Global Scientific Data Infrastructures: The Role of Data Visualization

Capri, 12.5.2011

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Fraunhofer Institute for Computer Graphics Research (IGD)

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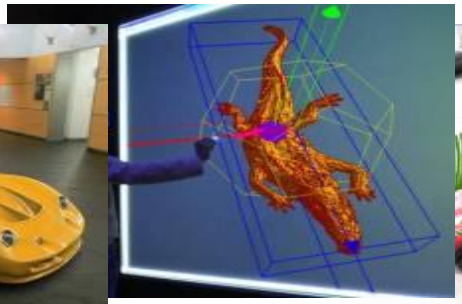
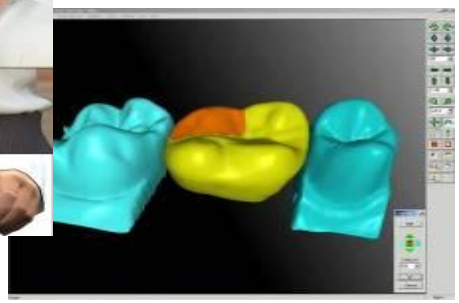
Fraunhofer IGD

- **Research and Development in the area of Computer Graphics**
  - Director: Prof. D. Fellner, 180 Researchers (FTE), 17 Mio. € Turnover
  - 4 locations: Darmstadt, Rostock (Germany),Singapore and Graz (Austria)

- Applications in Different Domains
  - Product development (automotive, aerospace, architecture, garment industry …)
  - Medical IT
  - Traffic Engineering and Telematics
  - Ambient Intelligence
  - Financial Sector (Information Visualization, Information Mining)
  - e-Application, e-Learning, e-Business, Digital libraries

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TUD Graphisch-Interaktive Systeme

Technische Universität Darmstadt, Germany – Interactive Graphic Systems Group

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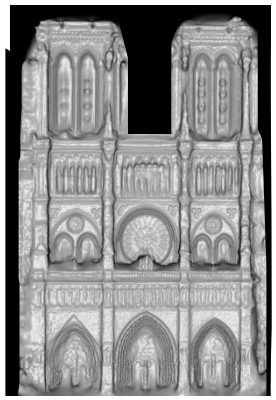
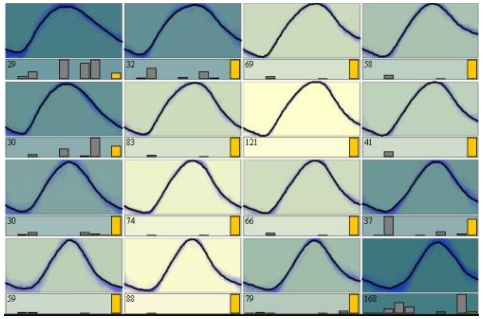
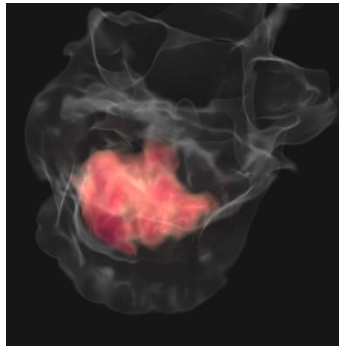
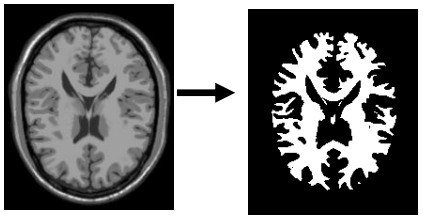
Fraunhofer IGD

- Head: Prof. Fellner
- Research Areas
  - Visual Inference (Prof. Roth)
  - Capturing Reality (Prof. Goesele)
  - Medical Computing (Dr. Wesarg)
  - Image and Shape Analysis (Doc. Kuijper)
  - Visual Analysis and Search (Dr. v. Landesberger)
- Close cooperation with
  - Fraunhofer IGD
  - Graz University of Technology









TUD Graphisch-Interaktive Systeme

Overview

1. Introduction
2. Visual Support for Data Workflows
   1. Data acquisition
   2. Data curation
   3. Data analysis
   4. Data publishing
3. Conclusion

Overview

1. Introduction
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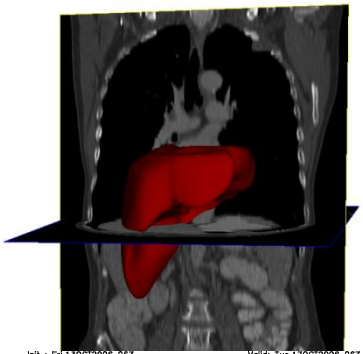
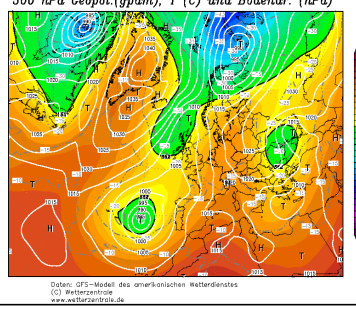
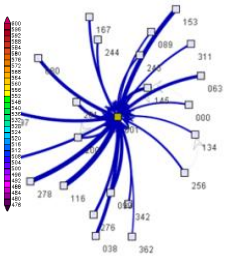
1. Scientific Data

- Massive amounts data arise in research projects
  - Climate Research, Earth Observation, Nuclear and High Energy Physics, etc.
  - Biomedical research
  - …
- Various types of data
  - Spatial and abstract data
    - Time series, multivariate data, spatial data, graphs,…
  - Multimedia data
    - Pictures, videos, 3D models,…

