Parameter Spaces; Conclusions

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Vienna University of Technology,
VRVis Research Center, Vienna
Parameter Space Exploration

Many different approaches

Main tasks for ensemble simulations:

- What are the outputs for selected control parameters?
- Which control parameters should I choose for desired output?
- What happens when I change parameters?
World Lines

Simulation steering for flood management

Video
Vismon

Parameter space exploration for fisheries

Vismon: Facilitating Analysis of Trade-Offs, Uncertainty, and Sensitivity In Fisheries Management Decision Making

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3Department of Computer Science, University of British Columbia

Abstract
In this design study, we present an analysis and abstraction of the data and task in the domain of fisheries management, and the design and implementation of the Vismon tool to address the identified requirements. Vismon was designed to support sophisticated data analysis of simulation results by managers who are highly knowledgeable about the fisheries domain but not experts in simulation software and statistical data analysis. The previous workflow required the scientists who built the models to spearhead the analysis process. The features of Vismon include sensitivity analysis, comprehensive and global trade-offs analysis, and a staged approach to the visualization of the uncertainty of the underlying simulation model. The tool was iteratively refined through a multi-year engagement with fisheries scientists with a two-phase approach, where an initial diverging experimentation phase to test many alternatives was followed by a converging phase where the set of multiple linked views that proved effective were integrated together in a usable way. Several fisheries scientists have used Vismon to communicate with policy makers, and it is scheduled for deployment to policy makers in Alaska.

Categories and Subject Descriptors (according to ACM CCS): I.3.8 [Computer Graphics] Applications H.5.2 [Information Interfaces and Presentation] Graphical User Interfaces (GUI), Evaluation/methodology
Vismon

Figure 2: The Vismon interface: (a) Constraint pane, top-left, shows the list of management options and indicators in separate tabs; (b) Contour Plot Matrix pane, top-right, shows the contour plots of indicators as functions of the two management options and supports scenario selection; (c) Trade-offs pane, bottom, shows detail with the indicators for the selected scenarios; (d) Separate sliders are assigned to management options and indicators in Constraint pane.
Decision Trees

Interactive Exploration of Parameter Space in Data Mining: Comprehending the Predictive Quality of Large Decision Tree Collections

L. Padua, H. Schulze, K. Matkovic, C. Delreiuix

C&G 2014
Main Idea

Decision tree collection

Parameters have to be set in order to create a tree

240 trees

ROC Curves

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
<th>Attribute</th>
<th>Independent or Dependant</th>
<th>Type</th>
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<td>0.05, 0.10, 0.15, 0.2</td>
<td>Independent</td>
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<td>Function</td>
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Main Idea

Decision tree collection

Parameters have to be set in order to create a tree

240 trees

ROC Curves
Parameters Exploration
Parameters Exploration

a.

b.

c.
Decision Tree Collections

Very positive feedback

Great potential
Spinel Explorer
The Spinel Explorer
Interactive Visual Analysis of Spinel Group Minerals

M. L. Ganuza, G. Ferracutti, F. Gargiulo,
S. M. Castro, E. Bjerg, E. Gröller, K. Matković
What are Spinels?

Constituents of igneous and metamorphic rocks

Oxides of, e.g., magnesium, iron, manganese, ...
What are Spinels?

Very resistant to chemical modifications after the crystallization

- Provide useful information about geological environment where host rocks were formed

- Great help in search for mineral deposits of economic interest
Data Collection

Microprobe Analysis

Slicing

EMG

11 major chemical elements

<table>
<thead>
<tr>
<th>sample</th>
<th>TiO(_2)</th>
<th>Al(_2)O(_3)</th>
<th>Cr(_2)O(_3)</th>
<th>V(_2)O(_3)</th>
<th>FeO</th>
<th>MnO</th>
<th>MgO</th>
<th>CaO</th>
<th>ZnO</th>
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<td>0.05</td>
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... ... ... ... ... ... ... ... ... ... ...

Magnetite and Ulvöspinel end-members, 60 dimensions in total

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<tr>
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<th>MnAl(_2)O(_4)</th>
<th>ZnAl(_2)O(_4)</th>
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... ... ... ... ... ... ... ... ...

