



fc siplt Matlab toolbox, User's Guide* version 0.2.6

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Abstract

This Matlab toolbox uses a **siMESH** object, coming from the **csimesh** toolbox, to display simplicial meshes or datas on simplicial meshes. Its kernel uses the **graphics4mesh** toolbox.

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*L^AT_EX manual, revision 0.2.6, compiled with Matlab 2022a, and toolboxes **fc-siplt**[0.2.6], **fc-tools**[0.0.35], **fc-bench**[0.1.3], **fc-hypermesh**[1.0.4], **fc-amat**[0.1.3], **fc-meshtools**[0.1.4], **fc-graphics4mesh**[0.1.6], **fc-oogmsh**[0.3.0], **fc-simesh**[0.4.6]

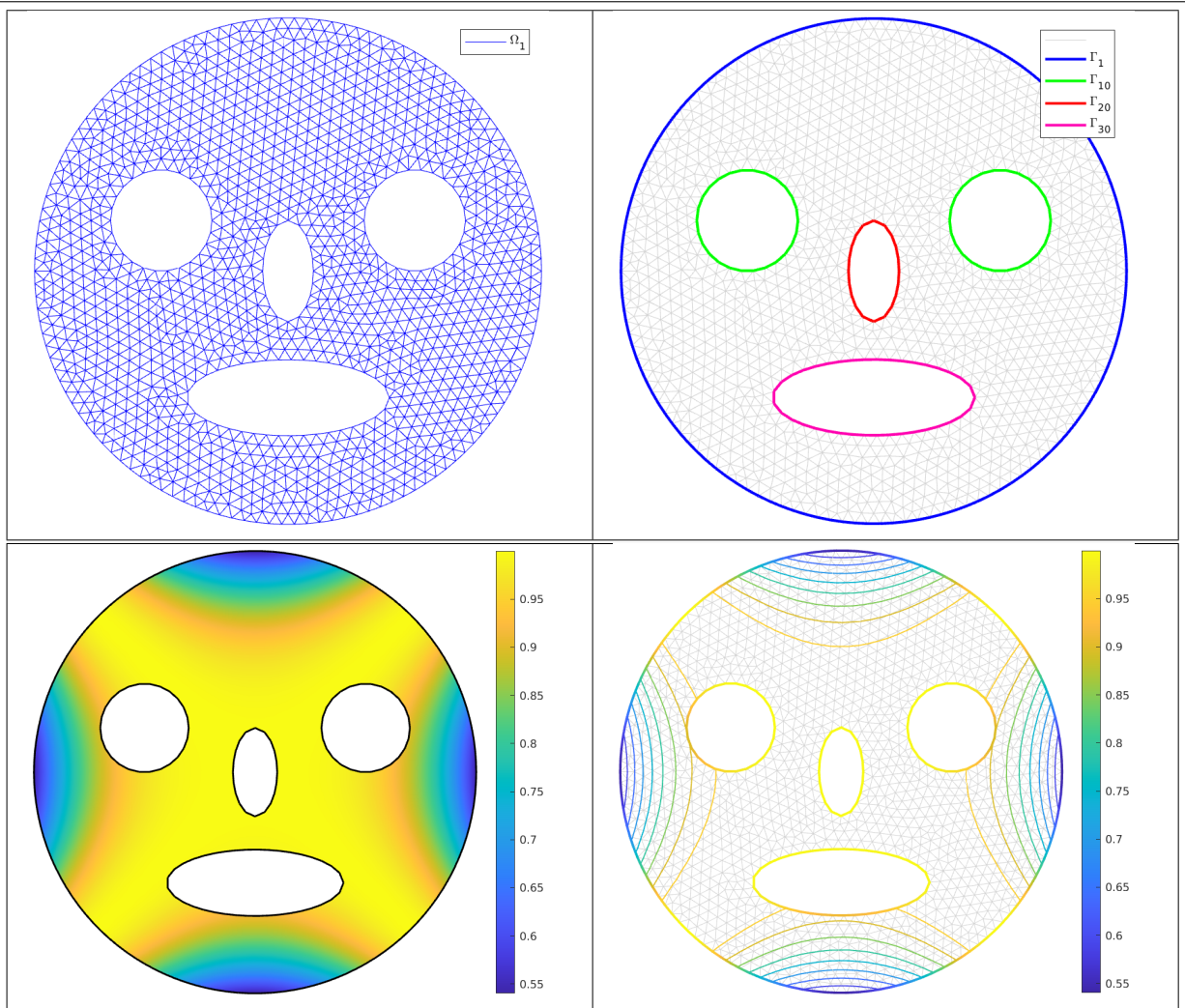
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1 Introduction

This **experimental** Matlab toolbox uses the [graphics4mesh](#) toolbox[1] to do some graphic representations on a **siMESH** object of the [simesh](#) toolbox[2].

In Listing 1, a 2D example is provided with the 4 generated figures. For graphic representations, one can also used **Th.plotmesh(...)** instead of **fc_siplt.plotmesh(Th,...)**, **Th.plot(...)** instead of **fc_siplt.plot(Th,...)** and so on.



```

geofile=fc_simesh.get_geo(2,2,'sample2D01.geo');
% Using GMSH >= 4.0.0 to create mesh file
meshfile=fc_oogmsh.gmsh.buildmesh2d(geofile,200,'force',true);
% Creating siMesh object by reading the mesh file
Th=fc_simesh.siMesh(meshfile);
% Computing datas on siMesh object
u=@(x,y) cos(x.^2-y.^2);
U=Th.eval(u);
% Graphics
figure(1)
fc_siplt.plotmesh(Th,'inlegend',true)
axis image;axis off
legend()

figure(2)
fc_siplt.plotmesh(Th,'color','LightGray')
hold on
fc_siplt.plotmesh(Th,'d',1,'inlegend',true,'LineWidth',2)
axis image;axis off
legend()

figure(3)
fc_siplt.plot(Th,U,'plane',true)
colorbar
shading interp
axis image;axis off
hold on
fc_siplt.plotmesh(Th,'d',1,'LineWidth',1.5,'color','k')

figure(4)
fc_siplt.plotmesh(Th,'color','LightGray')
axis image;axis off
hold on
fc_siplt.plot(Th,U,'d',1,'LineWidth',2,'plane',true)
colorbar
fc_siplt.plotiso(Th,U,'niso',10,'LineWidth',1,'plane',true)

```

Listing 1: `fc_siplt.demos.sample2D01` script with figure 1 (top left), figure 2 (top right), figure 3 (bottom left) and figure 4 (bottom right).

2 Installation

This toolbox was only tested on Ubuntu 22.04.1 with Matlab R2022a.

One just has to get/download the install file

`mfc_siplt_install.m`

or get it on the dedicated web page. Thereafter, one runs it under Matlab. This command downloads, extracts and configures the *fc-siplt* toolbox and all the required toolboxes in the current directory.

For example, to install this toolbox in the `~/Matlab` directory, one has to copy the file `mfc_siplt_install.m` in the `~/Matlab` directory. Then in a Matlab terminal run the following commands

```
>> cd ~/Matlab
>> mfc_siplt_install
```

There is the output of the `mfc_siplt_install` command on a Linux computer:

```
Parts of the <fc-siplt> Matlab toolbox.
Copyright (C) 2017-2023 F. Cuvelier

1- Downloading and extracting the toolboxes
2- Setting the <fc-siplt> toolbox
Write in ~/Matlab/fc-siplt-full/fc_siplt-0.2.6/configure_loc.m ...
3- Using toolboxes :
->          fc-tools : 0.0.35
->          fc-bench : 0.1.3
->          fc-hypermesh : 1.0.4
->          fc-amat : 0.1.3
->          fc-meshtools : 0.1.4
->          fc-graphics4mesh : 0.1.6
->          fc-oogmsh : 0.3.0
->          fc-simesh : 0.4.6
with          fc-siplt : 0.2.6
*** Using instructions
To use the <fc-siplt> toolbox:
addpath('~/Matlab/fc-siplt-full/fc_siplt-0.2.6')
fc_siplt.init()

See ~/Matlab/mfc_siplt_set.m
```

The complete toolbox (i.e. with all the other needed toolboxes) is stored in the directory `~/Matlab/fc-siplt-full` and, for each Matlab session, one has to set the toolbox by:

```
>> addpath('~/Matlab/fc-siplt-full/mfc-siplt-0.2.6')
>> fc_siplt.init()
```

If it's the first time the `fc_siplt.init()` function is used, then its output is

```
Try to use default parameters!
Use fc_tools.configure to configure.
Write in ~/Matlab/fc-siplt-full/fc_tools-0.0.35/configure_loc.m ...
Try to use default parameters!
Use fc_bench.configure to configure.
Write in ~/Matlab/fc-siplt-full/fc_bench-0.1.3/configure_loc.m ...
Try to use default parameters!
Use fc_hypermesh.configure to configure.
Write in ~/Matlab/fc-siplt-full/fc_hypermesh-1.0.4/configure_loc.m ...
Try to use default parameters!
Use fc_amat.configure to configure.
Write in ~/Matlab/fc-siplt-full/fc_amat-0.1.3/configure_loc.m ...
Try to use default parameters!
Use fc_meshtools.configure to configure.
Write in ~/Matlab/fc-siplt-full/fc_meshtools-0.1.4/configure_loc.m ...
Try to use default parameters!
Use fc_graphics4mesh.configure to configure.
Write in ~/Matlab/fc-siplt-full/fc_graphics4mesh-0.1.6/configure_loc.m ...
Try to use default parameters!
Use fc_oogmsh.configure to configure.
Write in ~/Matlab/fc-siplt-full/fc_oogmsh-0.3.0/configure_loc.m ...
Try to use default parameters!
Use fc_simesh.configure to configure.
Write in ~/Matlab/fc-siplt-full/fc_simesh-0.4.6/configure_loc.m ...
Using fc_siplt[0.2.6] with fc_tools[0.0.35], fc_bench[0.1.3], fc_hypermesh[1.0.4],
          fc_amat[0.1.3], fc_meshtools[0.1.4], fc_graphics4mesh[0.1.6],
          fc_oogmsh[0.3.0], fc_simesh[0.4.6].
[fc-oogmsh] Configured to use gmsh 4.11.1 with default MSH file format version 4.1
```

Otherwise, the output of the `fc_siplt.init()` function is

```
Using fc_siplt[0.2.6] with fc_tools[0.0.35], fc_bench[0.1.3], fc_hypermesh[1.0.4],
fc_amat[0.1.3], fc_meshtools[0.1.4], fc_graphics4mesh[0.1.6],
fc_oogmsh[0.3.0], fc_simesh[0.4.6].
[fc-oogmsh] Configured to use gmsh 4.11.1 with default MSH file format version 4.1
```

For **uninstalling**, one just have to delete directory

~/Matlab/fc-siplt-full

3 **fc_siplt.plotmesh** function

The **fc_siplt.plotmesh** function displays the mesh or parts of the mesh defined by an **siMESH** object.

Syntaxe

```
fc_siplt.plotmesh(Th)
fc_siplt.plotmesh(Th,Name,Value,...)
```

Description

fc_siplt.plotmesh(Th) displays all the (**Th.d**)-dimensional simplices elements of **Th**, a **siMESH** object.

fc_siplt.plotmesh(Th,Name,Value,...) specifies function options using one or more **Name,Value** pair arguments. Options of first level are

- '**d**' : to specify the dimension of the simplices elements (default : **Th.d**)
- '**labels**' : to select the labels of the elements to display,
- '**color**' : to specify the color of the displayed mesh elements. (default : use one color by displayed mesh elements),
- '**inlegend**' : add a legend name to graph if true (default : **false**)
- '**bounds**' : If **true**, draw the borders of the selected elementaries mesh elements (only for 2-dimensional simplices). (default : **false**)
- '**cutPlane**' : cut mesh by n plans given by n -by-4 array P where the equation of the i -th cut plane is given by

$$P(i,1)x + P(i,2)y + P(i,3)z + P(i,4) = 0.$$

The normal vector $P(i,1 : 3)$ pointed to the part of the mesh not displayed. (only for simplices in dimension 3) default : **[]** (no cut).