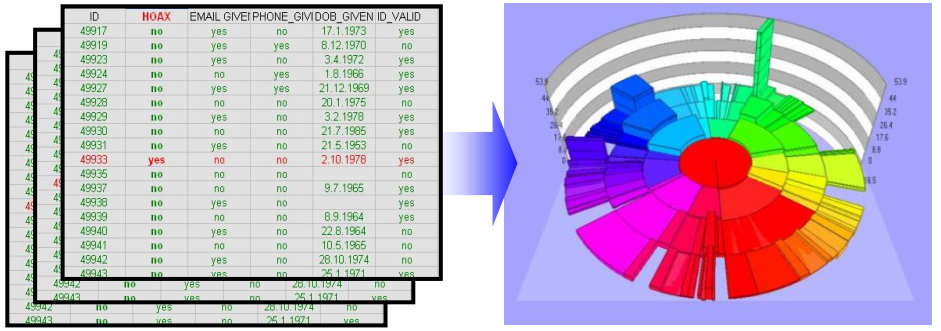


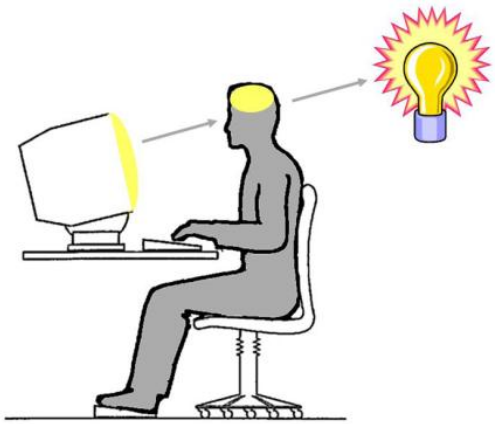


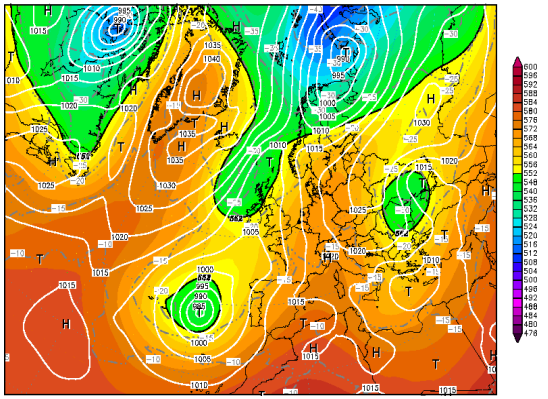


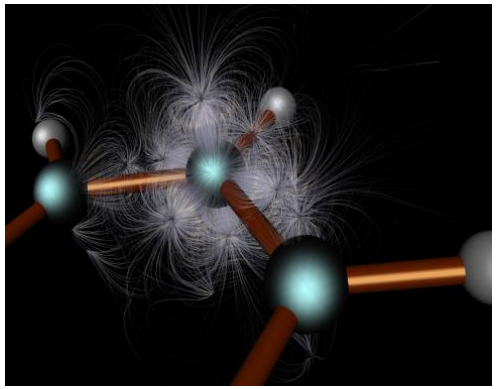
1. Introduction to Data Visualization

- **Visualization role**
  - “A picture is worth a thousand words”
    - makes it possible to absorb large amounts of data quickly
  - “Using vision to think”
    - Natural human sense to identify complex / new patterns





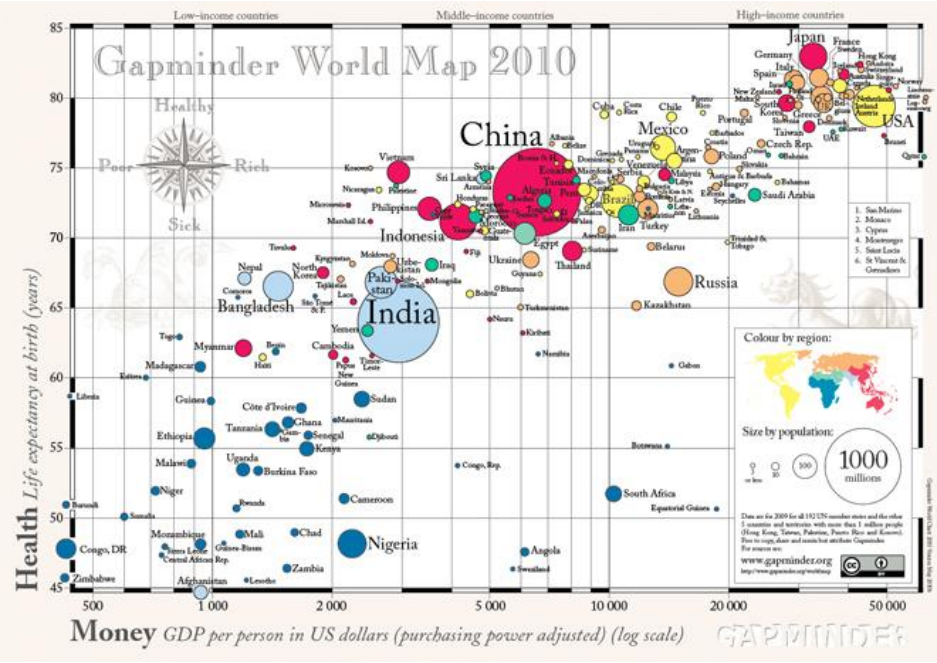




1. Introduction to Data Visualization

- **Visualization role**
  - "A picture is worth a thousand words"
    - makes it possible to absorb large amounts of data quickly
  - "Using vision to think"
    - Natural human sense

- **Interaction**
  - Exploration of the data from various sides
  - Focus on interesting parts

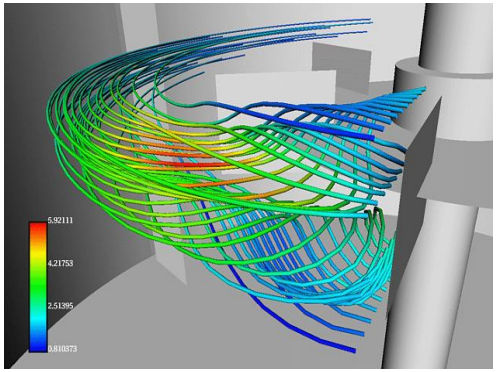


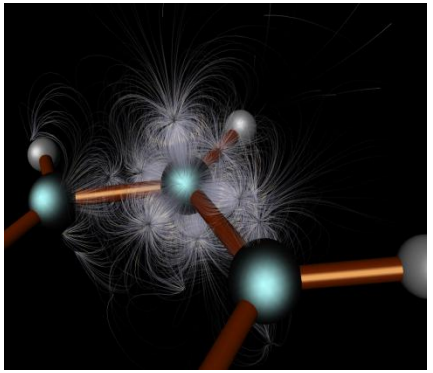
→ **Human-driven data understanding**

www.gapminder.org

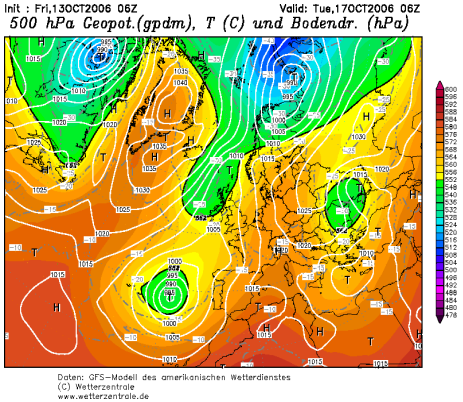
1. Data Visualization – a Traditional View

- **Visualization**
  - “Nice pictures” of the available data
  - Present scientific results
  - Understand scientific results





Can visual computing do more?