Data Characteristics

Ratio Columns – 3 columns summ to 100%
3 such column groups

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Data Characteristics

Ratio Columns – 6 columns summ to 1 (100%)
2 such column groups

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<td>0.28</td>
<td>0.01</td>
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</tbody>
</table>
```
Plotting Data

Ratio columns are plotted using triangular and prism plot
Current Workflow – Static Diagrams
Current Workflow – Static Diagrams

Magnetite Prism

Ulvöspinel Prism
Spinel Explorer Motivation

Plots typically used in the spinel chemical analysis are static.

They are also generated employing different tools, and printouts or screenshots are then used in the analysis.

Tedious manual comparison is a daily routine of experts.
Interactive Spinel Explorer

Unified system for the exploration of spinel minerals

Linked views supporting:

- Scatter-plots, triangle plots, spinel prism, histograms, parallel coordinates, and statistics overviews

Multiple composite brushing
Interactive Spinel Explorer
Interactive Triangle Plot
Interactive Triangle Plot
Interactive Triangle Plot
Interactive Triangle Plot
Interactive Triangle Plot
Interactive Spinel Prism
Interactive Spinel Prism
Analysis Goals

Two key objectives to determine:

Tectonic setting based on the chemical composition

Geological processes linked with the compositional variation of the spinel group minerals dataset
Case Study

Ophiolites from Frontal Cordillera of Central Andes

Different compositional groups related with diverse geological processes

Identify different geological processes
Workflow

Data preparation

- Samples are analyzed as described
- 60 dimensional data set is available

State of the art:

- Manual exploration of the similarities of subgroups

New method:

- Interactive exploration of the similarities of subgroups
Case Study

Ophiolites from the Frontal Cordillera of the Central Andes, Argentina

Using the Spinel Explorer

1. Control parameters configuration.

2. Scatterplots view set up.
Case Study

Ophiolites from the Frontal Cordillera of the Central Andes, Argentina

Using the Spinel Explorer

1. Control parameters configuration.
2. Scatterplots view set up.
   - A trend is detected!
Case Study

Ophiolites from the Frontal Cordillera of the Central Andes, Argentina

Using the Spinel Explorer

1. Control parameters configuration.

2. Scatterplots view set up.
   - A trend is detected!

3. Magnetite prism view to verify the trend.
Case Study

Ophiolites from the Frontal Cordillera of the Central Andes, Argentina

Using the Spinel Explorer

1. Control parameters configuration.

2. Scatterplots view set up.
   - A trend is detected!

3. Magnetite prism view to verify the trend.
   - The plot confirms what we expected!
   - 3 different groups seem to be identified.
Case Study

Ophiolites from the Frontal Cordillera of the Central Andes, Argentina

Using the Spinel Explorer

1. Control parameters configuration.

2. Scatterplots view set up.
   - A trend is detected!

3. Magnetite prism view to verify the trend.
   - The plot confirms what we expected!
   - 3 different groups seems to be identified.

4. Additional views confirm that the dataset comprises three main compositional groups.


VRvis
Case Study

Ophiolites from the Frontal Cordillera of the Central Andes, Argentina

Using the Spinel Explorer

Cr-rich group represents the magmatic composition of the spinel minerals.

Al-rich group represents metamorphosed spinels in conditions of very high temperature.

Al-poor group with the strong variation in the Y(Fe) ratio represents metamorphic crystals.
Evaluation and Lessons Learned

Developed in close cooperation with geologists

Geology researchers are main users

Impressed and hesitant to use “such a complicated system” at first

We needed “their“ views

Very positive feedback on parallel coordinates (unknown up to now)

Very quick adaptation, due to intensive static plots use?
Evaluation and Lessons Learned

Developed in close cooperation with geologists

Geology researchers are main users

"I really like the possibility to show many end-members at once. The solution seems really simple, and yet, I never thought something like this would be possible", (as up to now)

Very quick adaptation, due to intensive static plots use?
Conclusions

We introduce unified visual analytics framework for geological data

Spinel Explorer employs coordinated multiple views, and, for the first time, interactive triangle plot and interactive spinel prism

We introduce a new domain to visual analytics community, and new analysis procedures and new plots to the geology community

Geologists feedback on interaction and integration into a unified framework was very positive

Future work: semi-automatic comparison, interactive splitting planes, semi-automatic clustering
Interactive Visual Analysis – main idea

On top level:

- due to the data→information→knowledge cascade (knowledge/insight being implicitly coded within data), we need means to abstract insight from data
- integrating the best from “two worlds”, we combine
  - data exploration/analysis by the user, based on interactive visualization
  - and data analysis by the computer, based on statistics, machine learning, etc.
