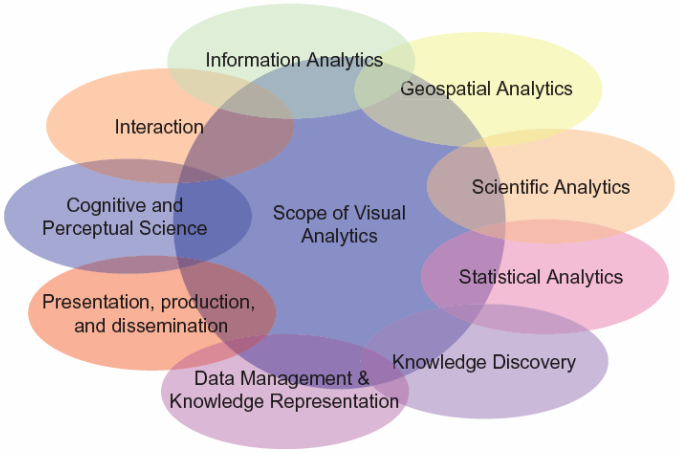
Geospatial Visual Analytics:

suggestions for the

Body of Knowledge for Visual Analytics Education



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http://geoanalytics.net

IEEE VisWeek'08 workshop presentation

Outline

- What is special about spatial data
- Outline of the body of knowledge on geospatial VA
- Existing assets

What is special about spatial data ?

- Spatial heterogeneity
  - places are different (urban vs. rural areas, sea vs. land…)
  - spatial processes operate differently in different places
  - spatial relationships may differ according to direction…
- Autocorrelation in space and time
  - Tobler's law: Everything is related to everything else, but near things are more related than distant things
- Scale
  - Patterns differ depending on scale

characteristics of spatial data

- continuous (measurements are not → error)
- error in:
  - > locations (projection, etc.)
  - > distances (elevation; constraints; alternatives)
  - > attributes (poor models; limited samples)
  - > time
- complexities:
  - > scale (features / processes scale dependent)
  - > time-dependence

… of temporal data

- time is linear AND
- time is cyclical
- multiple embedded & overlapping cycles

Need to integrate human's sense of space and place, tacit knowledge about their properties and relationships

Dimensionality of data in Geospatial Visual Analytics

- multi-dimensional data + geographical space and time that require special attention:
  - Space includes 2 or 3 coordinates plus
    the geographical context (which is difficult to formalize)
  - Time has two models, linear and cyclical;
    often necessary to consider simultaneously several temporal cycles
    (monthly, weekly, daily etc.; these cycles may overlap)

Complexity of data in Geospatial Visual Analytics

- Example: data about moving entities
- Multiple different data sets need to be analyzed together:
  - moving entities and their properties;
  - spatial positions with time stamps and other characteristics (speed, direction…);
  - relevant objects in geo-space (buildings, roads…);
  - relevant events and processes in time (football game, earthquake, IEEE VisWeek, global warming, US elections…)
- Interplay of geography, time and entities:
  - e.g. a {dynamic} query should operate characteristics of movement such as speed, acceleration, direction, turn; all in geographical and temporal context

Summary

In geospatial visual analytics

- it is necessary to work simultaneously with multiple data sets of different structure
- using several visual representations and computational methods working together

General notes:

- geography is not just x,y{,z};
- a map is not equivalent to a scatter plot:
  - a map usually contains several information layers (spatial context)
  - and can activate analyst's knowledge about space & places
- distances in geo space ≠ distances on a plane
  - distances on the Earth surface
  - domain-specific distances, e.g. along roads; anisotropy
  - barriers, inaccessible places, …

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Outline of the Body of Knowledge on Geospatial VA

- Spatial and spatio-temporal objects and phenomena: types and properties
- Representation of phenomena and objects in data; types of spatial and spatio-temporal data
- Visualisation of spatial information: cartographic principles and representation techniques; geovisualisation
- Transformations of spatial and spatio-temporal data
- Elements of spatial statistics
- Analytical methods for different types of spatial and spatio-temporal data
- Spatial decision support

