



# Documentation of the FC-OOGMSH Octave package version 0.0.16\*

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## Abstract

This experimental Octave package make it possible to generate mesh files from *.geo* files by using `gmsh`. It's also possible with the `ooGMSH` class to read the mesh file and to store its contains in more user-friendly form. This toolbox must be regarded as a very simple interface between `gmsh` files and Octave . So you are free to create any data structures or objects you want from an `ooGMSH` object.

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\*Compiled with Octave 4.2.1

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## 1 Introduction

The FC-OOGMSH Octave package is closely related to `gmsh`, see [2] or [1], which is a three-dimensional finite element mesh generator with built-in pre- and post-processing facilities. `gmsh` can also build two-dimensional meshes and three-dimensional surface meshes. This package was initially created to make it possible from Octave to rapidly

- generate mesh file from `.geo` file by using `gmsh`
- efficiently read this mesh file and store its contents in `ooGMSH` Octave object easy to manipulate.

The `ooGMSH` Octave object can be used to create, from a `.msh` file, any data structures or objects needed by your project. For example, the `fc-simesh` Octave package uses this package to create the `siMESH` object containing all the simplices elements of the mesh.

### remark 1.1

Under Windows 7 the 32bit version of `gmsh` seems to be needed : the system function of Octave does not support 64bit applications?

This package was tested under

OS	Octave	gmsh
Ubuntu 17.10	4.2.0 and 4.2.1	2.x.0, with $x$ in 12,13,15,16 3.0.x, with $x$ from 0 to 6
macOS Sierra 10.12.6	4.2.1	2.x.0, with $x$ in 13,14,15,16 3.0.x, with $x$ from 0 to 5
Windows 10.0.15063	4.2.0 and 4.2.1	2.x.0, with $x$ in 12,13,14,16 3.0.x,with $x$ from 0 to 5

Firstly, we explain how to configure the FC-OOGMSH packagefor using `gmsh`. Thereafter, we describe the FC-OOGMSH's functions which use `gmsh` to create mesh files.

## 2 Installation

### 2.1 Installation automatic, all in one (recommanded)

For this method, one just have to get/download the install file

```
ofc_oogmsh_install.m
```

or get it on the dedicated web page. Thereafter, one run it under Octave. This command download, extract and configure the *fc-oogmsh* package and the required *fc-tools* package in the current directory.

By default, the gsmsh binary is supposed to be located in

- <USERDIR>/bin/gsmsh under linux,
- <USERDIR>/GMSH/Gmsh.app/Contents/MacOS/gsmsh under Mac OS X,
- <USERDIR>/Softwares/GMSH/gsmsh.exe (32 bit version) under Windows

It can be directly given by using the 'gsmsh\_bin' option of the install command:

```
ofc_oogmsh_install('gsmsh_bin', '<GMSH>')
```

where <GMSH> is the gsmsh binary with path.

It's also possible, after installation, to change the gsmsh binary by using

```
fc_oogmsh.configure('gsmsh_bin', '<GMSH>')
```

command under Octave.

For example, to install this package in ~/Octave/packages directory, one have to copy the file ofc\_oogmsh\_install.m in the ~/Octave/packages directory. Then in a Octave terminal run the following commands

```
>> cd ~/Octave/packages
>> ofc_oogmsh_install
```

There is the output of the ofc\_oogmsh\_install command:

```
Parts of the GNU Octave <fc-oogmsh> package.
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1- Downloading and extracting the packages
  -> <fc-tools>[0.0.18] ... OK
  -> <fc-oogmsh>[0.0.16] ... OK
2- Setting the <fc-oogmsh> package
   run fc_oogmsh.configure('gsmsh_bin', '<PATH>/gsmsh') to change
  -> Using GMSH binary : /home/cuvelier/bin/gsmsh
Write in ~/Octave/packages/fc-oogmsh-full/fc_oogmsh-0.0.16/configure_loc.
m ...
  -> done
3- Using the <fc-oogmsh> package
   Under Octave:
     addpath('~/Octave/packages/./fc-oogmsh-full/fc_oogmsh-0.0.16')
     fc_oogmsh.init()

See ~/Octave/packages/ofc_oogmsh_set.m
```

