High-Performance Visualization of Geographic Data

Presented by

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Geographic information systems: a short introduction

- **GIS = Geographic information system**
  - Information system to manage geographic data

- **Uses**
  - Data integration, analysis, modeling, and visualization

- **Example applications**
  - Government
  - Homeland security
  - Resource management
  - Environmental management
  - ...
GIS and high-performance computing: Incentives for convergence

- Growing size of geographic databases (TB per day)
  - Hi-res satellite imagery
  - Sensor networks
  - LIDAR, SAR, MODIS, and other sensor platforms

- Integration of multiple data sources
  - In Internet applications
  - Using OpenGIS standards

- New technologies for scientific computing
  - Dynamic data analysis
  - Data mining and visual exploratory methods
  - Simulation models
High-performance visualization architecture for GIS

- EVEREST visualization cluster
  - 30×8 foot viewing area
  - 11,530×3,072 pixel array (35 MP)
  - 27 digital light projectors
  - 15 rendering nodes

- Software
  - OS Scientific Linux
  - Xdmx distributed X server
  - GRASS graphic information system
pd-GRASS: Parallel display for GRASS GIS

- GRASS GIS
  - Free GIS package
  - No license fees
  - Works on Linux

- pd-GRASS
  - GRASS module for parallel visualization
  - Full parallelization
  - Tested with data sets of up to 40 GB
  - Full GRASS GIS functionality
  - Available under GPL from http://www.ornl.gov/gist/software/grass/
Shuttle radar Topography mission (SRTM) dataset

• 90 m cell size
• About $3 \times 10^9$ pixel
• Approximately 7 GB
High-resolution 3-D View of LIDAR data: Beyond desktop capabilities

LIDAR data set for the city of Houston

- Resolution: 3 cm horizontal, 1 cm vertical
- $10^8$ cells
- Approximately 4 GB

Data courtesy of Center for Space Research, UT–Austin
Parallel geospatial computing

- **Uses**
  - Processing of large data sets
  - Visual analytics of dynamic data
  - Rendering of scientific animations

- **Tools**
  - GRASS+SLURM
    - GRASS=Free Linux-based GIS
    - SLURM=Simple Linux Utility for Resource Management (LLNL)

- **Computational domain decomposition**
  - By data layer
  - By function
  - By geographic region

- **Application example**
  - Decluttering of a map of the southeastern United States electric grid
High-performance visualization of agent-based transportation models

- Meso- and macro-scale models
- Testing evacuation scenarios
- Up to a million links
Geospatial analytics: visual exploration and inferencing for dynamic geographic data

Geographic spread of socio-economic and environmental processes and events

- History of the U.S. electric infrastructure
- Scenarios for development of nuclear power production
Animations of high-resolution remote sensing data

Normalized Difference Vegetation Index (NDVI) calculated from MODIS (Moderate Resolution Imaging Spectroradiometer) imagery shows the condition of the vegetated areas at spatial resolution of 250 m and 16 days time intervals.

NDVI can be compared with temperature and precipitation from preceding period to determine effects of weather on vegetation growth.
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