Elements of Body of Knowledge
Types of Spatial Objects and Phenomena

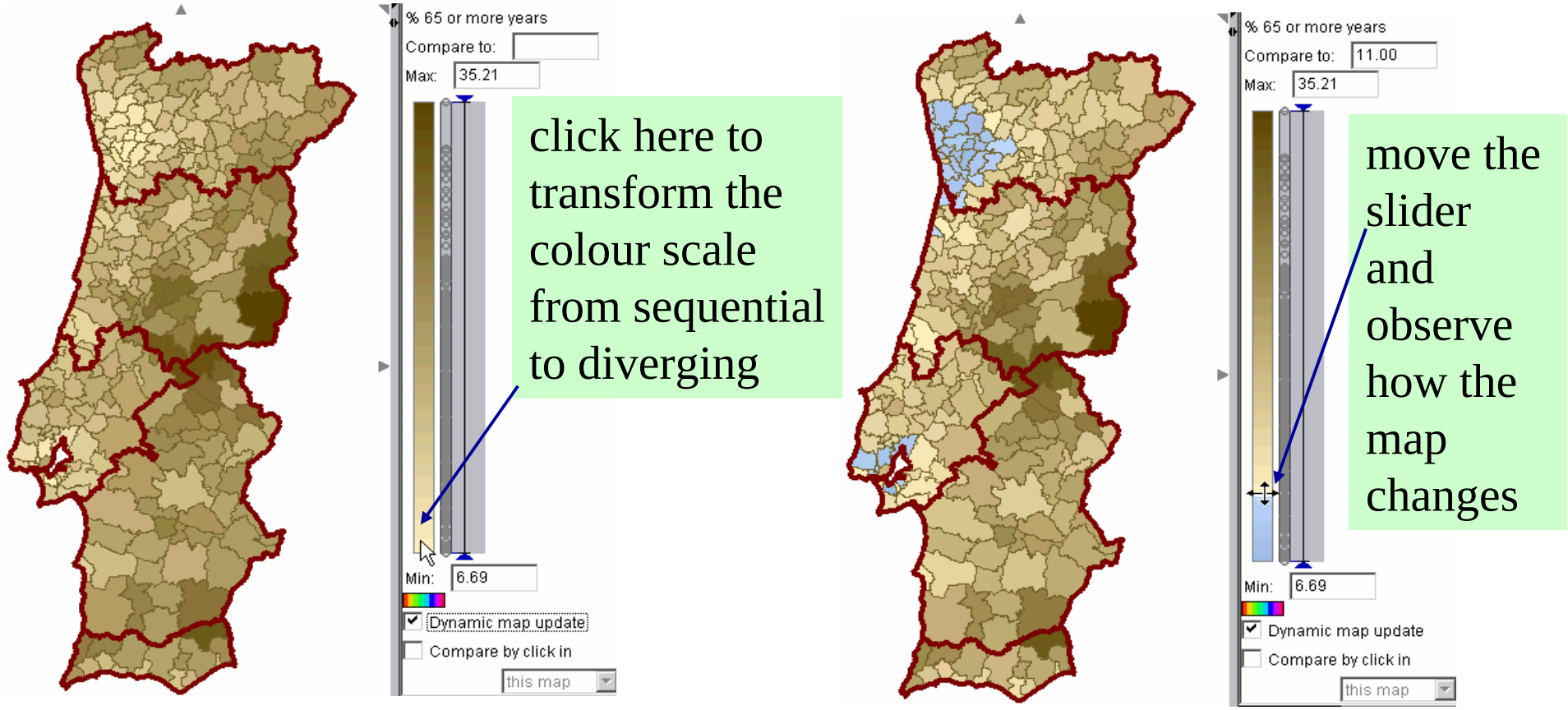
- Discrete spatial objects vs. spatially continuous phenomena
- Point, lines, areas, surfaces
- Smooth vs. abrupt spatial variation
- Spatial divisions and spatially aggregated information
- …
- Role of scale

Elements of Body of Knowledge
Types of Temporal Variance

- Changes of thematic properties (values of attributes) associated with places
  - e.g. district population, data from stationary sensors
- Existential changes (appearance and disappearance)

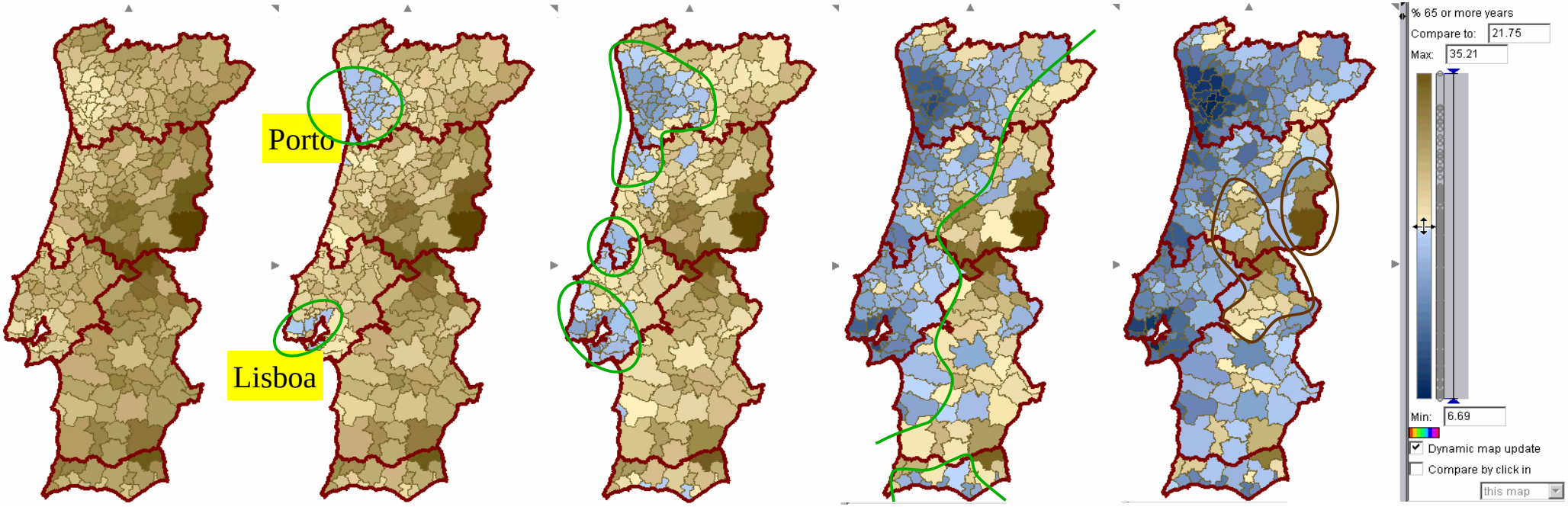
  Events: objects with limited life time
  - e.g. earthquakes, traffic incidents, observations of rare plants or animals
- Changes of spatial properties: location, size, shape, orientation, altitude, etc.
  - e.g. movement of vehicles, growth of cities
- …