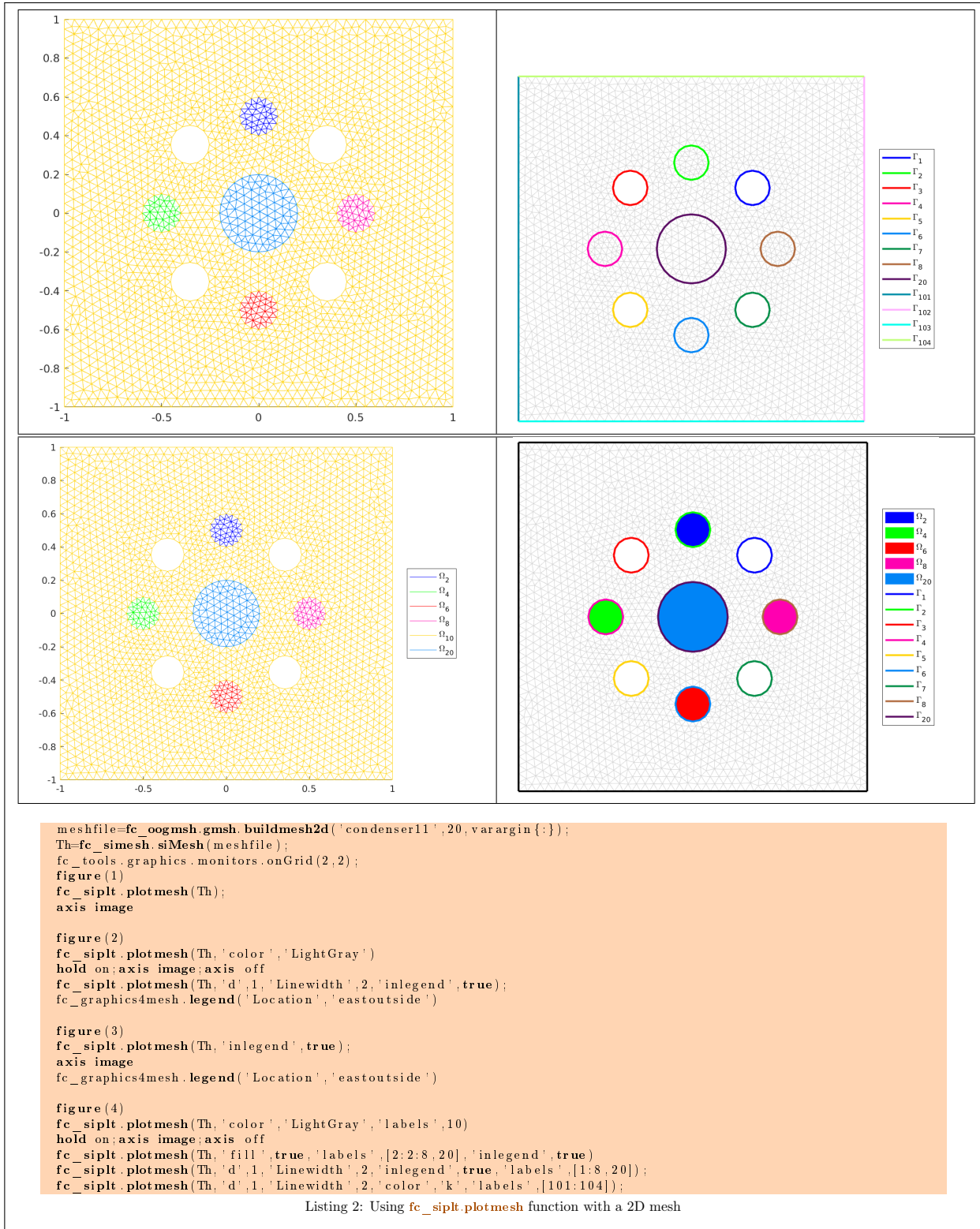
The options of second level depend on the type of elementaries mesh elements to represent.

One can use any option of the following functions according to the type of d -simplex to be represented.

- In dimension 3,
 - if $d == 3$, **patch** function is used,
 - if $d == 2$, **trimesh** function is used,
 - if $d == 1$, **plot3** function is used,
 - if $d == 0$, **plot3** function is used,
- In dimension 2,
 - if $d == 2$, **trimesh** function is used,
 - if $d == 1$, **plot** function is used,
 - if $d == 0$, **plot** function is used,
- In dimension 1,
 - if $d == 1$, **line** function is used,
 - if $d == 0$, **plot** function is used,

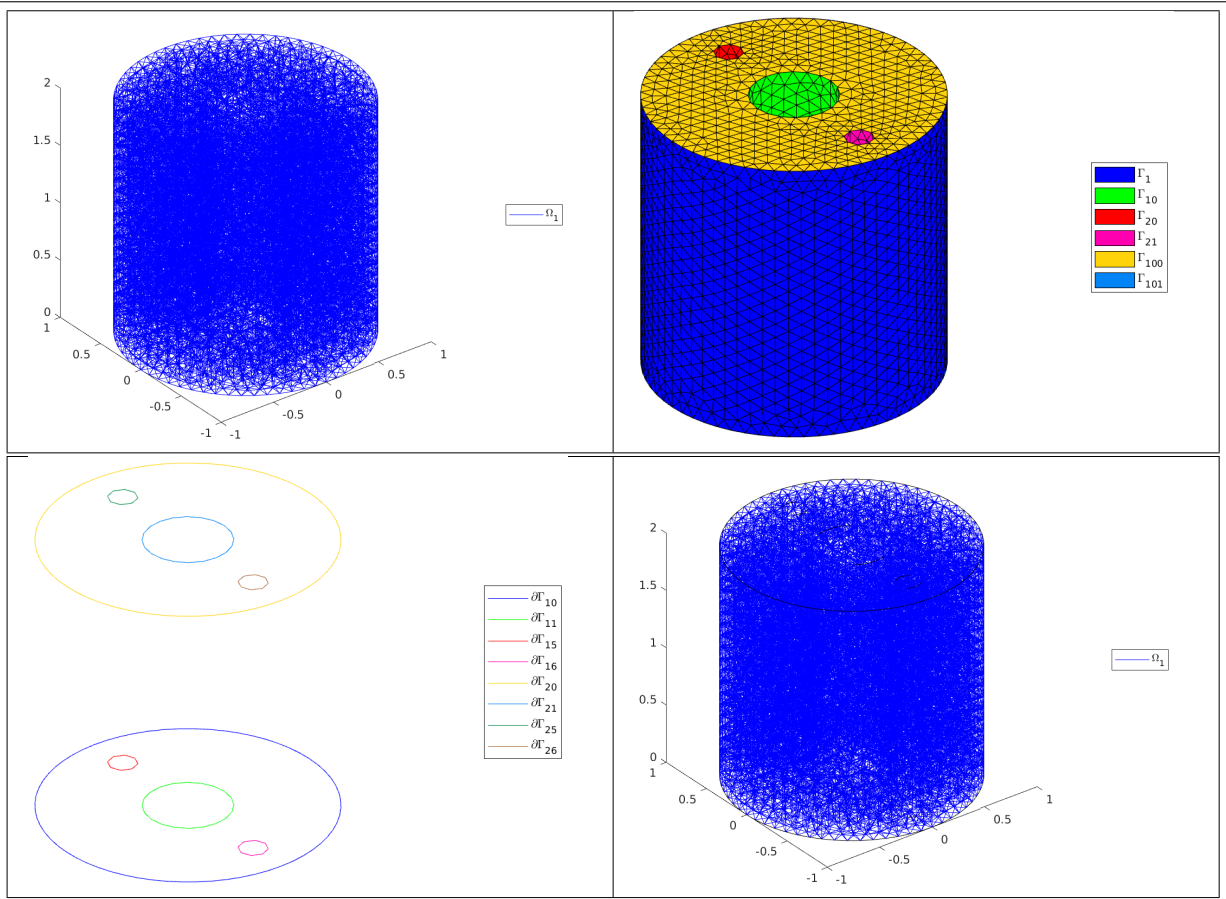
3.1 2D example

the following code is part of the **fc_siplt.demos.plotmesh2D** function.



3.2 3D example

the following code is part of the **fc_siplt.demos.plotmesh3D** function.



```

meshfile=fc_oogmsh.gmsh.buildmesh3d('cylinder3holes',10,varargin{:});
Th=fc_simesh.siMesh(meshfile);
fc_tools.graphics.monitors.onGrid(3,3,'figures',1:7);
figure(1)
fc_siplt.plotmesh(Th,'inlegend',true)
axis image
fc_graphics4mesh.legend('Location','eastoutside')

figure(2)
fc_siplt.plotmesh(Th,'d',2,'inlegend',true);
axis image;axis off
fc_graphics4mesh.legend('Location','eastoutside')

figure(3)
fc_siplt.plotmesh(Th,'d',1,'inlegend',true);
axis image;axis off
fc_graphics4mesh.legend('Location','eastoutside')

figure(4)
fc_siplt.plotmesh(Th,'inlegend',true)
hold on
fc_siplt.plotmesh(Th,'d',1,'color','k');
axis image
fc_graphics4mesh.legend('Location','eastoutside')

figure(5)
fc_siplt.plotmesh(Th,'d',2,'inlegend',true);
axis image
fc_graphics4mesh.legend('Location','eastoutside')

figure(6)
fc_siplt.plotmesh(Th,'d',2,'edgecolor',0.8*[1 1 1],'facecolor','None','edgealpha',0.5)
hold on;axis image
fc_siplt.plotmesh(Th,'d',1,'inlegend',true);
fc_graphics4mesh.legend('Location','eastoutside')

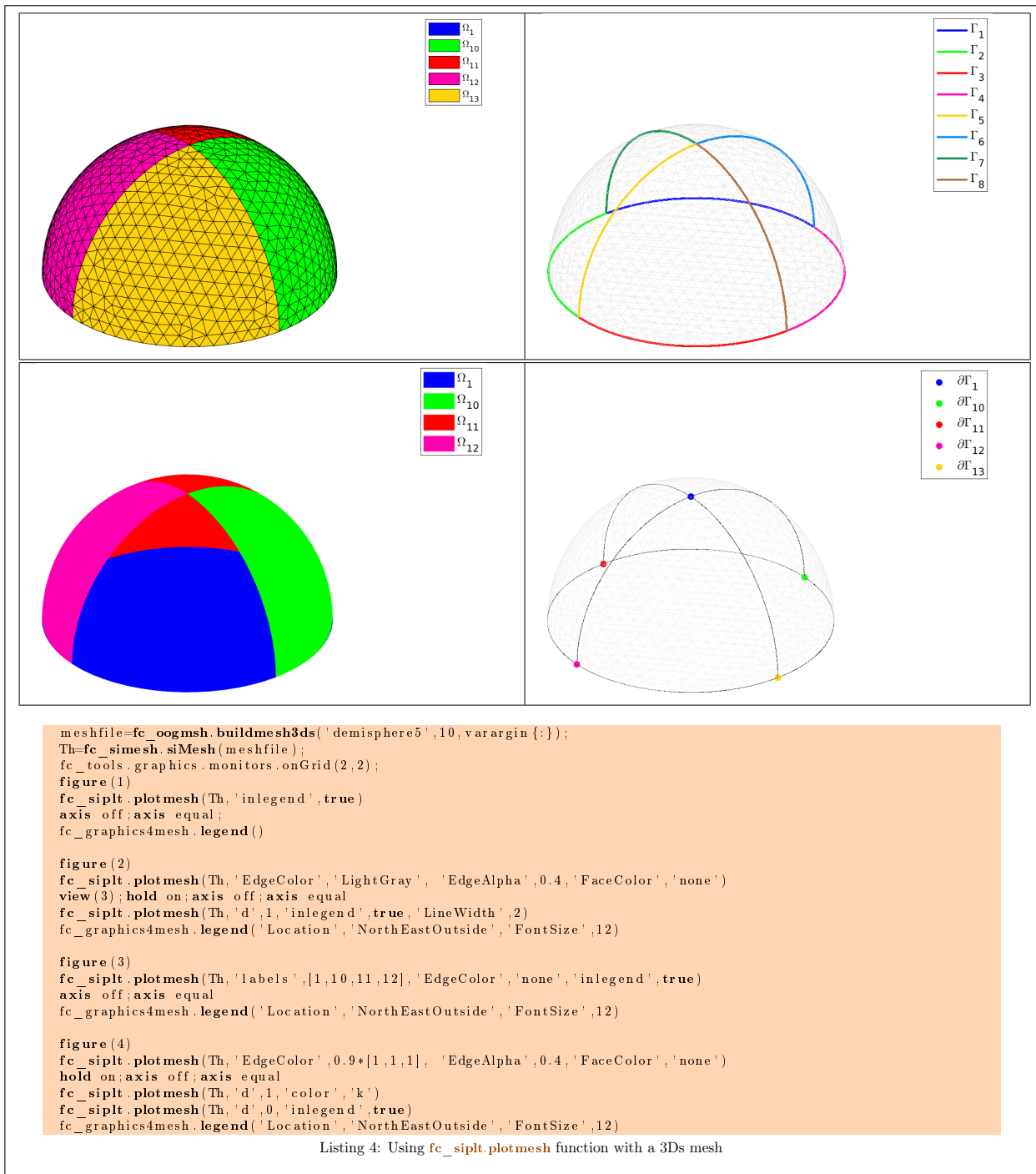
figure(7)
P=[fc_tools.graphics.PlaneCoefs([0 0 1],[0 0 1]); fc_tools.graphics.PlaneCoefs([0 0 1],[-1 0 0])];
fc_siplt.plotmesh(Th,'cutPlane',P,'Color','DarkGrey')
hold on;axis image
fc_siplt.plotmesh(Th,'d',2,'cutPlane',P,'inlegend',true);

```

Listing 3: Using `fc_siplt.plotmesh` function with a 3D mesh

3.3 3Ds example

the following code is part of the `fc_siplt.demos.plotmesh3Ds` function.



