SMG2S User Manual

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Chapter 1

Introduction

1.1 Getting Started

SMG2S (Scalable Matrix Generator with Given Spectrum) is a software which provides to generator the non-Hermitian Matrices with User-customized eigenvalues. SMG2S is implemented in parallel based on MPI (Message Passing Interface) and C++11 to support efficiently the generation of test matrices on distributed memory platforms.

Iterative linear algebra methods are important for the applications in various fields. The analysis of the iterative method behaviors is complex, and it is necessary to evaluate their convergence to solve extremely large non-Hermitian eigenvalue and linear problems on parallel and/or distributed machines. This convergence depends on the properties of spectra. Thus, we propse SMG2S to generate large matrices with known spectra to benchmark these methods. The generated matrices are non-Hermitian and non-trivial, with very high dimension. SMG2S can generate the non-Hermitian matrices with user-custormized eigenvalues.

The ability of SMG2S to keep the accuracy of given spectrum can be verified by the functionality proposed inside SMG2S. This function is based the shift inverse power method. SMG2S gives also an graphic user interface to compare the given and final spectral distribution for the verification.

We will describe the following subset of the SMG2S.

- **Parallel Vector and Matrix:**
- **Nilpotency Matrix Object:**
- **Generating Matrix with predescribed eigenvalues:**
- **Interface to Other Languages/Libraries:**
- **Verification of Eigenvalues of Generated Matrix:**

1.2 Installation

To obtain SMG2S, please follow the instructions at the SMG2S download page: https://github.com/brunowu/SMG2S.

Prerequisites:

- C++ Compiler with **c++11** support;
- Cmake (version minimum 3.6);
- (Optional) PETSc and SLPEc are necessary for the verification of the ability to keep the given spectrum.

Int the main directory:

```
cmake . –DCMAKE_INSTALL_PREFIX=${INSTALL_DIRECTORY}
```

The main.cpp will generate an exectutable smg2s.exe to demonstrate a minimum sample :

```
make
```

The main part of SMG2S is a colllection of header files. Install the header files into ${INSTALL_DIRECTORY}

```
make install
```

For testing:

```
make test
```

The output of test should be like:

```
Running tests...
Test project /User/name/SMG2S
Start 1: Test_Size_10000_w_proc1
1/4 Test #1: Test_Size_10000_w_proc1 .. Passed 1.20 sec
Start 2: Test_Size_20000_w_proc2
2/4 Test #2: Test_Size_20000_w_proc2 .. Passed 1.22 sec
Start 3: Test_Size_10000_s_proc1
3/4 Test #3: Test_Size_10000_s_proc1 .. Passed 1.20 sec
Start 4: Test_Size_10000_s_proc2
4/4 Test #4: Test_Size_10000_s_proc2 .. Passed 0.66 sec

100% tests passed, 0 tests failed out of 4

Total Test time (real) = 4.29 sec
```

1.3 Copyright and Licensing of SMG2S

1.4 Referencing SMG2S

@article{galichergenerate, title={Generate Very Large Sparse Matrices Starting from a Given Spectrum}, author={Galicher, Hervé and Boillod-Cerneux, France and Petiton, Serge and Calvin, Christophe} }

1.5 Directory Structure

1.6 List of SMG2S Developers

Hmmm.

Chapter 2

Templated SMG2S Parallel Matrix and Vector

2.1 Parallel Vector

2.1.1 Vector Map

2.1.2 Creating a Distributed Vector

2.1.3 Parallel Matrix

2.1.4 Matrix Map

2.1.5 Creating a Distributed Matrix

Chapter 3

Templated Nilpotency Matrix Object

Chapter 4

Generating Matrix with SMG2S

4.1 Generation Workflow

4.2 Example

Silly daemons

Chapter 5

Interface to Other Languages/Libraries

5.1 Interface to C

5.2 Interface to Python

5.3 Interface to PETSc

5.4 Interface to Trilinos/Teptra

Silly daemons

Chapter 6

Verification of Eigenvalues

6.1 Prerequisites

6.2 Verifcation by Shifted Inverse Power Method

6.3 Script for result cleaning

6.4 Plot by Graphic User Interface

Silly daemons