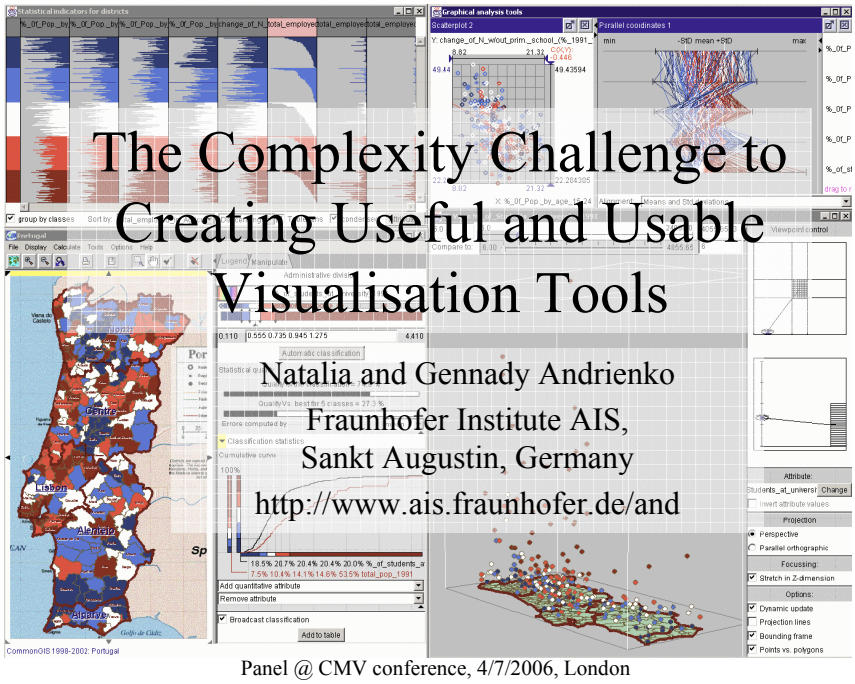

The Complexity Challenge to Creating Useful and Usable Visualisation Tools

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Panel @ CMV conference, 4/7/2006, London

The Value of Visualisation

- Visualisation can stimulate insight into data and underlying phenomena
  - Many positive examples; see "Graphic Discovery" by H.Wainer, books from E.Tufte, …
- Visualisation can also be useless or even misleading
  - Not always it uncovers non-obvious things
  - Not always the viewer understands what is seen
  - It can stimulate jumping to wrong conclusions

Provocative Questions

- Is insight always gained by chance?
- Is visual analytics an art requiring specific talent?
- Is the number of successful applications of any visualisation tool close to 1?
  - specifically, the example described in the paper about this tool (if any)

Discoveries can have a huge impact but they occur very rarely, or not at all.

Catherine Plaisant @ AVI 2004

If the answers are positive…

- Is insight always gained by chance?
- Is visual analytics an art requiring specific talent?
- Is the number of successful applications of any visualisation tool close to 1?
  - specifically, the example described in the paper about this tool (if any)

- It is not worth to invest effort and money in the visualisation research and in "creating instruments for ideation"

⇒ It is in our interests to **prove** that the answers are **negative**!

Negative answers mean …

- Is insight always gained by chance?
- Is visual analytics an art requiring specific talent?
- Is the number of successful applications of any visualisation tool close to 1?
  - specifically, the example described in the paper about this tool (if any)

- No, this is a result of systematic efforts
- No, this is a skill that can be acquired by an ordinary person
- No, it is possible to create such tools that not only the authors can successfully apply

The Negative Answers Pose Challenges

- Insight is a result of systematic efforts
  - What is the system? How can insight be planned?
- Visual analytics is a skill that can be acquired by an ordinary person
  - What are the principles and procedures to acquire?
  - How these can be effectively taught?
- It is possible to create such tools that not only the authors can successfully apply
  - What qualities and abilities must these tools possess?

Attempts to Respond

- Visual analytics is a skill that can be acquired by an ordinary person
  - What are the principles and procedures to acquire?
  - How these can be effectively taught?

