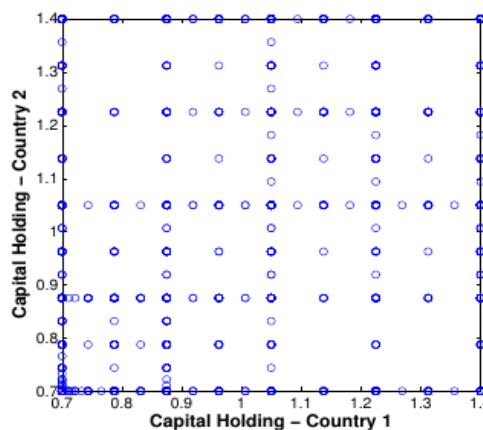


Hands on Session (I) – Several Sparse Grid Toolboxes

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July 20th, 2017

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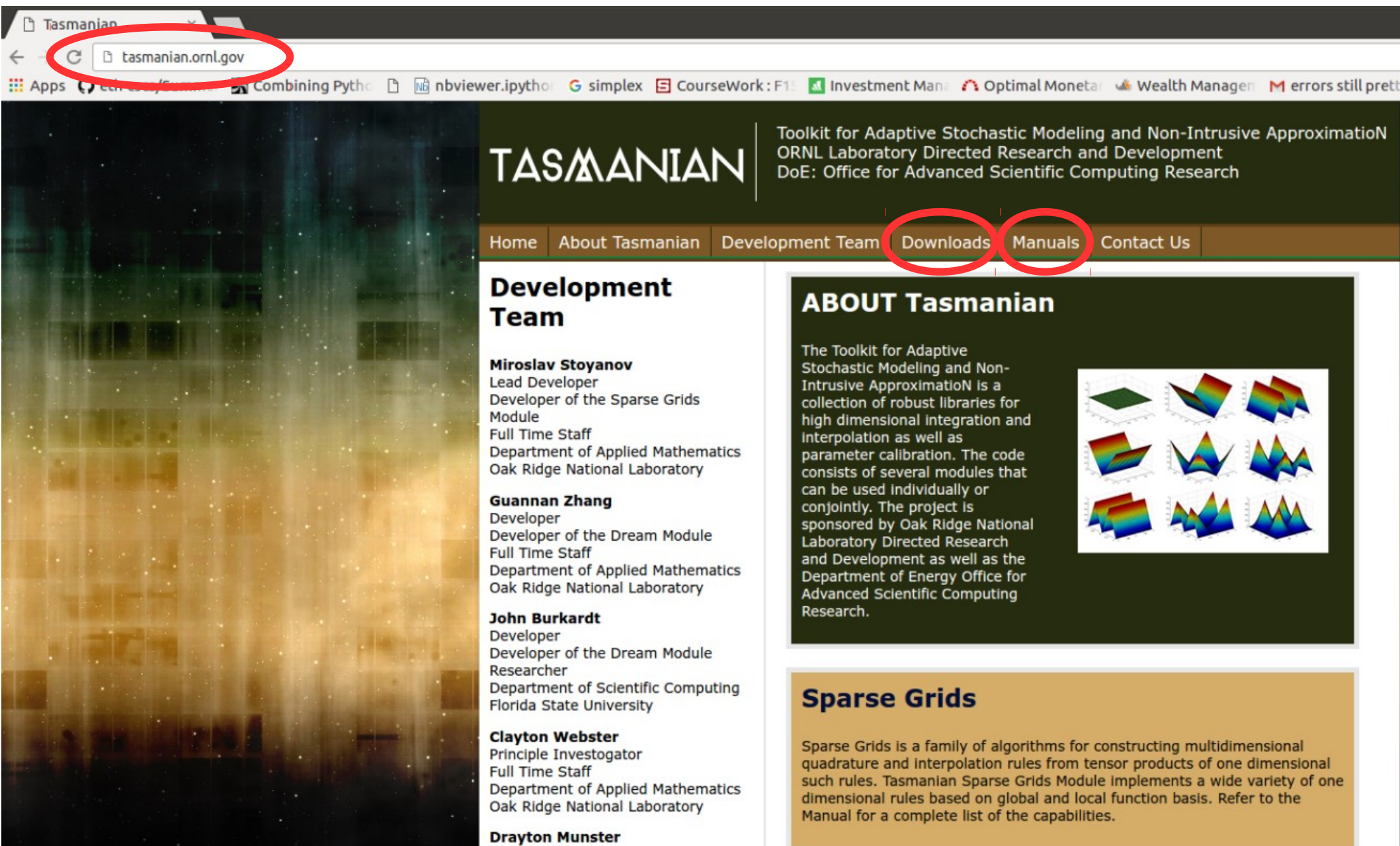


