



FC-PSIMESH Matlab toolbox, User's Guide *

François Cuvelier[†]

February 8, 2017

Abstract

This object-oriented Matlab toolbox allows to use partitioned simplices meshes generated from `gmsb` (in dimension 2 or 3). A particular care was taken to the graphics representations of partitioned meshes and datas on partitioned meshes.

This code uses the FC-SIMESHMatlab toolbox and we suppose the reader to be familiar with it.

Contents

1	Partitioned mesh, PSIMESH object	2
1.1	Samples	3
1.1.1	2D samples	3
1.1.2	3D samples	4
1.1.3	3D surface samples	9
1.2	PSIMESH object	10
2	PSIMESH methods	11
2.1	PSIMESH constructor	11
2.2	function EVAL	11
2.2.1	2D example	12
2.2.2	3D example	13
2.2.3	3D surface example	13
2.3	function PLOTMESH	14
2.3.1	2D example	15

*Compiled with Matlab 2015b

[†]Université Paris 13, Sorbonne Paris Cité, LAGA, CNRS UMR 7539, 99 Avenue J-B Clément, F-93430 Villetaneuse, France, cuvelier@math.univ-paris13.fr.

This work was partially supported by ANR Dedales.

2.3.2	3D example	19
2.3.3	3D surface example	22
2.4	function PLOT	24
2.4.1	2D example	25
2.4.2	3D example	27
2.4.3	3D surface example	30
2.4.4	function PLOTISO	31
2.4.5	2D example	31
2.4.6	3D example	32
2.4.7	3D surface example	34
2.4.8	function SLICEMESH	34
2.4.9	3D example	35
2.4.10	function SLICE	36
2.4.11	3D example	36
2.4.12	function SLICEISO	37
2.4.13	3D example	38
2.4.14	function PLOTVECTORFIELD	38
2.4.15	2D example	39
2.4.16	3D example	41
2.4.17	3D surface example	43

1 Partitioned mesh, psiMesh object

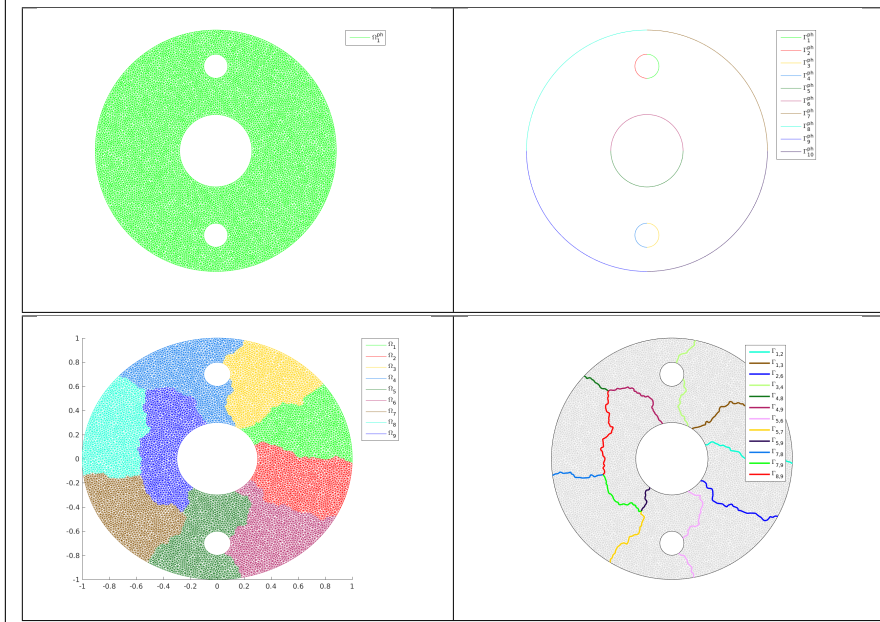
In geometry, a simplex is a generalization of the notion of a triangle or tetrahedron to arbitrary dimensions. Specifically, a k -simplex in $\mathbb{R}^{\dim}$, $k \leq \dim$, is a polytope which is the convex hull of its $k + 1$ vertices of $\mathbb{R}^{\dim}$. More formally, suppose the $k + 1$ vertices $q^0, \dots, q^k \in \mathbb{R}^{\dim}$ such that $q^1 - q^0, \dots, q^k - q^0$ are linearly independent. Then, the k -simplex K determined by them is the set of points

$$K = \left\{ \sum_{i=0}^k \lambda_i q^i \mid \lambda_i \geq 0, i \in \llbracket 0, k \rrbracket, \text{ with } \sum_{i=0}^k \lambda_i = 1 \right\}.$$

- A **k -simplicial elementary mesh** in $\mathbb{R}^{\dim}$, $k \leq \dim$, is a mesh with **unique label** only composed with k -simplices. It corresponds to the `SIMESHELT` object of the `FC-SIMESH` toolbox.
- A **d -simplicial mesh** in $\mathbb{R}^{\dim}$, $d \leq \dim$, is an union of **k -simplicial elementary meshes** with $k \in \llbracket 0, d \rrbracket$. It corresponds to the `SIMESH` object of the `FC-SIMESH` toolbox.
- A **partitioned d -simplicial mesh** in dimension $\dim$, is an union of **d -simplicial mesh** in $\mathbb{R}^{\dim}$. It corresponds to `PSIMESH` object defined in this toolbox.

1.1 Samples

1.1.1 2D samples



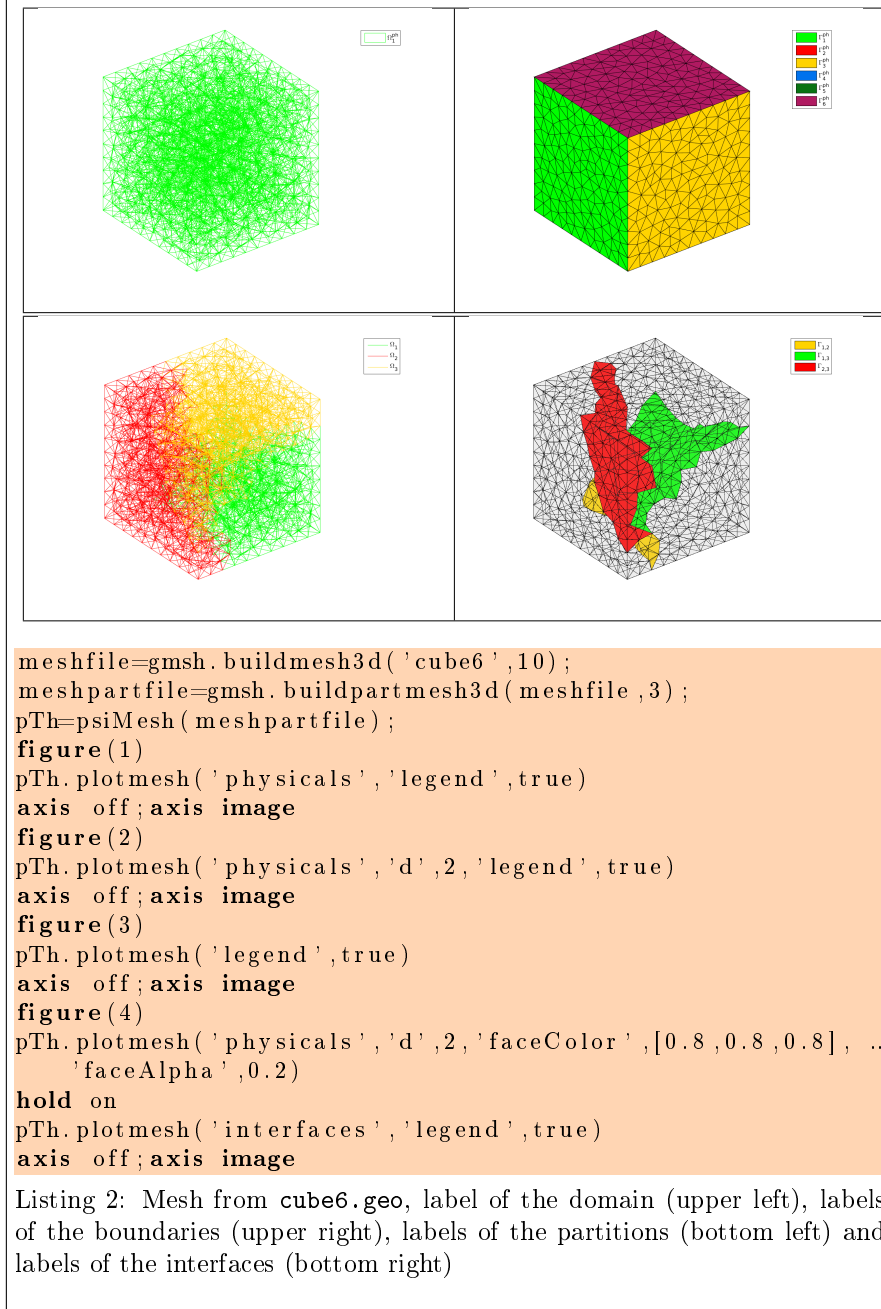
```

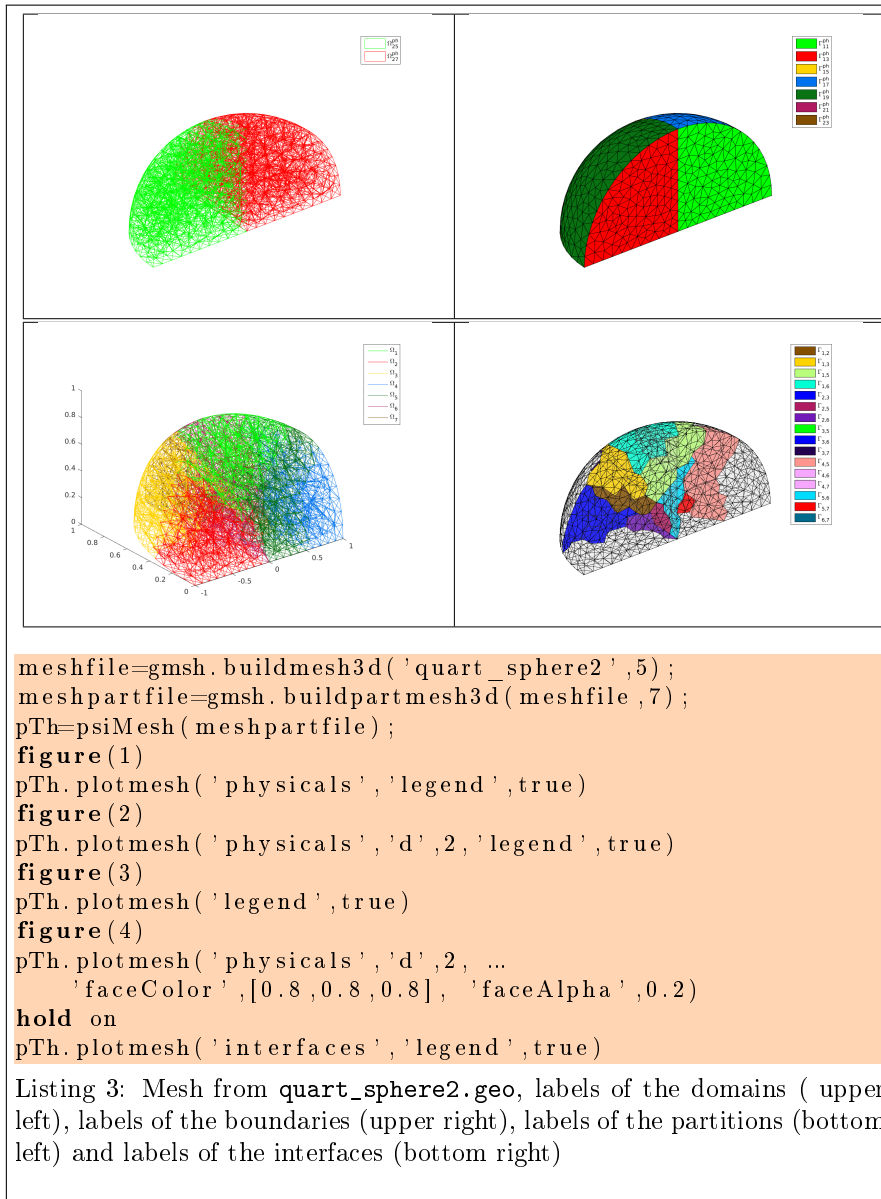
meshfile=gmesh.buildmesh2d('disk3holes',50);
meshpartfile=gmesh.buildpartmesh2d(meshfile,9);
pTh=psiMesh(meshpartfile);
figure(1)
pTh.plotmesh('physicals','legend',true)
axis off;axis image
figure(2)
pTh.plotmesh('physicals','d',1,'legend',true)
axis off;axis image
figure(3)
pTh.plotmesh('legend',true)
axis off;axis image
figure(4)
pTh.plotmesh('color','LightGrey')
hold on;axis off;axis image
pTh.plotmesh('physicals','d',1,'color','k')
pTh.plotmesh('interfaces','legend',true,'linewidth',2)

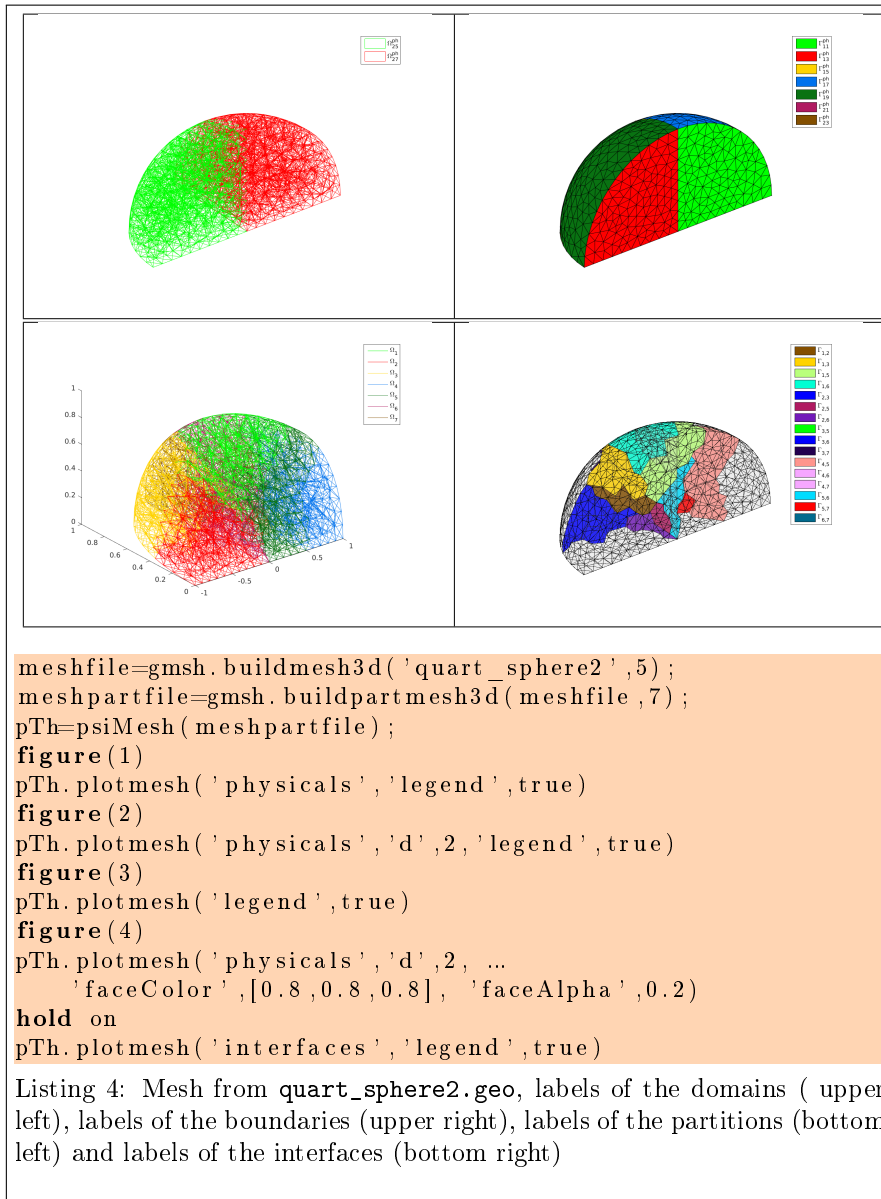
```