4 `fc_siplt.plot` function

The `fc_siplt.plot` function displays scalar datas on the mesh or parts of the mesh defined by an `siMESH` object.

Syntaxe

```

fc_siplt.plot(Th,u)
fc_siplt.plot(Th,u,Name,Value,...)

```

Description

`fc_siplt.plot(Th,u)` displays data `u` on all the `(Th.d)`-dimensional simplices elements of `Th`, a `siMESH` object. The data `u` is an 1D-array of size `Th.nq` or `Th.nqGlobal` or `Th.nqParent`.

`fc_siplt.plot(Th,u,Name,Value, ...)` specifies function options using one or more `Name,Value` pair arguments.

Options of first level are

- `'d'` : to specify the dimension of the simplices elements (default : `Th.d`)
- `'labels'` : to select the labels of the elements to display data,
- `'plane'` : if true, made a 2D representation in the xy -plane, otherwise made a 3D representation with z -value set to `u` (default : `false`)

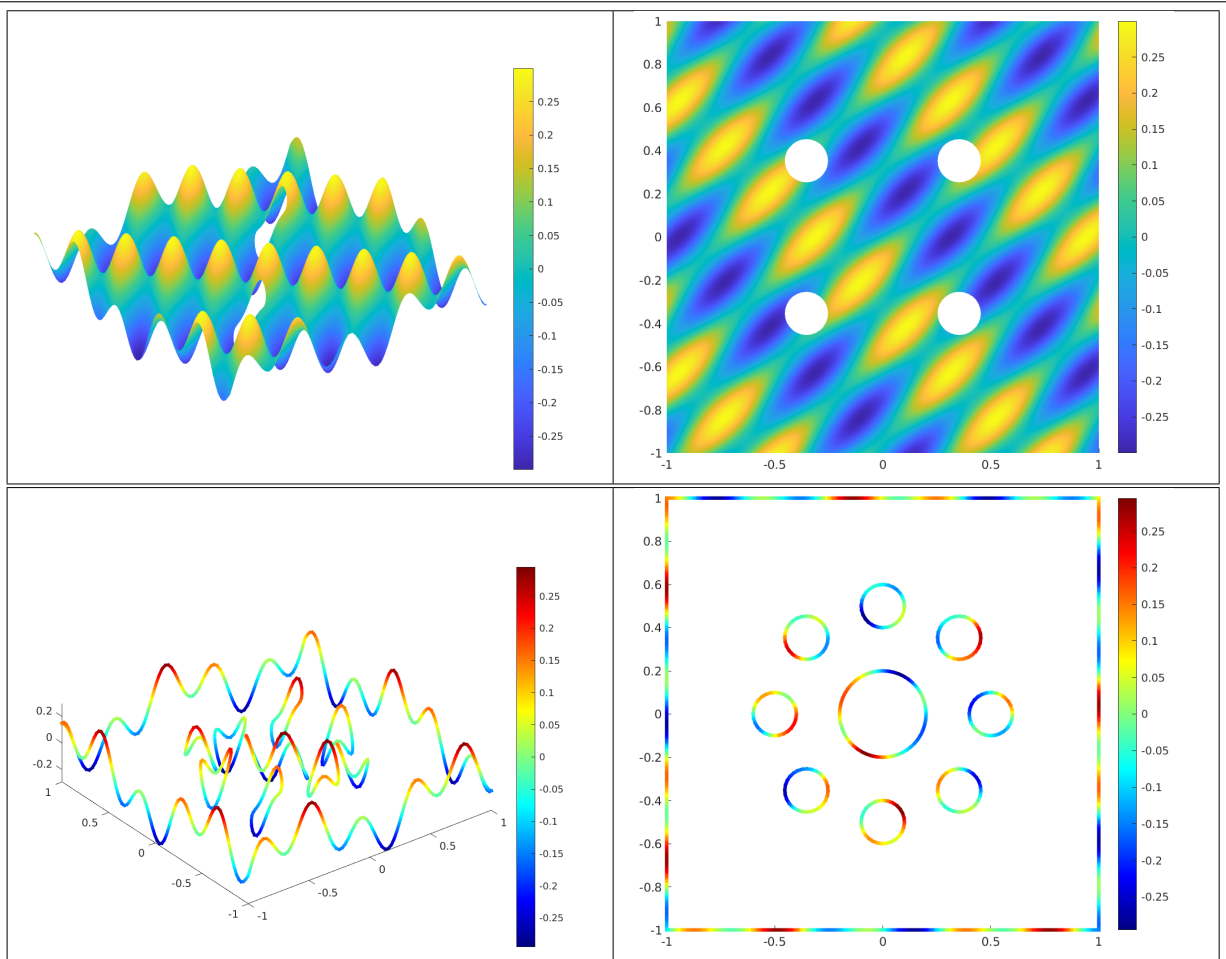
The options of second level depend on the type of elementaries mesh elements on which we want to represent datas.

One can use any option of the following functions according to the type of d -simplex.

- In dimension 3, `patch` function is used for $d \in \llbracket 1, 3 \rrbracket$.
- In dimension 2,
 - for $d == 2$, if `'plane'` option is true, `patch` function is used, otherwise it's `trisurf` function,
 - for $d == 1$, `patch` function is used.
- In dimension 1 and $d == 1$, `plot` function is used

4.1 2D example

the following code is part of the `fc_siplt.demos.plot2D` function.



```

meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser11',40,varargin{:});
Th=fc_simesh.siMesh(meshfile);
u=@(x,y) 0.3*cos(5*(2*x-y)).*sin(5*(x-2*y));
U=Th.eval(u);

fc_tools.graphics.monitors.onGrid(2,2);
figure(1)
fc_siplt.plot(Th,U);
axis image;axis off;view(3)
colorbar
shading interp

figure(2)
fc_siplt.plot(Th,U,'plane',true);
axis image
colorbar
shading interp

figure(3)
fc_siplt.plot(Th,U,'d',1,'Linewidth',3);
axis image
colormap('jet')
view(3)
colorbar

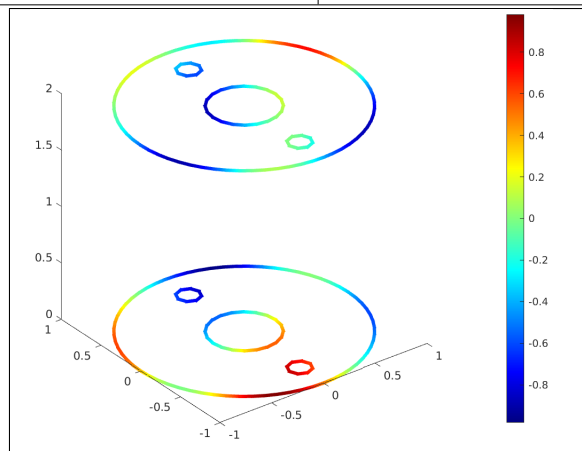
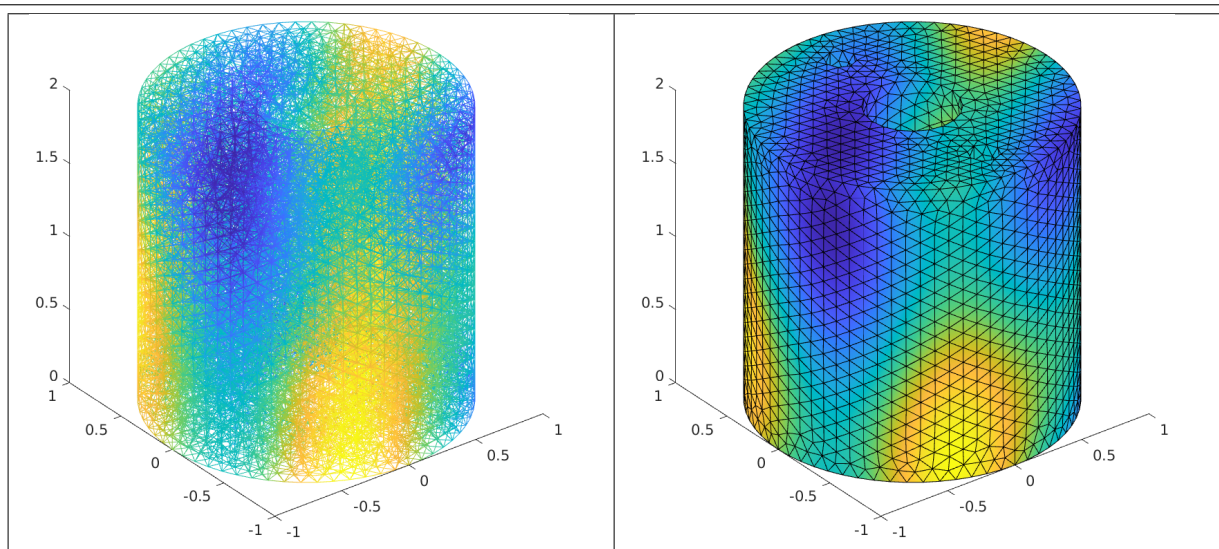
figure(4)
fc_siplt.plot(Th,U,'d',1,'Linewidth',3,'plane',true);
axis image
colormap('jet')

```

Listing 5: Using `fc_siplt.plot` function with a 2D mesh

4.2 3D example

the following code is part of the `fc_siplt.demos.plot3D` function.



```

meshfile=fc_oogmsh.gmsh.buildmesh3d('cylinder3holes',10,varargin{:});
Th=fc_simesh.siMesh(meshfile);
u=@(x,y,z) cos(2*x-y-z).*sin(x-2*y+z);
U=Th.eval(u);

fc_tools.graphics.monitors.onGrid(2,2,'figures',1:3);
figure(1)
fc_siplt.plot(Th,U);
axis image

figure(2)
fc_siplt.plot(Th,U,'d',2);
axis image

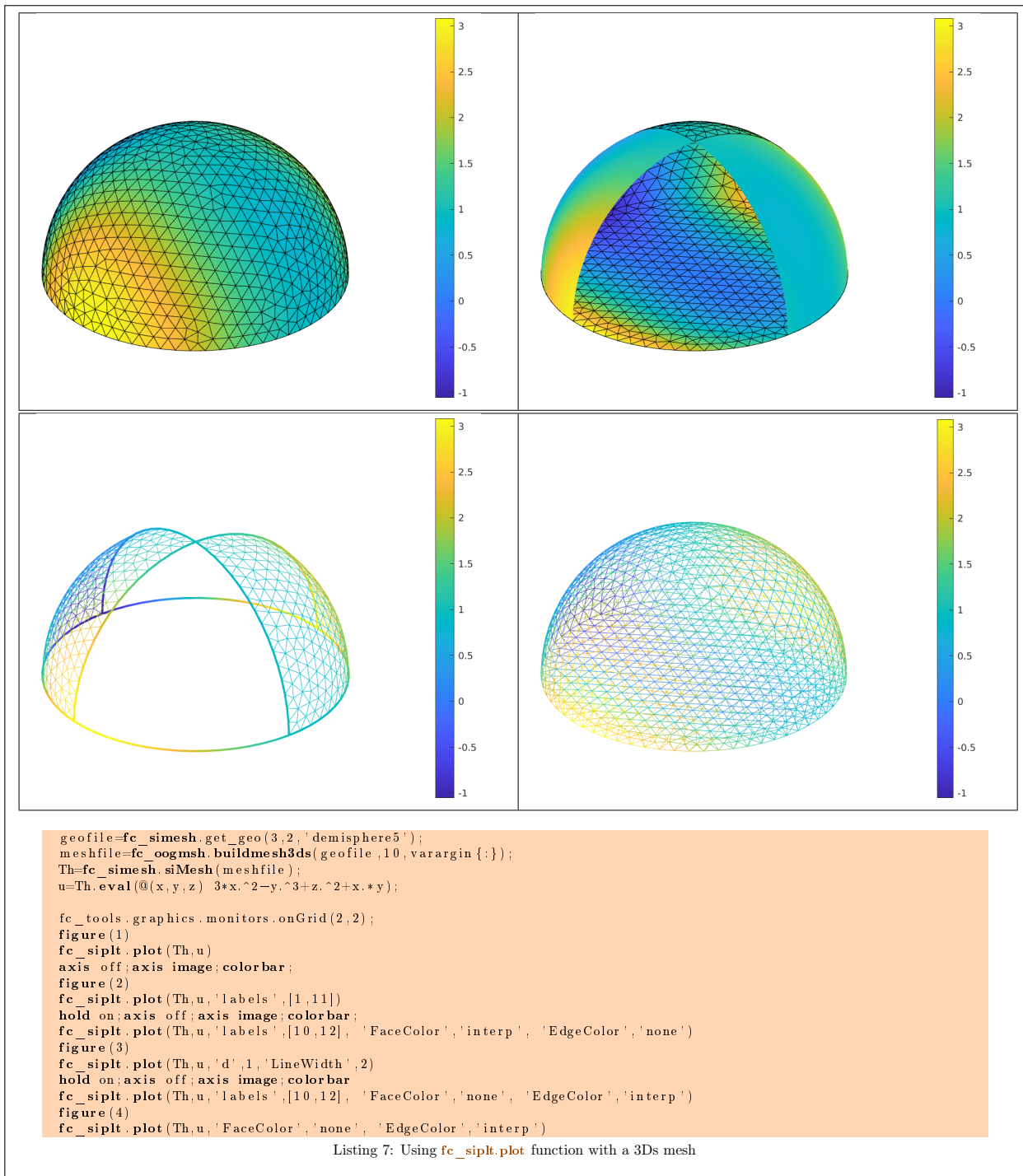
figure(3)
fc_siplt.plot(Th,U,'d',1,'Linewidth',3);
axis image
colormap('jet')

```

Listing 6: Using `fc_siplt.plot` function with a 3D mesh

4.3 3Ds example

the following code is part of the `fc_siplt.demos.plot3Ds` function.