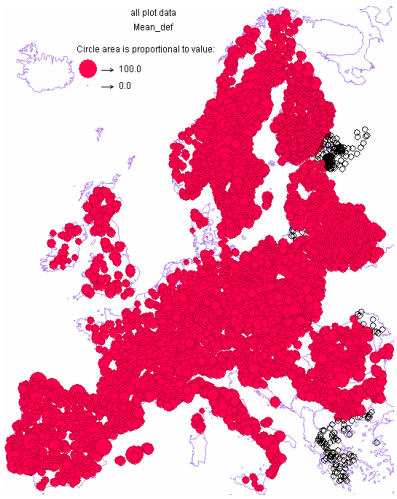
Teaching by example:

- An experiment with domain specialists
- Using a non-trivial dataset from their domain
- Visual exploration done by visualisers
- An illustrated report for the domain experts

(a few excerpts follow)

The Data

- Large volume: 6169 spatially-referenced time series
- Dimensions: Space × Time
- Many missing values
- Lack of spatial and temporal smoothness



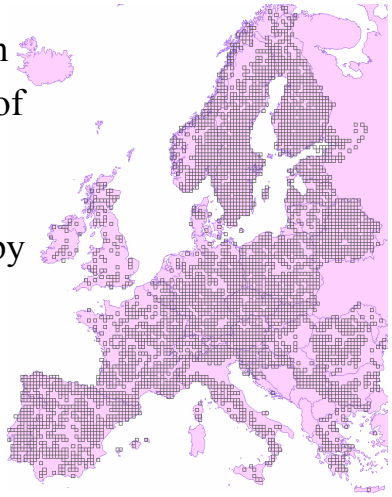
General Procedure

1. See the whole
   - Space + Time → 2 complementary views
     1) Evolution of spatial patterns in time
     2) Distribution of temporal behaviours in space
2. Divide and focus
   - Data are complex → Have to be explored by slices and subsets (object groups, countries, years, …)
3. Attend to particulars
   - Detect outliers, strange behaviours, …

See the whole: Handle large data volumes

- Approach: data aggregation
- Task 1: Explore evolution of spatial patterns
- Appropriate data transformation: aggregate by small space compartments (regular grid); various aggregates (mean, max)

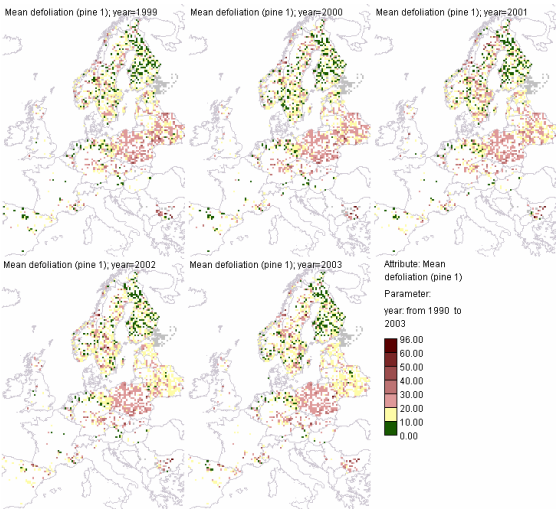
➢ Gain: no symbol overlapping



Explore evolution of spatial patterns

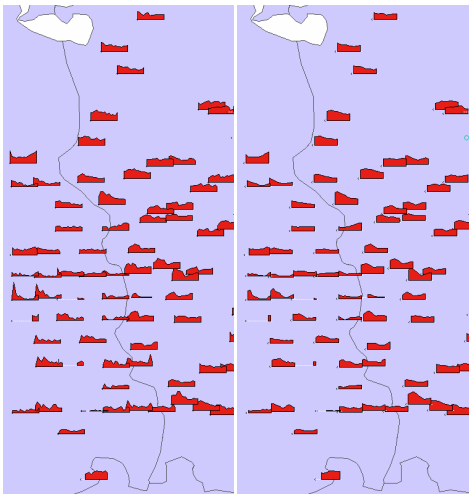
a) Animated map
b) Map sequence

Observations:
- Persistently high values in Poland
- Improvement in Belarus
- Mosaic distribution in most countries: great differences between close locations
- Outliers



