

## Méthodes Python de pilotage de GMSH

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### Résumé :

Ce document présente le superviseur permettant de piloter GMSH depuis Python, et donc depuis le fichier de commandes Aster.

Ce superviseur produit tout type de maillages 2D en utilisant le logiciel GMSH ([www.geuz.org/gmsh](http://www.geuz.org/gmsh)). Il est notamment utilisé dans Aster par l'outil de post-traitement interactif STANLEY afin de générer des éléments de maillage pour le post-traitement, mais peut être étendu à d'autres applications : maillage paramétrique, remaillage, etc.

## 1 Mode d'emploi

Il y a quatre étapes à suivre pour produire un maillage avec le superviseur GMSH :

- 1) Définition de la géométrie ;
- 2) Définition des discrétisations ;
- 3) Création du maillage GMSH et des group\_ma et objets Physical associés ;
- 4) Importation du maillage GMSH dans Aster.

### Exemple simple d'utilisation :

Dans l'exemple suivant, on utilise les fonctionnalités du superviseur pour générer le maillage d'une plaque rectangulaire :

#### Géométrie

```
from sup_gmsht import *  
  
larg = 5.  
H_beton = 3.  
H_S1 = 4.  
t_beton = 25.  
prog_S1 = 1.1
```

On importe le module et on définit quelques paramètres.

```
# Geometrie  
O = Point(0, 0)  
A = Point(larg, 0)  
B = Point(larg, H_beton)  
C = Point(0, H_beton)  
D = Point(0, -H_S1)  
E = Point(larg, -H_S1)  
  
OA = Line(O,A)  
AB = Line(A,B)  
BC = Line(B,C)  
OC = Line(O,C)  
  
OD = Line(O,D)  
DE = Line(D,E)  
AE = Line(A,E)  
  
S2 = Surface(OA,AB,BC,OC)  
S1 = Surface(OD,DE,AE,OA)
```

On crée des points, des lignes entre les points et des surfaces à partir des lignes.

```
# Discretisation
OA.Transfinite(1)
BC.Transfinite(1)
DE.Transfinite(1)

N_beton = int(H_beton/t_beton + 0.5)
AB.Transfinite(N_beton)
OC.Transfinite(N_beton)

N_S1 = Progress(H_S1, r=prog_S1, h=t_beton)
OD.Transfinite(N_S1,prog_S1)
AE.Transfinite(N_S1,prog_S1)

S2.Transfinite()
S1.Transfinite()
```

On définit la discrétisation des lignes et des surfaces.

```
# Maillage
mesh = Mesh()
mesh.Physical('FOND',DE)
mesh.Physical('LAT_G',OC,OD)
mesh.Physical('LAT_D',AB,AE)
mesh.Physical('INTERFAC',OA)
mesh.Physical('HAUT',BC)
mesh.Physical('S2',S2)
mesh.Physical('S1',S1)
```

On crée l'objet maillage et on définit les groupes de mailles qui seront des `group_ma` dans la SD maillage Aster et des *Physical* dans GMSH (ces derniers seront nommés GM1, GM2, etc...).

```
MA = mesh.LIRE_GMSH(
    MODI_QUAD = 'OUI'
)
```

Importation du maillage dans Aster : MA est un maillage Aster.

## 2 Liste des fonctions disponibles

La liste des fonctions est extraite directement du source, `sup_gmsh.py`, ce qui explique qu'elle soit en anglais.

### 2.1 Classe générique pour les objets géométriques

**class Geometric :**

private attribute  
parameters : dictionnary of the attributes (except relation and parameters itself)  
see `__getattr__` and `__setattr__`

Attributes

num : index among gmsh objects  
md : mesh descriptor  
mesh : related mesh object  
relation : model object in case of coincidence

Public methods

Is\_point : return true is the object inherits of the Point class

Is\_line : return true is the object inherits of the Line class

Is\_surface : return true is the object inherits of the Surface class

Is\_volume : return true is the object inherits of the Volume class

Is\_same\_dimension : return true is both objects are of the same dimension  
(point, line, surface or volume)  
in -> object to compare to self

Duplicate : duplicate an object and base its mesh\_descriptor  
on the mesh\_descriptor of the model

Coincide : assert that an object is coincident with a model one  
All the attributes are then automatically read from  
the model object (see `__setattr__` and `__getattr__`).  
in -> model object

Private method

Root :

Provides the root object of an object, ie the object itself if there is no relation  
or the deepest model in case of relation.