The complete toolbox (i.e. with all the other needed packages) is stored in the directory ~/Octave/packages/fc-oogmsh-full and, for each Octave session, one have to set the package by:

```
>> addpath('~/Octave/packages/fc-oogmsh-full/fc_oogmsh-0.0.16')
>> fc_oogmsh.init()
```

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

```
~/Octave/packages/fc-oogmsh-full
```

## 3 gmsh interface

All the functions provided in this section use `gmsh` to create a mesh file from a `gmsh` geometry script file (extension `.geo`).

### 3.1 function `gmsh.buildmesh2d`

This function uses `gmsh` and a `.geo` file (describing a 2D-geometry) to generate a 2D-mesh.

#### Syntaxe

```
meshfile=gmsh.buildmesh2d(geofile,N)
meshfile=gmsh.buildmesh2d(geofile,N,Name,Value)
```

#### Description

`meshfile=gmsh.buildmesh2d(geofile,N)` create a 2D-mesh using `gmsh` and the `geo` file `geofile` (without path). The integer `N` has two functions : numbering the name of the generated mesh as `<geofile without extension and path> + <-N.msh>` and passing this number to `gmsh` via the option `"-setnumber N <N>"`. Usually we used this parameter in `gmsh` to set the prescribed mesh element size at the points. (see given `geo` files)  
As output return a file name (with full path) corresponding to the mesh generated by `gmsh`.

`meshfile=gmsh.buildmesh2d(geofile,N,Name,Value, ...)` specifies function options using one or more `Name,Value` pair arguments. The `Name` options can be

- `'geodir'` : to specify the directory of the `geo` file `geofile`,
- `'meshdir'` : to specify the directory where the mesh file will be written,
- `'meshfile'` : to specify the name of the mesh file (with path and `.msh` extension),
- `'check'` : to perform various consistency checks on mesh with `gmsh`, if `Value` is true. (default : false)
- `'force'` : to force meshing even if the mesh file already exists if `Value` is true (default : false)
- `'verbose'` : to specify the degree of verbosity ( 0, silence; 2, default; ...)
- `'strings'` : cells array of strings corresponding to `gmsh` options given with `-string "..."` (default empty) (see `gmsh` documentation)

**Examples** All the following examples use the *.geo* file `condenser11.geo` which is in the directory `geodir` of the toolbox.

#### Matlab commands with output

```
disp('****_gmsm.buildmesh2d_:1st_call')  
meshfile=gmsm.buildmesh2d('condenser11',25,'force',true);  
disp('****_gmsm.buildmesh2d_:2nd_call')  
meshfile=gmsm.buildmesh2d('condenser11',25);
```

```
**** gmsm.buildmesh2d : 1st call  
[fc-oogmsm] Input file : <fc-oogmsm>/geodir/2d/condenser11.geo  
[fc-oogmsm] Starting building mesh /tmp/tmp.AQq7Ww94D9/fc-oogmsm-full/fc_oogmsm-0.0.16/meshes/condenser11-25.msh with ...  
gmsm 3.0.6  
[fc-oogmsm] Using command : gmsm -2 -setnumber N 25 <fc-oogmsm>/geodir/2d/condenser11.geo -o ...  
/tmp/tmp.AQq7Ww94D9/fc-oogmsm-full/fc_oogmsm-0.0.16/meshes/condenser11-25.msh  
Be patient...  
**** gmsm.buildmesh2d : 2nd call  
[fc-oogmsm] Input file : <fc-oogmsm>/geodir/2d/condenser11.geo  
[fc-oogmsm] Mesh file /tmp/tmp.AQq7Ww94D9/fc-oogmsm-full/fc_oogmsm-0.0.16/meshes/condenser11-25.msh already exists.  
-> Use "force" flag to rebuild if needed.
```

