Development of a Web Geological Feature Service (WGFS) for delivery and querying of 3D objects in Gocad

Gocad Mining Users’ Meeting VI

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Project Supervisors:
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Thierry Badard, Ph.D.
Donna Kirkwood, Ph.D.

Context

- GEOIDE project
  - GEOmatics for Informed DEcisions
  - A Geomatics Network funded by Networks of Centres of Excellence

- GeoTopo3D
  - Development of a 3D predictive modeling platform for exploration, assessment and efficient management of mineral, petroleum and groundwater resources
    - Laval University (Geology and Geomatics), University of New Brunswick, Ryerson University
    - Geological Survey of Canada / Ministère des Ressources Naturelles et Faune du Québec / UQAT (Université du Québec en Abitibi-Témiscamingue), URSTM (Unité de recherche et de service en technologie minérale) / Mira Geosciences / Ontario Power Generation
Master degree project:
Elaboration of concepts for the development of a 3D GIS: with application in geology

Involving Geomatics and Geology departments at Laval University, MRN, QC (Géologie Québec), UQAT

PhD A. Aubiès-Trouilh
U: URSTM

MSc K. Bédard
U: URSTM, P: MRNFQ

PhD D. Blessent
U: OPG, Mira P: GSC-Québec

3D model collaborative communication over the internet

PhD L. Hashemi
U: OPG, P: Mira

PhD D. Blessent
U: OPG, Mira P: GSC-Québec

PhD E. Janssens
U: GSC, P: GSC

PhD E. Janssens
U: GSC, P: GSC

PhD D. Blessent
U: OPG, Mira P: GSC-Québec

Geomodels
• Develop Workflows

3D GIS
• Data structures
• DBMS/standardisation

MSc E. Desgagné
U: MRNFQ, URSTM, P: MRNFQ

MSc to come

Numerical modeling

October 4th, 2006
The storage and querying of data are of major importance for today’s organisations.

3D geological models are complex and valuable data because of:
- acquisition cost of primal data
- time and expertise needed to build them
- Update and maintenance cost

Efficient storage and querying strategies must be put in place to optimize the investment.
Introduction

DBMS

- Database Management System (DBMS) are very popular for the storage of data (ex: Oracle, SQLServer, MySQL...)

- They are known to offer many advantages such as:
  - Better accessibility of data (Multi-users access)
  - Data Integrity
  - Data Security
  - Centralization of data
  - ...

- Linking with DBMS is widely used in 2D Geographic Information Systems (GIS) and has proven his efficiency

Problem statement

- Gocad like others 3D modeling software uses file-based method for the storage of data and does not support database for the storage of models

- Existing frameworks for developing Web-based and Standard-compliant spatial applications are not yet supporting 3D objects

- Spatial DBMS are 2D oriented

- Spatial analysis operators in 3D modeling software are often limited
Main Objective

- To develop a generic and open system to link a 3D modeling software (like Gocad) with DBMS via Web Protocol
  - Import data into Gocad from a database
  - Modify and create new features
  - Return back the resulting model to database

Specific Objectives

- To take advantage of an interoperable approach
  - by adopting ISO and OGC standards

- To Implement a library of spatial analysis operators centralized on server and accessible via web service
  - Standardisation of spatial operations
  - Transparent access to same spatial operators for any client

- To develop a prototype implementing these concepts

- To test the solution with MRN 3D geological tetrahedral model and SIGEOM database

October 4th, 2006
Web Feature Service (WFS) is an OGC specification that is used to implement the query system between the client and the server.

- Technology neutral
- Allow access to spatial data over the Web
- Data returned in GML format (ISO 19136 standard)
The server is the part of the system where the application logic and data access are handled.
- implementation of the spatial schema ISO 19107
- WFS application
- library of spatial analysis algorithms
- A datastore for each different data source supported by the system

Special data structure is needed for storage of data because DBMS are not supporting 3D solid geometry

System Architecture
3D Web Geological Feature Server (WGFS)

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The system is developed with Java language because of its portability and of the availability of open source related to technology.

Deegree is an open source Java framework for developing standard spatial application. It has been chosen for:
- its implementation of ISO 19107 spatial schema (partially)
- Its full implementation of the WFS specifications.

3D models are stored as GML documents:
- the popular open source DBMS MySQL is used for the storage of GML documents in the prototype.

In GML 3 specifications, 3D objects can be represented with composite geometries.

Objects are thus composed of a collection of homogeneous primitives:
- compositeCurve
- compositeSurface
- compositeSolid

A tetrahedral 3D model can be represented in GML with a compositeSolid where each tetrahedron is a solid composed of surfaces.
Implementation

Example of a GML solid

```
<gml:Solid xmlns="EPSG:4326">
  <gml:exterior>
    <gml:CompositeSurface>
      <gml:surfaceMember>
        <gml:OrientableSurface orientation="*">
          <gml:boundSurface>
            <gml:Polygon>
              <gml:linearRing>
                <gml:coordinates>
                    0.0,0.0,0.0 0.0,0.0,0.0 1.0,0.0,2.0 0.0,0.0,2.0
                </gml:coordinates>
              </gml:linearRing>
            </gml:Polygon>
          </gml:boundSurface>
        </gml:OrientableSurface>
      </gml:surfaceMember>
    </gml:CompositeSurface>
  </gml:exterior>
</gml:Solid>
```

Spatial analysis operators

✧ A first spatial analysis operator will be implemented, the 3D bounding box intersection (bbox), to restrict the selection of objects in a particular area inside a model.

✧ Other 3D operators could be added in future works like Equals, Disjoint, Touches, Within, Overlaps, Crosses, Intersects, Contains, Beyond
How does it work?

Client
Gocad ©
Plugin
WFS

getCapabilities
Available
models

3D-WGFS
Deegree
Datastores
Oracle
Spatial
PostGIS
Generic
SQL

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Server URL: http://192.0.1.3080/deegree/soap/soapws/services

Get available models

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3D-WGFS

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getFeatures

Data
(GML format)

Deegree
Datastores
Oracle
Spatial
PostGIS
Generic
SQL

getFeatures

Data

SQL query

DBMS
GML 3 storage
SIGEOM data

Client
Gocad
Plugin
WFS

getFeatures

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(GML format)

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Generic
SQL

getFeatures

Data

SQL query

DBMS
GML 3 storage
SIGEOM data

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Eventually, other functionalities will be added to the system like:

- Saving to database of new or modified 3D models (WFS Transaction)
- Lock of features for updating purposes in multi-users environment
Conclusion

Tests and future works

- First tests with the prototype were successful and further works can be done to enhance and optimize the system
  - More tests must be carried out with a complete 3D model

- Functionalities must be added to Gocad plugin:
  - to see non-spatial information related to geometric objects in Gocad
  - to build query with filter expression based on non-spatial data (Ex: lithology = ‘V3B’ AND stratigraphy = ‘[arch]3’)

- The library of spatial analysis operators must be completed

Thank you!

October 4th, 2006