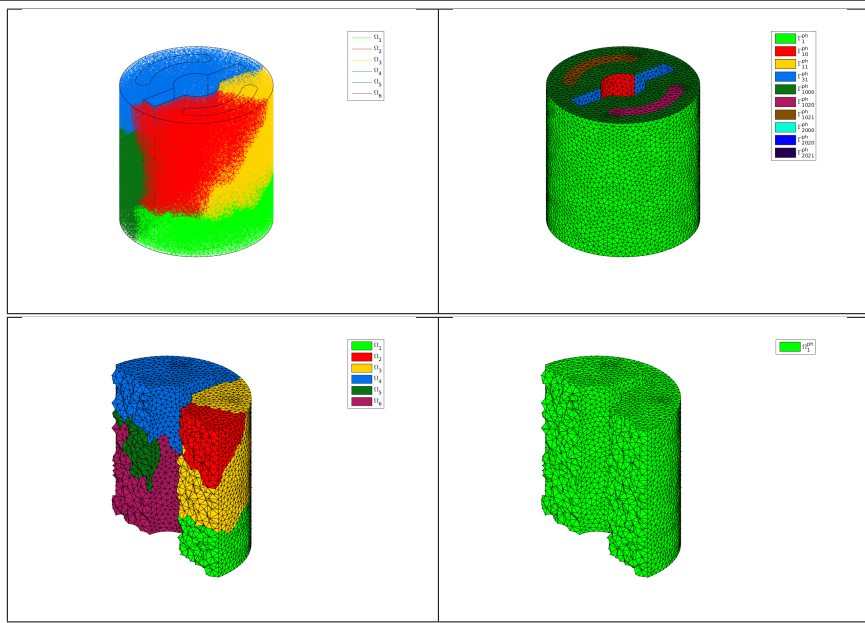
Listing 1: Mesh from `disk3holes.geo`, label of the domain (upper left), labels of the boundaries (upper right), labels of the partitions (bottom left) and labels of the interfaces (bottom right)

1.1.2 3D samples







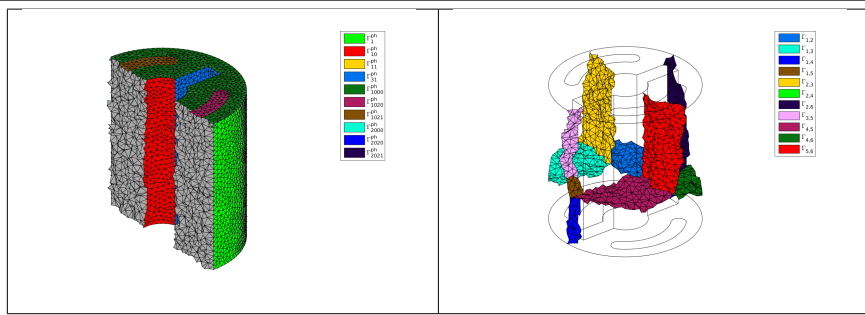


```

pTh=fc_psimesh.build_psimesh('cylinderkey03','N',ns*8,'np',6,...
    'geodir','geodir3d','d',3,'verbose',2);
figure(1)
pTh.plotmesh('partitions','labels',1,'legend',true)
axis off;axis equal;
hold on
pTh.plotmesh('d',1,'Color','black');
figure(2)
pTh.plotmesh('physicals','d',2,'legend',true)
axis equal;
P=fc_tools.graphics.PlaneCoefs([0 0 0],[-1 0 0]);
figure(3)
pTh.plotmesh('cutPlan',P,'legend',true)
axis off;axis equal;
figure(4)
pTh.plotmesh('physicals','cutPlan',P,'legend',true)
axis off;axis equal;

```

Listing 5: Mesh from cylinderkey03.geo, with 6 partitions



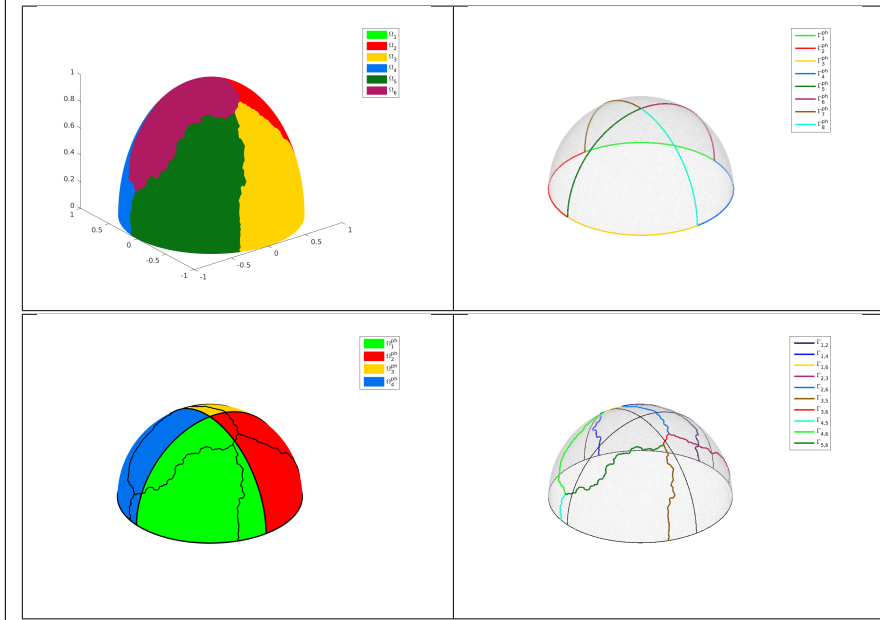
```

pTh=fc_psimesh.build_psimesh('cylinderkey03','N',ns*8,'np',6,...
    'geodir',geodir3d,'d',3,'verbose',2);
P=fc_tools.graphics.PlaneCoefs([0 0 0],[-1 0 0]);
figure(1)
pTh.plotmesh('cutPlan',P,'color','DarkGrey')
axis off;axis equal;
hold on
pTh.plotmesh('physicals','d',2,'cutPlan',P,'legend',true)
figure(2)
pTh.plotmesh('d',1,'color','black')
axis off;axis equal;
hold on
pTh.plotmesh('interfaces','d',2,'legend',true)

```

Listing 6: Mesh from cylinderkey03.geo with 6 partitions (more)

1.1.3 3D surface samples



```

meshfile=gmesh.buildmesh3ds('demisphere4surf',ns*25,'force',false);
meshpartfile=gmesh.buildpartmesh3ds(meshfile,6,'force',false);
pTh=psiMesh(meshpartfile);
figure(1);
pTh.plotmesh('EdgeColor','none','legend',true);
figure(2)
pTh.plotmesh('FaceColor','None', ...
            'EdgeColor',0.8*[1,1,1],'EdgeAlpha',0.3);
hold on
pTh.plotmesh('physicals','d',1,'LineWidth',2,'legend',true);
figure(3)
pTh.plotmesh('physicals','EdgeColor','None','legend',true);
hold on
pTh.plotmesh('physicals','d',1,'color',[0,0,0], ...
            'LineWidth',2);
pTh.plotmesh('interfaces','Color',[0,0,0], ...
            'LineWidth',1.5,'LineStyle','-');
figure(4)
pTh.plotmesh('FaceColor','None', ...
            'EdgeColor',0.8*[1,1,1],'EdgeAlpha',0.3);
hold on
pTh.plotmesh('physicals','d',1,'color','k','LineWidth',1);
pTh.plotmesh('interfaces','LineWidth',2,'legend',true);

```

Listing 7: Mesh from `demisphere4surf.geo`, labels of the domains (upper left), labels of the boundaries (upper right), labels of the partitions (bottom left) and labels of the interfaces (bottom right)


Partitioned simplicial mesh, PSIMESH object

dim	:	integer space dimension
d	:	integer d-dimensional simplicial mesh
$\mathcal{T}_h$	:	array of SIMESH objects, one by partition we set $\Omega_i = \mathcal{T}_h(i)$
np	:	number of partitions (i.e. length of $\mathcal{T}_h$)
nq	:	number of vertices
PhysElts	:	cell arrays of physical/geometrical structure ...
InterElts	:	cell arrays of interfaces structure ...


InterElts, interface element structure associated with an PSIMESH object

d	:	integer d-dimensional simplicial interfaces
labels	:	list of interface labels in PSIMESH object
parts	:	np-by-1 cells array. $parts\{i\}$ contains all interface labels of $\Omega_i = \mathcal{T}_h(i)$
Gamma	:	np-by-np (sparse or not) matrix. $\Gamma(i, j)$ is the interface label of $\partial\Omega_i \cap \partial\Omega_j$ if not empty, 0 otherwise. We set $\Gamma_{i,j} = \Gamma(i, j)$
GammaIdx	:	np-by-np (sparse or not) matrix. $\Gamma_{i,j}$ is the index in the cells array $\mathcal{T}_h(i).sTh$ of $\Gamma_{i,j}$.


PhysElts, physical element structure associated with an PSIMESH object

d	:	integer d-dimensional simplicial physical elements
labels	:	list of nl physical labels in PSIMESH object
parts	:	array of np lists $parts(i)$ contains all physical labels of $\Omega_i = \mathcal{T}_h(i)$
connect	:	nl-by-np sparse matrix. $connect(l, i) \neq 0$ if labels(l) physical element is partially in Ω_i

2 psiMesh methods

2.1 PSIMESH constructor

The constructor of the `psiMesh` class can initialize the object from a partitioned mesh file (obtained from `gmsh`).

remark 2.1

The interfaces between mesh partitions must have their labels less than 0 or, greater than or equal to 10000.

Syntaxe

```
pTh=psiMesh(meshfile)
```

Description

`pTh=psiMesh(meshfile)` create the `psiMesh` object `pTh` from the mesh file `meshfile` (`gmsh` format by default).

Examples The following example use the `.geo` file `condenser11.geo` which is in the directory `geodir` of the toolbox.

Matlab commands with output

```
meshfile=gmsh.buildmesh2d('condenser11',25,'verbose',0);
mpfile=gmsh.buildpartmesh2d(meshfile,5,'verbose',0);
disp('***_Read_partitioned_mesh_***')
pTh=psiMesh(mpfile);
info(pTh)
```

```
*** Read partitioned mesh ***
Variable pTh [psiMesh object] :
dim=2, d=2, np=5
nq=2990, nme=5722
Partition 1 , label 1 :
nq=623, nme=1143
Partition 2 , label 2 :
nq=624, nme=1144
Partition 3 , label 3 :
nq=631, nme=1145
Partition 4 , label 4 :
nq=625, nme=1145
Partition 5 , label 5 :
nq=633, nme=1145
```

2.2 function EVAL

The method `eval` evaluates a function on a partitioned mesh defined by an `psiMesh` object.