## Matlab commands with output

```
meshfile=gmsH. buildmesh2d('condenser11',25,'force',true, ...  
    'verbose',4, 'strings',{ 'Mesh.Algorithm=1;', ...  
    'Mesh.ScalingFactor=2;'});
```

```
[fc-oogmsH] Input file : <fc-oogmsH>/geodir/2d/condenser11.geo  
[fc-oogmsH] Overwriting mesh file /tmp/tmp.AQq7Ww94D9/fc-oogmsH-full/fc_oogmsH-0.0.16/meshes/condenser11-25.msh  
[fc-oogmsH] Starting building mesh /tmp/tmp.AQq7Ww94D9/fc-oogmsH-full/fc_oogmsH-0.0.16/meshes/condenser11-25.msh with ...  
    gmsH 3.0.6  
[fc-oogmsH] Using command : gmsH -2 -setnumber N 25 -string "Mesh.Algorithm=1;Mesh.ScalingFactor=2;" ...  
    <fc-oogmsH>/geodir/2d/condenser11.geo -o ...  
    /tmp/tmp.AQq7Ww94D9/fc-oogmsH-full/fc_oogmsH-0.0.16/meshes/condenser11-25.msh  
Be patient ...  
[fc-oogmsH] gmsH output :  
Info : Running '/home/cuvellier/bin/gmsH -2 -setnumber N 25 -string Mesh.Algorithm=1;Mesh.ScalingFactor=2; ...  
    <fc-oogmsH>/geodir/2d/condenser11.geo -o ...  
    /tmp/tmp.AQq7Ww94D9/fc-oogmsH-full/fc_oogmsH-0.0.16/meshes/condenser11-25.msh' [GmsH 3.0.6, 1 node, max. 1 thread]  
Info : Started on Wed Nov 22 15:39:01 2017  
Info : Reading '<fc-oogmsH>/geodir/2d/condenser11.geo' ...  
Info : Reading '<fc-oogmsH>/geodir/2d/options01_data.geo' ...  
Info : Done reading '<fc-oogmsH>/geodir/2d/options01_data.geo'  
Info : Reading '<fc-oogmsH>/geodir/2d/shape_functions.geo' ...  
Info : Done reading '<fc-oogmsH>/geodir/2d/shape_functions.geo'  
Info : Removing duplicate mesh vertices ...  
Info : Found 0 duplicate vertices  
Info : No duplicate vertices found  
Info : Done reading '<fc-oogmsH>/geodir/2d/condenser11.geo'  
Info : Finalized high order topology of periodic connections  
Info : Meshing 1D ...  
Info : Meshing curve 101 (Line)  
Info : Meshing curve 102 (Line)  
Info : Meshing curve 103 (Line)  
Info : Meshing curve 104 (Line)  
Info : Meshing curve 106 (Circle)  
Info : Meshing curve 107 (Circle)  
Info : Meshing curve 108 (Circle)  
Info : Meshing curve 109 (Circle)  
Info : Meshing curve 111 (Circle)  
Info : Meshing curve 112 (Circle)  
Info : Meshing curve 113 (Circle)  
Info : Meshing curve 114 (Circle)  
Info : Meshing curve 116 (Circle)  
Info : Meshing curve 117 (Circle)  
Info : Meshing curve 118 (Circle)  
Info : Meshing curve 119 (Circle)  
Info : Meshing curve 121 (Circle)  
Info : Meshing curve 122 (Circle)  
Info : Meshing curve 123 (Circle)  
Info : Meshing curve 124 (Circle)  
Info : Meshing curve 126 (Circle)  
Info : Meshing curve 127 (Circle)  
Info : Meshing curve 128 (Circle)  
Info : Meshing curve 129 (Circle)  
Info : Meshing curve 131 (Circle)  
Info : Meshing curve 132 (Circle)  
Info : Meshing curve 133 (Circle)  
Info : Meshing curve 134 (Circle)  
Info : Meshing curve 136 (Circle)  
Info : Meshing curve 137 (Circle)  
Info : Meshing curve 138 (Circle)  
Info : Meshing curve 139 (Circle)  
Info : Meshing curve 141 (Circle)  
Info : Meshing curve 142 (Circle)  
Info : Meshing curve 143 (Circle)  
Info : Meshing curve 144 (Circle)  
Info : Meshing curve 146 (Circle)  
Info : Meshing curve 147 (Circle)  
Info : Meshing curve 148 (Circle)  
Info : Meshing curve 149 (Circle)  
Info : Done meshing 1D (0.007997 s)  
Info : Meshing 2D ...  
Info : Meshing surface 105 (Plane, MeshAdapt)  
Info : Meshing surface 110 (Plane, MeshAdapt)  
Info : Meshing surface 120 (Plane, MeshAdapt)  
Info : Meshing surface 130 (Plane, MeshAdapt)  
Info : Meshing surface 140 (Plane, MeshAdapt)  
Info : Meshing surface 150 (Plane, MeshAdapt)  
Info : Done meshing 2D (0.277016 s)  
Info : 3538 vertices 7209 elements  
Info : Writing '/tmp/tmp.AQq7Ww94D9/fc-oogmsH-full/fc_oogmsH-0.0.16/meshes/condenser11-25.msh' ...  
Info : Done writing '/tmp/tmp.AQq7Ww94D9/fc-oogmsH-full/fc_oogmsH-0.0.16/meshes/condenser11-25.msh'  
Info : Stopped on Wed Nov 22 15:39:02 2017
```

