New Features in SGeMS

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Outline

• Introduction to SGeMS
  – What is SGeMS
  – Resources

• New Features
  – Improved user-interface
    • Context Sensitive Menus
  – Geostatistics
    • Regions
    • Geobody Connectivity
    • Octant search
  – Extended Python-SGeMS Interface
    • Connection with External Software
    • Complex workflows

• Work in Progress
Stanford Geostatistical Modeling Software

- Developed in C++
- Cross-platform
- 32 and 64 bits
- More than 25,000 downloads (non unique)
- 600 downloads/month average
Resources

- [sgems.sourceforge.net](http://sgems.sourceforge.net)
  Source code and binary
  Online help and forums

### SGEMS Discussion Boards

#### User

Post new Forum topic

<table>
<thead>
<tr>
<th>Topic</th>
<th>Replies</th>
<th>Created</th>
<th>Last reply</th>
</tr>
</thead>
<tbody>
<tr>
<td>How to load a gslib object through command line</td>
<td>1</td>
<td>1 week 9 hours ago by goptavares</td>
<td>5 days 14 hours ago by goptavares</td>
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<tr>
<td>How to standardize a variogram to unit sill</td>
<td>0</td>
<td>1 week 2 days ago by bortz</td>
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<td>How to create a continuous training image</td>
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<td>2 weeks 3 days ago by goptavares</td>
<td>1 week 3 days ago by aboucher</td>
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<td>1 week 3 days ago by pejman</td>
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<td>Remove trend from data</td>
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<td>13 weeks 20 hours ago by zhenamire</td>
<td>1 week 3 days ago by pejman</td>
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<td>How to do cross validation in SGEMS?</td>
<td>1</td>
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<td>1 week 4 days ago by pejman</td>
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<td>Importing SGEMS to Python</td>
<td>4</td>
<td>2 weeks 5 days ago by hamed_al</td>
<td>1 week 5 days ago by hamed_al</td>
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Interface between Python and SGeMS

SGeMS provide three commands to have Python interact with SGeMS data and algorithms. One can import or export data from/to SGeMS or execute the SGeMS commands.

- `get_property(gridName, propertyName)`
  Retrieve the property `propertyName` from the grid `gridName` and return the value in a python list.

- `set_property(gridName, propertyName, data)`
  Save the python list `data` to the grid `gridName` with the name `propertyName`. Note that it will overwrite an existing property with the same `propertyName`.

- `execute(command)`
  Execute any of the SGeMS command described [here](#).

These commands are in the library sgems. One must first include these functions in Python with the command `import sgems`. For example, the following code creates a 50x50 3D cartesian grid called `grid` using the SGeMS command `NewCartesianGrid`:
Context Sensitive Menus

- Quick access to common operations
  rename, delete, histogram
- Data Transforms
  Unary operations on properties
  inverse, log, unitScaling, …
- Trends
- Data Management
  Easily swap large files to/from disk
- User defined Python Scripts
- New class of commands
  Accessible from right-click menu
  e.g. Geobody
Pluggable Python Scripts

Custom python script(s) accessible from property menu

Two steps to extending SGeMS

  Write the custom algorithm (aka, the python script)
  Place the script in the folder `${INSTALLATION}/actions/python`

No compilation needed

No limit on the number of scripts

Example: Compute the ordering sequence of property values

```python
import sgems
from scipy import array, argsort

data = array(sgems.get_property(grid, prop))
id = argsort(data)
sgems.set_property(grid, prop+"_argsorted", id.tolist())
```
Regions

Partition a grid into active and inactive cells

Accessible for:
- Data exploration (histogram, scatter-plot, qqplot)
- Search neighborhood
- Python script
- Graphical interface

Commands to manipulate regions
Number of Data: 1e+06
Mean: 3.52699
Variance: 137.93
Summary Statistics:
- Maximum: 656
- Upper Quartile: 0
- Median: 0
- Lower Quartile: 0
- Minimum: 0

GeobodyDefinition(full_id_real0)
Search Strategy

- Option to consider other regions for conditioning (smooth transition)

- Octant Search: Especially important with vertical wells
  - Minimum # of non-empty octant
  - The minimum of samples per octant to be considered non-empty
  - Max samples per octant to consider

- Improved kd-tree structure for neighborhood search on point set (approx 10 times faster)
Recall: Python scripting

SGeMS integrates Python for scripting

Python is a widely used language
  - Scientific capabilities
  - Visualization
  - Input/Output
  - Free and open source

SGeMS provides commands to interact with Python, allowing the building of complex workflows, e.g.
  - Calling external programs
  - Sensitivity analysis
  - Hierarchical modeling
  ...

SCRF 2010
New: extended python commands

- Dimensions of a grid: `get_dims()`
- List of properties of a grid: `get_property_list()`
- Index given a location (x,y,z): `get_location()`
- Location (x,y,z) given an index: `get_nodeid()`
- Manipulation of regions
  - `SetRegionFromComplement`
  - `SetRegionFromPropertyIf`
  - `DeleteObjectRegions`
  - `MergeObjectRegionsIntersection`
  - `MergeObjectRegionsUnion`
- Create masked grid from cartesian grid based on region: `CreateMgridFromCgrid`
Extending SGeMS

Algorithms
- Write a C++ plugin
- Write a pluggable python script
- Call a program from SGeMS through Python
- Call SGeMS externally (e.g. Matlab, Java)

Input/Output Filters
- Streamsim (Eclipse-based) binary file
- CSV file with alphanumeric entries

Example:
- StudioSI: streamlines history matching
- MATLAB: mGstat
Example 1: MGSTAT

- Completely develop by a third party Prof Thomas Mejer, Denmark
- Call SGeMS from Matlab.
  The matlab user is unaware of the SGeMS interface

```matlab
S1=sgems_get_par('snesim_std');
...
S1.XML.parameters.Nb_Realizations.value=4;
S1=sgems_grid(S1);
```

http://mgstat.sourceforge.net
Example 2: StudioSL and History Matching (ppm) with Streamlines

- StudioSL is a flow simulator using streamlines developed by Streamsim Technologies Inc.
- With the help of Dr. Darryl Fenwick, we build an interface such that SGeMS was called when performing PPM.
- Tested on a large fractured Middle East field (dual porosity model).
- Once the script are set-up the users do not have to interact with SGeMS interfaces.
Dual porosity history matching

- StudioSL HM
  - plugin to read bininc format
- SGeMS Geomodel
  - plugin to write bininc format
- Streamlines
- Compute HM errors

SCRF 2010
#Load the training images
LoadObjectFromFile  dla::sgems
LoadObjectFromFile  ti_grid::sgems

#Load the probability field from ppm
LoadObjectFromFile  ppmProportionsCube.bininc::All

#Create a 2D grid and simulate the fractures
NewCartesianGrid  ppmProportionsLayer::129::276::1
RunScript  pfield_dla_manager.py

#Run a 2D simulation for the fracture set
RunGeostatAlgorithm  snesim ...

#Run a 3D Simulation for the superK
RunGeostatAlgorithm  snesim ...

#combine the 2d and 3d simulations
RunScript  snesim-2d-to-3d.py

#Save the resulting simulation
SaveGeostatGrid  ppmProportionsCube::fracture.bininc::streamsim
Work in Progress

- Explicit support for categorical variables
- Improved data management
  - Grouping of relevant properties
  - Distributions
- Project workspace restoration
Questions?