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2. Visual Support for Scientific Data Workflow

- Visualization as an integral part of scientific data workflows

- Visual support for **all stages** of scientific data workflow
  - Visualization as a **key way** of producing, examining and accessing scientific data
  - Scientific data includes "**visual documents**"
    → visual computing methods

2. Visual Support for Scientific Data Workflow

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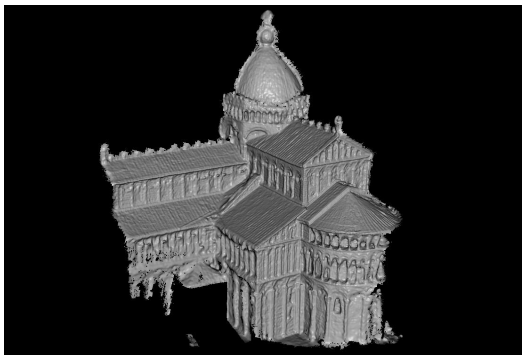
Acquire | Curate | Analyze | Publish

- Automatic data capturing (e.g., video)

  →data processing to gain more information

→Manual data collection/creation

  - Individual
  - Community-based



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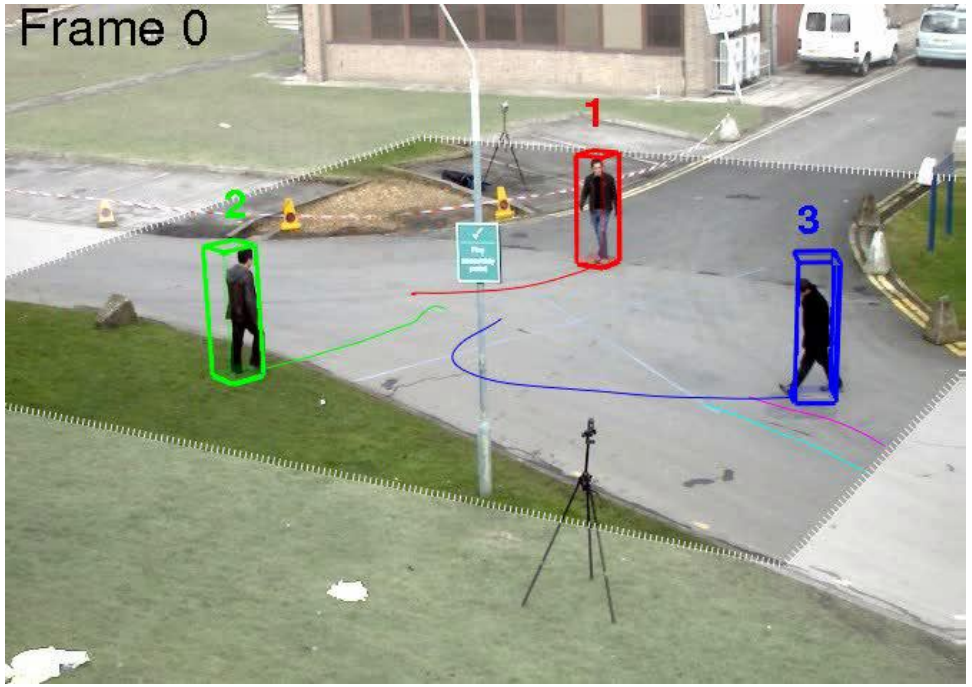

Human tracking in complex environments

[Andriyenko et al. 2011]

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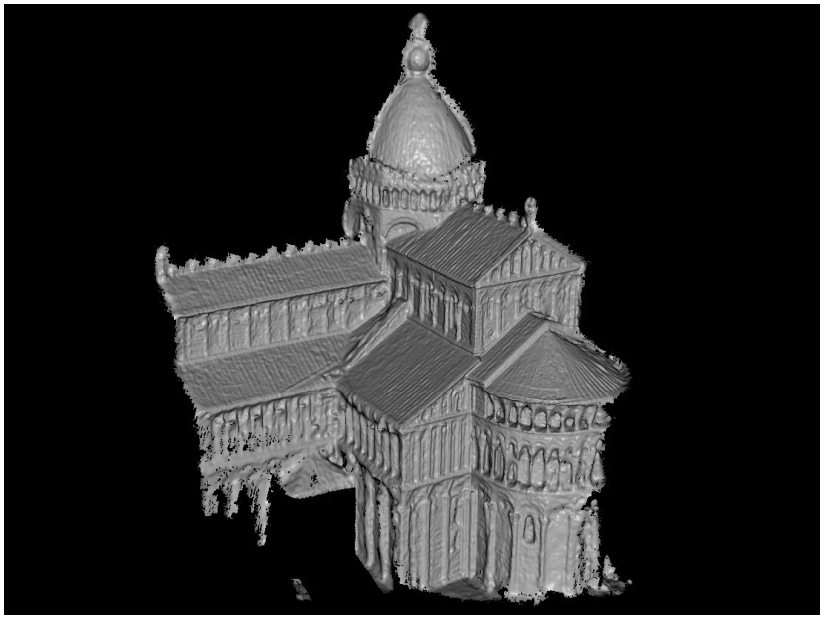