### 3.2 function `gmsh.buildmesh3d`

This function uses `gmsh` and a `.geo` file (describing a 3D-geometry) to generate a 3D-mesh. See function `gmsh.buildmesh2d` for usage and options.

### 3.3 function `gmsh.buildmesh3ds`

This function uses `gmsh` and a `.geo` file (describing a 3D surface geometry or a 3D-geometry) to generate a 3D surface mesh. See function `gmsh.buildmesh2d` for usage and options.

### 3.4 function `gmsh.buildpartmesh2d`

This function uses `gmsh` and a `.msh` file (containing of a 2D-mesh) to generate a 2D partitioned mesh.

#### Syntaxe

```
partmeshfile=gmsh.buildpartmesh2d(meshfile,np)
partmeshfile=gmsh.buildpartmesh2d(meshfile,np,Name,Value)
```

#### Description

`partmeshfile=gmsh.buildpartmesh2d(meshfile,np)` create a 2D partitioned mesh using `gmsh` and the `.msh` file `meshfile` (with path). The integer `np` is the number of partitions.

As output return a file name (with full path) corresponding to the partitioned mesh generated by `gmsh`. The output file name is construct as following : `<meshfile without extension>-part<np>.msh`

`partmeshfile=gmsh.buildpartmesh2d(meshfile,np,Name,Value, ...)` specifies function options using one or more `Name,Value` pair arguments. The `Name` options can be

- `'savedir'` : to specify the directory where the partitioned mesh file will be written,
- `'check'` : to perform various consistency checks on mesh with `gmsh`, if `Value` is true. (default : false)
- `'force'` : to force meshing even if the mesh file already exists if `Value` is true (default : false)
- `'verbose'` : to specify the degree of verbosity ( 0, silence; 2, default; ...)
- `'strings'` : cells array of strings corresponding to `gmsh` options given with `-string "..."` (default empty) (see `gmsh` documentation)

**Examples** All the following examples use the `meshfile` as output of the command :

```
meshfile=gmsb.buildmesh2d('condenser11',25);
```

#### Matlab commands with output

```
meshfile=gmsb.buildmesh2d('condenser11',25,'verbose',0);
pmlile=gmsb.buildpartmesh2d(meshfile,5,'force',true);
```

```
[fc-oogmsb] Input file : /tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25.msh
[fc-oogmsb] Overwriting mesh file /tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25-part5.msh ...
with gmsb 3.0.6
[fc-oogmsb] Using command : gmsb -2 -saveall -part 5 ...
/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25.msh -o ...
/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25-part5.msh
Be patient...
```

