.

8.10 kMeansBase.hpp

Go to the documentation of this file.

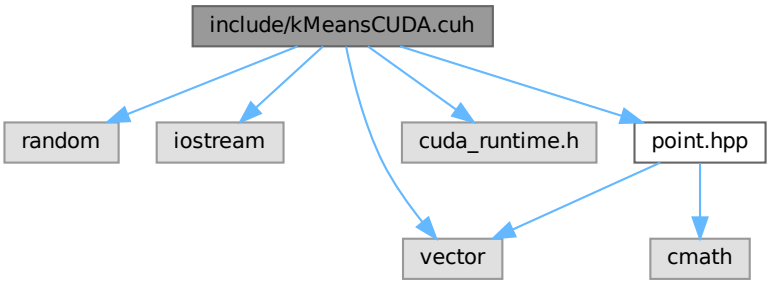
```
00001
00006 #ifndef KMEANS_BASE_HPP
00007 #define KMEANS_BASE_HPP
00008
00009 #include <vector>
00010 #include "point.hpp"
00011
00012 namespace km
00013 {
00019     class KMeansBase
00020     {
00021
00022     public:
00028         KMeansBase(const int &k, const std::vector<Point> &points);
00029
00035         KMeansBase(const int &k);
00036
00040         virtual ~KMeansBase() = default;
00041
00045         virtual void run() = 0;
00046
00051         [[nodiscard]] auto getPoints() const -> std::vector<Point>;
00052
00057         [[nodiscard]] auto getCentroids() const -> std::vector<Point>;
00058
00063         [[nodiscard]] auto getIterations() const -> int;
00064
00065     protected:
00066         int k;
00067         std::vector<Point> points;
00068         std::vector<Point> centroids;
00069         int number_of_iterations;
00070     };
00071 } // namespace k
00072
00073 #endif // KMEANS_BASE_HPP
```

8.11 include/kMeansCUDA.cuh File Reference

Implementation of the K-means clustering algorithm using CUDA.

```
#include <random>
#include <iostream>
#include <vector>
#include <cuda_runtime.h>
#include <point.hpp>
```

Include dependency graph for kMeansCUDA.cuh:



Classes

- class km::KMeansCUDA

  Represents the K-means clustering algorithm using CUDA.

Namespaces

- namespace km

  Main namespace for the project.

Macros

- #define KMEANS_CUDA_HPP

8.11.1 Detailed Description

Implementation of the K-means clustering algorithm using CUDA.

8.11.2 Macro Definition Documentation

8.11.2.1 KMEANS_CUDA_HPP

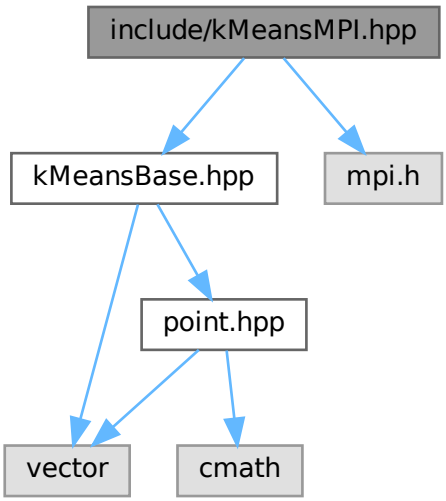
```
#define KMEANS_CUDA_HPP
```

8.12 include/kMeansMPI.hpp File Reference

Implementation of the K-means clustering algorithm using MPI.

```
#include "kMeansBase.hpp"
#include <mpi.h>
```

Include dependency graph for kMeansMPI.hpp:



Classes

- class km::KMeansMPI

  Represents the K-means clustering algorithm using MPI.

Namespaces

- namespace km

  Main namespace for the project.

8.12.1 Detailed Description

Implementation of the K-means clustering algorithm using MPI.

8.13 kMeansMPI.hpp

Go to the documentation of this file.