Elements of Body of Knowledge
Visual representation and interaction (an example)



Elements of Body of Knowledge
Visual representation and interaction (patterns to look for)

By moving the slider, we see more patterns and gain more understanding of value distribution



West-to-east increase

Clusters of low values around Porto and Lisboa

One more cluster of low values

Coast-inland contrast

Clusters of high values in central-east

Spatial decision support

Specific features of spatial decision support problems:

- Complex nature of geographic space
- Multiple actors with different roles
- Tacit criteria and knowledge

Requirements to Visual Analytics:

- Support decision making as a process (stages: intelligence, design and choice)
- Support exploration of the problem and solution options
- Support rational choice
- Support reasoning, deliberation and communication
- Support time-critical decision making
- Support analysis of decision effectiveness and revision of decisions
- Support different actors

Course on Geospatial Visual Analytics
http://geoanalytics.net/and/lecturesVA

Geospatial Visual Analytics: lectures

- Lecture 1. Introduction to Visual Analytics slides
- Lecture 2. Interactive Maps and Multiple Coordinated Views in Geospatial Visual Analytics slides
- Lecture 3. Data Transformations for Geospatial Visual Analytics slides
- Lecture 4. Visual Analysis of spatio-temporal Data (time series) slides
- Lecture 5. Visual Analysis of spatio-temporal Data (events) slides
- Lecture 6. Visual Analysis of spatio-temporal Data (behaviors of moving objects) slides
- Lecture 7. Visual Analysis of spatio-temporal Data (collective movement) slides
- Lecture 8. Spatial Decision Support slides
- Concluding Remarks slides

This course has been presented in KTH Stockholm, October 2008

Questions and comments: Natalia and Gennady Andrienko http://geoanalytics.net/and

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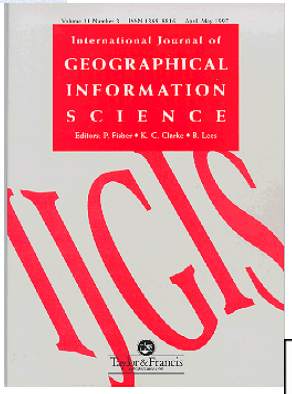
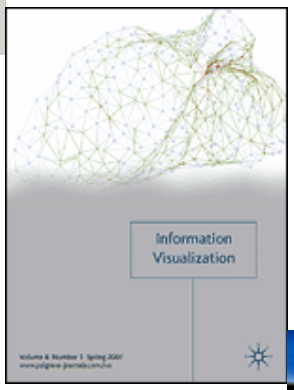
International Cartographic Association
Commission on GeoVisualization

http://geoanalytics.net
welcome to join our activities!





- GIScience 2006 workshop outcomes:
  Special issue on
  "GeoVisual Analytics for Spatial Decision Support",
  including "Setting the Research Agenda" paper
  Int.J.GIScience, 2007, v.21(8)
- AGILE 2008 workshop (May 2008, Girona, Spain)
  "GeoVisualization of Dynamics, Movement and Change"
  Special issue of
  Information Visualization (issue 3/4, 2008),
  including "Key issues & developing approaches" paper
  http://geoanalytics.net/GeoVis08/ (long abstracts, slides)
- GIScience workshop (September 2008, Salt Lake City, USA)
  "Geospatial Visual Analytics"
  forthcoming special issue of
  Cartography and GIScience (issue 3, 2009)
  http://geoanalytics.net/GeoVisualAnalytics08/ (long abstracts, slides)