5 `fc_siplt.plotiso` function

The `fc_siplt.plotiso` function displays isolines from datas on the mesh or parts of the mesh defined by an `siMESH` object. This function only works with 2-simplices in space dimension 2 or 3.

Syntaxe

```

fc_siplt.plotiso(Th,u)
fc_siplt.plotiso(Th,u,Name,Value,...)

```

Description

`fc_siplt.plotiso(Th,u)` displays data `u` on all the 2-dimensional simplices elements of `Th`, a `siMESH` object.. The data `u` is an 1D-array of size `Th.nq` or `Th.nqGlobal` or `Th.nqParent`.

`fc_siplt.plotiso(Th,u,key,value, ...)` specifies function options using one or more `key,value` pair arguments.

Options of first level are

- `'niso'` : to specify the number of isolines (default : 10)
- `'isorange'` : to specify the list of isovalues (default : empty)
- `'isocolorbar'` : if `true`, colorbar with isovalues is drawn (default : `false`)
- `'format'` : to specify the format of the isovalues on the colorbar (default : `'%g'`)
- `'labels'` : to select the labels of the elements to display data,
- `'plane'` : if true, isolines are in the *xy*-plane, otherwise isolines are in 3D with *z*-value set to `u` (default : `false`)
- `'color'` : to specify one color for all isolines (default : empty)
- `'mouse'` : if `true`, display information on clicked isoline (default : `false`)

The options of second level are all options of

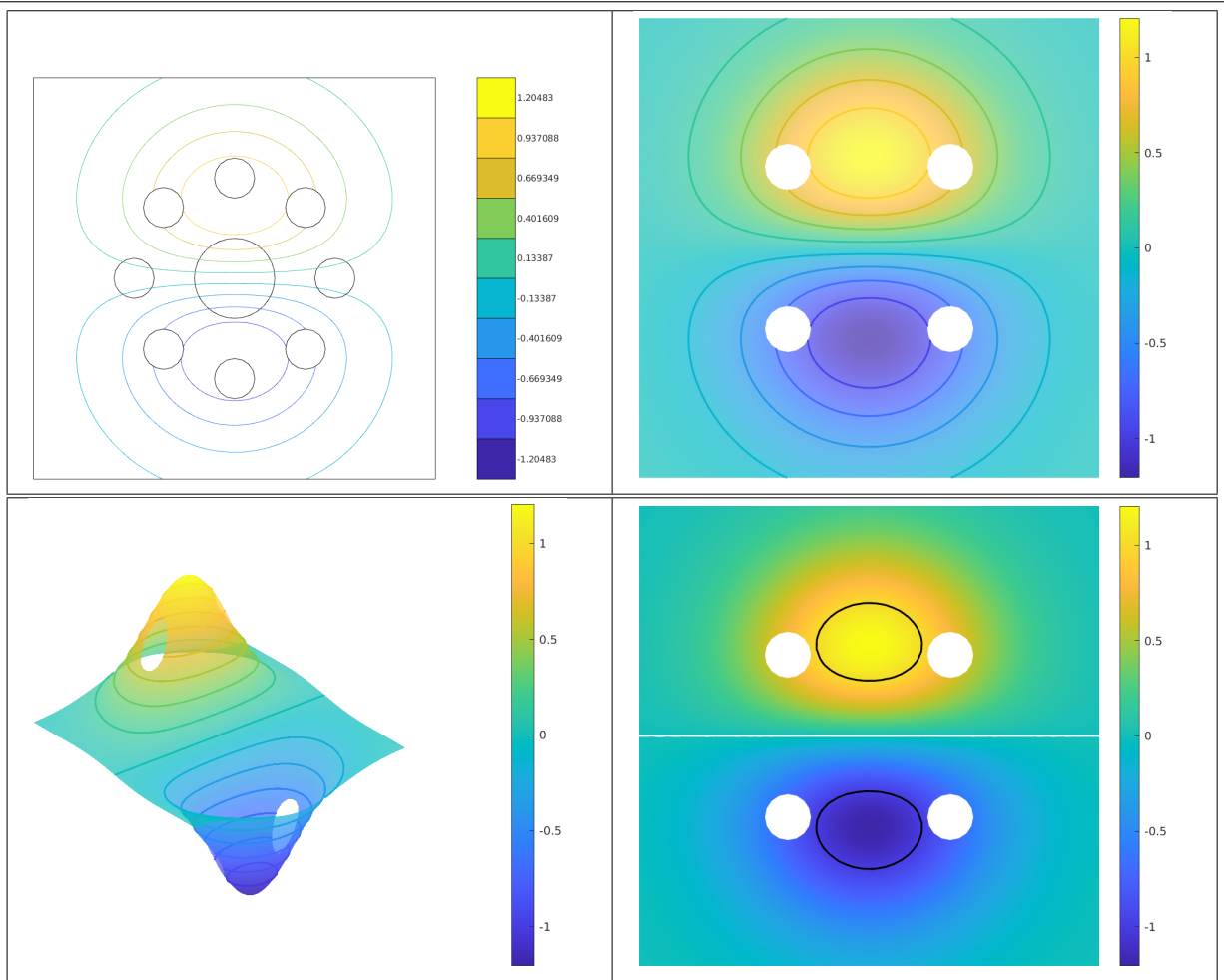
- `plot3` function in dimension 3 or in dimension 2 with `'plane'` option set to `false`
- `plot` function in 2 with `'plane'` option set to `true`

This function accepts until 4 output arguments :

- 1st output is the colors of the isolines
- 2nd output is the isovalues of the isolines
- 3th output is the handle of the colobar iso.
- 4th output is all the handles of the isolines as an 2D-array of dimension N-by-niso, where N is the number of 2-simplex elementary meshes where isolines are drawn.

5.1 2D example

the following code is part of the `fc_siplt.demos.plotiso2D` function.



```

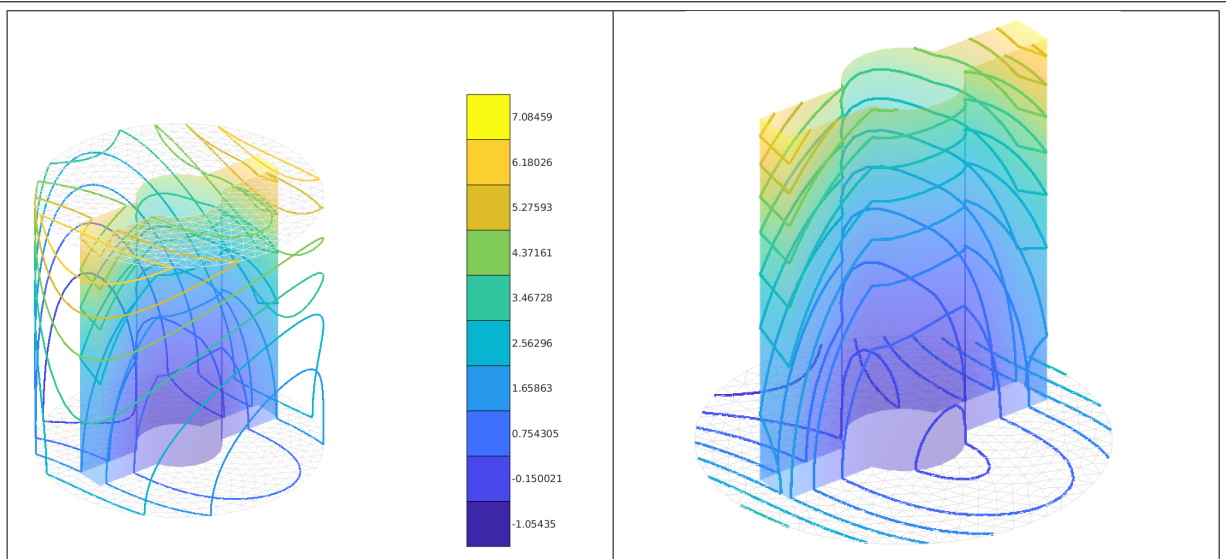
meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser11',25,varargin{:});
Th=fc_simesh.siMesh(meshfile);
u=Th.eval(@(x,y) 5*exp(-3*(x.^2+y.^2)).*cos(x).*sin(y));
fc_tools.graphics.monitors.onGrid(2,2);
figure(1)
fc_siplt.plotmesh(Th,'d',1,'color','k')
hold on;axis off;axis image;
fc_siplt.plotiso(Th,u,'isocolorbar',true)
figure(2)
fc_siplt.plot(Th,u,'plane',true,'FaceAlpha',0.7)
hold on;axis off;axis image;shading interp;
fc_siplt.plotiso(Th,u,'plane',true,'LineWidth',1.5)
colorbar
figure(3)
fc_siplt.plot(Th,u,'FaceAlpha',0.7)
view(3)
shading interp;hold on;axis off;axis image;
fc_siplt.plotiso(Th,u,'niso',15,'LineWidth',1.5)
colorbar
figure(4)
fc_siplt.plot(Th,u,'plane',true)
shading interp;hold on;axis off;axis image;
fc_siplt.plotiso(Th,u,'isorange',0,'LineWidth',1.5,'color','w')
fc_siplt.plotiso(Th,u,'isorange',[-1,1], 'LineWidth',1.5, 'color','k','plane',true)

```

Listing 8: Using `fc_siplt.plotiso` function with a 2D mesh

5.2 3D example

the following code is part of the `fc_siplt.demos.plotiso3D` function.



```

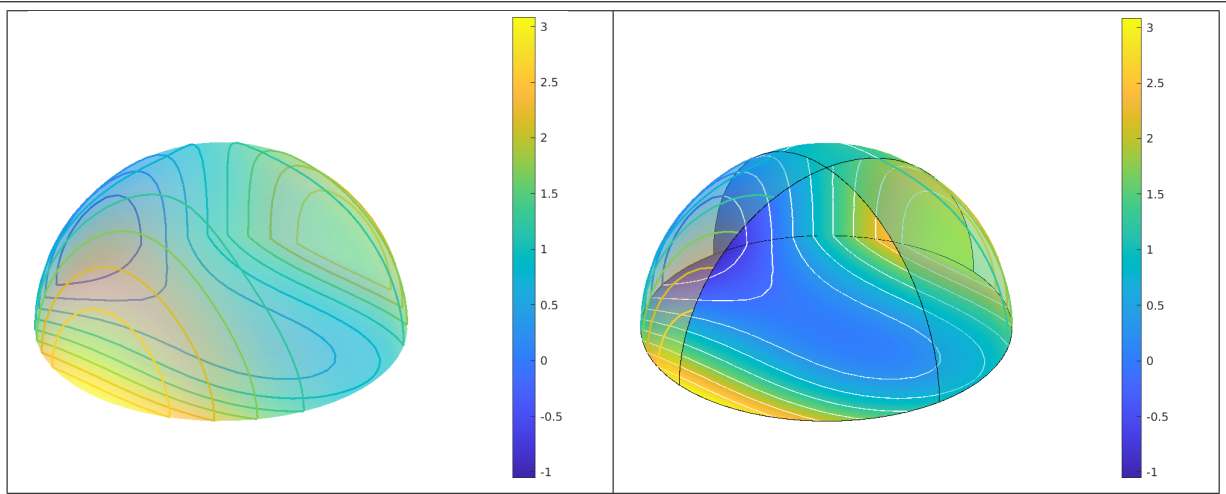
geofile=fc_simesh.get_geo(3,3,'cylinderkey');
meshfile=fc_oogmsh.gmsh.buildmesh3d(geofile,10,varargin{:});
Th=fc_simesh.siMesh(meshfile);
u=Th.eval(@(x,y,z) 3*x.^2-y.^3+z.^2+x.*y);
fc_tools.graphics.monitors.onGrid(1,2);
figure(1)
fc_siplt.plot(Th,u,'d',2,'labels',[10,11,31],'FaceColor','interp','EdgeColor','none','FaceAlpha',0.4)
hold on;view(3);axis off;axis equal;
fc_siplt.plotmesh(Th,'d',2,'labels',[1000,1020,1021,2000,2020,2021],'FaceColor','none','EdgeColor',0.9*[1,1,1])
fc_siplt.plotiso(Th,u,'isocolorbar',true,'LineWidth',1.5)
figure(2)
fc_siplt.plot(Th,u,'d',2,'labels',[10,11,31],'FaceColor','interp','EdgeColor','none','FaceAlpha',0.4)
hold on;axis off;axis equal;
fc_siplt.plotmesh(Th,'d',2,'labels',[2000,2020,2021],'FaceColor','none','EdgeColor',0.9*[1,1,1])
fc_siplt.plotiso(Th,u,'labels',[10,11,31,2000,2020,2021],'LineWidth',1.5,'niso',15)