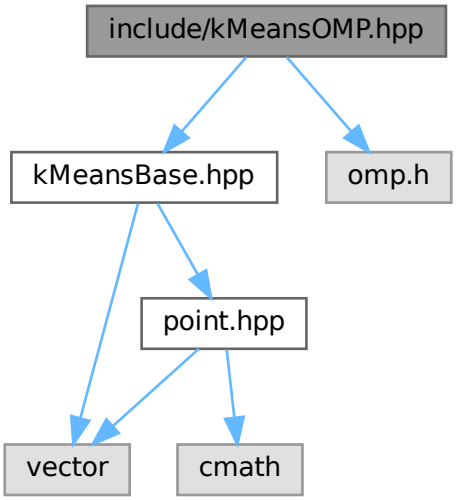
```
00001
00006 #ifndef KMEANS_MPI_HPP
00007 #define KMEANS_MPI_HPP
00008
00009 #include "kMeansBase.hpp"
00010 #include <mpi.h>
00011
00012 namespace km
00013 {
00019     class KMeansMPI : public KMeansBase
00020     {
00021     public:
00027         KMeansMPI(const int &k, const std::vector<Point> &points, std::vector<std::pair<int, Point>>
      local_points);
00028
00033         KMeansMPI(const int &k, std::vector<std::pair<int, Point>> local_points);
00034
00038         void run() override;
00039
00040     private:
00041         std::vector<std::pair<int, Point>> local_points;
00042     };
00043 } // namespace k
00044
00045 #endif // KMEANS_MPI_HPP
```

8.14 include/kMeansOMP.hpp File Reference

Implementation of the K-means clustering algorithm using OpenMP.

```
#include "kMeansBase.hpp"
#include <omp.h>
```

Include dependency graph for kMeansOMP.hpp:



Classes

- class km::KMeansOMP

  Represents the K-means clustering algorithm using OpenMP.

Namespaces

- namespace km

  Main namespace for the project.

8.14.1 Detailed Description

Implementation of the K-means clustering algorithm using OpenMP.

8.15 kMeansOMP.hpp

Go to the documentation of this file.

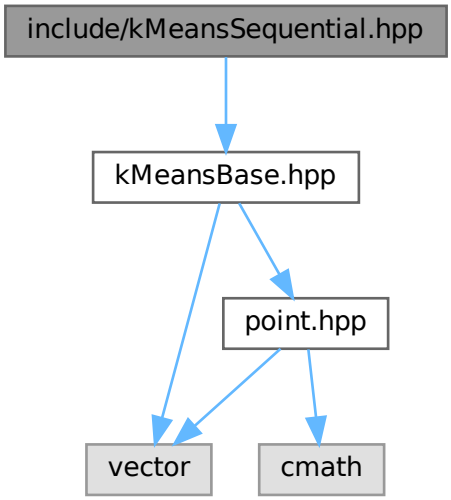
```
00001
00006 #ifndef KMEANS_OMP_HPP
00007 #define KMEANS_OMP_HPP
00008
00009 #include "kMeansBase.hpp"
00010 #include <omp.h>
00011
00012 namespace km
00013 {
```

```
00019     class KMeansOMP : public KMeansBase
00020     {
00021     public:
00027         KMeansOMP(const int &k, const std::vector<Point> &points);
00028
00032         void run() override;
00033     };
00034 } // namespace km
00035
00036 #endif // KMEANS_OMP_HPP
```

8.16 include/kMeansSequential.hpp File Reference

Implementation of the K-means clustering algorithm.

`#include "kMeansBase.hpp"`
Include dependency graph for kMeansSequential.hpp:



Classes

- class km::KMeansSequential

  Represents the K-means clustering algorithm.

Namespaces

- namespace km

  Main namespace for the project.

8.16.1 Detailed Description

Implementation of the K-means clustering algorithm.

8.17 kMeansSequential.hpp

Go to the documentation of this file.