Syntaxe

```
pTh.eval(fun)
pTh.eval(fun,Name,Value, ...)
```

Description

`pTh.eval(fun)` evaluates the function `fun` on all the vertices of the partitioned mesh. The return value is an array of dimension `Th.nq-by-1`. If `fun` is a cell array of m functions, the return value is a `pTh.nq-by- $m$` array.

`pTh.plot(fun,Name,Value, ...)` specifies function options using one or more `Name,Value` pair arguments. Options of first level are

- **'split'** : the return value is splitted by partitions and so its a cell array of dimension `pTh.np` where each cell (one by partition) is an array of dimension the number of vertices of the partition by m .

2.2.1 2D example

The following example use the `.geo` file `condenser11.geo` which is in the directory `geodir` of the toolbox.

Matlab commands with output

```
pTh=fc_psimesh.build_psimesh('condenser11','N',25,'np',7);
u=@(x,y) cos(x+y);
pTh.info()
disp('without_splitting')
U=pTh.eval(u);
V=pTh.eval(u,'split',true);
whos('U','V')
```

```
[fc-oogmsh] Input file : <fc-oogmsh>/geodir/condenser11.geo
[fc-oogmsh] Mesh file <fc-oogmsh>/meshes/condenser11-25.msh already exists.
-> Use "force" flag to rebuild if needed.
[fc-oogmsh] Input file : <fc-oogmsh>/meshes/condenser11-25.msh
[fc-oogmsh] Mesh file <fc-oogmsh>/meshes/condenser11-25-part7.msh already exists.
-> Use "force" flag to rebuild if needed.
Variable pTh [psiMesh object] :
    dim=2, d=2, np=7
    nq=2990, nme=5722
Partition 1 , label 1 :
    nq=449, nme=817
Partition 2 , label 2 :
    nq=454, nme=818
Partition 3 , label 3 :
    nq=454, nme=817
Partition 4 , label 4 :
    nq=455, nme=817
Partition 5 , label 5 :
    nq=450, nme=818
Partition 6 , label 6 :
    nq=450, nme=817
Partition 7 , label 7 :
    nq=456, nme=818
without_splitting
    Name      Size      Bytes Class      Attributes
    U          2990x1      23920 double
    V           7x1       26128 cell
```

2.2.2 3D example

The following example use the *.geo* file `cylinderkey03.geo` which is in the directory `geodir` of the toolbox. This file contains description of a 3D mesh with simplices of dimensions 1, 2 and 3.

Matlab commands with output

```
geofile='cylinderkey03';
pTh=fc_psimesh.build_psimesh(geofile,'N',ns*8,'np',6,...
    'geodir',geodir3d,'d',3,'verbose',2);
u=@(x,y,z) cos(x+y-z);
pTh.info()
U=pTh.eval(u);
V=pTh.eval(u,'split',true);
whos('U','V')
```

```
[fc-oogmsh] Input file : /home/cuvelier/Travail/Recherch/Matlab/fc-psimesh/doc/./geodir/3d/cylinderkey03.geo
[fc-oogmsh] Mesh file <fc-oogmsh>/meshes/cylinderkey03-16.msh already exists.
-> Use "force" flag to rebuild if needed.
[fc-oogmsh] Input file : <fc-oogmsh>/meshes/cylinderkey03-16.msh
[fc-oogmsh] Mesh file <fc-oogmsh>/meshes/cylinderkey03-16-part6.msh already exists.
-> Use "force" flag to rebuild if needed.
Variable pTh [psiMesh object] :
    dim=3, d=3, np=6
    nq=18204, nme=88702
Partition 1 , label 1 :
    nq=3312, nme=14783
Partition 2 , label 2 :
    nq=3215, nme=14784
Partition 3 , label 3 :
    nq=3228, nme=14784
Partition 4 , label 4 :
    nq=3291, nme=14783
Partition 5 , label 5 :
    nq=3224, nme=14784
Partition 6 , label 6 :
    nq=3243, nme=14784
Name      Size      Bytes Class      Attributes
U          18204x1      145632 double
V           6x1       156776 cell
```

2.2.3 3D surface example

The following example use the *.geo* file `demisphere5.geo` which is in the directory `geodir` of the toolbox. This file contains description of a 3D mesh with simplices of dimensions 1 and 2.

Matlab commands with output

```
pTh=fc_psimesh.build_psimesh('demisphere4surf','N',ns*10, ...
    'np',6,'d',2);
u=@(q) cos(q(1,:)+q(2,:)-q(3,:));
pTh.info()
U=pTh.eval(u);
V=pTh.eval(u,'split',true);
whos('U','V')
```

```
[fc-oogmsh] Input file : <fc-oogmsh>/geodir/demisphere4surf.geo
[fc-oogmsh] Mesh file <fc-oogmsh>/meshes/demisphere4surf-20.msh already exists.
-> Use "force" flag to rebuild if needed.
[fc-oogmsh] Input file : <fc-oogmsh>/meshes/demisphere4surf-20.msh
[fc-oogmsh] Mesh file <fc-oogmsh>/meshes/demisphere4surf-20-part6.msh already exists.
-> Use "force" flag to rebuild if needed.
Variable pTh [psiMesh object] :
dim=3, d=2, np=6
ng=3068, nne=6006
Partition 1, label 1 :
ng=546, nne=1001
Partition 2, label 2 :
ng=544, nne=1001
Partition 3, label 3 :
ng=545, nne=1001
Partition 4, label 4 :
ng=546, nne=1001
Partition 5, label 5 :
ng=547, nne=1001
Partition 6, label 6 :
ng=553, nne=1001
Name      Size      Bytes Class      Attributes
U          3068x1      24544 double
V           6x1      26920 cell
```

2.3 function PLOTMESH

The method `plotmesh` displays completes or partials *kinds* of mesh elements defined by an `psiMesh` object. The select *kind* of mesh elements to draw is one of the following :

'partitions' (default), 'physicals' or 'interfaces'

Syntaxe

```
pTh.plotmesh()
pTh.plotmesh(kind)
pTh.plotmesh(Name,Value,...)
pTh.plotmesh(kind,Name,Value,...)
```

Description

`pTh.plotmesh()` displays all the `pTh.d`-dimensional simplices elements of all the partitions.

`pTh.plotmesh(kind)` where `kind` is the string 'partitions' (default), 'physicals' or 'interfaces'. Displays all the d -dimensional simplices elements of all the kind contains in `psiMesh` object `pTh`. The default value for d is `pTh.d-1` if `kind` is 'interfaces' otherwise is `pTh.d`.

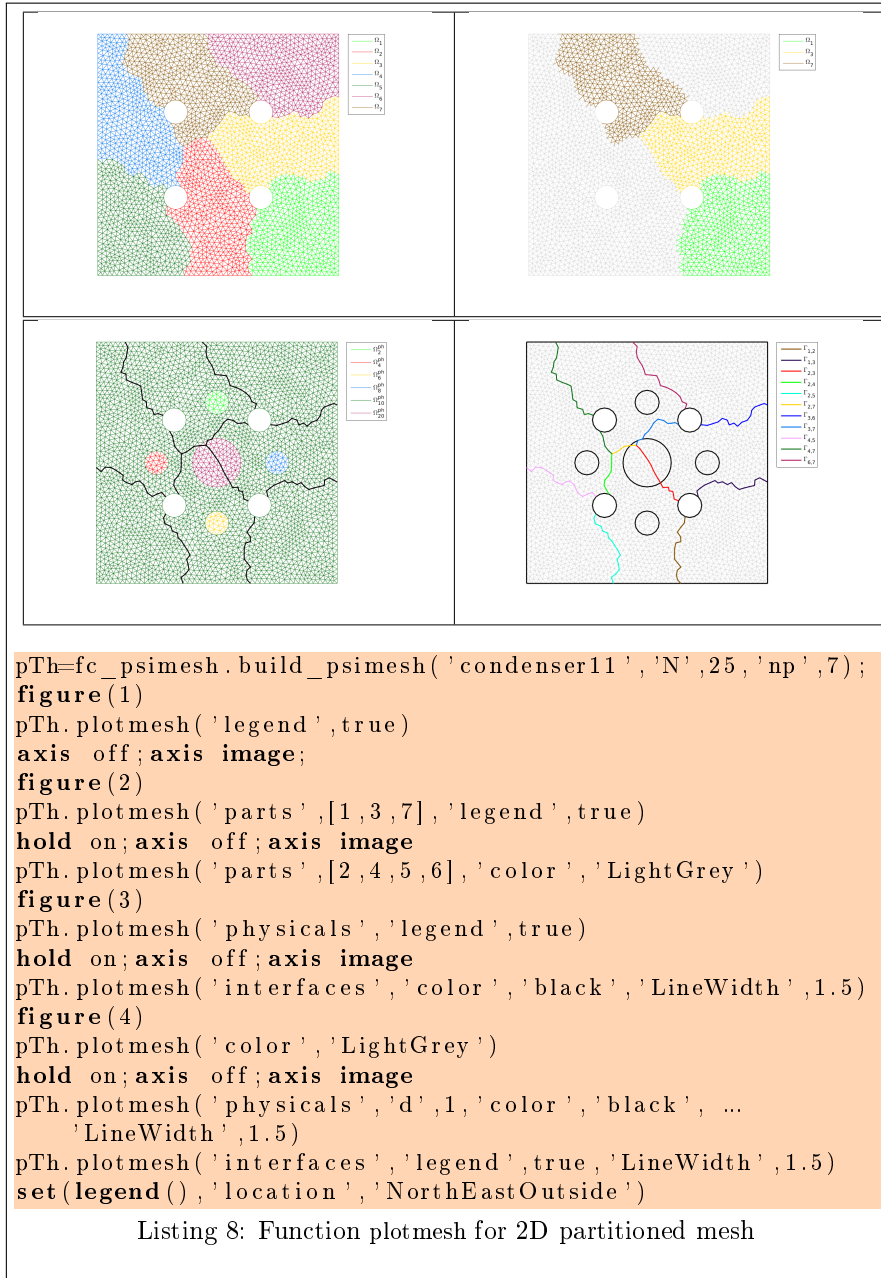
`pTh.plotmesh(Name,Value,...)` specifies function options using one or more `Name,Value` pair arguments. Options of first level are

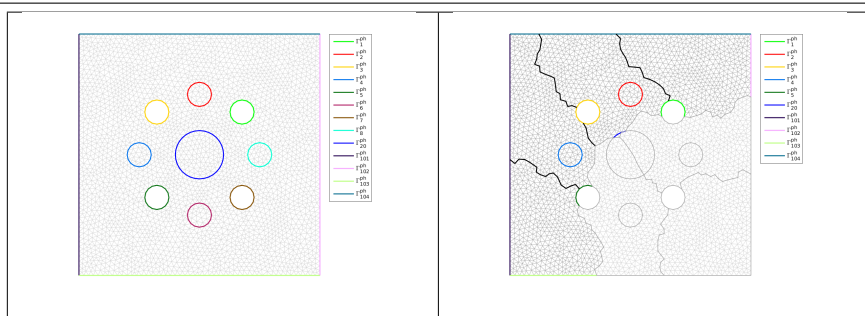
- `'parts'` : to select the labels of the partitions to display,
- `'d'` : to select the dimensional d -simplices elements to display,
- `'labels'` : to select the labels of the elements to display,
- `'color'` : to specify the color of the displayed elements.
- `'legend'` : add a legend to graph if true (default : false)

The options of second level depend on the type of elementaries mesh elements to represent. (see `plotmesh` function of `mooMesh` class)

2.3.1 2D example

The following example use the `.geo` file `condenser11.geo` which is in the directory `geodir` of the toolbox.