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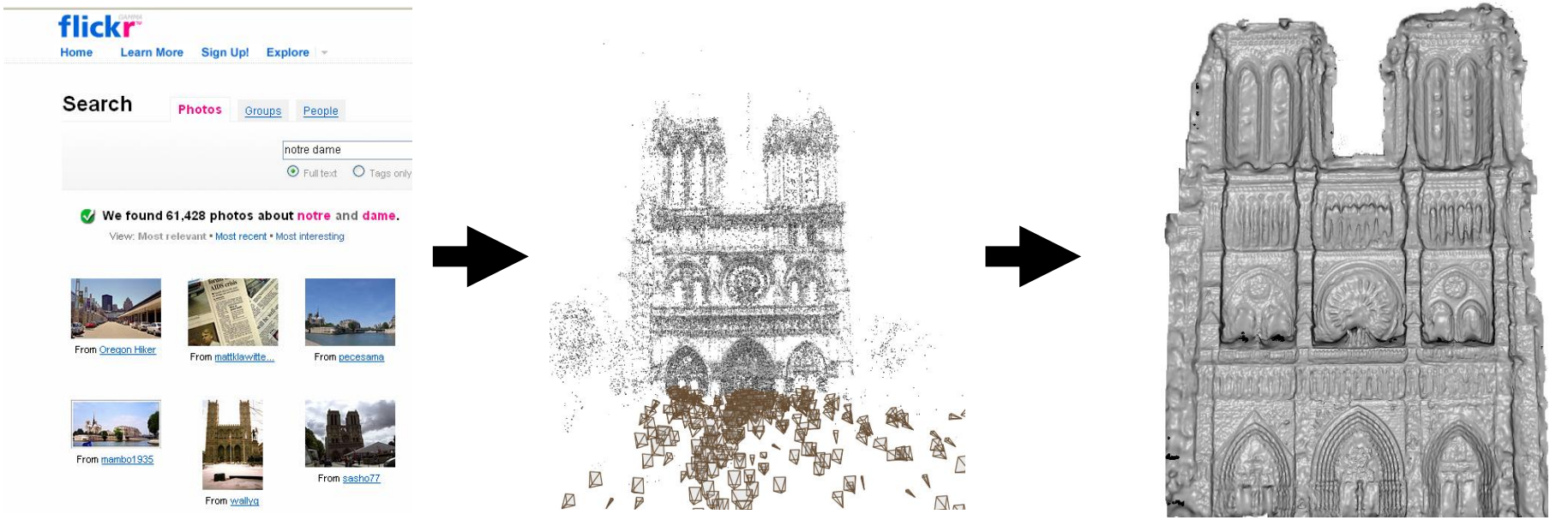

- Reconstruction of a 3D Model using multi-view stereo [Goesele et al. 2007]
- Notre Dame facade based on 653 photos from Flickr captured by 313 persons

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2. Visual Support for Scientific Data Workflow

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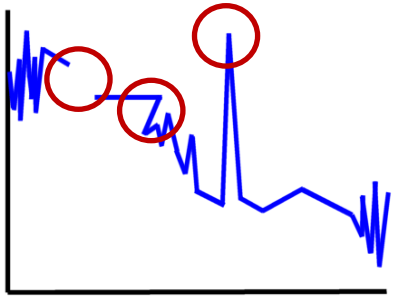
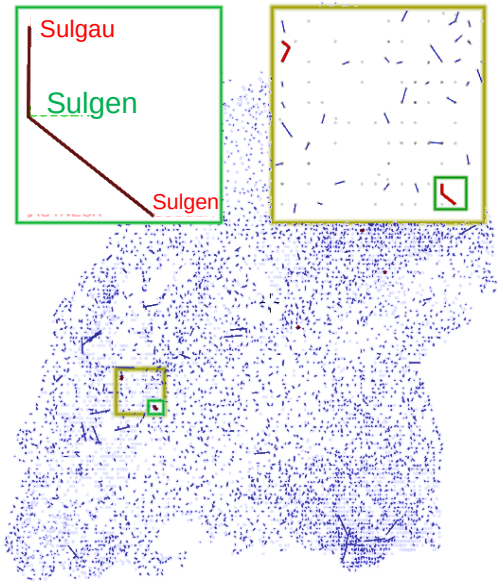
Acquire | **Curate** | Analyze | Publish

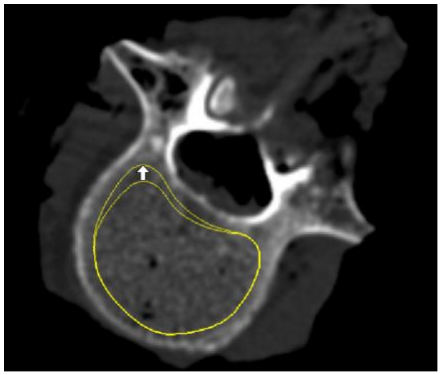
- Show acquired data
  - Data quality information
  - Decision on further processing





[Sanftmann et al. 2009]

- Visual data curation
  - Visual data editing



[Wesarg et al.2010]

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2. Visual Support for Scientific Data Workflow

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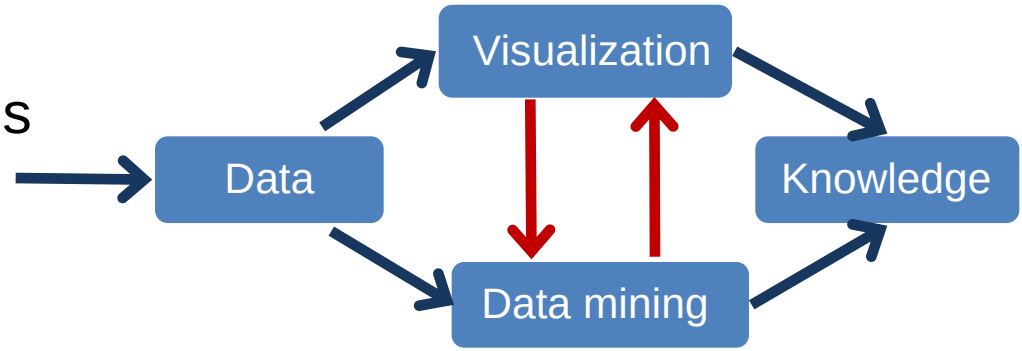
Acquire > Curate > **Analyze** > Publish

- Visual support for data analysis
  - Visual data mining
  - Visual feedback



- Visual support for collaborative data analysis

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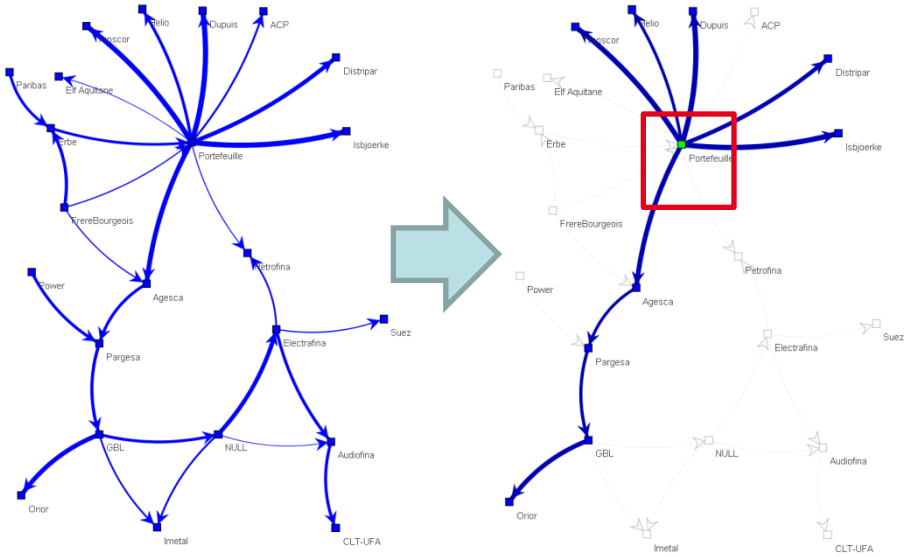
  - Visual data mining
  - Visual feedback
- Visual support for collaborative data analysis