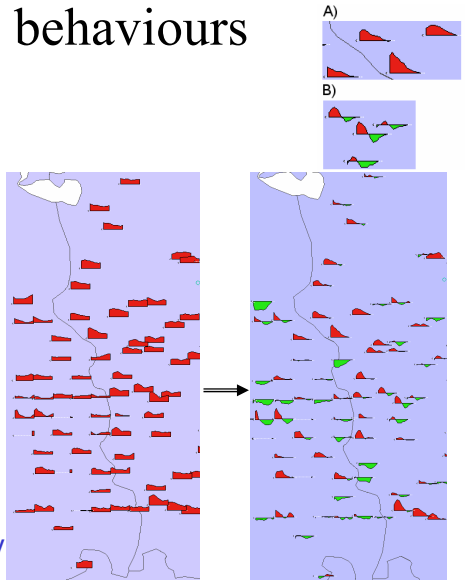
Explore spatial distribution of temporal behaviours

- Are behaviours in neighbouring places similar?
- Step 1. Smoothing supports revealing general patterns and disregarding fluctuations and outliers (we shall look at outliers later)



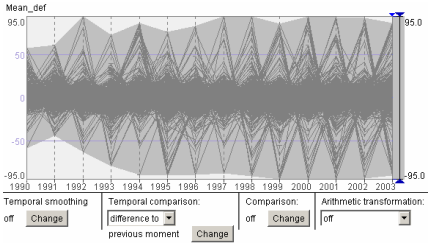
Explore spatial distribution of temporal behaviours

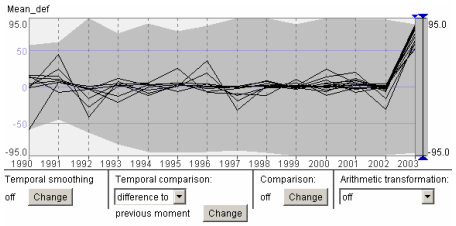
- Are behaviours in neighbouring places similar?
- Step 2. Temporal comparison (e.g. with particular year, mean for a period) helps to disregard absolute differences in values and thus focus on behaviours



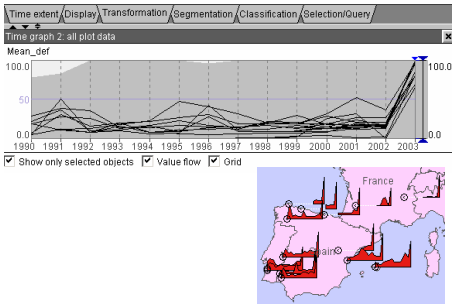
Observation: no strong similarity between neighbouring places

Attend to particulars: extreme changes





1. Transform the time graph to show changes
2. Select extreme changes in a specific year (here 2003)



Tools

- Visualisation on thematic maps, time graphs, other aspatial displays
- Aggregation: reduce data volume and symbol overlapping; simplify and abstract data
- Filtering: divide and focus (select subsets)
- Display coordination: see corresponding data on different displays from various viewpoints
- Data transformation: smoothing, computing changes, normalisation etc.

It is important to use the tools in combination

Reaction of the "Students"

- It is too complex!
- We have our own tools and established procedures of data analysis! (e.g. spatial statistics)
- Better give us simple tools for presenting our {view on} data to external world!

Usability?

- The tools are complex to understand and difficult to use?
  - No, each tool is quite manageable *(users' opinion)*
- The tools are too numerous and diverse; they can be combined in many ways
  - Just reduce the number of tools? But none of them seems to be excessive! *(users' opinion)*
- How can we know when to apply what? *(users' cry for help)*

Visual Analysis is inherently complex!

- View data from various perspectives
  - e.g. temporal variation of spatial behaviour vs. spatial variation of temporal behaviour
- View data at various scales
  - from "see the whole" to "attend to particulars"
- "See in relation" (make numerous comparisons)
- Decompose and synthesise
- Requires multiple diverse tools

Appropriate approaches?

- "Ostensible simplicity": be powerful and flexible but appear light and simple
  - Find the minimal tool combination sufficient for given data and tasks; hide unnecessary tasks
    - Theoretical background required
  - Automate whatever possible
- User guidance: be able to guide inexperienced users
  - Define generic procedures of visual analysis
  - Find good ways to provide guidance (not annoying!)
- "Incremental intelligence": be able to learn from experienced users
  - Store analysis scenarios; recognise similar cases; replay

Additional requirements

- Link exploratory tools (hypothesis generation) with confirmatory (hypothesis testing)
- Give facilities to capture and communicate observations and discoveries (transform user's visual impressions and ideas into something tangible)

Conclusion

- Is it possible to create “instruments for ideation” with such capabilities?
- Are visualisation researchers ready to join their efforts for responding the complexity challenge?