```

Listing 9: Using `fc_siplt.plotiso` function with a 3D mesh

5.3 3Ds example

the following code is part of the `fc_siplt.demos.plotiso3Ds` function.



```

meshfile=fc_oogmsh.gmsh.buildmesh3ds('demisphere5',10,varargin{:});
Th=fc_simesh.siMesh(meshfile);

u=Th.eval(@(x,y,z) 3*x.^2-y.^3+z.^2+x.*y);
fc_tools.graphics.monitors.onGrid(1,2);
figure(1)
fc_siplt.plot(Th,u,'FaceColor','interp','EdgeColor','none','FaceAlpha',0.4)
hold on;axis off;axis equal;colorbar
fc_siplt.plotiso(Th,u,'LineWidth',1.5)

figure(2)
fc_siplt.plot(Th,u,'labels',[1,11],'FaceColor','interp','EdgeColor','none')
hold on;axis off;axis equal;colorbar;
fc_siplt.plotiso(Th,u,'labels',[1,11],'LineWidth',1,'color','w')
fc_siplt.plot(Th,u,'labels',[10,12],'FaceColor','interp','EdgeColor','none','FaceAlpha',0.4)
fc_siplt.plotiso(Th,u,'labels',[10,12],'LineWidth',1.5)

```

Listing 10: Using `fc_siplt.plotiso` function with a 3Ds mesh

6 `fc_siplt.slicemesh` function

The `fc_siplt.slicemesh` function displays intersection of a plane and a 3D mesh or parts of a 3D mesh defined by an `siMESH` object.

Syntaxe

```

fc_siplt.slicemesh(Th,P)
fc_siplt.slicemesh(Th,P,Name,Value,...)

```

Description

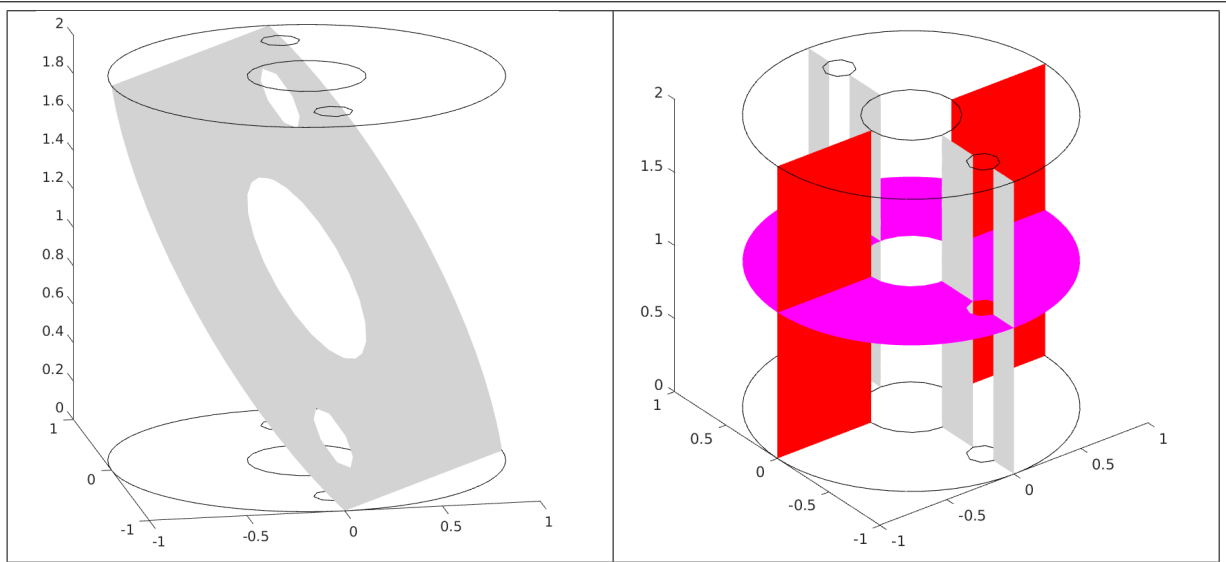
`fc_siplt.slicemesh(Th,P)` displays intersection of the plane defined by $P(1)x + P(2)y + P(3)z + P(4) = 0$ and all the 3-dimensional simplices elements of `Th`, a `siMESH` object. To compute P one can use the function `fc_tools.graphics.PlaneCoefs` of the `fc_tools` toolbox. With this function, the array P , is obtained with $P=fc_tools.graphics.PlaneCoefs(Q,V)$ where Q is a point in the plane and V is a vector orthogonal to it.

`fc_siplt.slicemesh(Th,P,Name,Value,...)` specifies function options using one or more `Name,Value` pair arguments. Options of first level are

- `'color'` : to specify the slice color (default : `'lightgrey'`, `rgb=[0.9,0.9,0.9]`)
- `'labels'` : to select the labels of the elements to intersect,

6.1 3D example

the following code is part of the `fc_siplt.demos.slicemesh3D` function.



```

meshfile=fc_oogmsh.buildmesh3d('cylinder3holes',10,varargin{:});
Th=fc_simesh.siMesh(meshfile);
fc_tools.graphics.monitors.onGrid(1,2);
figure(1)
P=fc_tools.graphics.PlaneCoefs([0 0 1],[1 -1 1]);
fc_siplt.slicemesh(Th,P)
hold on;axis equal;
fc_siplt.plotmesh(Th,'d',1,'color','k')
view(-11,15)

figure(2)
P=[fc_tools.graphics.PlaneCoefs([0 0 1],[1 0 0]); ...
   fc_tools.graphics.PlaneCoefs([0 0 1],[0 1 0]); ...
   fc_tools.graphics.PlaneCoefs([0 0 1],[0 0 1])];
fc_siplt.slicemesh(Th,P,'color',{'LightGray',[1 0 0],'m'}) % [1,0,0] => RGB => red
hold on;axis equal;
fc_siplt.plotmesh(Th,'d',1,'color','k')

```

Listing 11: Using `fc_siplt.slicemesh` function with a 3D mesh

7 `fc_siplt.slice` function

The method `fc_siplt.slice` function displays datas on the intersection of a plane and a 3D mesh or parts of a 3D mesh defined by an `siMESH` object.

Syntaxe

```

fc_siplt.slice(Th,u,P)
fc_siplt.slice(Th,u,P,Name,Value,...)

```

Description

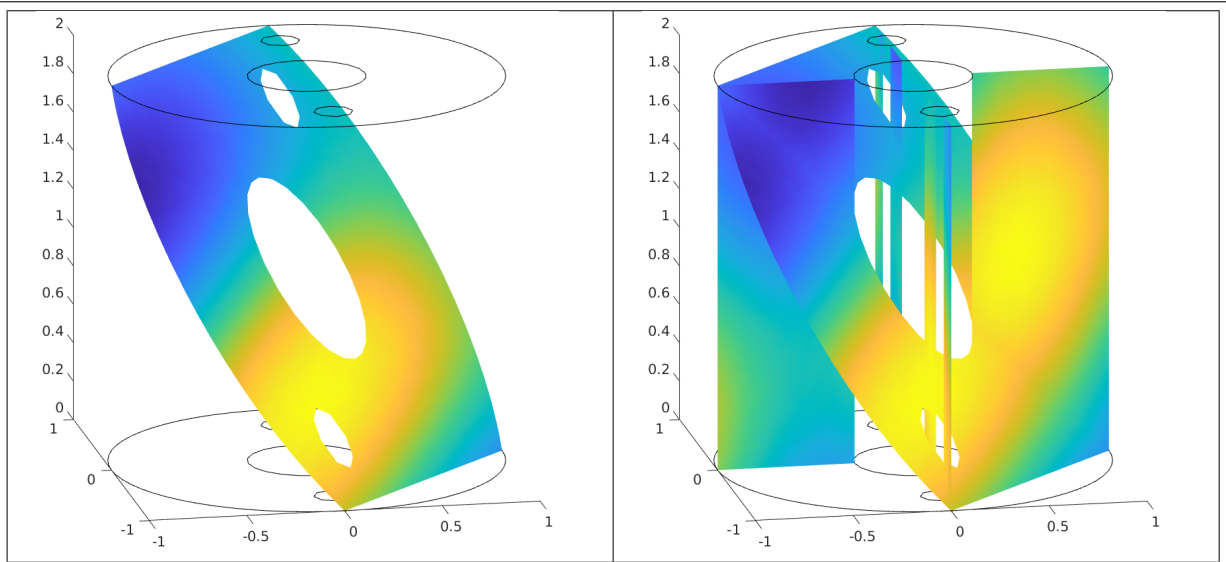
`fc_siplt.slice(Th,u,P)` displays `u` data on the intersection of the plane defined by $P(1)x + P(2)y + P(3)z + P(4) = 0$ and all the 3-dimensional simplices elements of `Th`, a `siMESH` object. The data `u` is an 1D-array of size `Th.nq` or `Th.nqGlobal` or `Th.nqParent`. To compute `P` one can use the function `fc_tools.graphics.PlaneCoefs` of the `fc_tools` toolbox. With this function, the array `P`, is obtained with `P=fc_tools.graphics.PlaneCoefs(Q,V)` where `Q` is a point in the plane and `V` is a vector orthogonal to it.

`fc_siplt.slice(Th,u,P,Name,Value,...)` specifies function options using one or more `Name,Value` pair arguments. Options of first level are

- `'labels'` : to select the labels of the elements to intersect,

7.1 3D example

the following code is part of the `fc_siplt.demos.slice3D` function.



```

meshfile=fc_oogmsh.buildmesh3d('cylinder3holes',10,varargin{:});
Th=fc_simesh.siMesh(meshfile);

u=@(x,y,z) cos(2*x-y-z).*sin(x-2*y+z);
U=Th.eval(u);

figure(1)
P=fc_tools.graphics.PlaneCoefs([0 0 1],[1 -1 1]);
fc_siplt.slice(Th,U,P)
hold on
fc_siplt.plotmesh(Th,'d',1,'color','k')
axis equal
view(-11,15)

P=[fc_tools.graphics.PlaneCoefs([0 0 1/2],[1 0 0]); ...
  fc_tools.graphics.PlaneCoefs([0 0 1/2],[0 1 0]); ...
  fc_tools.graphics.PlaneCoefs([0 0 1],[1 -1 1])];
figure(2)
fc_siplt.slice(Th,U,P)
hold on
fc_siplt.plotmesh(Th,'d',1,'color','k')
axis equal

```

Listing 12: Using `fc_siplt.slice` function with a 3D mesh

8 `fc_siplt.sliceiso` function

The `fc_siplt.sliceiso` function displays isolines of data on the intersection of a plane and a 3D mesh or parts of a 3D mesh defined by an `siMESH` object.

Syntaxe

```

fc_siplt.sliceiso(Th,u,P)
fc_siplt.sliceiso(Th,u,P,Name,Value,...)

```

Description

`fc_siplt.sliceiso(Th,u,P)` displays `u` data as isolines on the intersection of the plane defined by $P(1)x + P(2)y + P(3)z + P(4) = 0$ and all the 3-dimensional simplices elements of `Th`, a `siMESH` object. The data `u` is an 1D-array of size `Th.nq` or `Th.nqGlobal` or `Th.nqParent`. To compute `P` one can use the function `fc_tools.graphics.PlaneCoefs` of the `fc_tools` toolbox. With this function, the array `P`, is obtained with `P=fc_tools.graphics.PlaneCoefs(Q,V)` where `Q` is a point in the plane and `V` is a vector orthogonal to the plane.