- IVA, in general, is a loop (interactive & iterative),
  1. usually starting with some data visualization first,
  2. followed by user inspection and certain interaction
  3. the user interaction causes a new visualization, ⇒ 2.
  4. user-induced computations lead to vis., again, ⇒ 2.

IVA works for engineers, bioinformaticians, climatologists, ...
Basis of IVA

Given some data, e.g.,
- a (large) bunch of time series,
- some (larger) tables of numbers (usually multiple columns),
- spatiotemporal data that is multivariate,
- etc. (yes, it’s really that general!),

IVA is
- a flexible exploration & analysis methodology
- that utilizes a variety of different views on the data
- and feature extraction (interactively & computationally)

IVA enables
- interactive information drill-down, while navigating between overview & detail, seeing the unexpected, e.g., for hypothesis generation, steering the analysis
- IVA bridges the gap between the data & the user
Whereas data is explicit, information often is implicit.
From Data to Information (Insight)

Whereas data is explicit, information often is implicit

We need to

- interpret data (from numbers to meaning)
- read between the lines (relational information)
- pursue information drill-down (deep search)

Approaches are

- procedural, computational, automatic
- interactive (user in the interaction-feedback-loop)
- hybrid
Level 1: KISS-principle IVA

Base-level IVA (*solves many problems, already!*)
- bring up at least two different views on the data
- allow to mark up interesting data parts (*brushing*)
- utilize **focus+context visualization** to highlight the user selection consistently(!) in all views (*linking*)

With base-level IVA, you can already do
- **feature localization** – *brush high temperatures in a histogram, for ex., and see where they are in spacetime*
- **local investigation** – *for ex., select from spacetime and see how attributes are there (compared to all the domain)*
- **multivariate analysis** – *brushing vorticity values and studying related pressure values (selection compared to all)*
Getting more out of IVA (advanced IVA)

Starting from base-level IVA, level 2,

- we enable the **identification of complex features**, for ex., by exploiting a *feature definition language*
- we realize **advanced brushing schemes**, e.g., by realizing a *similarity brush*

With advanced IVA,

- we **drill deeper** (data → selections → features → ...)
- we **read between the lines** (semantic relations)
- **answer complex questions** about the data
Getting more out of IVA (advanced IVA)

Starting from base-level IVA, level 3,

- we facilitate interactive attribute derivation, e.g., by means of a formula editor
- we integrate statistics/ML on demand, e.g., by linking to R

With advanced IVA,

- we drill deeper (data → selections → features → ...)
- we read between the lines (semantic relations)
- answer complex questions about the data
Levels of IVA

1. Show
2. Brush
3. Combination
4. Multiple views & selections

5. Show
6. Brush
7. Combination
8. Multiple views & selections

9. Show
10. Brush
11. Combination
12. Attribute derivation
13. Multiple views & selections
14. Advanced brushing
Conclusions

IVA helps to integrate the user’s and the computer’s strengths to enable exploration and analysis

IVA is interactive and iterative

An approach to realize semantic abstraction from data (to features, insight)

Enables the joint analysis based on multiple perspectives, e.g., several feature detectors

Helps with questions of different character (physical, geometric, statistical, ...)

Info Vis – what have we learned?

What is InfoVis

“The use of computer-supported, interactive, visual representations of abstract data to amplify cognition”
Typical Visualization Tasks

Visualization is (can be) good for:

- exploration
  - find the unknown, unexpected
- hypothesis generation
- analysis
  - confirm or reject hypotheses
- information drill-down
- presentation
  - communicate/disseminate results
InfoVis Reference Model

Data
- Raw Data
- Data Tables

Visual Form
- Visual Structures
- Views

Data Transformations
- Visual Mappings
- View Transformations

Human Interaction (controls)
Visual Analytics – What is it?

James Thomas & Kristin A. Cook:

“Visual Analytics is the science of analytical reasoning facilitated by interactive visual interfaces”

[Thomas & Cook 2005]
Info Vis – what have we learned?

A little bit about colors and perception
Info Vis – what we learned?

TreeMap, table lens, Parallel coordinates, Chernoff faces,...
Info Vis – what have we learned?

Complex data

Some examples from real life

Families of curves, surfaces, sets
  - Everywhere
  - Many possibilities for analysis
  - Very hard to do it in a conventional way
  - Multiple simulation runs, image collections, car racing, bio-signals, ECG of pregnant sheep!, questionnaires, ...

Ideas

Praktikums – Diplomarbeiten!
Info Vis – what we did not learn?

Software Visualisierung

Visualisierung in der Bioinformatik (Andreas Karen)

Graph Drawing (Andreas Karen)

Text Visualization

Casual InfoVis, Many Eyes

InfoVis and Art

...
The Top Grossing Film of All Time, 1 x 1  2000

Jason Salavon
Thank you!

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