Methods Python of piloting of GMSH

Summary:

This document introduces the supervisor making it possible to control GMSH since Python, and thus since the command file Aster.

This supervisor produces any type of grids 2D by using software GMSH (www.geuz.org/gmsh). It is in particular used in Aster by the tool for postprocessing interactive STANLEY in order to generate elements of grid for postprocessing, but can be wide with other applications: parametric grid, mending of meshes, etc.
1 Instructions

There are four stages to follow to produce a grid with supervisor GMSH:

1) Definition of the geometry;
2) Definition of the discretizations;
3) Creation of grid GMSH and of GROUP_MA and associated objects "Physical";
4) Importation of grid GMSH in Aster.

Simple example of use:

In the following example, one uses the features of the supervisor to generate the grid of a rectangular plate:

Geometry

```python
from Utilitai.sup_gmsh importation *

larg = 5.
H_beton = 3.
H_S1 = 4.
t_beton = 25.
prog_S1 = 1.1
```

One imports the module and one defines some parameters.

```python
# Geometry
O = Not (0, 0)
With = Not (larg, 0)
B = Not (larg, H_beton)
C = Not (0, H_beton)
D = Not (0, -H_S1)
E = Not (larg, -H_S1)

OA = Line (O, A)
AB = Line (A, B)
BC = Line (B, C)
OC = Line (O, C)

OD = Line (O, D)
OF = Line (D, E)
AE = Line (A, E)

S2 = Surface (OA, AB, BC, OC)
S1 = Surface (OD, OF, AE, OA)
```
One creates points, lines between the points and of surfaces starting from the lines.

```python
# Discretization
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 ()
```

One defines the discretization of the lines and surfaces.

```python
# Grid
mesh = Mesh ()
mesh. Physical ('BOTTOM', OF)
mesh. Physical ('LAT_G', OC, OD)
mesh. Physical ('LAT_D', AB, AE)
mesh. Physical ('INTERFAC', OA)
mesh. Physical ('HIGH', BC)
mesh. Physical ('S2', S2)
mesh. Physical ('S1', S1)
```

One creates the object grid and one defines the groups of meshes which will be GROUP_MA in SD grid Aster and of “Physical” in GMSH (the latter will be named GM1, GM2, etc...).

```python
MY = mesh.LIRE_GMSH (MODI_QUAD = 'YES')
```

Importation of the grid in Aster: MA is a grid Aster.
2 List of the functions available

The list of the functions is extracted directly from the source, `sup_gmsh.py`, which explains why it is in English.

2.1 Generic class for the geometrical objects

```python
class Geometric:
    # private attribute
    parameters : dictionary of the attributes (except relation and parameters itself)
        see __getattr and __setattr

    Attributes
    num          : index among gmsh objects
    Mandelevium   : mesh descriptor
    mesh         : related mesh object
    relation     : model object in box of coincidence

    Public methods
    Is_point: return true is the object inherits of the Not 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 class Volume
    Is_same_dimension: return true is both objects are of the same dimension
        (not, line, surface gold volume)
    in - > object to compares to coil
    Duplicate   : duplicate year object and bases its mesh_descriptor one the mesh_descriptor of the model
    Coincide    : assert that year object is coincides with has 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 year object, IE the object itself yew there is No relation
        however the deepest model in box of relation.
    Geometric_coincide: check yew has geometrical coincidence is possible return information about the coincidence, false
    else.
    in - > model object
```

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Deep_coincide: proceed recursively to depending ensure coincidence of the sub-objects
   in -> model object
   in -> corresponds (information returned by Geometric_coincide)

__setattr: distinguish two sets of attributes
   relation (fast to has relation with has model object in
   box of coincidence)
   all the other attributes which are stored in the
dictionary parameters
   instead of the usual __dict yew there is No relation
   (see Coincides)
   and in the model object yew there has coincidence

__getattr: yew 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 thesis two overloaded methods, the access to the attributes
is usual yew
   there is No relation whereas the attributes of the model object are
   accessed
   transparently yew there has relation .

__cmp:
   The comparison of two objects involves possible coincidence. It is No
   more the object ids
   that are compared goal the object roots (.relation yew any).

Gmsh : produce the source codes for Gmsh
   in -> mesh

Gmsh_send: send has line code to the gmsh to interpret
   in -> line_code (G-string)

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

Object meshing: produce the source codes for the current object
   VAr -> object number (modified yew several objects are created)

2.2 Functions for the objects NOT

class Not (Geometric):

Public methods
   __init: in -> coordinates (the 3rd is zero by defect)

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

Attractor: define the not ace year attractor
   in -> scale_x: size amplification Factor in the X-direction
   in -> scale_y: size amplification Factor in the there-direction
   in -> distance: influence outdistances for the disturbance
Attributes
  coor: coordinates
  size: neighbouring element size
  attractor: parameters of the attractor
2.3 Functions for the objects **LINE**

```python
class Line (Geometric):

    LINE OBJECT

    Public methods

    Attractor: define the not ace year attractor
    in - > scale_x: size amplification Factor in the X-direction
    in - > scale_y: size amplification Factor in the there-direction
    in - > distance: influence outdistances for the disturbance

    class Circle (Line):

        CIRCLE OBJECT

    def Curve (l_x, l_y, l_z=None):

        CURVE OBJECT (in - > list of points)
```

2.4 Functions for the objects **SURFACE**

```python
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 has closed loop and returns the orientation of the edges

    Ruled: the surface is declares has ruled one

    Relocate: relocate the surface
    in - > tran: (numpy) vector of translation

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

    Transfinite: The mesh to Be transfinite declares

    Attributes
    lines: list of external boundary lines
    holes: list of internal holes (surfaces)
    ruled: indicates (false gold true) yew the surface has ruled surface
```
loops: list of boundary (external and internal) loops (computed when meshing)
2.5 Functions for the operations on the grids

```python
class Mesh_Descriptor:

    Attributes
    relation     Another mesh descriptor provides the mesh parameters
    parameters   dictionary of the mesh parameters
    size         Not size
    transfinite  Transfinite mesh (0 gold 1)
    number       Number of elements along has line
    (transfinite)
    progression  Progression of element size
    (transfinite)
    recombine    Recombine mesh gold not

    Specific access:
    md.parameter_name = xxx -> the relation is destroyed (set to None)
    xxx = md.parameter_name -> yew there has relation, the effective
    parameter is looked for recursively

    Deep copying: relation is set to the model instead of has true Copy

class Mesh:

    def __init__(coil, algorithm = 2, gmsh='gmsh'):

    def Physical (coil, name, *l_obj): creation of Physical (GMSH object)

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

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

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

    def Name (coil, MY, CREA_GROUP_NO ) : create the group_ma and/or the group_no

    def LIRE_GMSH (coil,
        UNITE_GMSH   = 19,
        UNITE_MAILLAGE = 20,
        MODI_QUAD   = 'NOT',
        CREA_GROUP_NO = 'YES'
    ) :

    Reading of the grid (format Aster) starting from its definition (format sup_gmsh)
    UNITE_GMSH   = logical Number of unit for the file msh
    UNITE_MAILLAGE = logical Number of unit for the file e-mail
    MODI_QUAD   = 'YES' if line->quad, 'NOT' if not
    CREA_GROUP_NO = 'YES' if they are created GROUP_NO, 'NOT' if not

2.6 Functions for the geometrical transformations

    def VectorProduct (U, v):

    def VectorNorm (U):

    class Rotation:
```

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in -> A, C, B