`fc_siplt.sliceiso(Th,u,P,key,value,...)` allows additional key/value pairs to be used when displaying `u`. The key strings could be

- `'labels'` : to select the labels of the elements to intersect,
- `'niso'` : to specify the number of isolines (default : 10)
- `'isorange'` : to specify the list of isovalues (default : empty)

- `'color'` : to specify one color for all isolines (default : empty)
- `'isocolorbar'` : if true display a colorbar. Default is false.
- `'format'` : to specify the format of the isovalues print in the colorbar. Default is `'%g'`.

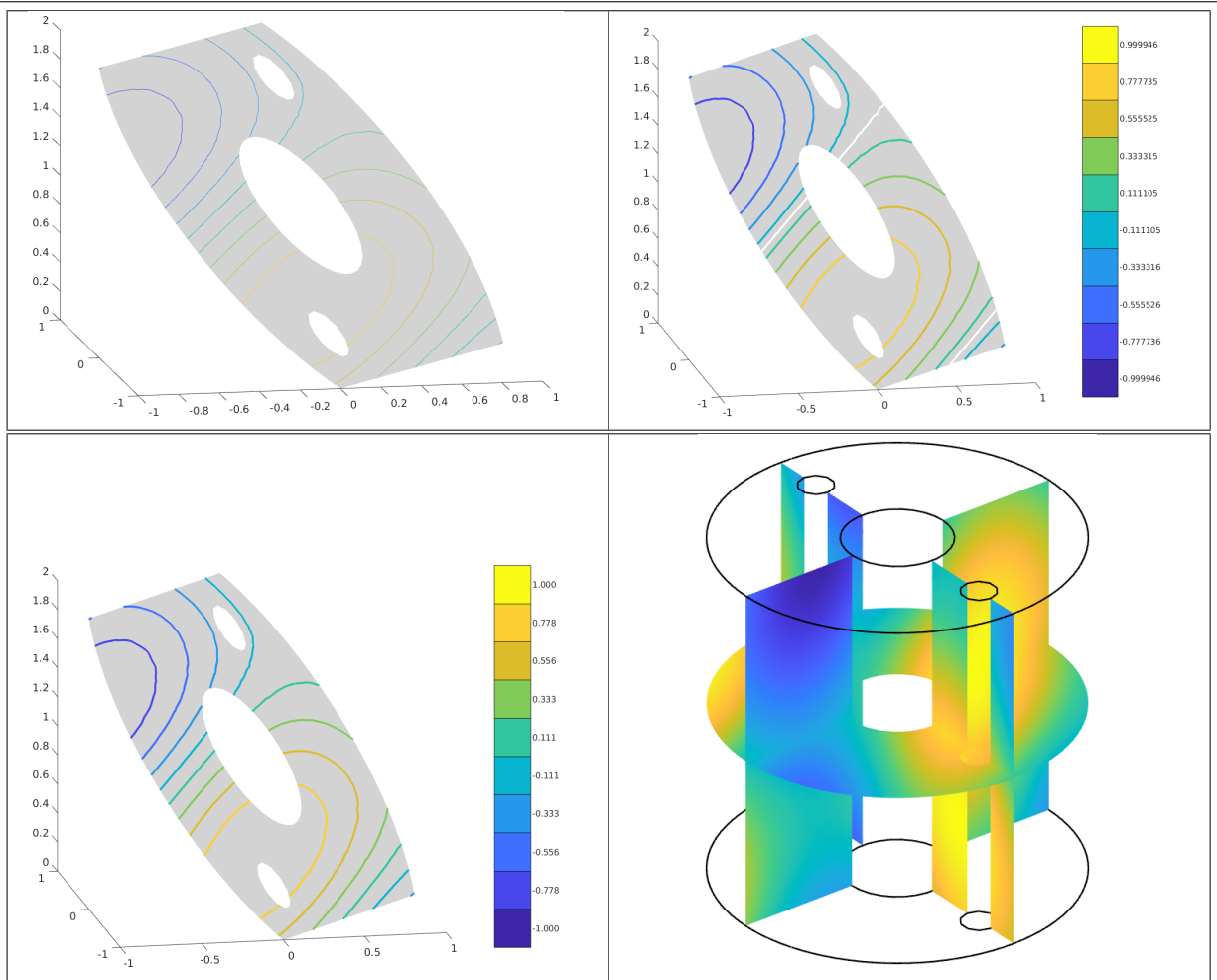
For key strings, one could also used any options of the `plot3` function.

This function accepts until 4 output arguments :

- 1st output is the colors of the isolines
- 2nd output is the isovalues of the isolines
- 3th output is the handle of the colobar iso.
- 4th output is all the handles of the isolines as an 2D-array of dimension N-by-niso, where N is the number of elementary meshes where isolines are drawn.

8.1 3D example

the following code is part of the `fc_siplt.demos.sliceiso3D` function.



```

meshfile=fc_oogmesh.buildmesh3d('cylinder3holes',15,varargin{:});
Th=fc_simesh.siMesh(meshfile);
u=@(x,y,z) cos(2*x-y-z).*sin(x-2*y+z);
U=Th.eval(u);

fc_tools.graphics.monitors.onGrid(2,3,'figures',1:5);
figure(1)
P=fc_tools.graphics.PlaneCoefs([0 0 1],[1 -1 1]);
fc_siplt.slicemesh(Th,P)
hold on
fc_siplt.sliceiso(Th,U,P)
view(-11,15)

figure(2)
P=fc_tools.graphics.PlaneCoefs([0 0 1],[1 -1 1]);
fc_siplt.slicemesh(Th,P)
hold on
[~,~,cax,h]=fc_siplt.sliceiso(Th,U,P,'isocolorbar',true);
fc_siplt.sliceiso(Th,U,P,'isorange',0,'color','w','LineWidth',2);
view(-11,15)
l=~isnan(h);
set(h(1),'LineWidth',2)
set(cax,'FontSize',8)

figure(3)
P=fc_tools.graphics.PlaneCoefs([0 0 1],[1 -1 1]);
fc_siplt.slicemesh(Th,P)
hold on
fc_siplt.sliceiso(Th,U,P,'isocolorbar',true,'LineWidth',2,'format','%0.3f');
view(-11,15)

figure(4)
P=[fc_tools.graphics.PlaneCoefs([0 0 1],[1 0 0]); ...
fc_tools.graphics.PlaneCoefs([0 0 1],[0 1 0]); ...
fc_tools.graphics.PlaneCoefs([0 0 1],[0 0 1])];
fc_siplt.plotmesh(Th,'d',1,'LineWidth',1,'color','k');
hold on;axis off;axis image;
fc_siplt.slice(Th,u,P,'Facecolor','interp')

figure(5)
fc_siplt.plotmesh(Th,'d',1,'LineWidth',2,'color','k');
hold on;axis off;axis image;
fc_siplt.slicemesh(Th,P(1:2,:))
fc_siplt.sliceiso(Th,U,P(1:2,:))
fc_siplt.slice(Th,U,P(3,:), 'Facecolor','interp')

```

Listing 13: Using `fc_siplt.sliceiso` function with a 3D mesh

9 `fc_siplt.plotquiver` function

The `fc_siplt.plotquiver` function displays vector field datas on the mesh or parts of the mesh defined by an `siMESH` object.

Syntaxe

```
fc_siplt.plotquiver(Th,V)
fc_siplt.plotquiver(Th,V,Key,Value,...)
```

Description

`fc_siplt.plotquiver(Th,V)` displays vector field `U` on all the `d`-dimensional simplices elements in dimension $d = 2$ or $d = 3$. The data `V` is an 2D-array of size `Th.nq`-by- d or 2-by-`Th.nq`.

`fc_siplt.plotquiver(Th,V,Key,Value,...)` specifies function options using one or more `Key,Value` pair arguments. Options of first level are

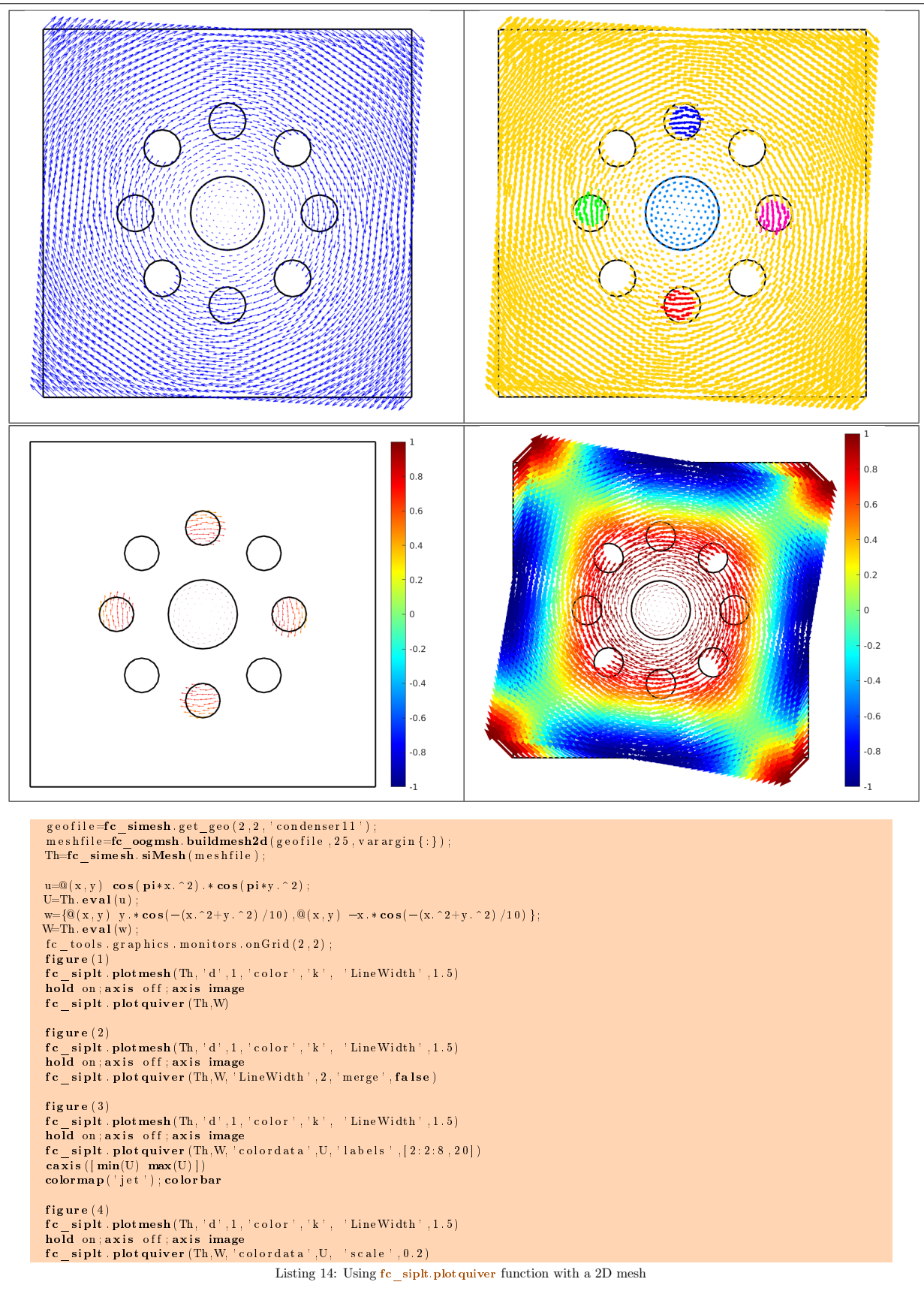
- `'labels'` : to select the labels of the elements to display data,
- `'freq'` : quiver frequencie, (default : 1)
- `'scale'` : quiver scale, (default : ...)
- `'colordata'` : set colors on each quiver (default : empty).

The options of second level depend on space dimension and `'colordata'` option. One can use any option of the following functions

- `quiver` function in dimension 2 with an empty `'colordata'`
- `quiver3` function in dimension 3 with an empty `'colordata'`
- `vfield3` function in dimension 2 or 3 with `'colordata'` set to an 1D-array of length `Th.nq`.