#### Matlab commands with output

```
meshfile=gmsb.buildmesh2d('condenser11',25,'verbose',0);
pmlile=gmsb.buildpartmesh2d(meshfile,5,'force',true, ...
'verbose',4,'strings',{'Mesh.Partitioner=2;', ...
'Mesh.MetisAlgorithm=3;'});
```

```
[fc-oogmsb] Input file : /tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25.msh
[fc-oogmsb] Overwriting mesh file /tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25-part5.msh
[fc-oogmsb] Starting building mesh /tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25-part5.msh ...
with gmsb 3.0.6
[fc-oogmsb] Using command : gmsb -2 -saveall -part 5 -string "Mesh.Partitioner=2;Mesh.MetisAlgorithm=3;" ...
/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25.msh -o ...
/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25-part5.msh
Be patient...
[fc-oogmsb] gmsb output :
Info : Running '/home/cuvellier/bin/gmsb -2 -saveall -part 5 -string Mesh.Partitioner=2;Mesh.MetisAlgorithm=3; ...
/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25.msh -o ...
/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25-part5.msh' [Gmsb 3.0.6, 1 node, max. ...
1 thread]
Info : Started on Wed Nov 22 15:39:24 2017
Info : Reading '/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25.msh'...
Info : 3529 vertices
Info : 7160 elements
Info : Done reading '/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25.msh'
Info : Finalized high order topology of periodic connections
Info : Meshing 1D...
Info : Done meshing 1D (1.1e-05 s)
Info : Meshing 2D...
Info : Done meshing 2D (3.7e-05 s)
Info : 3529 vertices 7160 elements
Info : Building graph...
Info : Partitioning graph...
Info : Launching METIS graph partitioner
METIS with weights
Info : Number of Edges Cut : 137
Info : Done partitioning graph
Info : Writing '/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25-part5.msh'...
Info : Done writing '/tmp/tmp.AQq7Ww94D9/fc-oogmsb-full/fc_oogmsb-0.0.16/meshes/condenser11-25-part5.msh'
Info : Stopped on Wed Nov 22 15:39:24 2017
```

### 3.5

#### function gmsb.buildpartmesh3d

This function uses `gmsb` and a `.msh` file (containing of a 3D-mesh) to generate a 3D partioned mesh.

### 3.6

#### function gmsb.buildpartmesh3ds

This function uses `gmsb` and a `.msh` file (containing of a 3D surface mesh) to generate a 3D partioned surface mesh.



This function uses `gmsh` and the `geodir/rectanglepart.geo` file to generate a 2D regular partitioned mesh of the rectangle  $[0, Lx] \times [0, Ly]$  with  $Nx \times Ny$  partitions.

### Syntaxe

```
meshfile=gmsh.buildpartrectangle(Lx,Ly,Nx,Ny,N)
meshfile=gmsh.buildpartrectangle(Lx,Ly,Nx,Ny,N, ...
    Name,Value)
```

### Description

`meshfile=gmsh.buildpartrectangle(Lx,Ly,Nx,Ny,N)` create a 2D regular partitioned mesh using `gmsh` of the rectangle  $[0, Lx] \times [0, Ly]$  with  $Nx \times Ny$  partitions. The `N` parameter is passed to `gmsh` to set the prescribed mesh element size at the points

As output return a file name (with full path) corresponding to the partitioned mesh generated by `gmsh`. The default output file name is construct as following : `rectanglepart-Lx%.3f-Ly%.3f-Nx%d-Ny%d-N%d.msh`

`meshfile=gmsh.buildpartrectangle(Lx,Ly,Nx,Ny,N,Name,Value, ...)` specifies function options using one or more `Name,Value` pair arguments. The `Name` options can be

- `'meshdir'` : to specify the directory where the partitioned mesh file will be written,
- `'meshfile'` : to specify the mesh file name with `.msh` extension. Without path, the file is written in `<meshdir>` directory.
- `'check'` : to perform various consistency checks on mesh with `gmsh`, if `Value` is true. (default : false)
- `'force'` : to force meshing even if the mesh file already exists if `Value` is true (default : false)
- `'verbose'` : to specify the degree of verbosity ( 0, silence; 2, default; ...)
- `'strings'` : cells array of strings corresponding to `gmsh` options given with `-string "..."` (default empty) (see `gmsh` documentation)