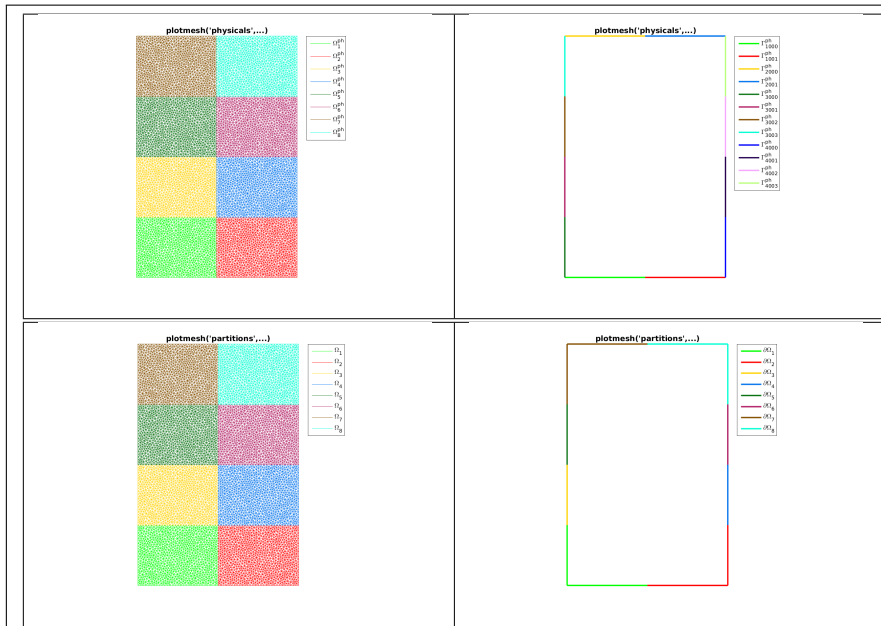


```

pTh=fc_psimesh.build_psimesh('condenser11','N',25,'np',7);
figure(1)
pTh.plotmesh('color','LightGrey')
hold on; axis off; axis image;
pTh.plotmesh('physicals','d',1,'legend',true, ...
'LineWidth',1.5)
figure(2)
pTh.plotmesh('parts',1:3,'color','LightGrey')
hold on; axis off; axis image;
pTh.plotmesh('parts',4:7,'color','DarkGrey')
pTh.plotmesh('physicals','d',1,'parts',4:7, ...
'legend',true, 'LineWidth',1.5)
pTh.plotmesh('interfaces','parts',4:7, ...
'color','black','LineWidth',1.5)
pTh.plotmesh('interfaces','parts',1:3, ...
'color','DarkGrey','LineWidth',1)
pTh.plotmesh('physicals','d',1,'parts',1:3,'color','DarkGrey', ...
'LineWidth',1)

```

Listing 9: Function plotmesh for 2D partitioned mesh (suite)

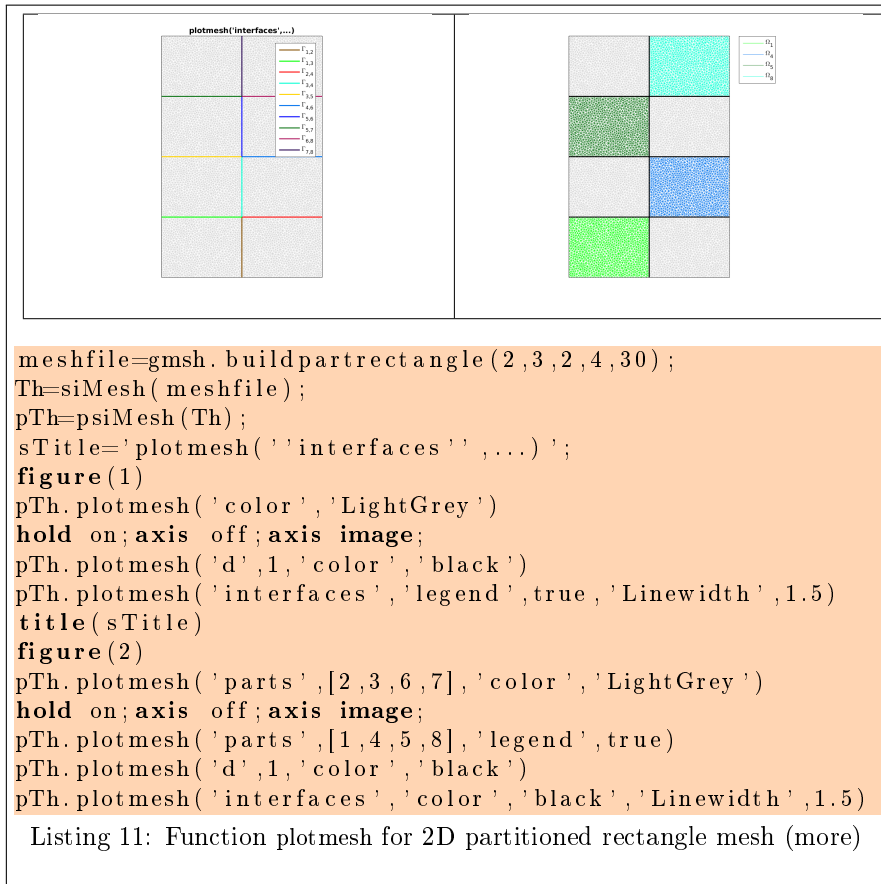


```

meshfile=gmsl. buildpartrectangle(2,3,2,4,30);
Th=siMesh( meshfile);
pTh=psiMesh(Th);
sTitle='plotmesh(''physicals'',...)' ;
figure(1)
pTh.plotmesh('physicals','legend',true)
axis off; axis image; title(sTitle);
figure(2)
pTh.plotmesh('physicals','d',1,'legend',true,'LineWidth',2)
axis off; axis image; title(sTitle)
sTitle='plotmesh(''partitions'',...)' ;
figure(3)
pTh.plotmesh('partitions','legend',true)
axis off; axis image; title(sTitle)
figure(4)
pTh.plotmesh('partitions','d',1,'legend',true,...
'LineWidth',2)
axis off; axis image; title(sTitle)

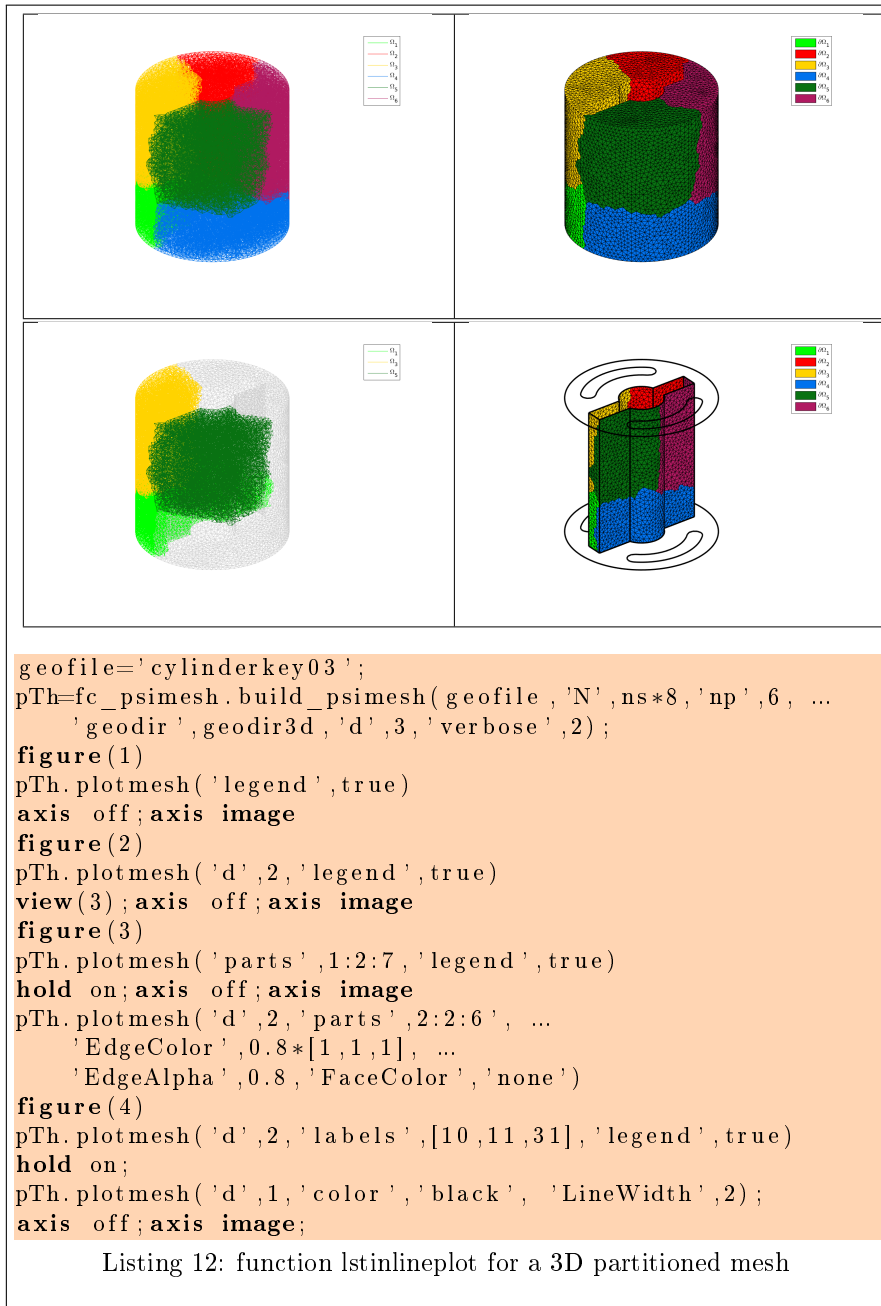
```

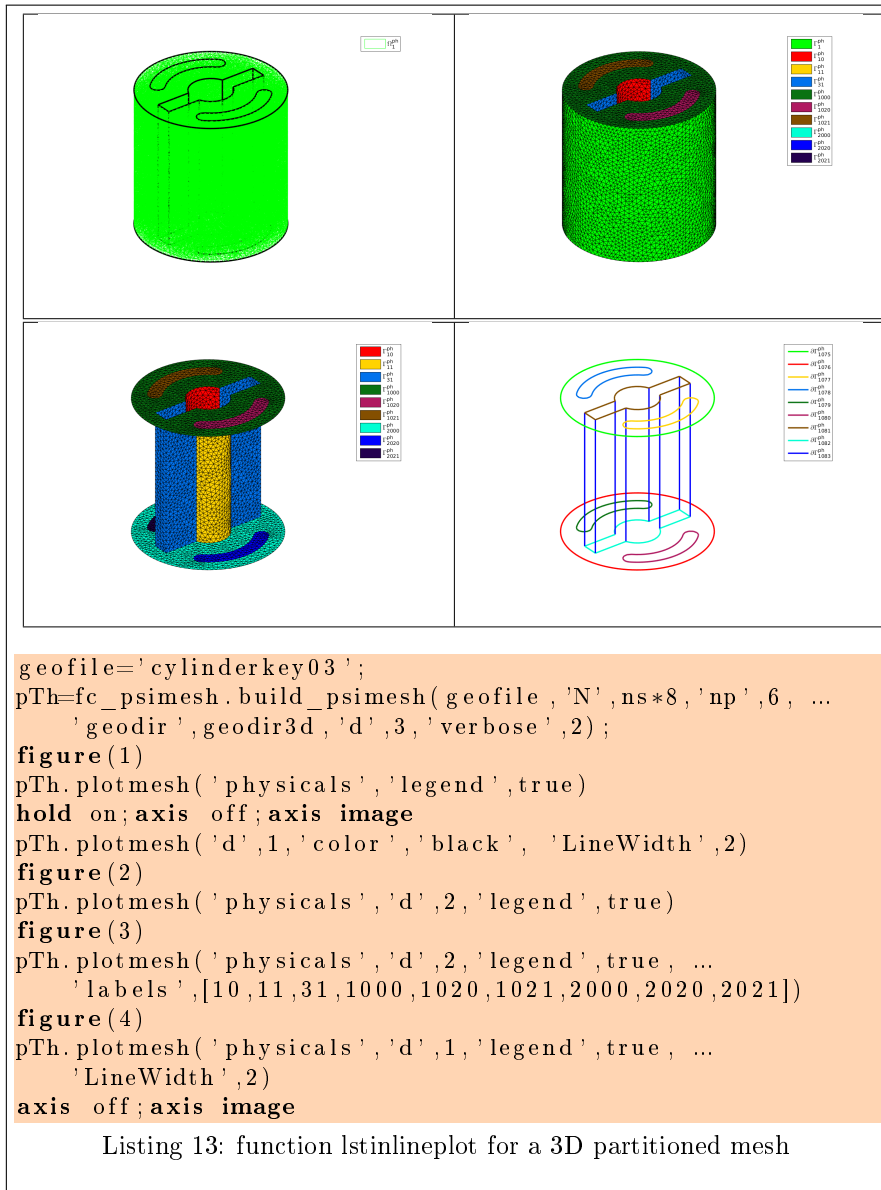
Listing 10: Function plotmesh for 2D partitioned rectangle mesh

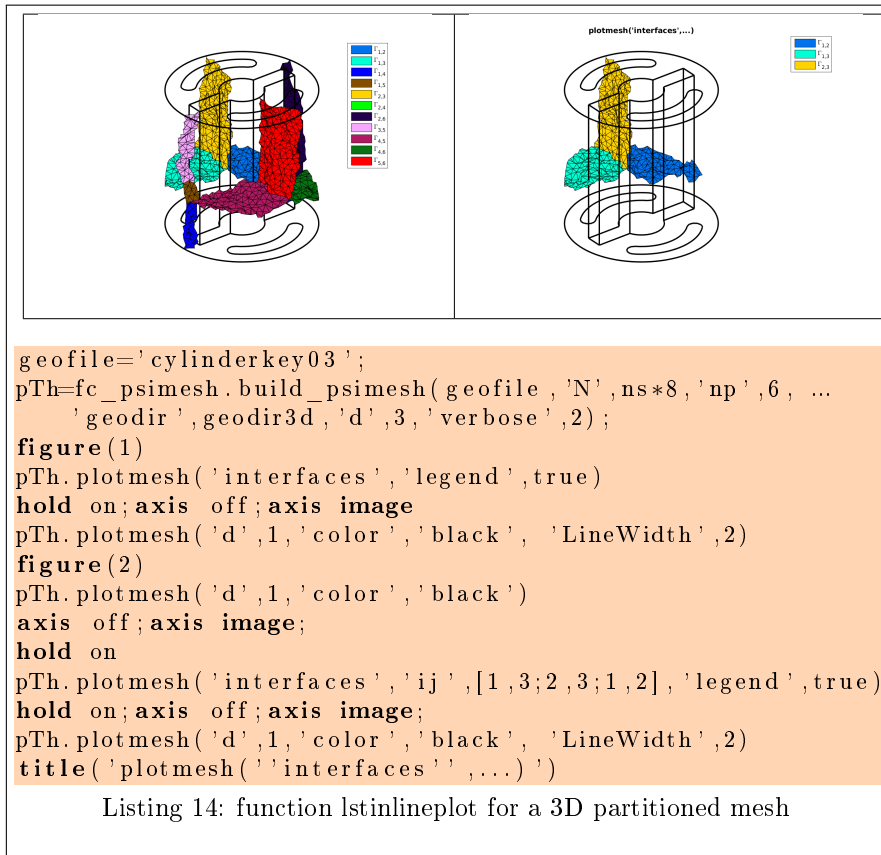


2.3.2 3D example

The following example use the *.geo* file `cylinderkey03.geo` which is in the directory `geodir/3d` of the toolbox. This file contains description of a 3D mesh with simplices of dimensions 1, 2 and 3.

