Numerical search for SIC-POVMs

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Chapter 1

Numerical search for SIC-POVMs

This in an implementation of various algorithms to find SIC-POVMs in complex vector spaces of arbitrary dimensions.

1.1 Structure

The code is organized in three directories:

- `main/`: logic specific to each algorithm employed, each file contains a `main` function
- `src/`: logic and data structures shared by all algorithms
- `test/`: tests of the code in the `src` directory

Chapter 2

Notes

Seeds 0-49 have been tested in dimension 40, time 310 minutes.

2.1 TO-DO

- Parallelize starting vectors, MPI
- A proper system for keeping track of results.
- Review the handling of data/variables between the functions in `gradient_descent`. (Related to the above point.)
- Stop generating a new array of indices to shuffle every time a new vector is generated? Can shuffle in-place instead.
- Add tests for FiducialVector
  - Indexing
  - Indexing exceptions
  - Remove complex phase
- Rewrite/document LatinSquares
- Move G-matrix code into FiducialVector

2.2 DONE

- Save loss, fiducial, time to file
- Parallelize starting vectors instead of loss, OpenMP
- Better generation of start vectors
- (Failed, gone back) Try `long double` for higher precision
- Precompute all d(d+1)/2 distinct values of G-matrix in analytic gradient function. Use a class such the same array may be used throughout the minimization of one vector?
- Simplify the loop over vector batches, better to loop seed by seed.

Chapter 3

Class Index

3.1 Class List

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

Chapter 4

Class Documentation

4.1 FiducialVector Class Reference

A complex vector with functionality required for determining a fiducial vector in arbitrary dimensions.

`#include <vectors.hpp>`

Public Member Functions

- FiducialVector (const unsigned int dimension)
  Constructor where elements of vector default to c-number 0.0 + 0.0i.
- FiducialVector (std::initializer_list< c_num > values)
  Constructor accepting an initializer list of values.
- c_num & operator[ ] (const int idx)
  Index elements by reference.
- c_num operator[ ] (const int idx) const
  Index elements by value without the possibility to change state of vector.
- double **norm_squared** () const
- double **norm** () const
- void normalize ()
  Rescale all elements by norm such that new norm equals 1.
- void remove_complex_phase ()
  Multiply all elements with phase factor such that phase of first element is 0.
- unsigned int **size** () const

Friends

- std::ostream & operator<< (std::ostream &os, const FiducialVector &v)
  Overload << operator to let instance of the class to be passed to stream e.g. for printing.

4.1.1 Detailed Description

A complex vector with functionality required for determining a fiducial vector in arbitrary dimensions.

4.1.2 Constructor & Destructor Documentation

4.1.2.1 FiducialVector()

```
FiducialVector::FiducialVector (
            std::initializer_list< c_num > values )
```

Constructor accepting an initializer list of values.

Usage: FiducialVector v { c_num(1, -1), c_num(2, -2), c_num(3, -3) };

4.1.3 Friends And Related Function Documentation

4.1.3.1 operator<<

```
std::ostream& operator<< (
            std::ostream & os,
            const FiducialVector & v )  [friend]
```

Overload << operator to let instance of the class to be passed to stream e.g. for printing.

Vector is added to ostream object with one element per line on the form a+bi, and ends in a newline.

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

- src/vectors.hpp
- src/vectors.cpp

4.2 G_Matrix Class Reference

Public Member Functions

- **G_Matrix** (const FiducialVector &vector)
- c_num & **idx** (const size_t k, const size_t l)
- c_num **idx** (const size_t k, const size_t l) const
- unsigned int **dim** () const

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

- src/wh_sic_povm.hpp
- src/wh_sic_povm.cpp

4.3 LatinSquares Class Reference

Public Member Functions

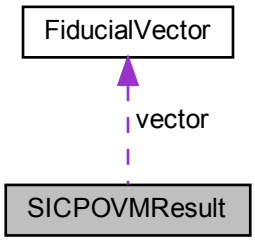
- **LatinSquares** (unsigned int dim)
- std::vector< unsigned int > **bins** ()
- FiducialVector **generate_initial_vector** (const unsigned int vector_idx)
- void **distribute_bins** (unsigned int seed)

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

- src/vectors.hpp
- src/vectors.cpp

4.4 SICPOVMResult Class Reference

Collaboration diagram for SICPOVMResult:



Public Member Functions

- **SICPOVMResult** (unsigned int dim, unsigned int vector_init_seed, unsigned int vector_idx)
- void **save_vector_to_file** ()
- void **save_loss_to_file** ()
- void **save_time_to_file** ()
- bool **is_fiducial** ()

Public Attributes

- FiducialVector **vector**
- unsigned int **dimension**
- unsigned int **vec_init_seed**
- unsigned int **vec_idx**
- unsigned int **time_ms** = 0
- std::vector< double > **loss**

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

- src/utils.hpp
- src/utils.cpp

4.5 test_func_info_t Struct Reference

Public Attributes

- test_func_t **function**
- const char * **name**

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

- test/main.hpp

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