**Examples** All the following examples ...

#### Matlab commands with output

```
pmfile=gmsh.buildpartrectangle(1,1,3,2,100,'force',true);
```

```
[fc-oogmsh] Input file : <fc-oogmsh>/geodir/2d/rectanglepart.geo
[fc-oogmsh] Starting building mesh ...
/tmp/tmp.AQq7Wv94D9/fc-oogmsh-full/fc_oogmsh-0.0.16/meshes/rectanglepart-Lx1.000-Ly1.000-Nx3-Ny2-N100.msh with ...
gmsh 3.0.6
[fc-oogmsh] Using command : gmsh -2 -setnumber N 100 -setnumber NX 3 -setnumber NY 2 -setnumber LX 1 -setnumber LY 1 ...
<fc-oogmsh>/geodir/2d/rectanglepart.geo -o ...
/tmp/tmp.AQq7Wv94D9/fc-oogmsh-full/fc_oogmsh-0.0.16/meshes/rectanglepart-Lx1.000-Ly1.000-Nx3-Ny2-N100.msh
Be patient...
```

## Matlab commands with output

```
pmfile=gmsH.buildpartrectangle(1,1,3,2,100,'verbose',4,...
    'force',true,'meshfile','./toto.msh');
```

```
[fc-oogmsH] Input file : <fc-oogmsH>/geodir/2d/rectanglepart.geo
[fc-oogmsH] Starting building mesh ./toto.msh with gmsH 3.0.6
[fc-oogmsH] Using command : gmsH -2 -setnumber N 100 -setnumber NX 3 -setnumber NY 2 -setnumber LX 1 -setnumber LY 1 ...
    <fc-oogmsH>/geodir/2d/rectanglepart.geo -o ./toto.msh
Be patient...
[fc-oogmsH] gmsH output :
Info : Running '/home/cuvelier/bin/gmsH -2 -setnumber N 100 -setnumber NX 3 -setnumber NY 2 -setnumber LX 1 ...
    -setnumber LY 1 <fc-oogmsH>/geodir/2d/rectanglepart.geo -o ./toto.msh' [GmsH 3.0.6, 1 node, max. 1 thread]
Info : Started on Wed Nov 22 15:39:47 2017
Info : Reading '<fc-oogmsH>/geodir/2d/rectanglepart.geo'...
Info : Reading '<fc-oogmsH>/geodir/2d/partitions01.data.geo'...
Info : Done reading '<fc-oogmsH>/geodir/2d/partitions01.data.geo'
Info : Reading '<fc-oogmsH>/geodir/2d/partitions_shape.geo'...
Info : Done reading '<fc-oogmsH>/geodir/2d/partitions_shape.geo'
Info : Done reading '<fc-oogmsH>/geodir/2d/rectanglepart.geo'
Info : Finalized high order topology of periodic connections
Info : Meshing 1D...
Info : Meshing curve 1 (Line)
Info : Meshing curve 2 (Line)
Info : Meshing curve 3 (Line)
Info : Meshing curve 4 (Line)
Info : Meshing curve 5 (Line)
Info : Meshing curve 6 (Line)
Info : Meshing curve 7 (Line)
Info : Meshing curve 8 (Line)
Info : Meshing curve 9 (Line)
Info : Meshing curve 10 (Line)
Info : Meshing curve 11 (Line)
Info : Meshing curve 12 (Line)
Info : Meshing curve 13 (Line)
Info : Meshing curve 14 (Line)
Info : Meshing curve 15 (Line)
Info : Meshing curve 16 (Line)
Info : Meshing curve 17 (Line)
Info : Done meshing 1D (0.00258 s)
Info : Meshing 2D...
Info : Meshing surface 19 (Plane, Delaunay)
Info : Meshing surface 21 (Plane, Delaunay)
Info : Meshing surface 23 (Plane, Delaunay)
Info : Meshing surface 25 (Plane, Delaunay)
Info : Meshing surface 27 (Plane, Delaunay)
Info : Meshing surface 29 (Plane, Delaunay)
Info : Done meshing 2D (0.354671 s)
Info : 13685 vertices 27682 elements
Info : Writing './toto.msh'...
Info : Done writing './toto.msh'
Info : Stopped on Wed Nov 22 15:39:47 2017
```

## 4 ooGmsH class

The `ooGMSH` class can be used to read `gmsH` mesh files with the MSH ASCII file format described for example in [1], section 9.1.