Note – Install all libraries

- Note: I prepared you the packages with all the dependencies.
- in order to install, follow these steps:
 1. log onto MIDWAY, and go to your git repository.
> cd OSM_Lab/SparseGrid/SparseGridCode
 2. Install Tasmanian (SG library), SPINTERP (SG library), IPOPT, and PYIPOPT (optimizer)

```
> install_SG.sh
```

TASMANIAN – open source code



The screenshot shows the Tasmanian website in a web browser. The address bar shows 'tasmanian.ornl.gov'. The navigation bar includes links for Home, About Tasmanian, Development Team, Downloads, Manuals, and Contact Us. The 'Downloads' and 'Manuals' links are circled in red. The main content area is divided into two columns. The left column is titled 'Development Team' and lists three team members: Miroslav Stoyanov, Guannan Zhang, and John Burkardt. The right column is titled 'ABOUT Tasmanian' and describes the toolkit. Below this, there is a section for 'Sparse Grids'.

Tasmanian

Toolkit for Adaptive Stochastic Modeling and Non-Intrusive Approximation
ORNL Laboratory Directed Research and Development
DoE: Office for Advanced Scientific Computing Research

Home About Tasmanian Development Team **Downloads** **Manuals** Contact Us

Development Team

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Full Time Staff
Department of Applied Mathematics
Oak Ridge National Laboratory

Guannan Zhang
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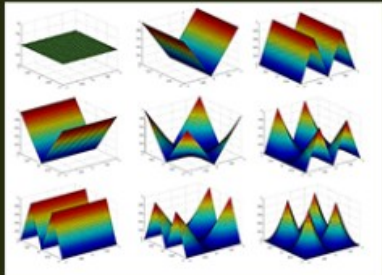
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ABOUT Tasmanian

The Toolkit for Adaptive Stochastic Modeling and Non-Intrusive Approximation is a collection of robust libraries for high dimensional integration and interpolation as well as parameter calibration. The code consists of several modules that can be used individually or conjointly. The project is sponsored by Oak Ridge National Laboratory Directed Research and Development as well as the Department of Energy Office for Advanced Scientific Computing Research.



Sparse Grids

Sparse Grids is a family of algorithms for constructing multidimensional quadrature and interpolation rules from tensor products of one dimensional such rules. Tasmanian Sparse Grids Module implements a wide variety of one dimensional rules based on global and local function basis. Refer to the Manual for a complete list of the capabilities.

Software tutorial

The Toolkit for Adaptive Stochastic Modeling and Non-Intrusive Approximation
<http://tasmanian.ornl.gov/>

TASMANIAN Sparse Grids.

Very recent open source library written in CPP:

- Contains “ordinary and adaptive” sparse grids.
- Many more basis functions (global polynomials, wavelets,...).
- Interfaces to **Python** and **Matlab**.
 - **You better use it out of C++ or Python**
- Moderately parallelized (with OpenMP).

Compile & run TASMANIAN*

!!! READ THE *** MANUAL (RTFM) !!!

→ **Log on to MIDWAY**

> ssh USERNAME@midway1.rcc.uchicago.edu

→ **Load matlab**

> module load matlab

→ **Start MATLAB without graphical interface**

> matlab -nojvm

1. go to simple example:

> cd OSM_Lab/SparseGrid/SparseGridCode/analytical_examples/TASMANIAN_Matlab

2. let's have a look at the example:

> tsg_example_OSM_17.m

3. launch matlab & run example:

> tsg_example_OSM_17()

4. NOTE: Tasmanian $[-1,1]^d$ instead of $[0,1]^d$

If you are interested in CPP code examples, TASMANIAN provides examples here:

> cd TasmanianSparseGrids/Example/example.cpp

> make

*more examples provided from TASMANIAN in InterfaceMATLAB/tsgExample.m → beyond scope of lecture.

TASMANIAN in Python

!!! READ THE *** MANUAL (RTFM) !!!