Geometric\_coincide : check if a geometrical coincidence is possible  
return information about the coincidence, false else.  
in -> model object

Deep\_coincide : proceed recursively to ensure coincidence of the relevant sub-objects  
in -> model object  
in -> correspond (information returned by Geometric\_coincide)

`__setattr__` : distinguish two sets of attributes  
relation (to express a relation with a model object in case of coincidence)  
all the other attributes which are stored in the dictionary parameters  
instead of the usual `__dict__` if there is no relation (see `Coincide`)  
and in the model object if there is a coincidence

`__getattr__` : if the object is related (relation  $\neq$  None) the attribute is read  
in the model object. Else, it is read in the current object, actually  
in the dictionary parameters (see `__setattr__`)

Thanks to these two overloaded methods, the access to the attributes is usual if  
there is no relation whereas the attributes of the model object are accessed  
transparently if there is a relation .

`__cmp__` :  
The comparison of two objects involves possible coincidence. It is no more the object ids  
that are compared but the object roots (.relation if any).

`Gmsh` : produce the source code for `Gmsh`  
in -> mesh

`Gmsh_send` : send a line code to the gmsh interpreter  
in -> line\_code (string)

`Intermediate_meshing` : produce the source code for the intermediate objects  
in -> mesh

`Object meshing` : produce the source code for the current object  
var -> object number (modified if several objects are created)

## 2.2 Fonctions pour les objets POINT

**class Point(Geometric) :**

Public methods

`__init__` :  
in -> coordinates (the 3rd is zero by default)

`Size` : set the size of the neighbouring elements  
in -> size

`Attractor` : define the point as an attractor  
in -> `scale_x` : size amplification factor in the x-direction  
in -> `scale_y` : size amplification factor in the y-direction  
in -> distance: influence distance for the perturbation

Attributes

`coor` : coordinates  
`size` : neighbouring element size  
`attractor` : parameters of the attractor

## 2.3 Fonctions pour les objets LIGNE

**class Line(Geometric) :**

LINE OBJECT

Public methods

Attractor : define the point as an attractor

in -> scale\_x : size amplification factor in the x-direction

in -> scale\_y : size amplification factor in the y-direction

in -> distance: influence distance for the perturbation

**class Circle(Line) :**

CIRCLE OBJECT

**def Curve(l\_x,l\_y,l\_z=None) :**

CURVE OBJECT (in -> list of points)

## 2.4 Fonctions pour les objets SURFACE

**class Surface(Geometric) :**

SURFACE OBJECT (inherit from the Geometric class)

Public methods

\_\_init\_\_ :

in -> lines : external bounday of the surface (lines should be connected)

Holes : set the internal holes (surfaces)

in -> holes : list of holes

Boundary : checks that the boundary is a closed loop and returns the orientation of the edges

Ruled : declare the surface is a ruled one

Translate : translate the surface

in -> tran : (numpy) vector of translation

Recombine : recombine the surface (try to mesh with quadrangles instead of triangles)

Transfinite : Declare the mesh to be transfinite

Attributes

lines : list of external boundary lines

holes : list of internal holes (surfaces)

ruled : indicates (false or true) if the surface is a ruled surface

loops : list of boundary (external and internal) loops (computed when meshing)

## 2.5 Fonctions pour les opérations sur les maillages

**class Mesh\_Descriptor :**

Attributes

relation Another mesh descriptor provides the mesh parameters  
parameters dictionnary of the mesh parameters  
size Point size  
transfinite Transfinite mesh (0 or 1)  
number Number of elements along a line (transfinite)  
progression Progression of element size (transfinite)  
recombine Recombine mesh or not

Specific access :

md.parameter\_name = xxx -> the relation is destroyed (set to None)  
xxx = md.parameter\_name -> if there is a relation, the effective  
parameter is looked for recursively

Deep copying : a relation is set to the model instead of a true copy

**class Mesh :**

def \_\_init\_\_(self, algo = 2, gmsh='gmsh') :

def Physical(self, name, \*l\_obj) : creation of Physical (GMSH object)

def Save(self, file = 'fort.geo') : save the geo file

def View(self) : launch GMSH with the current geo file

def Create(self, file = 'fort.19') : save the geo file and create the msh file

def Name(self, MA, CREA\_GROUP\_NO ) : create the group\_ma and/or the group\_no

def LIRE\_GMSH (self,  
UNITE\_GMSH = 19,  
UNITE\_MALLAGE = 20,  
MODI\_QUAD = 'NON' ,  
CREA\_GROUP\_NO = 'OUI' ) :

Lecture du maillage (format Aster) a partir de sa definition  
(format sup\_gmsh)

UNITE\_GMSH = Numero d'unite logique pour le fichier msh  
UNITE\_MALLAGE = Numero d'unite logique pour le fichier mail  
MODI\_QUAD = 'OUI' si line->quad, 'NON' sinon  
CREA\_GROUP\_NO = 'OUI' si on cree les group\_no, 'NON' sinon

## 2.6 Fonctions pour les transformations géométriques

def VectorProduct(u,v) :

def VectorNorm(u) :

class Rotation :

in -> A,C,B