In a `.msh` file the kind of mesh elements are identified by their *elm-type* integer values :


<i>elm-type</i>	description
1	2-node line
2	3-node triangle
3	4-node quadrangle
4	4-node tetrahedron
5	8-node hexahedron
6	6-node prism
7	5-node pyramid
8	3-node second order line (2 nodes associated with the vertices and 1 with the edge)

9	6-node second order triangle (3 nodes associated with the vertices and 3 with the edges)
10	9-node second order quadrangle (4 nodes associated with the vertices, 4 with the edges and 1 with the face)
11	10-node second order tetrahedron (4 nodes associated with the vertices and 6 with the edges)
12	27-node second order hexahedron (8 nodes associated with the vertices, 12 with the edges, 6 with the faces and 1 with the volume)
13	18-node second order prism (6 nodes associated with the vertices, 9 with the edges and 3 with the quadrangular faces)
14	14-node second order pyramid (5 nodes associated with the vertices, 8 with the edges and 1 with the quadrangular face)
15	1-node point
16	8-node second order quadrangle (4 nodes associated with the vertices and 4 with the edges)
17	20-node second order hexahedron (8 nodes associated with the vertices and 12 with the edges)
18	15-node second order prism (6 nodes associated with the vertices and 9 with the edges)
19	13-node second order pyramid (5 nodes associated with the vertices and 8 with the edges)
20	9-node third order incomplete triangle (3 nodes associated with the vertices, 6 with the edges)
21	10-node third order triangle (3 nodes associated with the vertices, 6 with the edges, 1 with the face)
22	12-node fourth order incomplete triangle (3 nodes associated with the vertices, 9 with the edges)
23	15-node fourth order triangle (3 nodes associated with the vertices, 9 with the edges, 3 with the face)
24	15-node fifth order incomplete triangle (3 nodes associated with the vertices, 12 with the edges)
25	21-node fifth order complete triangle (3 nodes associated with the vertices, 12 with the edges, 6 with the face)
26	4-node third order edge (2 nodes associated with the vertices, 2 internal to the edge)
27	5-node fourth order edge (2 nodes associated with the vertices, 3 internal to the edge)
28	6-node fifth order edge (2 nodes associated with the vertices, 4 internal to the edge)
29	20-node third order tetrahedron (4 nodes associated with the vertices, 12 with the edges, 4 with the faces)
30	35-node fourth order tetrahedron (4 nodes associated with the vertices, 18 with the edges, 12 with the faces, 1 in the volume)
31	56-node fifth order tetrahedron (4 nodes associated with the vertices, 24 with the edges, 24 with the faces, 4 in the volume)

92	64-node third order hexahedron (8 nodes associated with the vertices, 24 with the edges, 24 with the faces, 8 in the volume)
93	125-node fourth order hexahedron (8 nodes associated with the vertices, 36 with the edges, 54 with the faces, 27 in the volume)

---

When reading a `.msh` file generated by `gmsht`, we split the mesh elements by *elm-type* and generate an array of `ELMT` structure. The dimension of this array is the number of different *elm-type* founds on the `.msh` file. The `Elmt` structure is given by