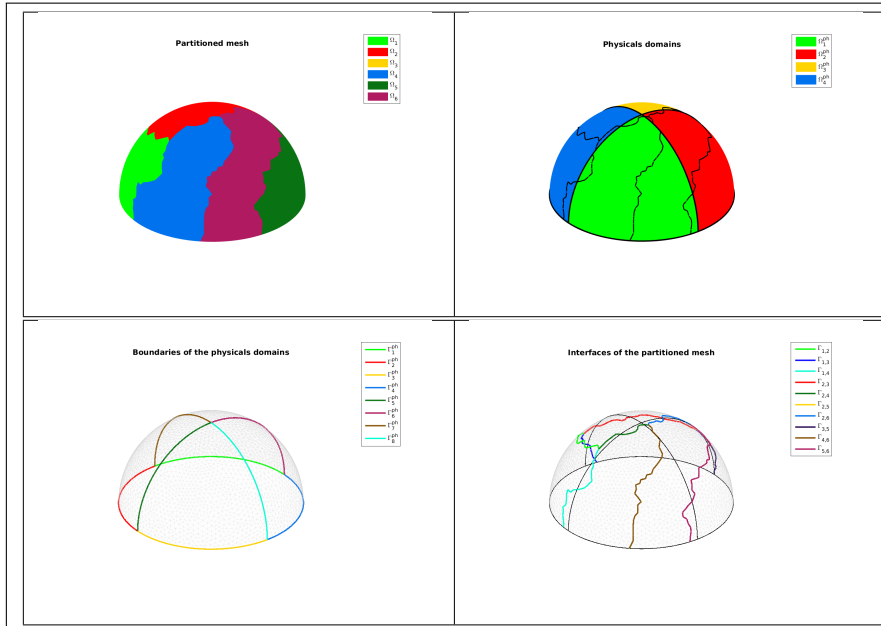






2.3.3 3D surface example

The following example use the *.geo* file *demisphere5.geo* which is in the directory *geodir* of the toolbox. This file contains description of a 3D surface mesh with simplices of dimensions 1 and 2.



```

pTh=fc_psimesh.build_psimesh('demisphere4surf','N',ns*10, ...
    'np',6,'d',2);
figure(1);
pTh.plotmesh('EdgeColor','none','legend',true);
axis off;axis image
title('Partitioned_mesh')
figure(2)
pTh.plotmesh('physicals','EdgeColor','None','legend',true);
hold on
pTh.plotmesh('physicals','d',1,'color','k','LineWidth',2);
pTh.plotmesh('interfaces','color','k','LineWidth',1.5, ...
    'LineStyle','-');
axis off;axis image
title('Physicals_domains')
figure(3)
pTh.plotmesh('FaceColor','None','EdgeColor',0.8*[1,1,1], ...
    'EdgeAlpha',0.3);
hold on
pTh.plotmesh('physicals','d',1,'LineWidth',2,'legend',true);
axis off;axis image
title('Boundaries_of_the_physicals_domains')
figure(4)
pTh.plotmesh('FaceColor','None','EdgeColor',0.8*[1,1,1], ...
    'EdgeAlpha',0.3);
hold on
pTh.plotmesh('physicals','d',1,'color','k','LineWidth',1);
pTh.plotmesh('interfaces','LineWidth',2,'legend',true);
axis off;axis image
title('Interfaces_of_the_partitioned_mesh')

```

Listing 15: function lstinelineplot for a 3D partitioned surface mesh

2.4 function PLOT

The method `plot` displays datas on the partitioned mesh or parts of the partitioned mesh defined by an `psiMesh` object.

Syntaxe With `pTh` a `psiMesh` object

```
pTh.plot(u)
pTh.plot(u, 'interfaces')
pTh.plot(u, Name, Value, ...)
pTh.plot(u, 'interfaces', Name, Value, ...)
```

Description

`pTh.plot(u)` displays data `u` on all the `pTh.d`-dimensional simplices elements.

The data `u` is either a cell array of size `pTh.np` or an 1D-array of size `pTh.nq` or `pTh.nqGlobal` or `pTh.nqParent`.

`pTh.plot(u, 'interfaces')` displays data `u` on all the interfaces.

`pTh.plot(u, Name, Value, ...)` or `pTh.plot(u, 'interfaces', Name, Value, ...)` specifies function options using one or more `Name, Value` pair arguments. Options of first level are

- `'parts'` : to select the labels of the partitions on which to display the data `u`,
- `'d'` : to specify the dimension of the simplices elements (default : `Th.d`)
- `'labels'` : to select the labels of the elements on which to represent data,
- `'plan'` : if true, (default : false)

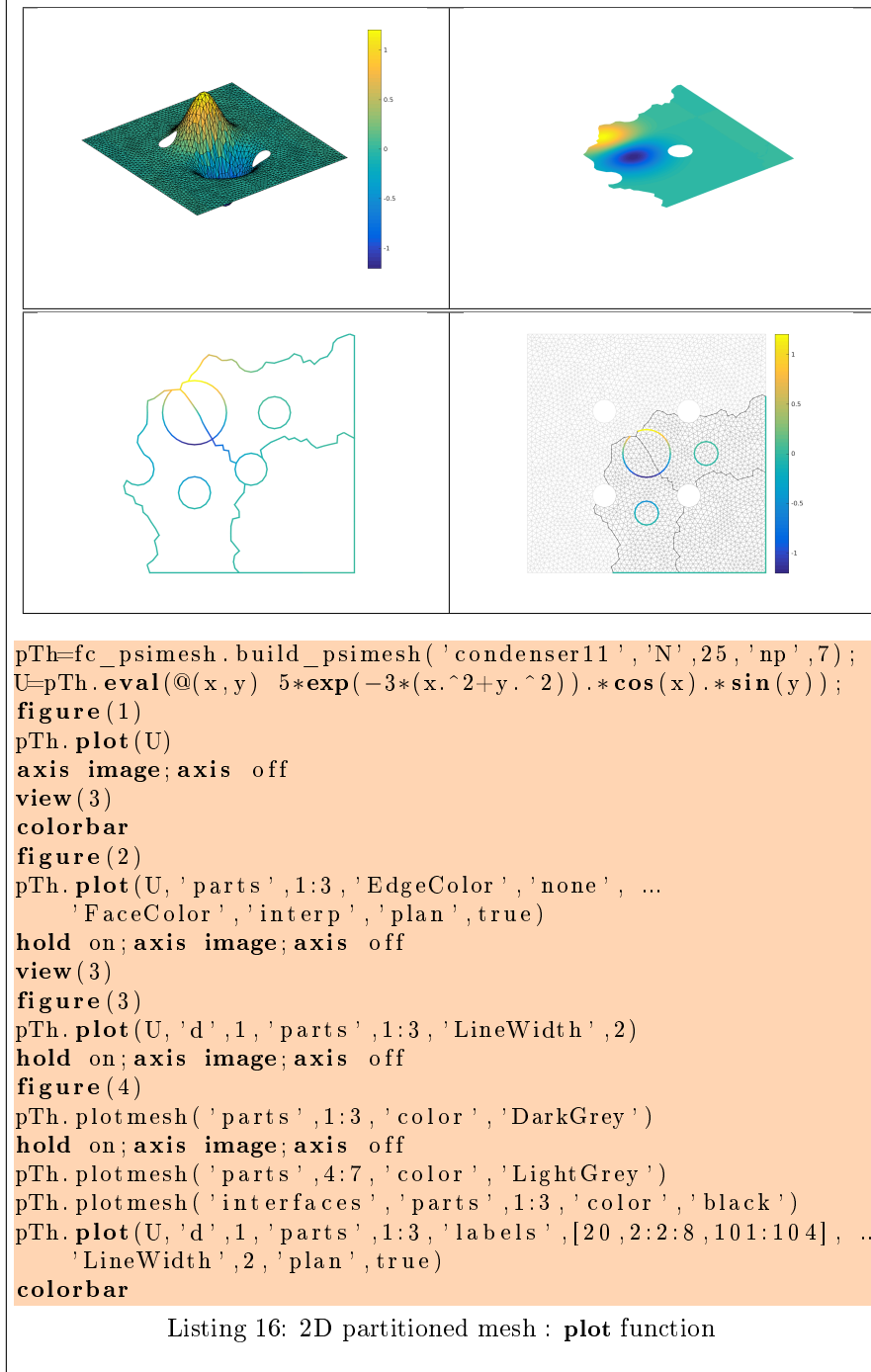
The options of second level depend on the type of elementaries mesh elements on which we want to represent datas.

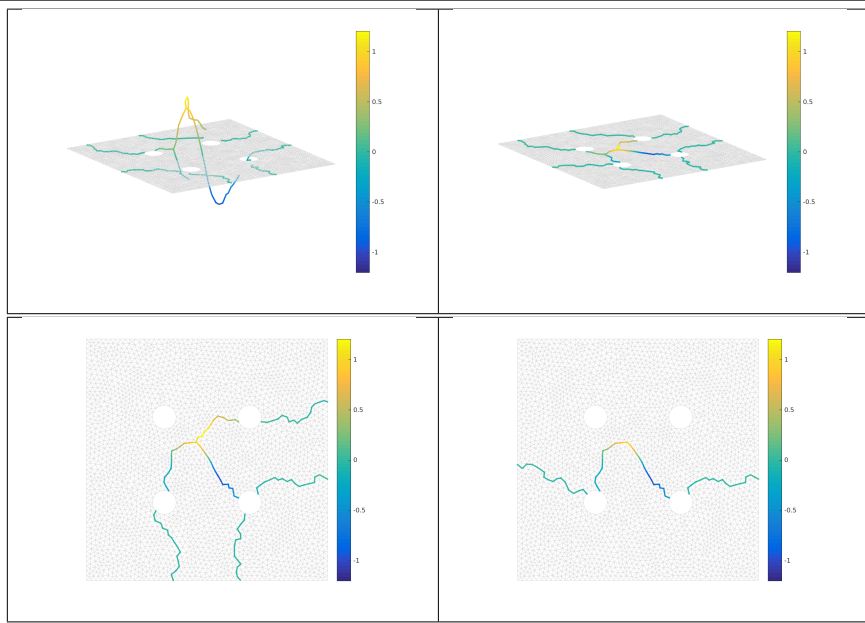
One can use any option of the following functions according to the type of d -simplex.