→ **Log on to MIDWAY**

> ssh USERNAME@midway1.rcc.uchicago.edu

1. go to simple example:

> cd OSM_Lab/SparseGrid/SparseGridCode/analytical_examples/TASMANIAN_Python

2. let's have a look at the example:

> OSM_example.py

3. run example:

> python OSM_example.py

4. NOTE: Tasmanian $[-1,1]^d$ instead of $[0,1]^d$

Alternative Toolboxes (I)

<http://www.ians.uni-stuttgart.de/spinterp/>

Sparse Grid Interpolation Toolbox

Sparse Grid Interpolation Toolbox

The Sparse Grid Interpolation Toolbox is a Matlab toolbox for recovering (approximating) expensive, possibly high-dimensional multivariate functions.

It was developed by Andreas Klimke at the [Institute of Applied Analysis and Numerical Simulation](#) at the [High Performance Scientific Computing](#) lab ("Lehrstuhl für Numerische Mathematik für Höchstleistungsrechner"), [Universität Stuttgart](#) during his Ph.D. studies.

Andreas continues to maintain and improve the toolbox in his spare time since April 2006. He is very grateful to the group and, in particular, Prof. Dr. Wohlmuth for the possibility to continue to host the Sparse Grid Interpolation Toolbox on the institute's Web site.

For more information on sparse grid interpolation and the features of the toolbox, please go to the [About page](#).

Please note the [License](#) information.

When referencing the toolbox in a publication, [please cite these references](#).

Latest news

Date	Headline
May 25, 2008	Version v5.1.1 released
February 24, 2008	Version v5.1.0 released
December 23, 2007	Version v5.0.0 released
October 24, 2007	Version v4.0.0 released
March 3, 2007	Version v3.5.1 released
July 25, 2006	Version v3.5.0 released
June 12, 2006	Version v3.2.0 released
January 30, 2006	Version v3.0.1beta released
January 13, 2006	Sparse Grid Interpolation Toolbox Web page online

Matlab is a registered trademark of The Mathworks, Inc.

Alternative Toolboxes (II)

<http://www.ians.uni-stuttgart.de/spinterp/>

- spinterp.
- Matlab-based implementation of sparse grids
- Not updated since 2008
- Piecewise linear basis function and few others (global)
- Dimensional adaptivity as options
- **no general adaptivity**
- **Not parallel**

Run Example Code on MIDWAY

→ **Log on to MIDWAY**

> ssh USERNAME@midway1.rcc.uchicago.edu

→ **Load matlab**

> module load matlab

→ **Start MATLAB without graphical interface**

> matlab -nojvm

→ **Go to example and run it.**

> cd OSM_Lab/SparseGrid/SparseGridCode/spinterp_v5.1.1

> addpath('spinterp_v5.1.1')

> spinit

> cd examples

> spdemo

```
%  
% A 2D-example for multi-linear sparse grid interpolation using the  
% Clenshaw-Curtis grid and vectorized processing of the function.  
%  
% See also SPINTERP, SPVALS.
```

```
% Author : Andreas Klimke, Universität Stuttgart  
% Version: 1.1  
% Date : September 29, 2003
```

```
% -----  
% Sparse Grid Interpolation Toolbox  
% Copyright (c) 2006 W. Andreas Klimke, Universitaet Stuttgart  
% Copyright (c) 2007-2008 W. A. Klimke. All Rights Reserved.  
% See LICENSE.txt for license.  
% email: klimkeas@ians.uni-stuttgart.de  
% web : http://www.ians.uni-stuttgart.de/spinterp  
% -----
```

```
% Some function f  
f = inline('1./((x*2-0.3).^4 +(y*3-0.7).^2+1)');
```

Test function

```
% Define problem dimension  
d = 2;
```

```
% Create full grid for plotting  
gs = 33;  
[X,Y] = meshgrid(linspace(0,2,gs),linspace(-1,1,gs));
```

```
% Set options: Switch vectorized processing on.  
options = spset('Vectorized', 'on', 'SparseIndices', 'off');
```

```
% Compute sparse grid weights over domain [0,2]x[-1,1]  
z = spvals(f, d, [0 2; -1 1], options);
```

Interpolate

```
% Compute inpterpolated values at full grid  
ip = spinterp(z, X, Y);
```