Visual graph analysis



[von Landesberger et al. 2008]

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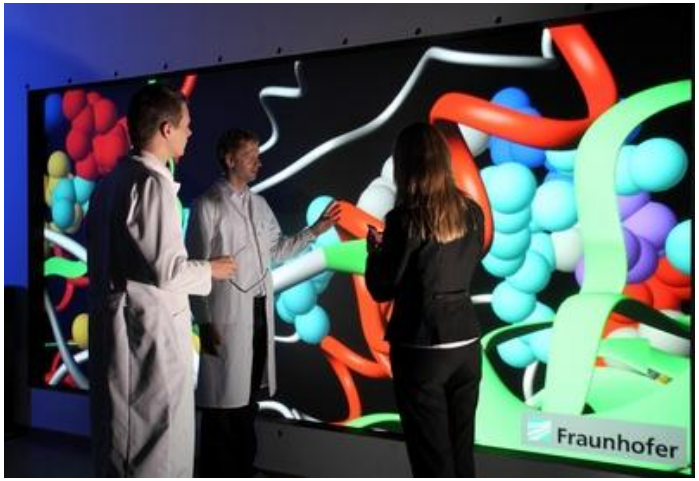
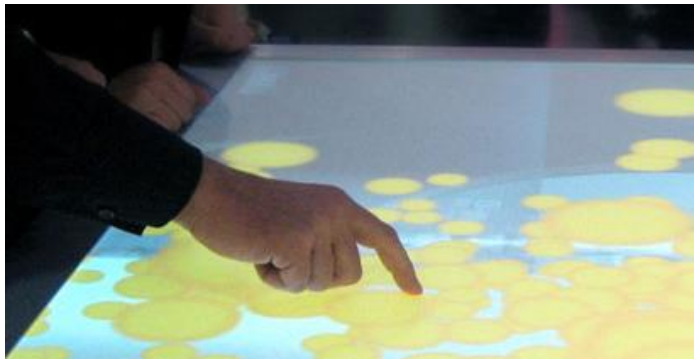


- Visual support for collaborative data analysis
  - New output devices



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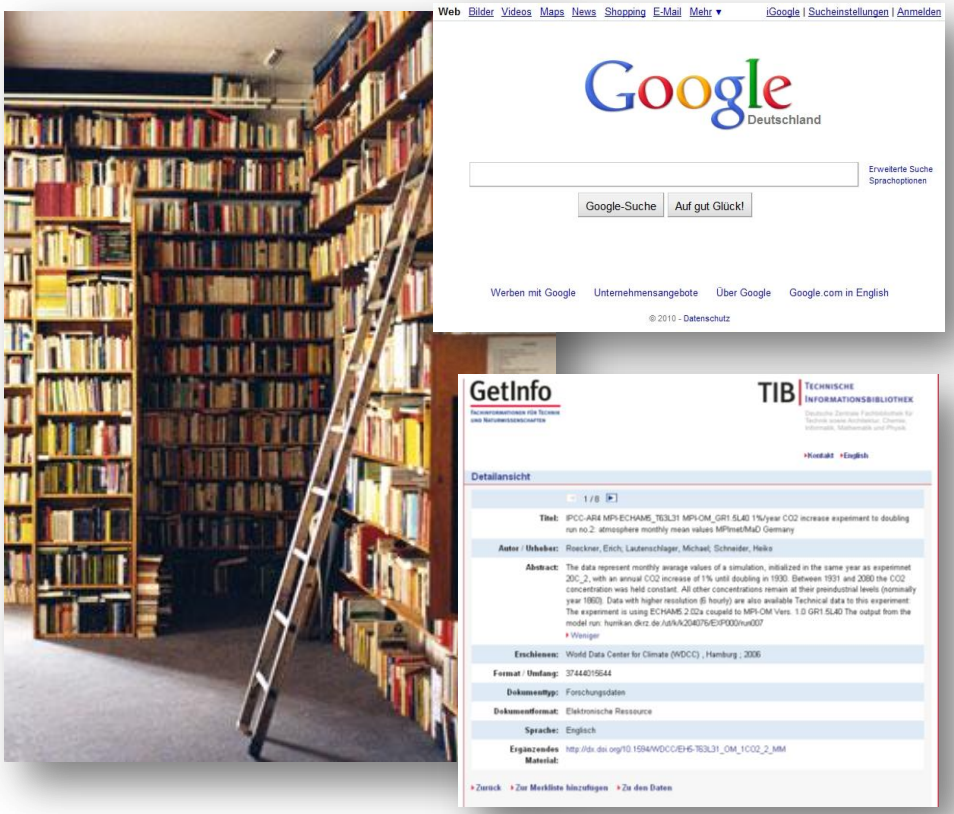
- Provide interactive visual interfaces for
  - **Exploring** the available data
  - **Searching** for available data
    - Define search query
    - Show search results
- Use **data content** not only the index structure



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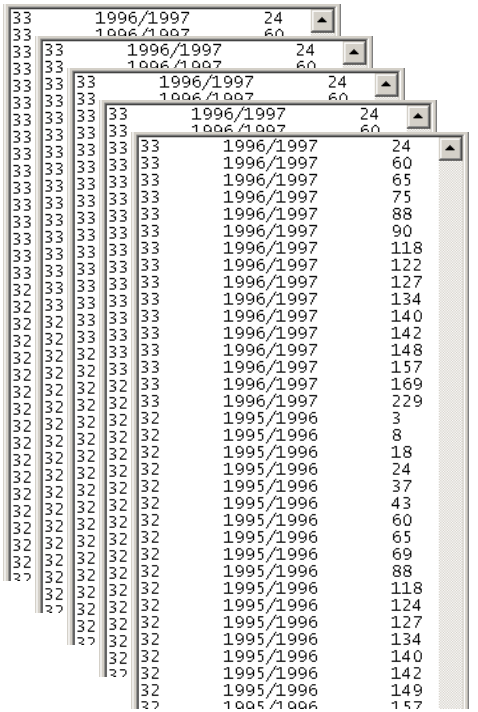
Available scientific data