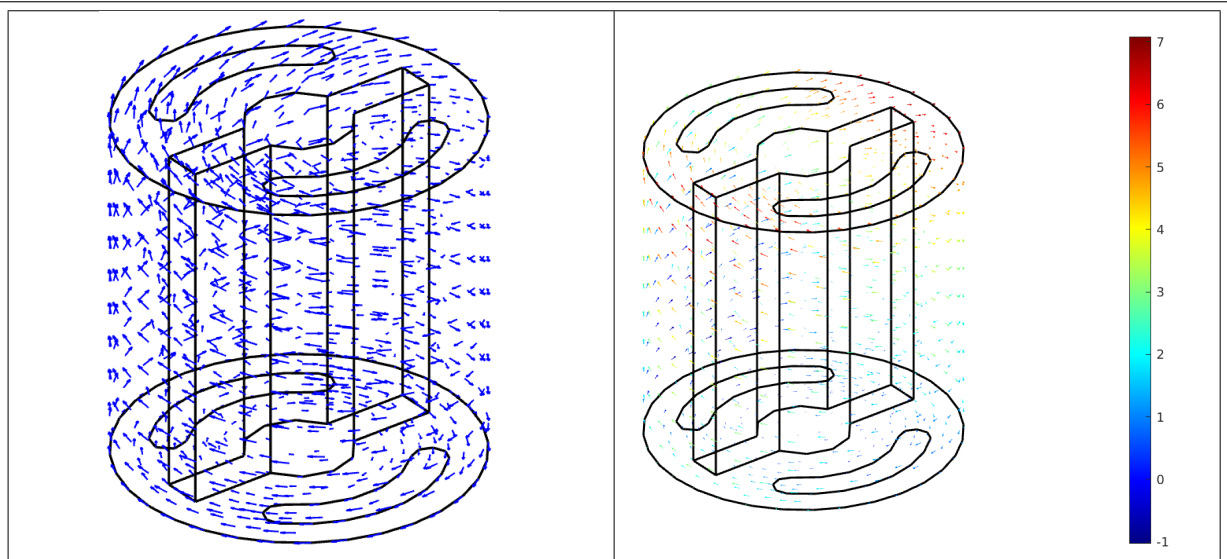
9.1 2D example

the following code is part of the `fc_siplt.demos.plotquiver2D` function.



9.2 3D example

the following code is part of the `fc_siplt.demos.plotquiver3D` function.



```

geofile=fc_oogmsh.get_geo(3,3,'cylinderkey');
meshfile=fc_oogmsh.buildmesh3d(geofile,5,varargin{:});
Th=fc_simesh.siMesh(meshfile);

w=@(x,y,z) y.*cos(-(x.^2+y.^2)/10),@(x,y,z) -x.*cos(-(x.^2+y.^2)/10),@(x,y,z) z/5 };
W=Th.eval(w);
u=Th.eval(@(x,y,z) 3*x.^2-y.^3+z.^2+x.*y);
fc_tools.graphics.monitors.onGrid(1,2);
figure(1)
fc_siplt.plotmesh(Th,'d',1,'color','k','LineWidth',1.5)
hold on
fc_siplt.plotquiver(Th,W,'LineWidth',1)
axis off;axis image

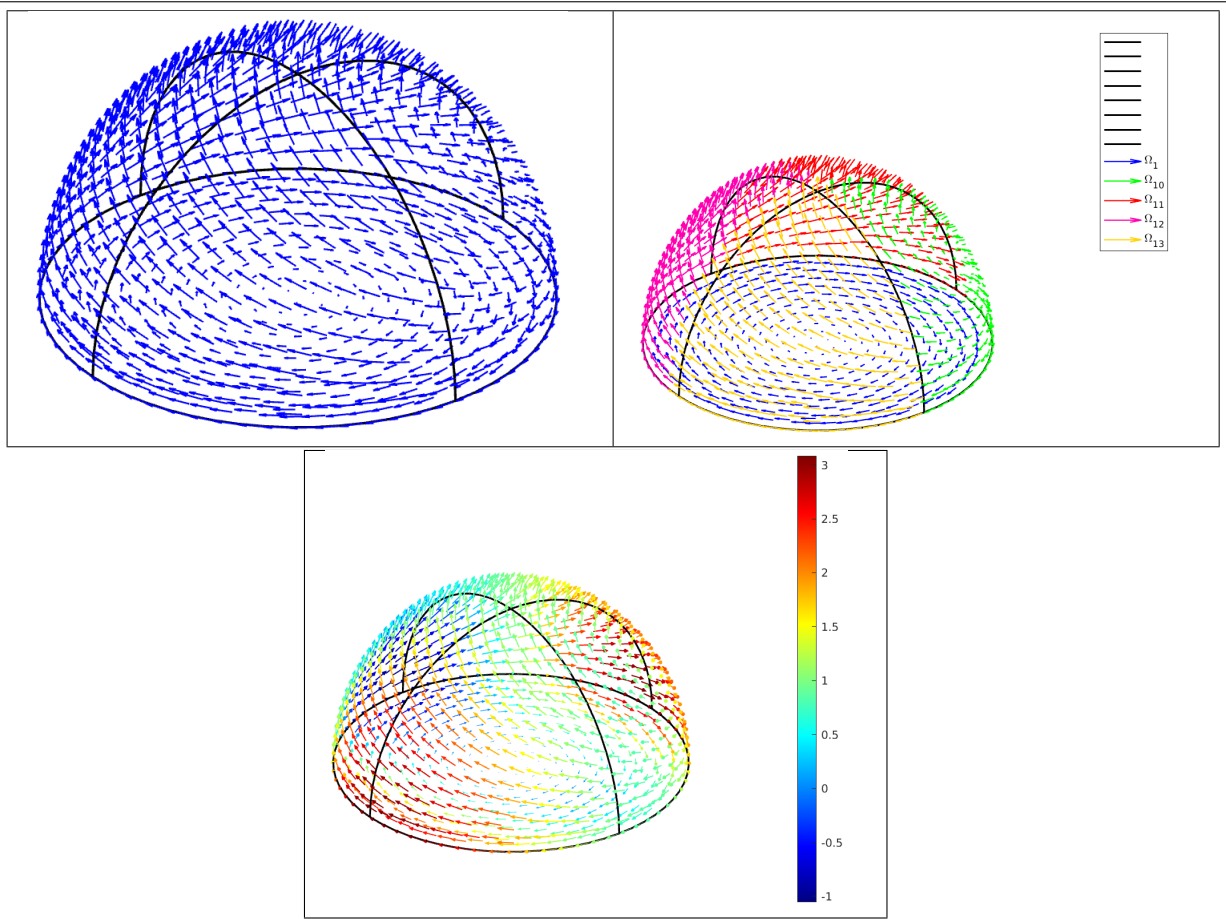
figure(2)
fc_siplt.plotmesh(Th,'d',1,'color','k','LineWidth',1.5)
hold on
fc_siplt.plotquiver(Th,W,'colordata',u,'scale',0.05)
axis off;axis image

```

Listing 15: Using `fc_siplt.plotquiver` function with a 3D mesh

9.3 3Ds example

the following code is part of the `fc_siplt.demos.plotquiver3Ds` function.



```

geofile=fc_simesh.get_geo(3,2,'demisphere5');
meshfile=fc_oogmsh.gmsh.buildmesh3ds(geofile,10,varargin{:});
Th=fc_simesh.siMesh(meshfile);

w=@(x,y,z) y.*cos(-(x.^2+y.^2)/10),@(x,y,z) -x.*cos(-(x.^2+y.^2)/10),@(x,y,z) z };
W=Th.eval(w);
u=Th.eval(@(x,y,z) 3*x.^2-y.^3+z.^2+x.*y);
fc_tools.graphics.monitors.onGrid(2,2,'figures',1:3);
figure(1)
fc_siplt.plotmesh(Th,'d',1,'color','k','LineWidth',1.5)
hold on;axis off;axis image
fc_siplt.plotquiver(Th,W,'LineWidth',1)

figure(2)
fc_siplt.plotmesh(Th,'d',1,'color','k','LineWidth',1.5)
hold on;axis off;axis image
fc_siplt.plotquiver(Th,W,'LineWidth',1,'merge',false,'inlegend',true)
legend('show')

figure(3)
fc_siplt.plotmesh(Th,'d',1,'color','k','LineWidth',1.5)
hold on;axis off;axis image
fc_siplt.plotquiver(Th,W,'colordata',u,'scale',0.1)

```

Listing 16: Using `fc_siplt.plotquiver` function with a 3Ds mesh

10 `fc_siplt.scatter` function

The `fc_siplt.scatter` function displays scalar datas as colored points on the mesh or parts of the mesh defined by an `siMESH` object.

Syntaxe

```

fc_siplt.scatter(Th,u)
fc_siplt.scatter(Th,u,Name,Value,...)

```

Description

`fc_siplt.scatter(Th,u)` displays data `u` on all the `(Th.d)`-dimensional simplices elements of `Th`, a `siMESH` object. The data `u` is an 1D-array of size `Th.nq` or `Th.nqGlobal` or `Th.nqParent`.

`fc_siplt.scatter(Th,u,Name,Value, ...)` specifies function options using one or more `Name,Value` pair arguments.

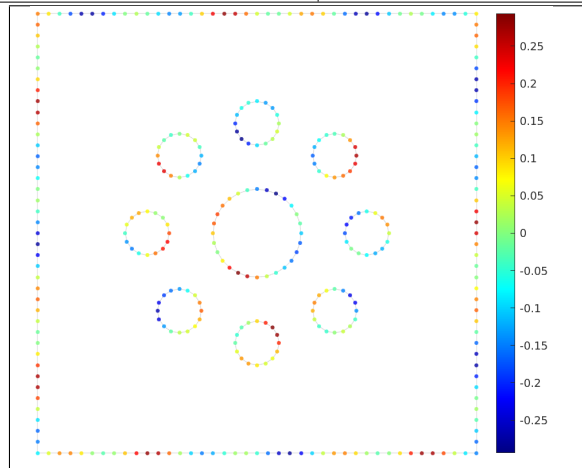
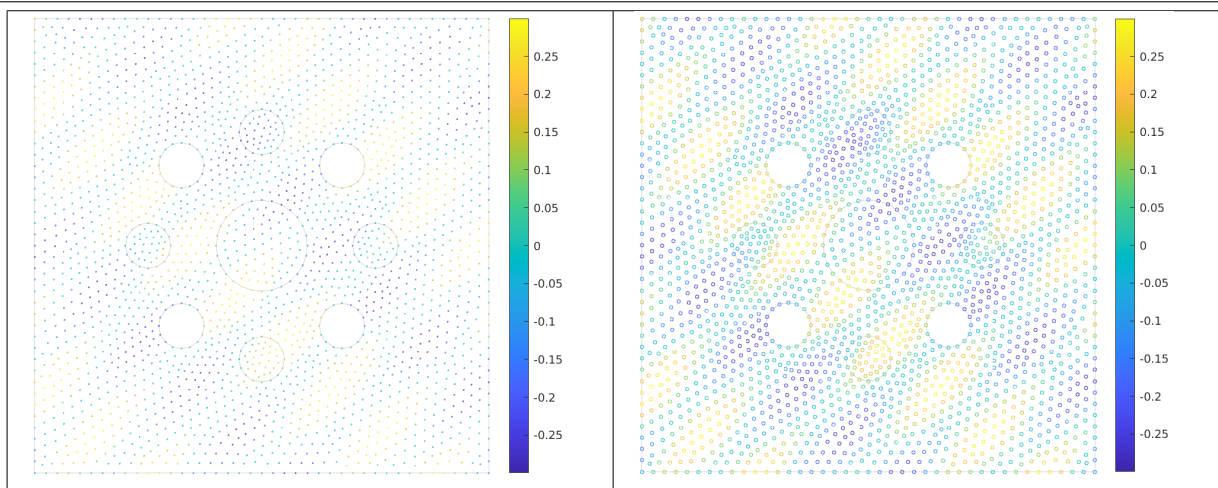
Options of first level are

- `'d'` : to specify the dimension of the simplices elements (default : `Th.d`)
- `'labels'` : to select the labels of the elements to display data,
- `'MarkerSize'` : size of the marker. Default is 1.
- `'ForcePatch'` : if `true`, uses `patch` function, otherwise uses `scatter` function in dimension 2 or `scatter3` function in dimension 3. Default is `false`.

The options of second level are those of the function used (see `'ForcePatch'` option).