### Fields of Elmt structure

type	: integer refers to the type of the element : 1 for 2-node line, 2 for 3-node triangle, ... See the <i>elm-type</i> description of [1], section 9.1.
geo	: string contains the kind of geometry: 'line', 'triangle', 'tetrahedron', ...
d	: integer space dimension or <i>d</i> -simplex.
order	: integer order of the element
n <sub>me</sub>	: integer number of mesh elements
me	: array of <i>d</i> + 1-by-n <sub>me</sub> integers connectivity array
phys_lab	: array of n <sub>me</sub> -by-... integers physical labels of the elements
geo_lab	: array of n <sub>me</sub> -by-... integers geometrical labels of the elements
nb_parts	: array of n <sub>me</sub> -by-1 integers number of mesh partitions to which the element belongs
part_lab	: array of n <sub>me</sub> -by-max(nb_parts) integers part_lab( <i>i</i> , 1 : nb_parts( <i>i</i> )) contains all the partitions index to which the <i>i</i> -th element belongs.

The `ooGMSH` class was created to store a maximum of(all the) information(s) contained in the `.msh` file. The properties of this class are:

## Properties of ooGmsh class

dim	: integer space dimension
n <sub>q</sub>	: integer number of vertices/nodes
q	: dim-by-n <sub>q</sub> array of reals array of vertex coordinates
types	: array of integers List of the element types found in the mesh file.
orders	: array of integers List of the orders of the element types found in the mesh file.
sElts	: array of Elmt structure One Elmt structure by element type, such that sElts( <i>i</i> ) contains all the elements of type types( <i>i</i> ) and order orders( <i>i</i> ).

The ooGmsh class have only one constructor :

```
Gh=ooGmsh(meshfile)
```

where meshfile is the name of ... a mesh file

### 4.1 Sample 1

The 2d .geo file *condenser.geo* is used to create a .msh file : *condenser-25.msh*. This .msh file contains only 1 (2-node line) and 2 (3-node triangle) *elm-type*.

#### Matlab commands with output

```
meshfile=gmesh.buildmesh('condenser',25,'verbose',0);  
Gh = ooGmsh(meshfile)
```

```
Gh =  
ooGmsh with properties:  
  dim: 2 double  
  nq: 55684 double  
  orders: 1 double  
  partitionedfile: 0 logical  
  q: (2x55684 double)  
  sElts: (3x1 struct)  
  toGlobal: (1x55684 double)  
  types: [ 1 2 15 ] (1x3 double)
```

### 4.2 Sample 2

The 3d .geo file *cylinderkey.geo* is used to create a .msh file : *cylinderkey-10.msh*. This .msh file contains 1 (2-node line), 2 (3-node triangle) and 4 (4-node tetrahedron) *elm-type*.

### Matlab commands with output

```
meshfile=gmesh.buildmesh3d('cylinderkey',10,'verbose',0,'force',true);  
Gh = ooGmsh(meshfile)
```

```
Gh =  
ooGmsh with properties:  
  dim: 3 double  
  nq: 6052 double  
  orders: 1 double  
  partitionnedfile: 0 logical  
  q: (3x6052 double)  
  sElts: (3x1 struct)  
  toGlobal: (1x6052 double)  
  types: [ 1 2 4 ] (1x3 double)
```

## 4.3 Sample 3

The 3d .geo file *ball8.geo* is used to create a 3d surface .msh file : *ball18-50.msh*. This .msh file contains 1 (2-node line), 2 (3-node triangle) and 15 (1-node point) *elm-type*.

### Matlab commands with output

```
meshfile=gmesh.buildmesh3ds('ball18',50,'verbose',0,'force',true);  
Gh = ooGmsh(meshfile)
```

```
Gh =  
ooGmsh with properties:  
  dim: 3 double  
  nq: 43204 double  
  orders: 1 double  
  partitionnedfile: 0 logical  
  q: (3x43204 double)  
  sElts: (3x1 struct)  
  toGlobal: (1x43204 double)  
  types: [ 1 2 15 ] (1x3 double)
```

## 4 References

- [1] Gmsh 2.15.0. <http://gmsh.info>, 2016.
- [2] C. Geuzaine and J.-F. Remacle. Gmsh: A 3-D finite element mesh generator with built-in pre- and post-processing facilities. *International Journal for Numerical Methods in Engineering*, 79(11):1309–1331, 2009.