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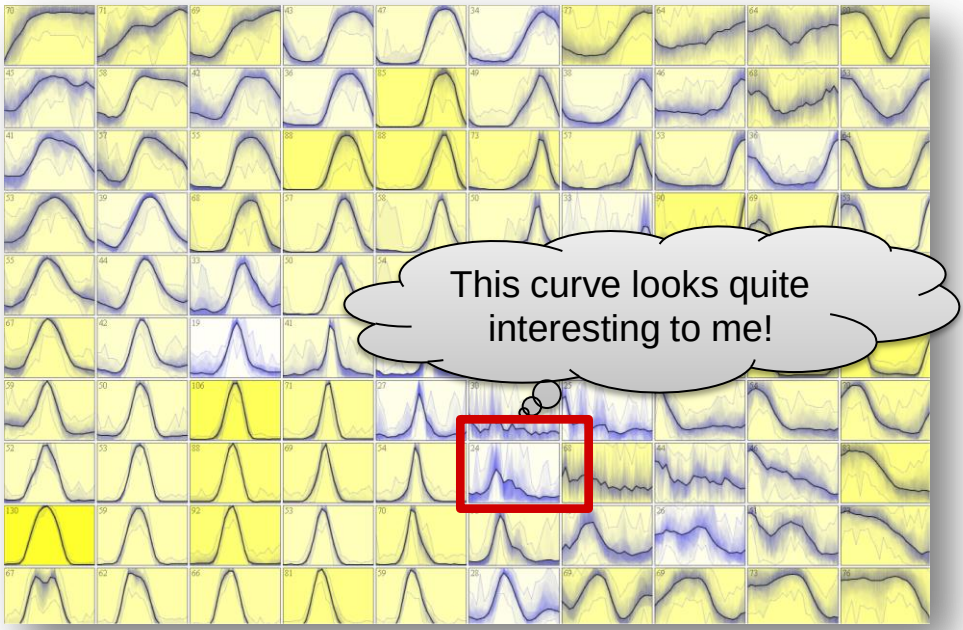
Visual data catalogue provides overview of available scientific data



[Bernard et al. 2010]

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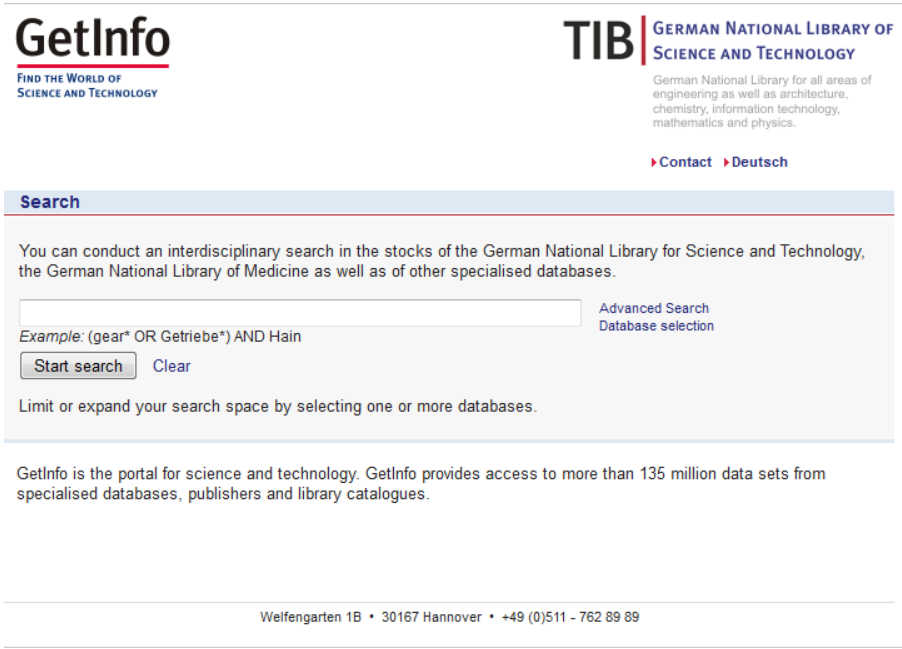
Metadata-based search in scientific databases



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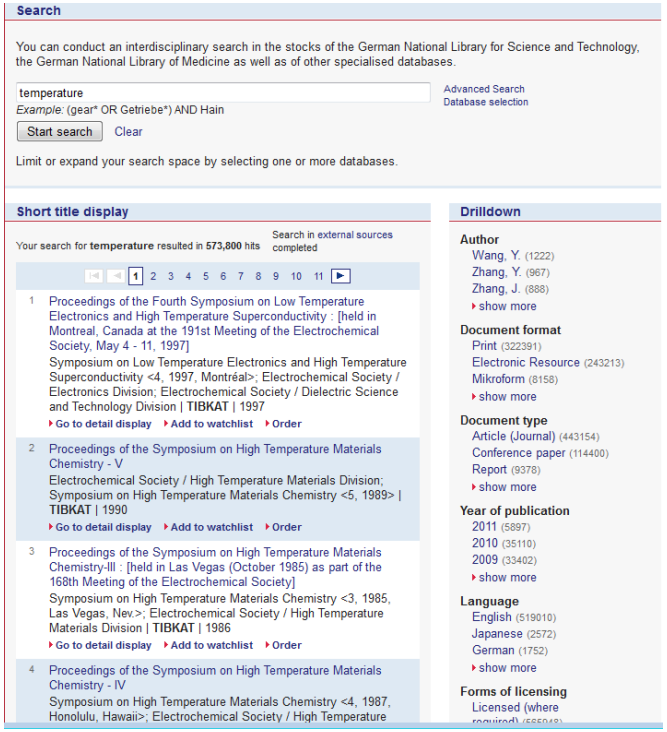
Metadata-based search result