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

2.4.1 2D example

The following example use the *.geo* file `condenser11.geo` which is in the directory `geodir` of the toolbox.





```

pTh=fc_psimesh.build_psimesh('condenser11','N',25,'np',7);
U=pTh.eval(@(x,y) 5*exp(-3*(x.^2+y.^2)).*cos(x).*sin(y));
figure(1)
pTh.plotmesh('color','LightGrey')
hold on;axis image;axis off
pTh.plot(U,'interfaces','Linewidth',2)
view([-33,16])
colorbar
figure(2)
pTh.plotmesh('color','LightGrey')
hold on;axis image;axis off
pTh.plot(U,'interfaces','plan',true,'Linewidth',2)
colorbar
view([-33,16])

figure(3)
pTh.plotmesh('color','LightGrey')
hold on;axis image;axis off
pTh.plot(U,'interfaces','parts',1:3,'LineWidth',2, ...
        'plan',true)
colorbar

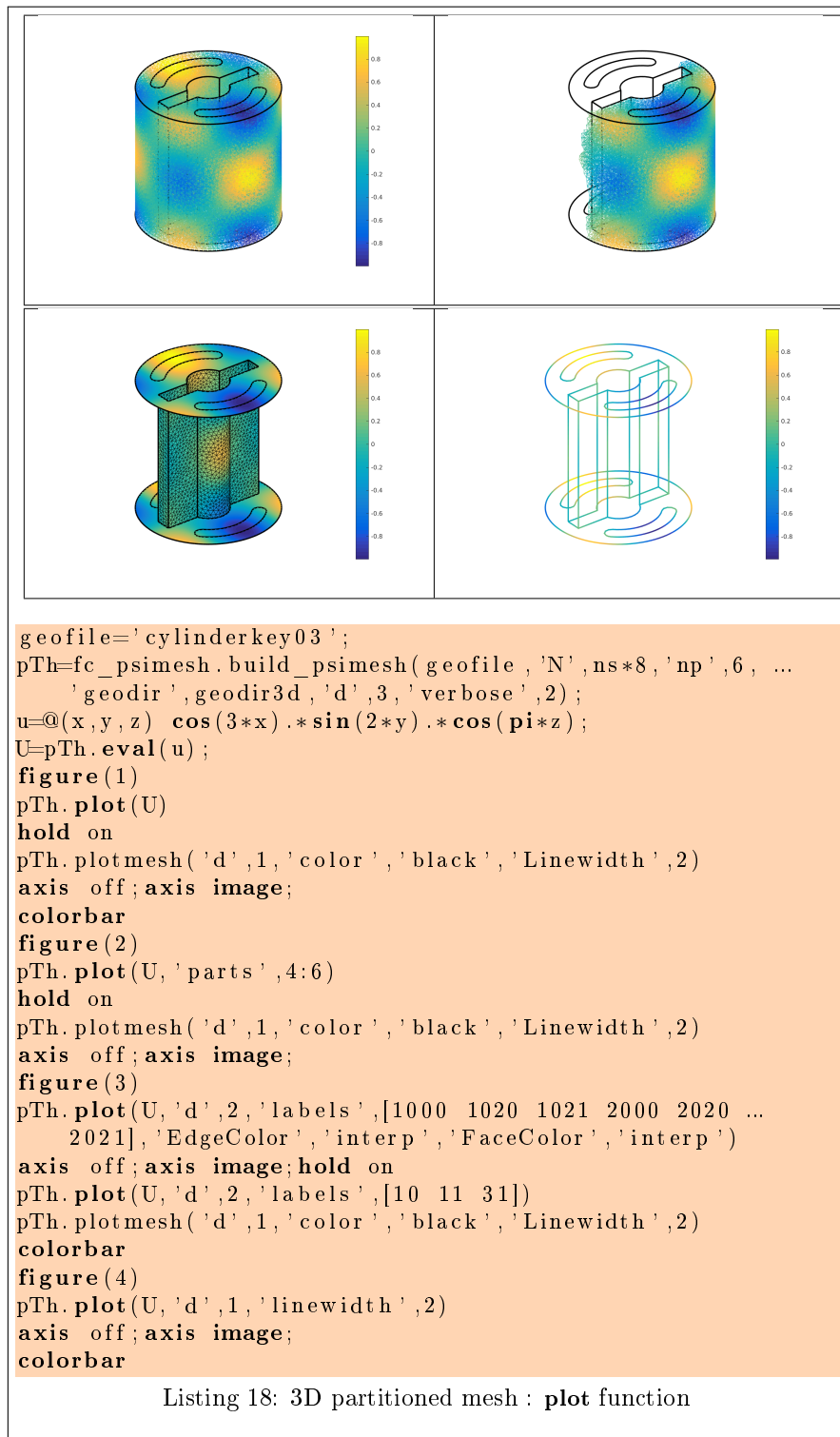
figure(4)
pTh.plotmesh('color','LightGrey')
hold on;axis image;axis off
pTh.plot(U,'interfaces','ij',[4,5;2,7;2,3;2,4;1,3], ...
        'plan',true,'LineWidth',2)
colorbar

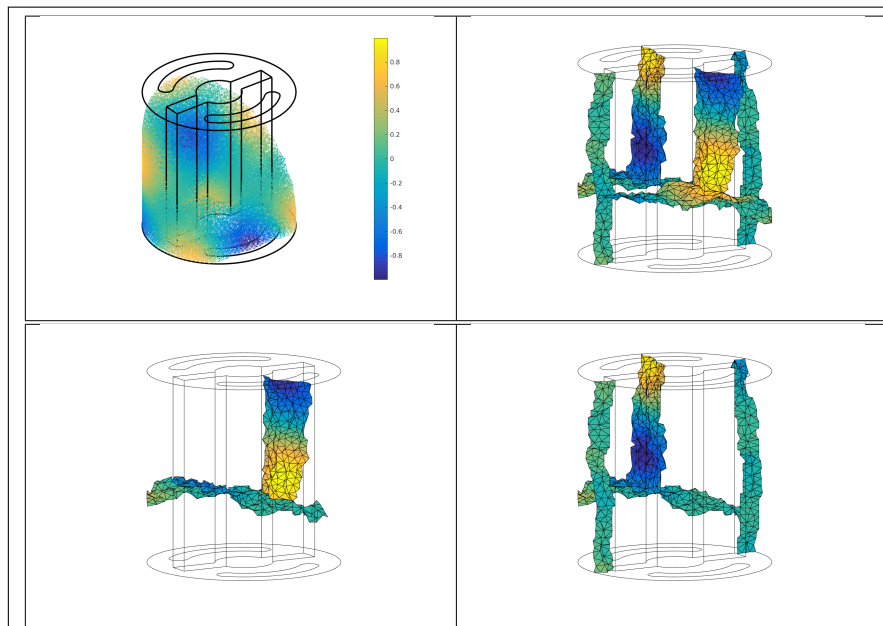
```

Listing 17: 2D partitioned mesh : **plot** function on interfaces

2.4.2 3D example

The following example use the *.geo* file `cylinderkey03.geo` which is in the directory `geodir` of the toolbox. This file contains description of a 3D mesh with simplices of dimensions 1, 2 and 3.





```

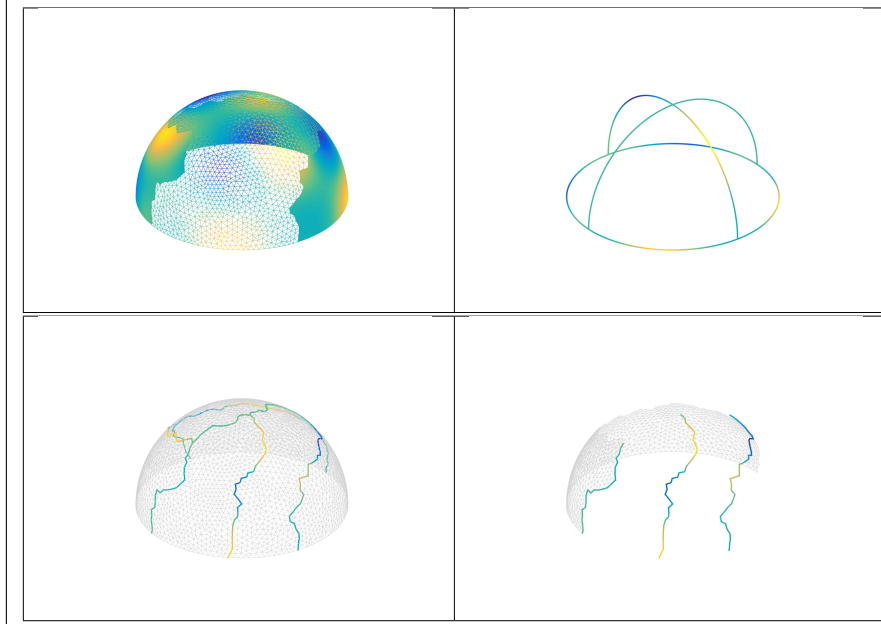
geofile='cylinderkey03';
pTh=fc_psimesh.build_psimesh(geofile,'N',ns*8,'np',6,...
    'geodir','geodir3d','d',3,'verbose',2);
u=@(x,y,z) cos(3*x).*sin(2*y).*cos(pi*z);
U=pTh.eval(u);
P=fc_tools.graphics.PlaneCoefs([0 0 1],[0 -1 1]);
figure(1)
pTh.plot(U,'cutPlan',P)
axis off;hold on
pTh.plotmesh('d',1,'color','black','Linewidth',2)
axis image;colorbar
figure(2)
pTh.plotmesh('d',1,'color','black')
axis off;axis image;hold on
pTh.plot(U,'interfaces')
view(-30,11)
figure(3)
pTh.plotmesh('d',1,'color','black')
axis off;axis image;hold on
pTh.plot(U,'interfaces','ij',[1,2;1,3;5,6])
view(-30,11)
figure(4)
pTh.plotmesh('d',1,'color','black')
axis off;axis image;hold on
pTh.plot(U,'interfaces','parts',1:3)
view(-30,11)

```

Listing 19: 3D partitioned mesh : **plot** function (more)

2.4.3 3D surface example

The following example use the `.geo` file `demisphere5.geo` which is in the directory `geodir` of the toolbox. This file contains description of a 3D surface mesh with simplices of dimensions 1 and 2.



```
pTh=fc_psimesh.build_psimesh('demisphere4surf','N',ns*10, ...
    'np',6,'d',2);
u=@(x,y,z) cos(5*x).*sin(3*y).*cos(4*z);
U=pTh.eval(u);
figure(1);
pTh.plot(U,'FaceColor','interp','EdgeColor','none', ...
    'parts',1:2:6)
hold on;axis off;axis image
pTh.plot(U,'FaceColor','none','EdgeColor','interp', ...
    'parts',2:2:6)
figure(2);
pTh.plot(U,'d',1,'LineWidth',2,'labels',1:8)
hold on;axis off;axis image
figure(3);
pTh.plotmesh('FaceColor','none','Edgecolor','LightGrey')
hold on;axis off;axis image
pTh.plot(U,'interfaces','LineWidth',2)
figure(4);
pTh.plotmesh('parts',[1,3],'FaceColor','none', ...
    'Edgecolor','LightGrey')
hold on;axis off;axis image
pTh.plot(U,'interfaces','ij',[4,1;4,6;5,6],'LineWidth',2)
```

Listing 20: 3D partitioned surface mesh : `plot` function

2.4.4 function PLOTISO

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

Syntaxe

```
pTh.plotiso(u)
pTh.plotiso(u,Name,Value, ...)
```

Description

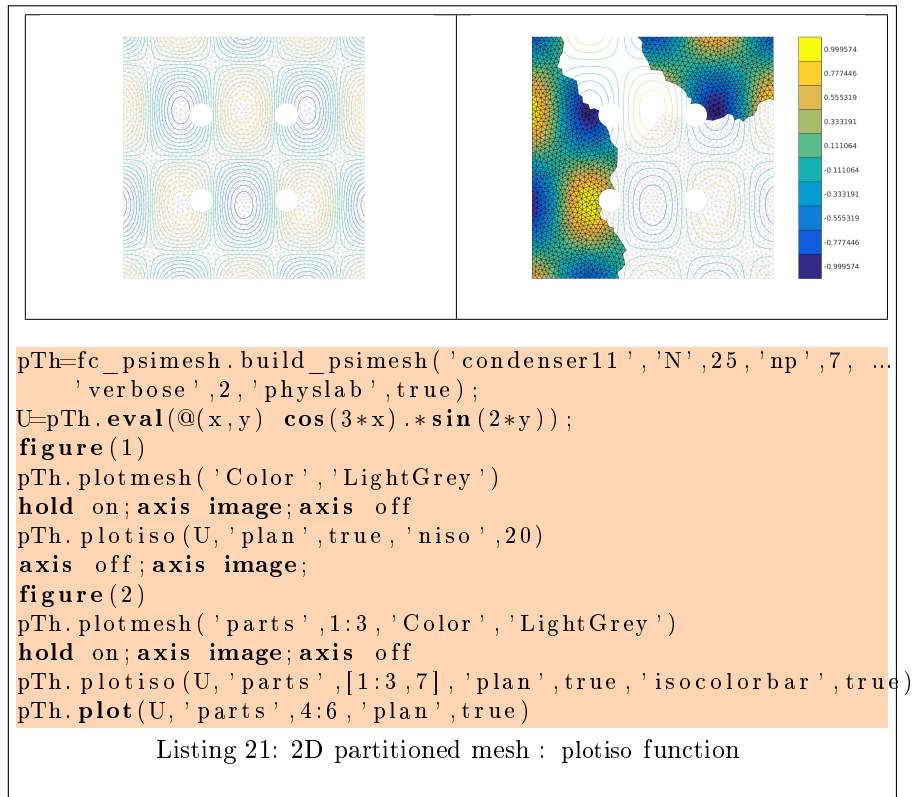
See method `plotiso` of `siMesh` class for description (see ??).

A supplementary Name,Value pair was added :

- **'parts'** : to select the labels of the partitions on which to display isolines.

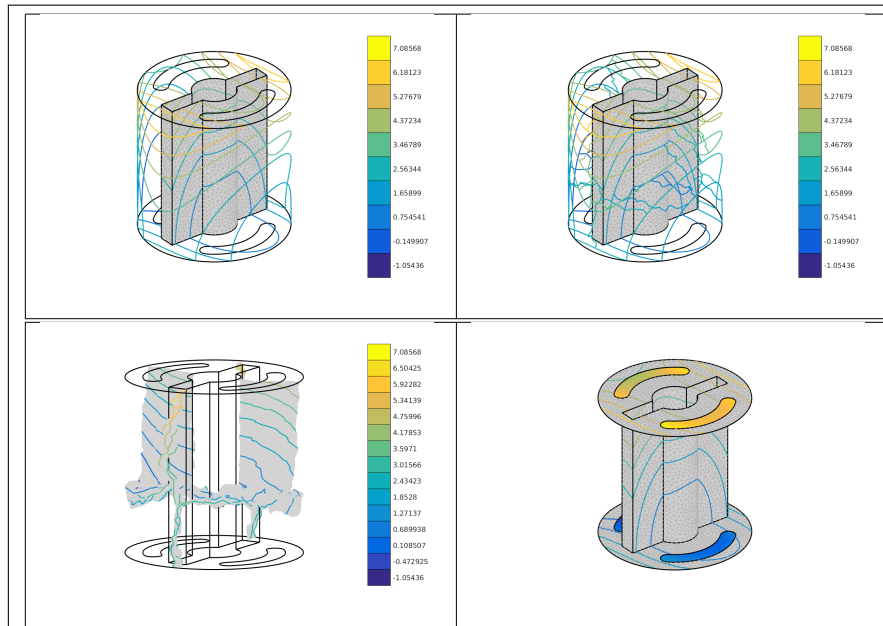
2.4.5 2D example

The following example use the `.geo` file `condenser11.geo` which is in the directory `geodir` of the toolbox.