10.1 2D example

the following code is part of the `fc_siplt.demos.scatter2D` function.



```

meshfile=fc_oogmsh.gmsh.buildmesh2d('condenser11',20,varargin{:});
Th=fc_simplt.siMesh(meshfile);
u=@(x,y) 0.3*cos(5*(2*x-y)).*sin(5*(x-2*y));
U=Th.eval(u);

fc_tools.graphics.monitors.onGrid(2,2,'figures',1:3);

figure(1)
fc_simplt.plotmesh(Th,'d',1,'color','LightGray')
hold on
fc_simplt.scatter(Th,U);
axis image;axis off;
colorbar

figure(2)
fc_simplt.plotmesh(Th,'d',1,'color','LightGray')
hold on
fc_simplt.scatter(Th,U,'MarkerSize',8);
axis off;axis image
colorbar

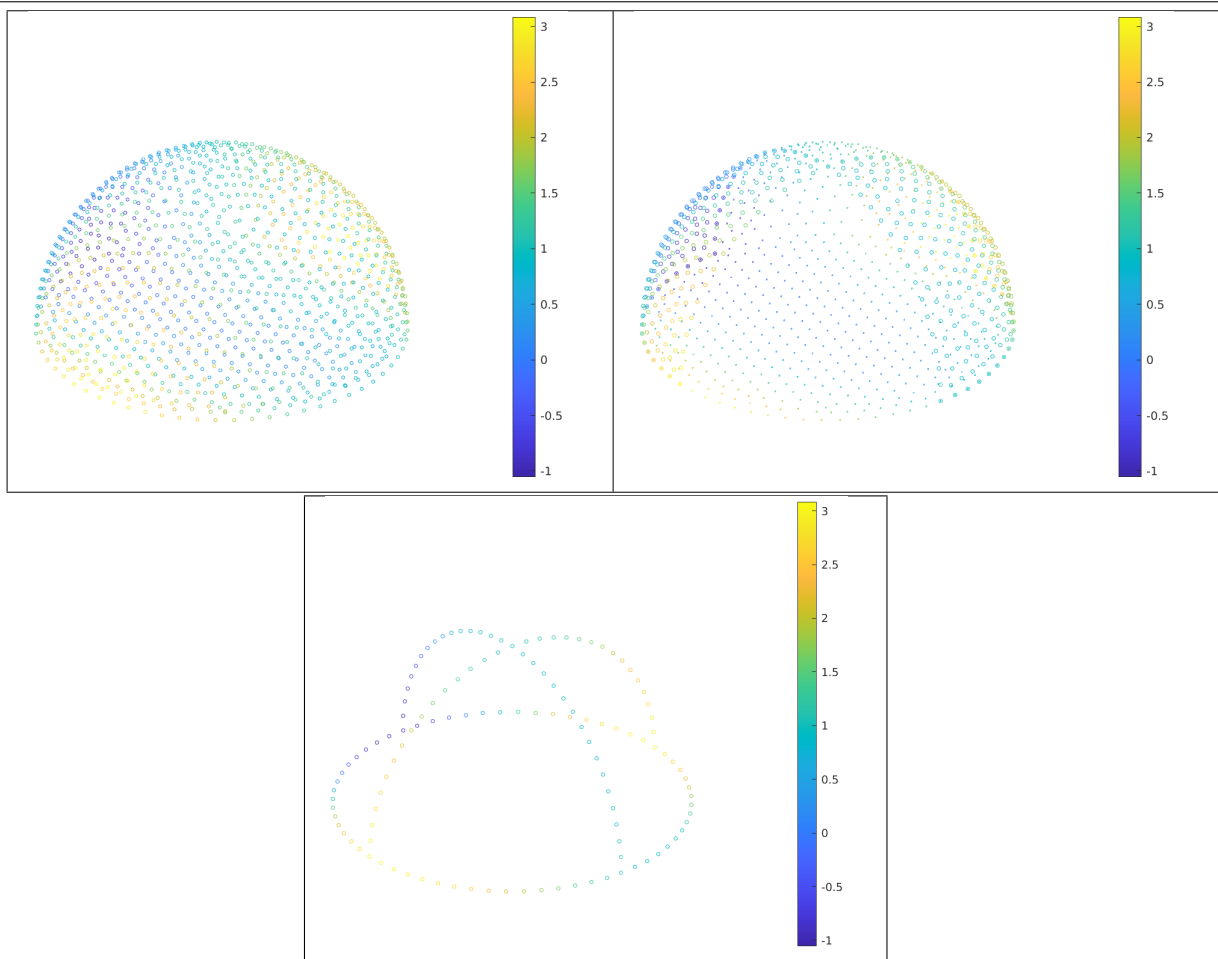
figure(3)
fc_simplt.plotmesh(Th,'d',1,'color','LightGray')
hold on % '*Alpha' options not yet implemented under Octave
fc_simplt.scatter(Th,U,'d',1,'MarkerSize',12,'MarkerEdgeAlpha',0,'MarkerFaceColor','flat','MarkerFaceAlpha',0.8)
axis off;axis image
colormap('jet')
colorbar

```

Listing 17: Using `fc_simplt.scatter` function with a 2D mesh

10.2 3Ds example

the following code is part of the `fc_simplt.demos.scatter3Ds` function.



```

geofile=fc_simesh.get_geo(3,2,'demisphere5');
meshfile=fc_oogmsh.buildmesh3ds(geofile,10,varargin{:});
Th=fc_simesh.siMesh(meshfile);
u=Th.eval(@(x,y,z) 3*x.^2-y.^3+z.^2+x.*y);

fc_tools.graphics.monitors.onGrid(2,2,'figures',1:3);

figure(1)
fc_siplt.scatter(Th,u,'MarkerSize',7)
view(3);axis off;axis image;colorbar;

figure(2)
fc_siplt.scatter(Th,u,'labels',[1,11])
hold on;axis off;axis image;colorbar;
fc_siplt.scatter(Th,u,'labels',[10,12], 'MarkerSize',9)
view(3)

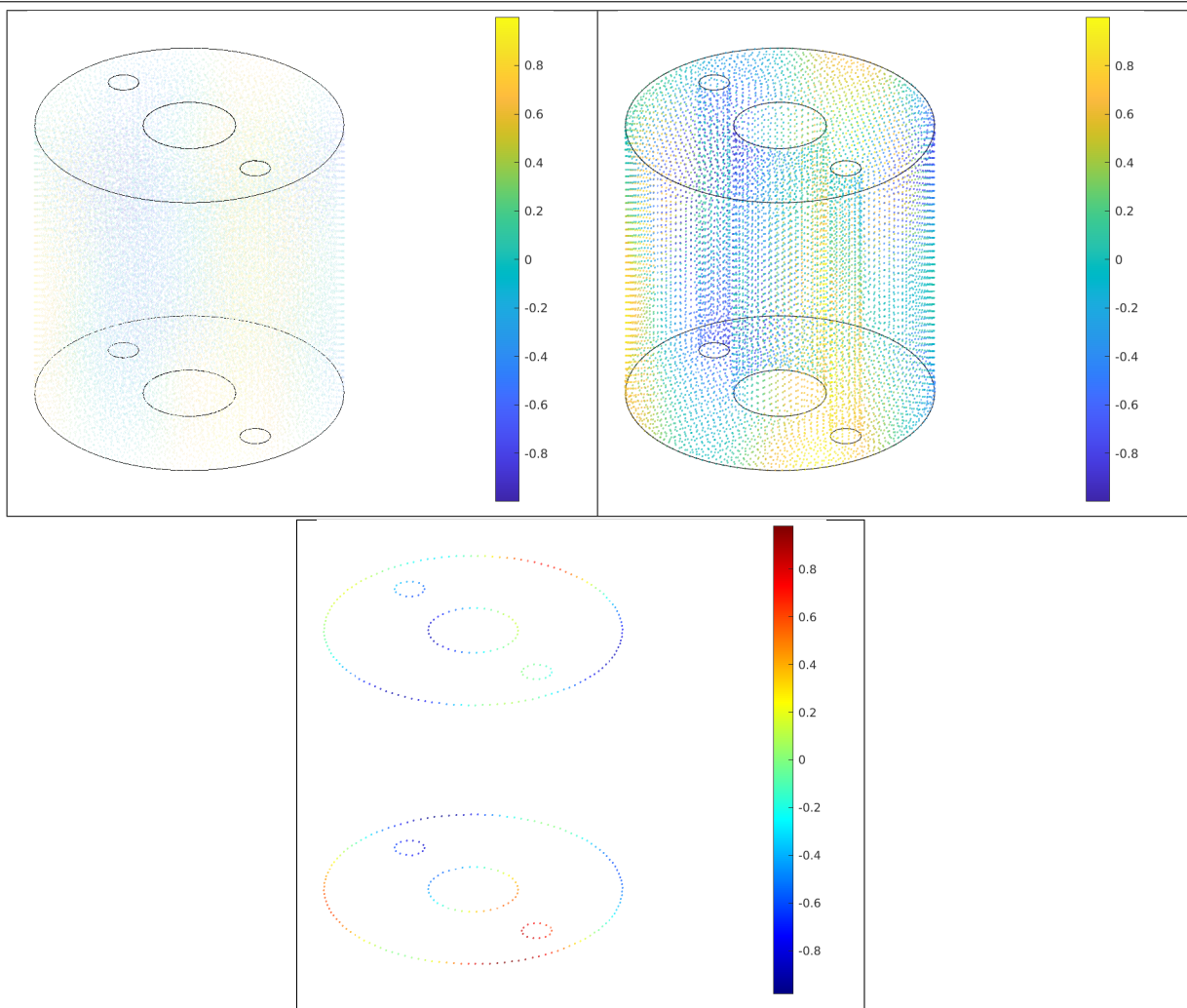
figure(3)
fc_siplt.scatter(Th,u,'d',1,'MarkerSize',9)
axis off;axis image;colorbar
view(3)

```

Listing 18: Using `fc_siplt.scatter` function with a 3Ds mesh

10.3 3D example

the following code is part of the `fc_siplt.demos.scatter3D` function.



```

meshfile=fc_oogmsh.gmsh.buildmesh3d('cylinder3holes',20,varargin{:});
Th=fc_simesh.siMesh(meshfile);
u=@(x,y,z) cos(2*x-y-z).*sin(x-2*y+z);
U=Th.eval(u);

```

```

fc_tools.graphics.monitors.onGrid(2,2,'figures',1:3);

```

```

figure(1)
fc_siplt.plotmesh(Th,'d',1,'color','k')
hold on
fc_siplt.scatter(Th,U,'MarkerEdgeAlpha',0.1);
axis image;axis off;view(3)
colorbar

```

```

figure(2)
fc_siplt.plotmesh(Th,'d',1,'color','k')
hold on
fc_siplt.scatter(Th,U,'d',2);
axis image;axis off;view(3)
colorbar

```

```

figure(3)
fc_siplt.scatter(Th,U,'d',1);
axis image;axis off;view(3)
colormap('jet')
colorbar

```

Listing 19: Using `fc_siplt.scatter` function with a 3D mesh

Appendices

A Listings

1	<code>fc_siplt.demos.sample2D01</code> script with figure 1 (top left), figure 2 (top right), figure 3 (bottom left) and figure 4 (bottom right).	3
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B References

- [1] F. Cuvelier. `fc_graphics4mesh`: a Matlab toolbox for displaying simplices meshes or datas on simplices meshes. <http://www.math.univ-paris13.fr/~cuvelier/software/>, 2017. User’s Guide.
- [2] F. Cuvelier. `fc_simesh`: an object-oriented Matlab toolbox for using simplices meshes generated from gmsh (in dimension 2 or 3) or an hypercube triangulation (in any dimension). <http://www.math.univ-paris13.fr/~cuvelier/software/>, 2017. User’s Guide.

Informations for git maintainers of the Matlab toolbox

git informations on the toolboxes used to build this manual

```
-----
name : fc-siplt
tag : 0.2.6
commit : 225d8579179b60686b16f116bee8ac4dc858e2d6
date : 2023-03-05
time : 17-00-59
status : 0
-----
name : fc-tools
tag : 0.0.35
commit : 1469d4cbac235c83155cf9195d9887e0a149177a
date : 2023-03-03
time : 13-50-59
status : 0
-----
name : fc-bench
tag : 0.1.3
commit : 0639dde1dee68427af4dab19f75b1c58dacf64a4
date : 2023-03-02
time : 09-35-44
status : 0
-----
name : fc-hypermesh
tag : 1.0.4.b
commit : 3ec06216dde6d376fcb766b085188b259986fe19
date : 2023-03-02
time : 12-46-15
status : 0
-----
name : fc-amat
tag : 0.1.3.b
commit : 36648a410d06d8af84f4950cd42681309d803dbf
date : 2023-03-02
time : 09-49-35
status : 0
-----
name : fc-meshtools
tag : 0.1.4.b
commit : 43f58ffcfa2ca359f2d948d156a8165274270376
date : 2023-03-02
time : 15-23-05
status : 0
-----
name : fc-graphics4mesh
tag : 0.1.6
commit : 184e91b337ead27cb05f945983446dc66ec02795
date : 2023-03-04
time : 08-38-29
status : 0
-----
name : fc-oogmsh
tag : 0.3.0.a
commit : 9e26c408792500dd34c5f2d90df7cc8fcc20cbbb
date : 2023-03-05
time : 06-36-30
status : 0
-----
name : fc-simesh
tag : 0.4.6.a
commit : 76deddaf6949d04bcc281cac685e5ba17914845b
date : 2023-03-05
time : 17-19-12
status : 0
-----
```

git informations on the L^AT_EX package used to build this manual

```
-----
name : fctools
tag :
commit : ce17e5ecb1d9999e3c8b228f7557f77310b7c9c5
date : 2023-03-05
time : 06:32:05
status : 1
-----
```

Using the remote configuration repository:

```
url      ssh://lagagit/MCS/Cuvelier/Matlab/fc-config
commit   ca906afbfb4703ef2dbaee43d9b4385267301e1
```