What Are The Grand Challenges in Geographic Information Science?

Results from the NSF Workshop on Geospatial & Geotemporal Informatics

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The Workshop

- Held in 2009 at NSF

- 2-day event

- 32 invited participants from academia (US and international), government, industry, K-12

- For more information:

  http://stgeoinfo.pbworks.com/

Questions

- 1. What is solved? Include expected and surprise successes.

- 2. What is almost solved? Include on-going hot areas.

- 3. What has failed? Include surprise failures.

- 4. What is missing? Discuss areas not currently on the radar.

- 5. What is next? Include both high risk and needed topics.

Birds-of-a-Feather

- 1.   Geovisual Analytics and Multimedia;

- 2.   From Long-Term Monitoring to Persistent Surveillance and GeoSensor Networks;

- 3.   The Effect of Google Earth and Similar Technologies; and

- 4.   Context Areas Beyond the Traditional CS and GIS

Panels

- 1.   Academic Research in View of Latest Industry Developments and Actual Government and Society Needs; and

- 2.   Emerging and Anticipated Future Trends and Needs: How Research Can Respond to Society Needs.

Findings

- I. New challenges in information extraction and modeling

- II. Data collection revisited

- III. Support for cross-discipline discovery using spatiotemporal information

- IV. Support for non-expert interaction with spatiotemporal information

New Challenges in Information Extraction And Modeling

Leading Areas

- Spatiotemporal modeling, esp. as it relates to fuzzy & abstract info
- Support for seamless navigation through space and time datasets:
  - Continuous updates of databases
  - Fully 3-D spaces
  - Space/time prediction (e.g. for event monitoring, resource allocation, alert issues)
  - Legacy and historical data integration
  - Now and then in Google Earth: continuously updating its content, accessing legacy and timely data and information, predicting emerging situations
- Event-driven approaches:
  - Event modeling
  - Automated attribute recognition
  - Event similarity assessment
  - Spatiotemporal event mining
  - Reasoning
  - Risk assessment, etc.
  - Integration in a spatiotemporal algebra

Leading Areas (cont.)

- Global monitoring: cross temporal- and spatial-scale analysis

- Mobility, flow, and evolution: from single to composite objects (e.g. cars, pollution front, groups of people, disease risk): modeling, analyzing, and communicating across space, time, and semantic hierarchies

- New representations through the integration of low- and high-level data (e.g. raw image data and interpreted GIS-data)

  - expert annotation

  - multiple theme-based representations of the same scene as intuitive context descriptions (a critical underpinning to knowledge discovery)

- GeoRealism: At the right space, time, resolution and quality

  - Point clouds vs. 3d models; video vs. events; trajectories vs. patterns

  - Vector with imagery; text (from wire news) with maps; verbal descriptions with 3d models

  - As fast as we need it, and nothing we don't.

Data Collection Revisited

Leading Areas

- Ambient spatial computing: adaptive, multi-modal, sensor-based

- Towards geosensor networks:

  - P2P

  - Sensors running multiple, isolated services

  - In-network, on-the-fly data analysis, interpretation, integration & resource allocation

  - An opportunity to reduce the gap between ST Research and DBMSs

- Humans as sensors, text and speech as data: extending temporal and spatial linguistic analysis

- GeoMedia:

  - Narrative-to-video and video-to-narrative capabilities

  - Text-to-image and image-to-text

- Location-based services revisited: in-situ analytics. Moving visual-analytical power to everyday devices and tasks

- Collaborative use of diverse data sources to track objects and events

- Mind the gap: identifying redundancies / gaps in massive amounts of ST datasets

Support for Cross-Discipline Discovery Using Spatiotemporal Information

Leading Areaas

- Decentralized geospatial computing

- Knowledge representation: within and cross-domain (e.g. temporal and event-based modeling for hazards, evacuation, and disaster recovery processes)

- Metadata: Visual/Hierarchical/Dynamic/Self-generated/Integrated/Composite

- Knowledge discovery tools to build empirical models for domain experts

  - Intuitive/visual spatiotemporal queries

  - Link between observation, field experiment, laboratory, and theory

  - Anomaly detection and causality

  - Scenario-based reasoning: support for what-if, counterfactual scenario generation and testing using spatiotemporal information

- Space and time scale harmonization: From atmospheric layers to molecular dynamics

Support for Non-Expert Interaction with Spatiotemporal Information

Leading Areas

- Ambient Spatial Intelligence: Personalized, ubiquitous, location-based services:

  - Scalability

  - Privacy

  - context- and preference-awareness

- Link to social networks: geo-chatting, geo-twitter (location-aware social informatics – geosocial informatics)

- Ad-hoc, purpose-driven social networking: recognizing common spatiotemporal activities and linking users/carriers to exchange information

  - From the classic (transportation services with information shared among neighboring/meeting vehicles) to the more exotic (recognizing patterns of activities and preferences to identify different groups of individuals as they interact with their environment)

Leading Areas (cont.)

- Support for 3-D modeling and interaction of non-professionals with their environment through consumer products (e.g. cameras, cell phones, dashboard-mounted units)

  - Geolocating amateur static and video imagery using scene descriptors

  - Using amateur data to update databases

  - Quality management of volunteered information

  - Delivering specialized information to amateur users to aid their navigation in (and interaction with) urban environments

- Data and information delivery onto new modalities (i-pods, phones, cars etc.)

- Dynamic integration/interaction across scales and domains

- New cross-disciplinary paradigms: Rethinking and expanding the chain from society needs to scientific response

- Privacy (again) and Ethics

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Thank you!