2.4.6 3D example

The following example use the *.geo* file `cylinderkey03.geo` which is in the directory `geodir` of the toolbox. This file contains description of a 3D mesh with simplices of dimensions 1, 2 and 3.



```

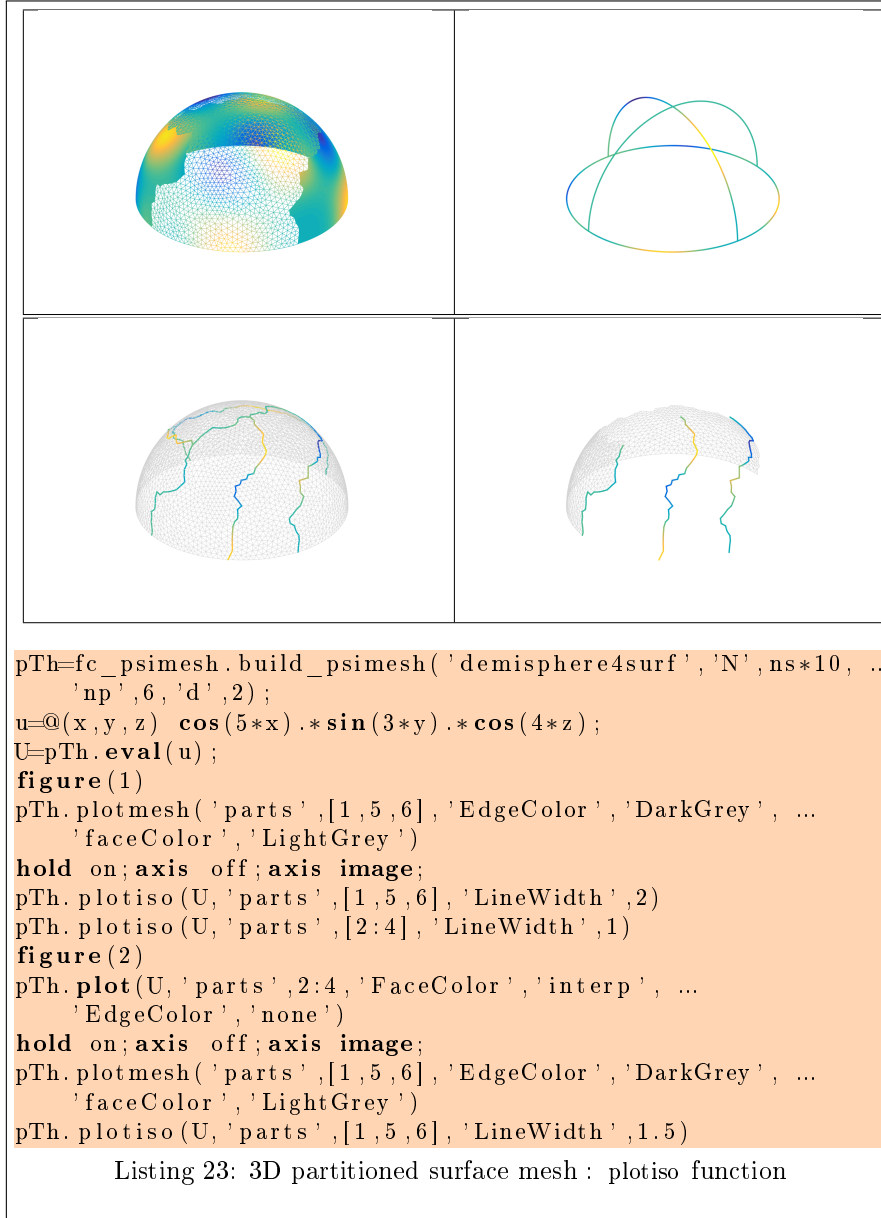
pTh=fc_psimesh.build_psimesh('cylinderkey03','N',ns*8, ...
    'np',6,'geodir',geodir3d,'d',3,'verbose',2);
U=pTh.eval(@(x,y,z) 3*x.^2-y.^3+z.^2+x.*y);
figure(1)
pTh.plotmesh('d',2,'EdgeColor','DarkGrey', ...
    'faceColor','LightGrey','labels',[10,11,31])
hold on;axis image;axis off
pTh.plotmesh('d',1,'Color','black','LineWidth',1.5);
pTh.plotiso(U,'isocolorbar',true,'LineWidth',1.5)
figure(2)
pTh.plotmesh('d',2,'EdgeColor','DarkGrey', ...
    'faceColor','LightGrey','labels',[10,11,31])
hold on;
pTh.plotmesh('d',1,'Color','black','LineWidth',1.5);
pTh.plotiso(U,'interfaces',true,'isocolorbar',true, ...
    'LineWidth',1.5)
axis image;axis off
figure(3)
pTh.plotmesh('interfaces','EdgeColor','none', ...
    'faceColor','LightGrey')
hold on;axis image;axis off
pTh.plotmesh('d',1,'Color','black','LineWidth',1.5);
pTh.plotiso(U,'interfaces',true,'physicals',false, ...
    'niso',15,'isocolorbar',true,'LineWidth',1.5)
view(-58,11)
figure(4)
pTh.plotmesh('d',2,'EdgeColor','DarkGrey', ...
    'faceColor','LightGrey','labels',[10,11,31,1000,2000])
hold on;axis image;axis off
pTh.plotmesh('d',1,'Color','black','LineWidth',1.5);
pTh.plotiso(U,'labels',[10,11,31,1000,2000],'LineWidth',1.5)
pTh.plot(U,'d',2,'labels',[1020,1021,2020,2021], ...
    'LineWidth',1.5,'Edgecolor','none','FaceColor','interp')

```

Listing 22: 3D partitioned mesh : plotiso function

2.4.7 3D surface example

The following example use the *.geo* file `demisphere5.geo` which is in the directory `geodir` of the toolbox. This file contains description of a 3D surface mesh with simplices of dimensions 1 and 2.



2.4.8 function SLICEMESH

The method `slicemesh` displays intersection of a plane and a 3D partitioned mesh defined by an `psiMesh` object.

Syntaxe

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

Description

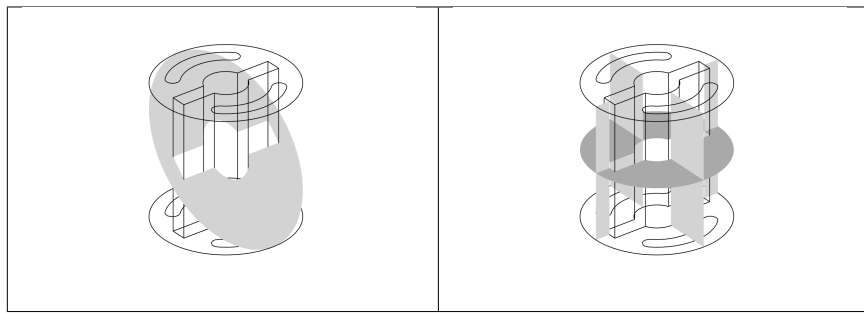
See method `slicemesh` of `siMesh` class for description (see ??).

A supplementary Name,Value pair was added :

- **'parts'** : to select the labels of the partitions on which to display the slice.

2.4.9 3D example

The following example use the `.geo` file `cylinderkey03.geo` which is in the directory `geodir/3d` of the toolbox. This file contains description of a 3D mesh with simplices of dimensions 1, 2 and 3.



```
geofile='cylinderkey03';
pTh=fc_psimesh.build_psimesh(geofile,'N',ns*8,'np',6,...
    'geodir',geodir3d,'d',3,'verbose',2);
U=pTh.eval(@(x,y,z) 3*x.^2-y.^3+z.^2+x.*y);
figure(1)
pTh.plotmesh('d',1,'LineWidth',1,'color','k')
hold on
P=fc_tools.graphics.PlaneCoefs([0 0 1],[0 -1 1]);
pTh.slicemesh(P,'Color','LightGrey')
axis off;axis image;

figure(2)
pTh.plotmesh('d',1,'LineWidth',1,'color','k')
hold on
P=fc_tools.graphics.PlaneCoefs([0 0 1],[-1 0 0]);
pTh.slicemesh(P,'Color','LightGrey')
P=fc_tools.graphics.PlaneCoefs([0 0 1],[0 -1 0]);
pTh.slicemesh(P,'Color','LightGrey')
P=fc_tools.graphics.PlaneCoefs([0 0 1],[0 0 -1]);
pTh.slicemesh(P,'Color','DarkGrey')
axis off;axis image;
```

Listing 24: function `lstinlineslicemesh` for a 3D partitioned mesh

2.4.10 function SLICE

The method `slice` displays datas on the intersection of a plane and a 3D partitioned mesh defined by an `psiMesh` object.

Syntaxe

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

Description

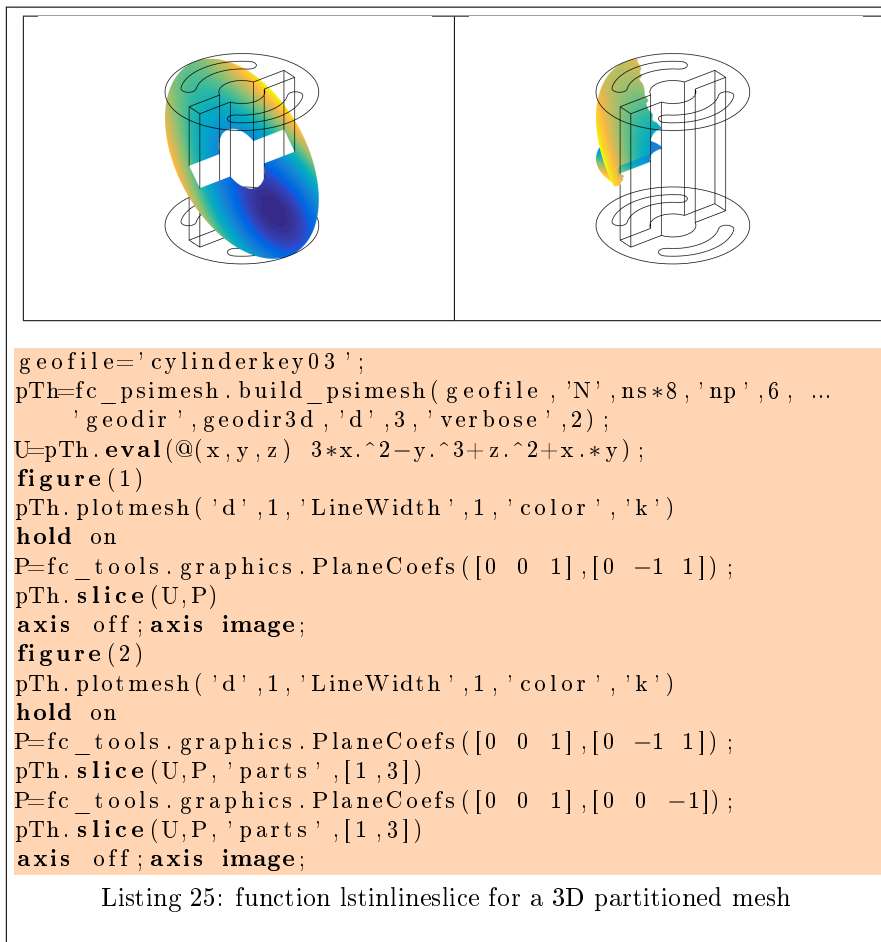
See method `slice` of `siMesh` class for description (see ??).

A supplementary Name,Value pair was added :

- `'parts'` : to select the labels of the partitions on which to display the slice.

2.4.11 3D example

The following example use the `.geo` file `cylinderkey03.geo` which is in the directory `geodir/3d` of the toolbox. This file contains description of a 3D mesh with simplices of dimensions 1, 2 and 3.



2.4.12 function SLICEISO

The method `sliceiso` displays datas as isolines on the intersection of a plane and a 3D partitioned mesh defined by an `psiMesh` object.

Syntaxe

```

Th.isoslice(u,P)
Th.isoslice(u,P,Name,Value,...)

```

Description

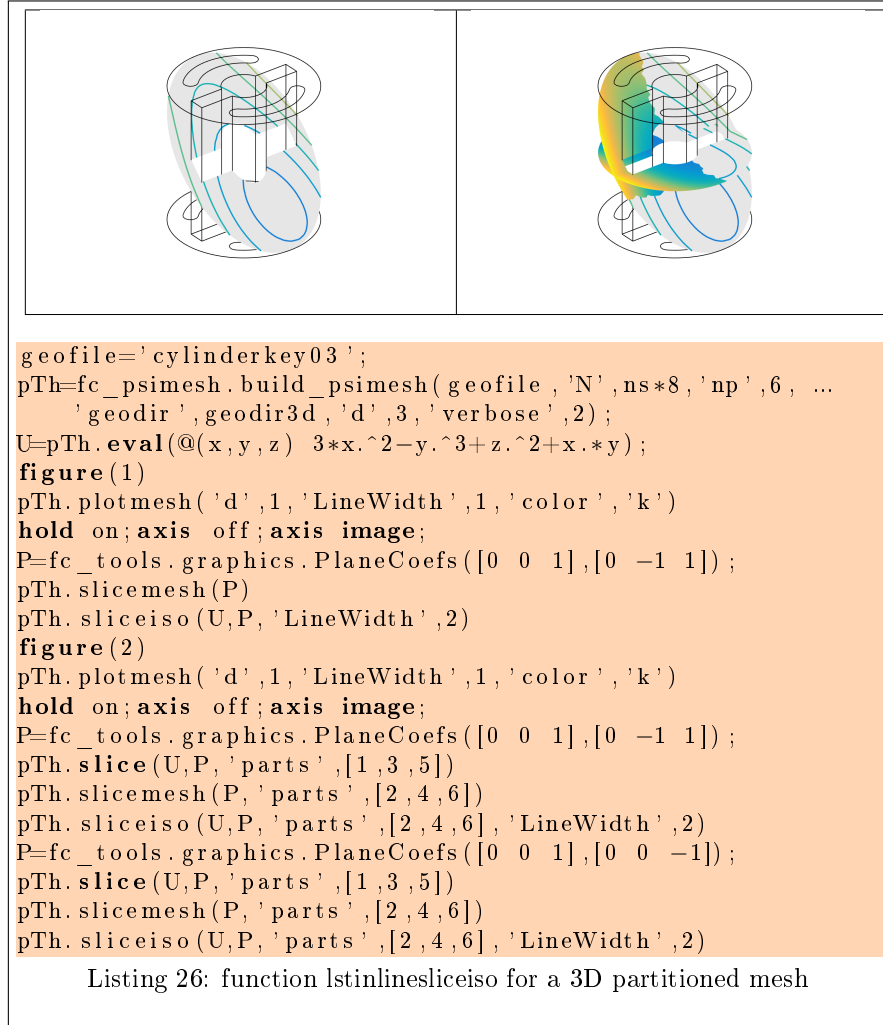
See method `sliceiso` of `siMesh` class for description (see ??).