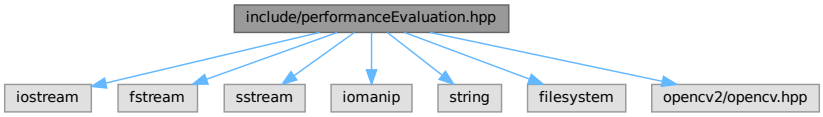
```
00001
00006 #ifndef KMEANS_SEQUENTIAL_HPP
00007 #define KMEANS_SEQUENTIAL_HPP
00008
00009 #include "kMeansBase.hpp"
00010
00011 namespace km
00012 {
00018     class KMeansSequential : public KMeansBase
00019     {
00020     public:
00026         KMeansSequential(const int &k, const std::vector<Point> &points);
00027
00031         void run() override;
00032     };
00033 }
00034
00035 #endif // KMEANS_SEQUENTIAL_HPP
```

8.18 include/performanceEvaluation.hpp File Reference

Performance evaluation class.

```
#include <iostream>
#include <fstream>
#include <sstream>
#include <iomanip>
#include <string>
#include <filesystem>
#include <opencv2/opencv.hpp>
```

Include dependency graph for performanceEvaluation.hpp:



Classes

- class km::Performance

  Represents the performance evaluation.

Namespaces

- namespace km

  Main namespace for the project.

8.18.1 Detailed Description

Performance evaluation class.

8.19 performanceEvaluation.hpp

Go to the documentation of this file.

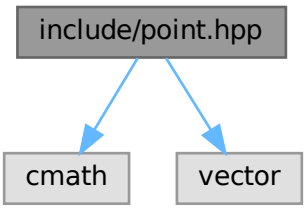
```
00001
00006 #ifndef PERFORMANCE_HPP
00007 #define PERFORMANCE_HPP
00008
00009 #include <iostream>
00010 #include <fstream>
00011 #include <sstream>
00012 #include <iomanip>
00013 #include <string>
00014 #include <filesystem>
00015 #include <opencv2/opencv.hpp>
00016
00017 namespace km
00018 {
00024     class Performance
00025     {
00026     public:
00030         Performance();
00031
00040         auto writeCSV(int different_colors_size, int k, int n_points, double elapsedKmeans, int
      number_of_iterations, int num_processes = 0) -> void;
00041
00047         static auto extractFileName(const std::string &outputPath) -> std::string;
00048
00055         auto fillPerformance(int choice, const std::string &img, const std::string &method) -> void;
00056
00057     private:
00062         auto createOrOpenCSV(const std::string &filename) -> void;
00063
00074         auto appendToCSV(const std::string &filename, int n_diff_colors, int k, int n_colors, const
      std::string &compType, double time, int num_processes, int number_of_iteratios) -> void;
00075
00076         std::string img;
00077         int choice{};
00078         std::string method;
00079     };
00080 }
00081
00082 #endif // PERFORMANCE_HPP
```

8.20 include/point.hpp File Reference

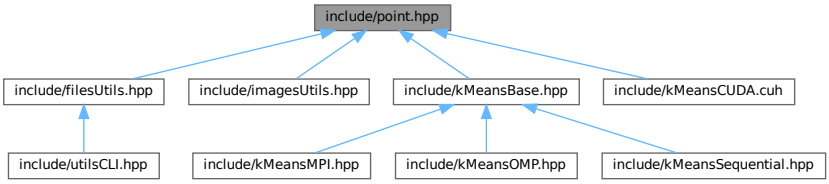
Point class representing a point in a feature space.

```
#include <cmath>
#include <vector>
```

Include dependency graph for point.hpp:



This graph shows which files directly or indirectly include this file:



Classes

- class km::Point

  Represents a point in a feature space.

Namespaces

- namespace km

  Main namespace for the project.

8.20.1 Detailed Description

Point class representing a point in a feature space.

8.21 point.hpp

Go to the documentation of this file.