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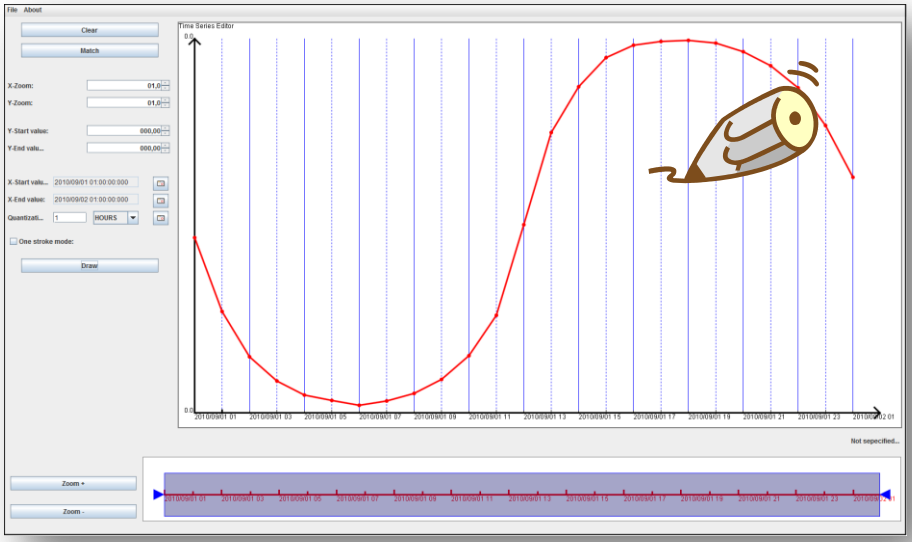
Content-based search
- visual interactive query definition



[Bernard et al. 2011]

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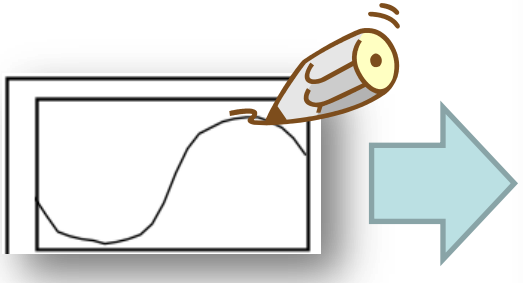
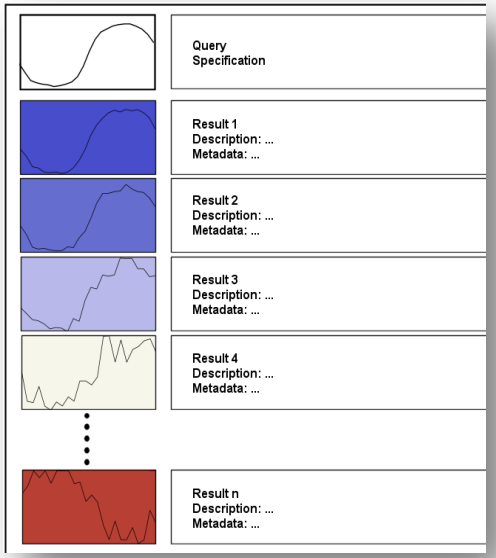
Content-based search result visualization





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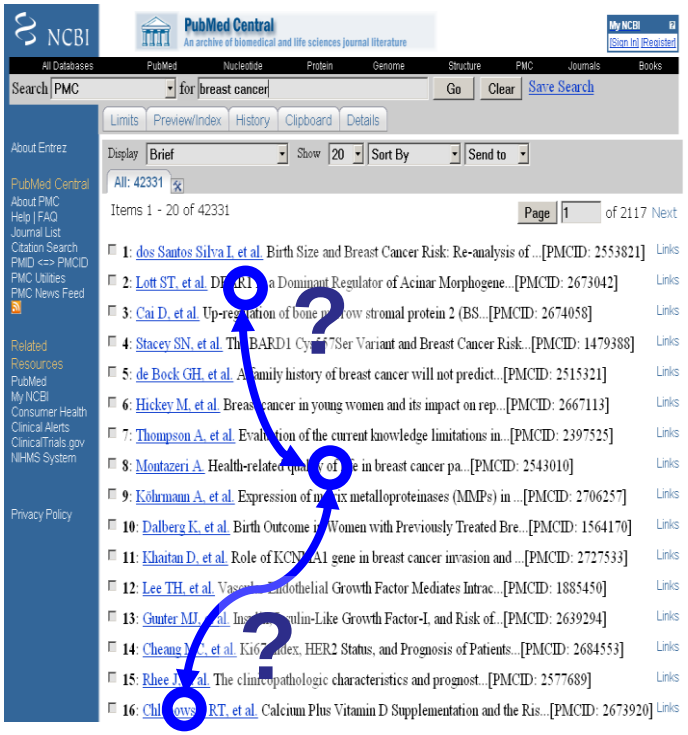
Search result presentation without visible connections between documents



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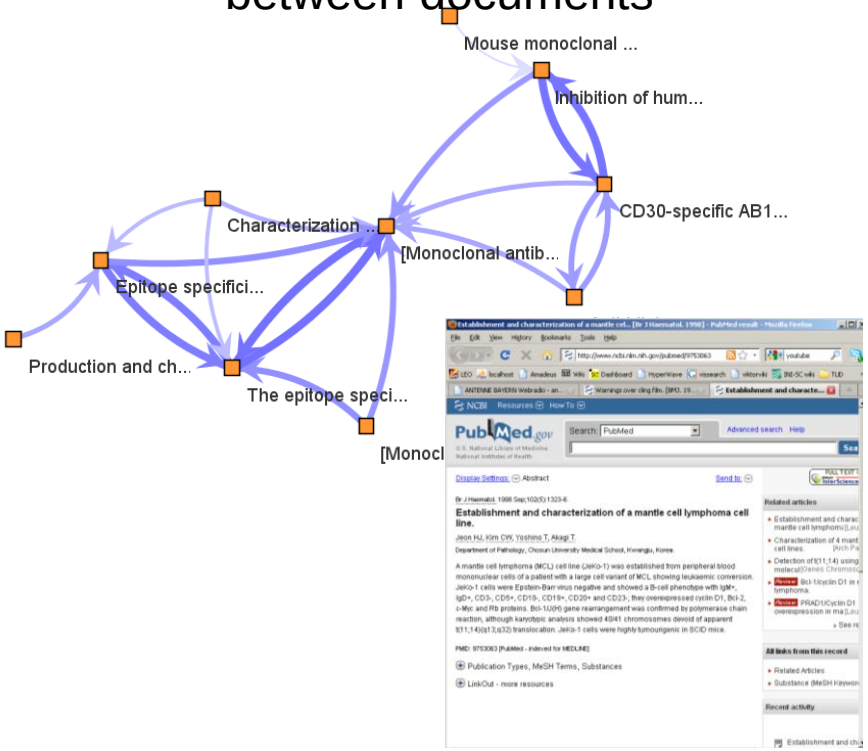
Exploration of connections between documents