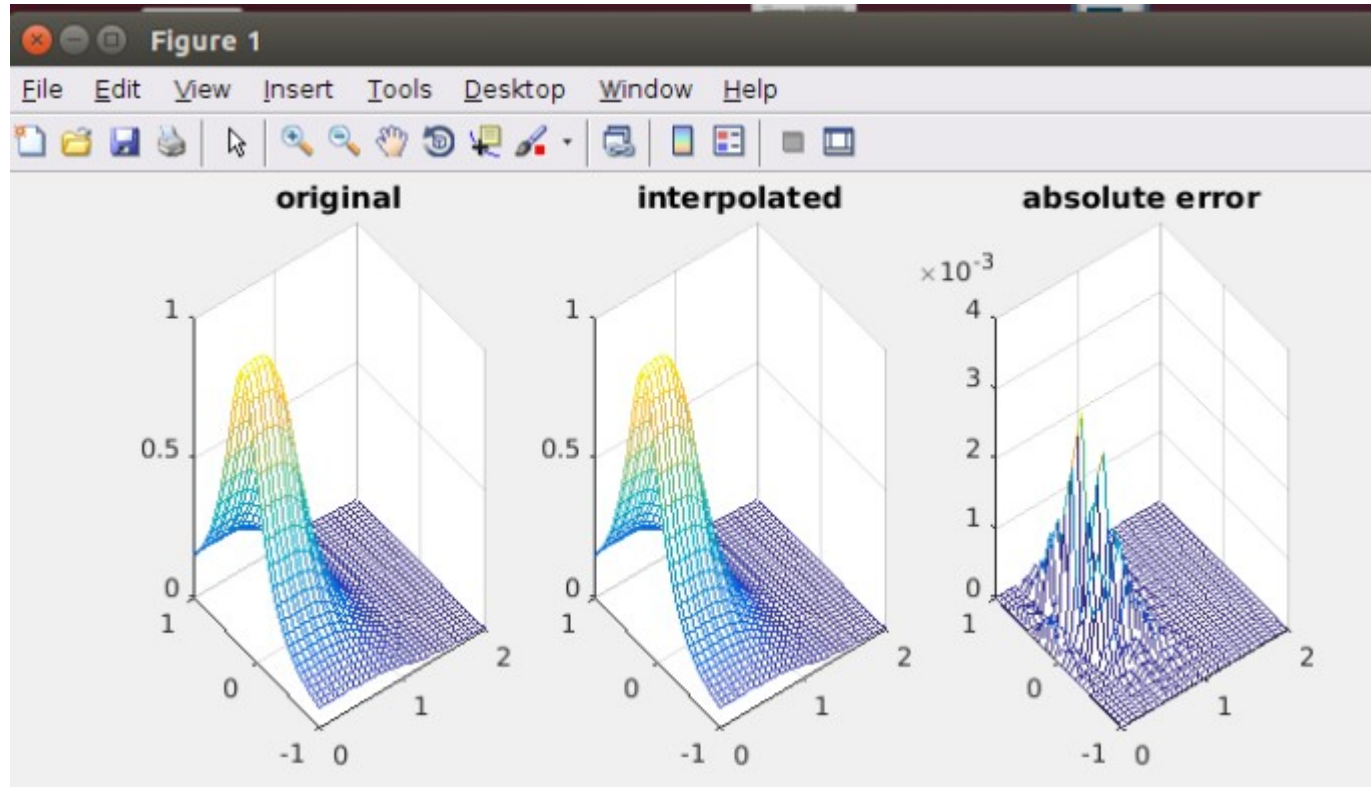
```
% Plot original function, interpolation, and error  
subplot(1,3,1);  
mesh(X,Y,f(X,Y));  
title('original');
```

```
subplot(1,3,2);  
mesh(X,Y,ip);  
title('interpolated');
```

```
subplot(1,3,3);  
mesh(X,Y,abs(f(X,Y)-ip));  
title('absolute error');
```

```
disp(' ');  
disp('Sparse grid representation of the function:');
```

What you should see...



Other Toolboxes (III)

<http://sgpp.sparsegrids.org/>

- C++ with some plug-ins
- Multiple local basis functions

SG++ Documentation

Welcome to the SG++ documentation.
The current version of SG++ can be found at [Downloads and Version History](#).

If you use any part of the software or any resource of this webpage and/or documentation, you implicitly accept the copyright (see the [Copyright](#)). This includes that you have to cite one of the papers dealing with sparse grids when publishing work with the help of SG++ (see below).

Images taken from [1]

[1] D. Pflüger, Spatially Adaptive Sparse Grids for Higher-Dimensional Problems. Verlag Dr. Hut, München, 2010. ISBN 9-783-868-53555-6.

Overview