Interactive Large-Data Modelling and Visualisation

Scientific Data Visualization

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Outline

• IESE earth science context
• Geophysical data
• Tools for large-data modelling and visualisation
• Case study: demonstration
• Discussion and future direction
IESE: Data collection, analysis and interpretation

Borehole and Surface Seismic Networks

- Earthquake locations
- Special data analysis and interpretation.
- Seismic velocity and velocity–ratio tomography
- Fracture density and orientation
IESE: Data collection, analysis and interpretation

Magnetotelluric Surveys

- Resistivity and polarization profiles
- Reservoir characterization
- Geothermal site surveys
IESE: Geophysical Data

Typical model data:

• Digital elevation maps (surface)
• Micro-seismic events
• Computed velocity models
• Magnetotelluric results
• Structural features…

Overlapping underground data, a dense 3D volumetric space!
IESE: Data Modelling and Visualisation

Data management and work flow

• Interactive graphics for informed data exploration
• Deliverables:
  – Reports
  – Videos
  – Presentations
  – Live demonstrations
Interactive Graphics

- Cross-platform
- Scriptable, extendable
- High performance
- Selected open-source tools:
  - Paraview
  - Voreen
  - Blender
  - Python
Interactive Graphics

Data abstraction

- Data types:
  - Points
  - Lines
  - Surfaces (open / closed meshes)
  - Volumes (voxels)
  - Each with associated scalar, vector, tensor attributes
    (size, shape, color, glyphs, etc.)
Case study demonstration using Blender

- Digital elevation model with overlays
- Micro-earthquake hypocentres
- Computed velocity model
Digital elevation models: Geotiff files
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Micro-earthquake hypocentres: Hypo71 files

HYPOT1

HYPOT1 is a very old program — more than 30 years old — that was used for many years in the 1970’s and early 1980’s for routine earthquake processing at the US Geological Survey in Menlo Park, CA, and at many seismic networks around the World.


The files are:

1. hypo71.zip (177 KB): A zip file containing the source code of HYPOT1 and 4 files for HYPOT1PC, which is the PC version of HYPOT1. These 4 files include the HYPOT1PC source code, executive code, an input file for testing, and the expected output file. The executive HYPOT1PC.exe can be run under the "Command Prompt" on a PC running under the Windows XP operating system.

2. hypo71manual.pdf (3.4 MB): The users (Revised) manual for HYPOT1 in PDF format. (Lee and Lahr, 1975: listings of the computer files are omitted because readers can list these files themselves).

3. 8517.html (6 KB): A description of HYPOT1 from Chapter 85.17 of the "International Handbook of Earthquake and Engineering Seismology."

Digital Elevation Map

Micro-Seismic Hypocentres
(size and colour indicates magnitude)

Low Velocity Anomaly

High Velocity Anomaly

Monitoring and Development of Geothermal Fields
Monitoring and Development of Geothermal Fields

- Digital Elevation Map (from below)
- Low Velocity Anomaly
- High Velocity Anomaly
- Micro-Seismic Hypocentres (size and colour indicates magnitude)
Monitoring and Development of Geothermal Fields
Future work

• Fully de-couple data from visualisation
• Common multi-user database
• Interactive stand-alone executable models
• ...
Discussion & Questions?

*(Blender demonstration)*