A supplementary Name,Value pair was added :

- **'parts'** : to select the labels of the partitions on which to display the slice.

2.4.13 3D example

The following example use the *.geo* file *cylinderkey03.geo* which is in the directory *geodir/3d* of the toolbox. This file contains description of a 3D mesh with simplices of dimensions 1, 2 and 3.



2.4.14 function PLOTVECTORFIELD

The method *plotVectorField* displays vector field datas on the mesh or parts of the partitioned mesh defined by an *psiMesh* object.

Syntaxe

```

pTh.plotVectorField(V)
pTh.plotVectorField(V,Name,Value,...)

```

Description

`pTh.plotVectorField(V)` displays the vector field V on the mesh. The vector field V could be :

- a `pTh.nq-by-pTh.dim` array.
- a `pTh.np-by-1` cells array where the i -th cell is an `pTh.Th{i}.nq-by-pTh.dim` array.

See method `plotVectorField` of `siMesh` class for description (see ??).

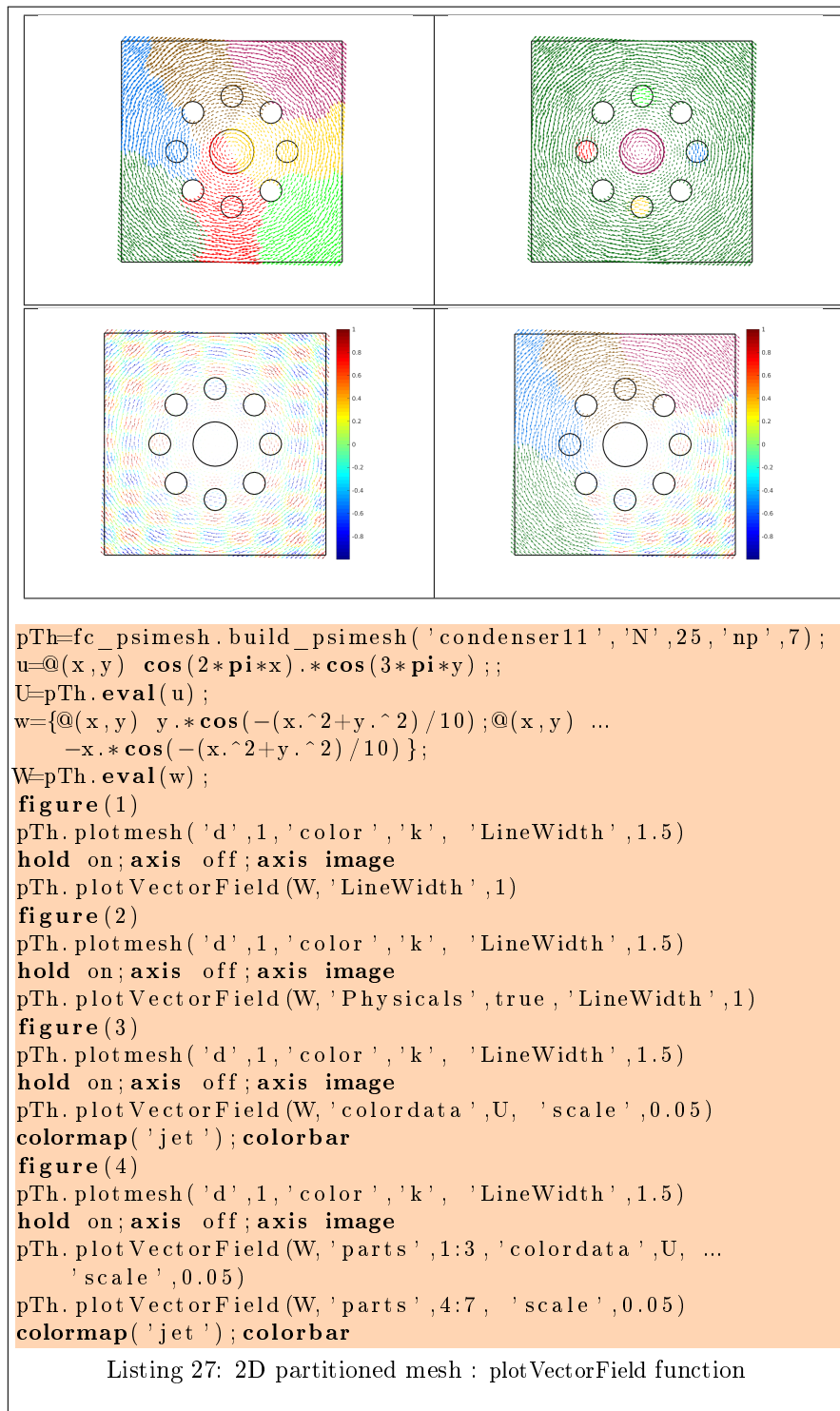
A supplementary Name,Value pair was added :

- `'parts'` : to select the labels of the partitions on which to display isolines.
- `'physicals'` : if set to true, the vector field is colored with the colors of the physical meshes. Default is false and the vector field is colored with the colors of the partition meshes.

The `'colordata'` option accept also, as value, a cell array of size `pTh.np`.

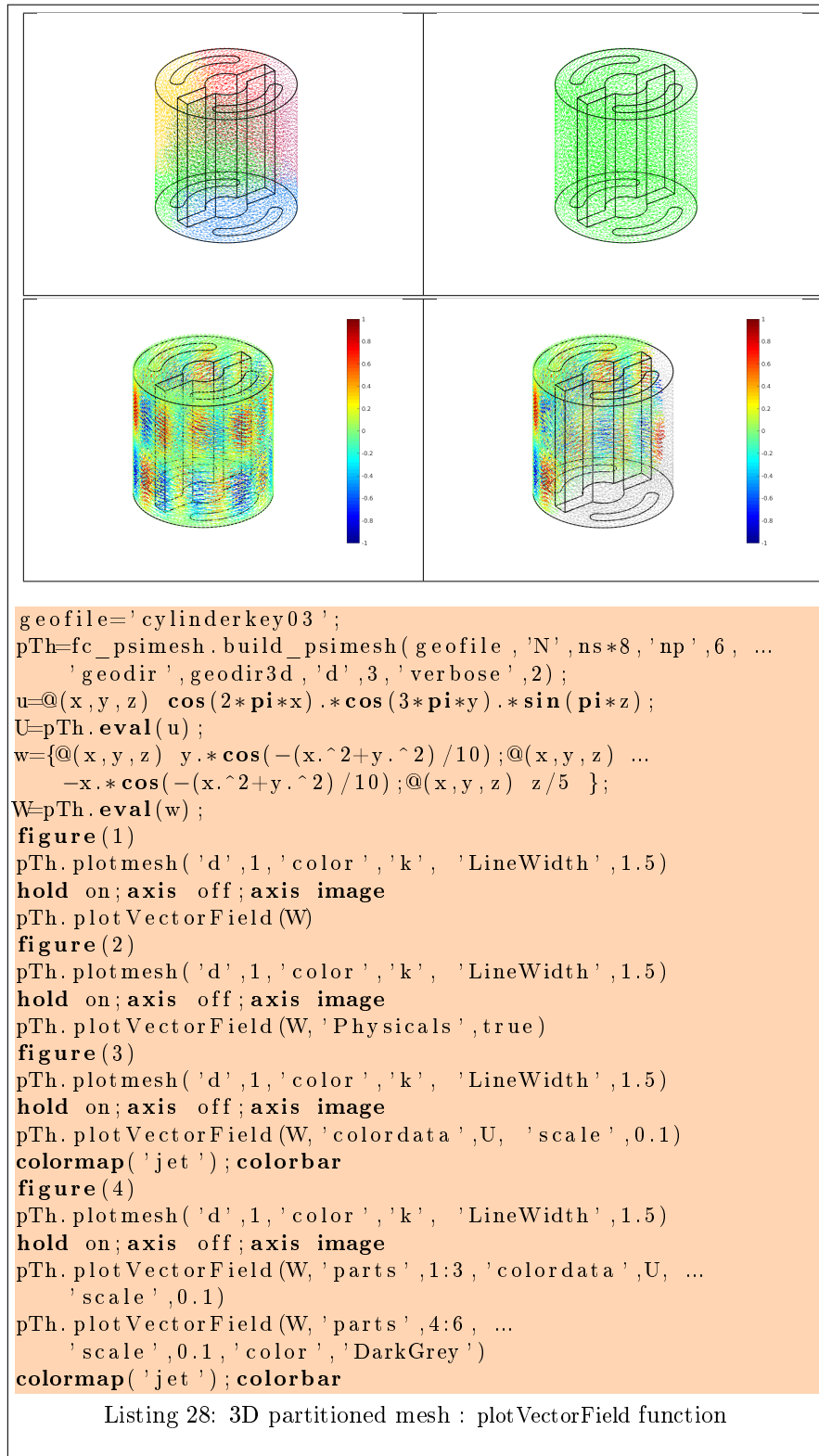
2.4.15 2D example

The following example use the `.geo` file `condenser11.geo` which is in the directory `geodir` of the toolbox.



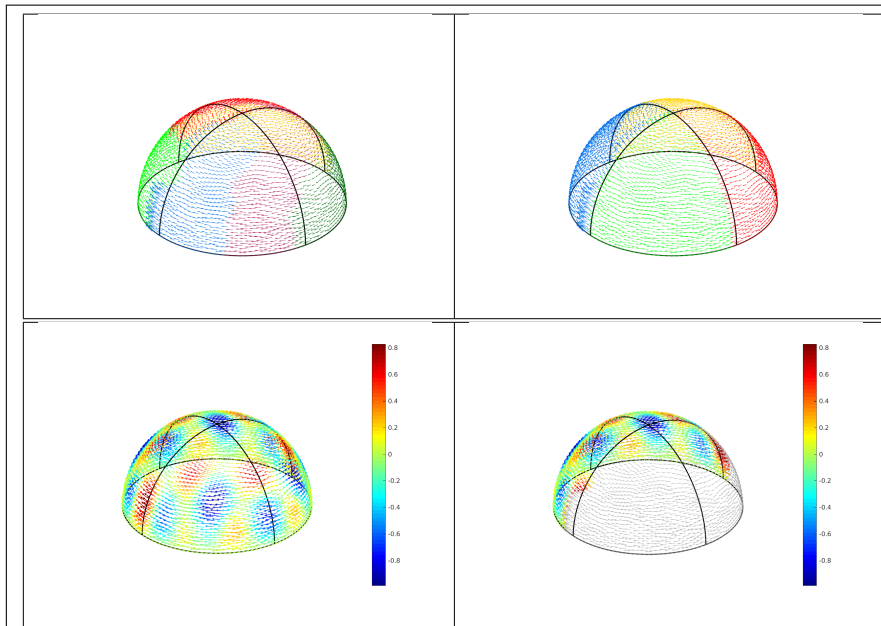
2.4.16 3D example

The following example use the *.geo* file `cylinderkey03.geo` which is in the directory `geodir` of the toolbox. This file contains description of a 3D mesh with simplices of dimensions 1, 2 and 3.



2.4.17 3D surface example

The following example use the *.geo* file `demisphere4surf.geo` which is in the directory `geodir` of the toolbox. This file contains description of a 3D surface mesh with simplices of dimensions 1 and 2.



```

pTh=fc_psimesh.build_psimesh('demisphere4surf','N',ns*10, ...
    'np',6,'d',2);
u=@(x,y,z) cos(2*pi*x).*cos(3*pi*y).*sin(pi*z);
U=pTh.eval(u);
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=pTh.eval(w);
figure(1)
pTh.plotmesh('d',1,'color','k','LineWidth',1.5)
hold on;axis off;axis image
pTh.plotVectorField(W)
figure(2)
pTh.plotmesh('d',1,'color','k','LineWidth',1.5)
hold on;axis off;axis image
pTh.plotVectorField(W,'Physicals',true)
figure(3)
pTh.plotmesh('d',1,'color','k','LineWidth',1.5)
hold on;axis off;axis image
pTh.plotVectorField(W,'colordata',U,'scale',0.1)
colormap('jet');colorbar
figure(4)
pTh.plotmesh('d',1,'color','k','LineWidth',1.5)
hold on;axis off;axis image
pTh.plotVectorField(W,'parts',1:3,'colordata',U, ...
    'scale',0.1)
pTh.plotVectorField(W,'parts',4:6, ...
    'scale',0.1,'color','DarkGrey')
colormap('jet');colorbar

```

Listing 29: 3D partitioned surface mesh : plotVectorField function