

Méthodes Python de pilotage de GMSH

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). 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 Utilitai.sup_gmsh 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      : dictionary 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 <> 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    dictionary 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_MAILLAGE = 20,
        MODI_QUAD       = 'NON' ,
        CREA_GROUP_NO   = 'OUI'
    ) :
```

```
    Lecture du maillage (format Aster) à partir de sa définition (format sup_gmsh)
```

```
    UNITE_GMSH      = Numéro d'unité logique pour le fichier msh
    UNITE_MAILLAGE = Numéro d'unité logique pour le fichier mail
    MODI_QUAD       = 'OUI' si line->quad, 'NON' sinon
    CREA_GROUP_NO   = 'OUI' si on crée 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