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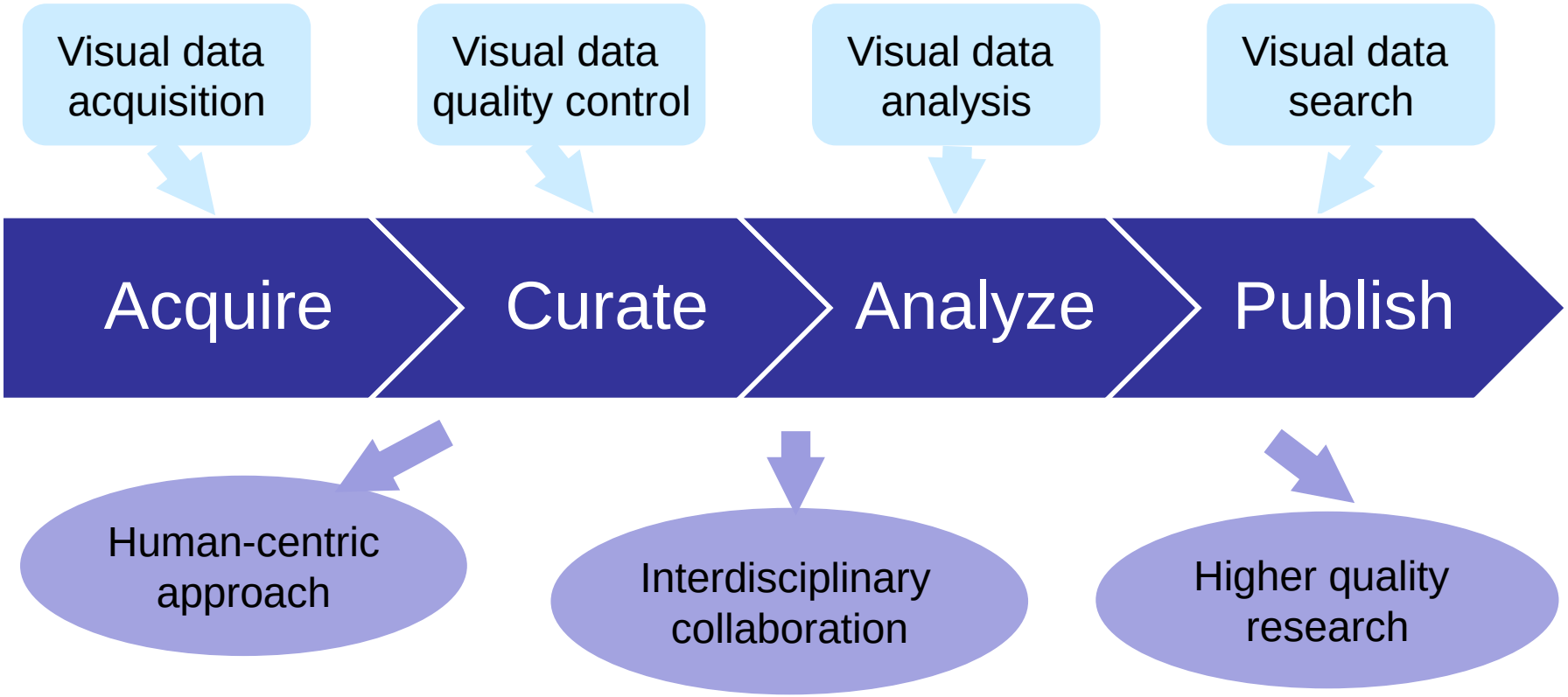
Contents

3. Conclusion

Scientific Data Infrastructures and Visual Computing:
high potential for mutual benefits



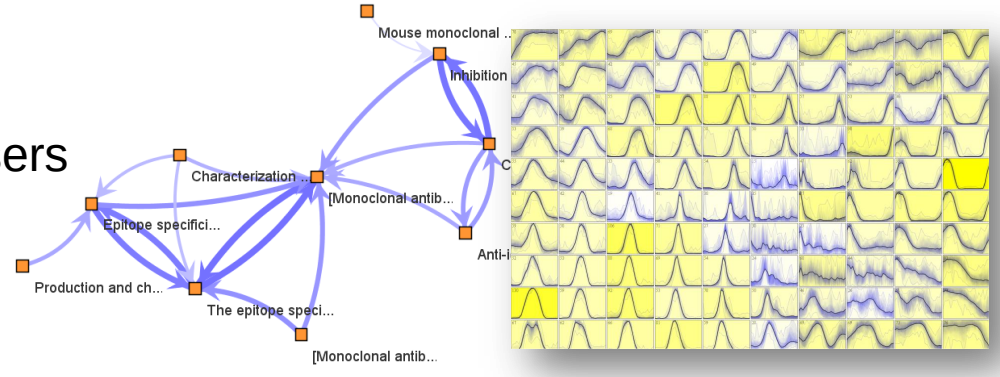
3. Challenges

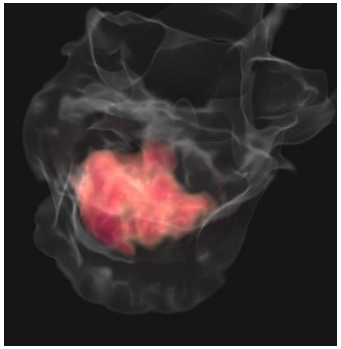
TECHNISCHE UNIVERSITÄT DARMSTADT

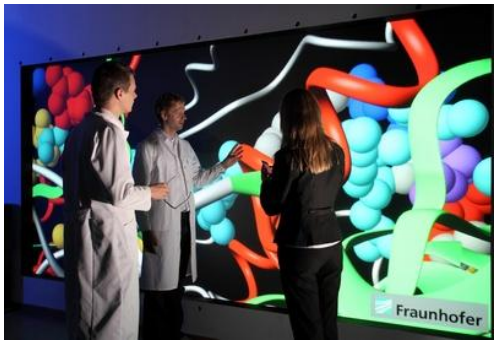
Fraunhofer IGD

Acquire > Curate > Analyze > Publish

- Visual solutions
  - Close cooperation with data users and data providers
- Input data
  - Common data standards
  - Common data semantics
- System interoperability
- Visualization scalability and interactivity







TIB Technische Informationsbibliothek

TUD Graphisch-Interaktive Systeme

End

Thank you for your kind attention