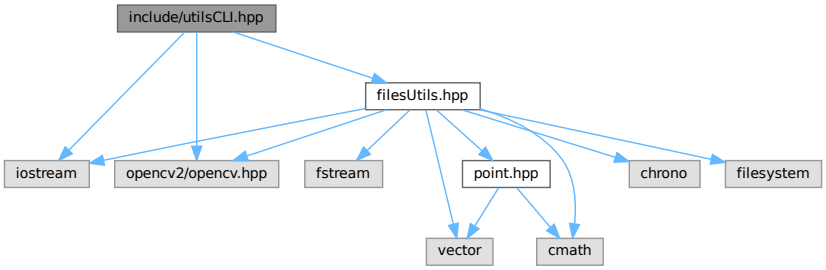
```
00001
00006 #ifndef POINT_HPP
00007 #define POINT_HPP
00008
00009 #include <cmath>
00010 #include <vector>
00011
00012 namespace km
00013 {
00019     class Point
00020     {
00021     public:
00022         int id{0};
00023         unsigned char r{0};
00024         unsigned char g{0};
00025         unsigned char b{0};
00026         int clusterId{-1};
00027
00032         Point();
00033
00039         Point(const int &id, const std::vector<int> &coordinates);
00040
00046         [[nodiscard]] auto distance(const Point &p) const -> double;
00047
00053         auto getFeature(int index) -> unsigned char &;
00054
00060         [[nodiscard]] auto getFeature_int(int index) const -> int;
00061
00067         auto setFeature(int index, int x) -> void;
00068     };
00069 } // namespace km
00070
00071 #endif // POINT_HPP
```

8.22 include/utilsCLI.hpp File Reference

Utility functions for the command-line interface.

```
#include <iostream>
#include <opencv2/opencv.hpp>
#include <filesUtils.hpp>
```

Include dependency graph for utilsCLI.hpp:



Namespaces

- namespace km::utilsCLI

  Provides utility functions for the command-line interface.
- namespace km

  Main namespace for the project.

Functions

- void km::utilsCLI::sequentialEncoderHeader ()

  Displays the header for the sequential encoder.
- void km::utilsCLI::mpiEncoderHeader ()

  Displays the header for the MPI encoder.
- void km::utilsCLI::ompEncoderHeader ()

  Displays the header for the OpenMP encoder.
- void km::utilsCLI::mainMenuHeader ()

  Displays the main menu header.
- void km::utilsCLI::decoderHeader ()

  Displays the decoder header.
- void km::utilsCLI::workDone ()

  Displays the work done message.
- void km::utilsCLI::compressionChoices (int &levelsColorsChoice, int &typeCompressionChoice, std::string &outputPath, cv::Mat &image, int executionStandard)

  Handles the compression choices.
- void km::utilsCLI::printCompressionInformations (int &originalWidth, int &originalHeight, int &width, int &height, int &k, size_t &different_colors_size)

  Prints the compression information.
- void km::utilsCLI::displayDecodingMenu (std::string &path, std::vector< std::filesystem::path > &image↩ Names, std::filesystem::path &decodeDir)

  Displays the decoding menu.

8.22.1 Detailed Description

Utility functions for the command-line interface.

8.23 utilsCLI.hpp

Go to the documentation of this file.

```
00001
00006 #ifndef UTILSCLI_HPP
00007 #define UTILSCLI_HPP
00008
00009 #include <iostream>
00010 #include <opencv2/opencv.hpp>
00011 #include <filesUtils.hpp>
00012
00018 namespace km
00019 {
00020     namespace utilsCLI
00021     {
00022
00026         void sequentialEncoderHeader();
00027
00031         void mpiEncoderHeader();
00032
00036         void ompEncoderHeader();
00040         void mainMenuHeader();
00041
00045         void decoderHeader();
00046
00050         void workDone();
00051
00060         void compressionChoices(int &levelsColorsChoice, int &typeCompressionChoice, std::string
      &outputPath, cv::Mat &image, int executionStandard);
00061
00071         void printCompressionInformations(int &originalWidth, int &originalHeight, int &width, int
      &height, int &k, size_t &different_colors_size);
00072
00079         void displayDecodingMenu(std::string &path, std::vector<std::filesystem::path> &imageNames,
      std::filesystem::path &decodeDir);
00080     };
00081 }
00082
00083 #endif // UTILSCLI_HPP
```

8.24 README.md File Reference

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