

Visual Analytics



CS 4460 – Intro. to Information Visualization
November 29, 2017
John Stasko

Agenda



- Overview of what the term means and how it relates to information visualization
- Some example VA research projects
- Discuss P5

Before there was VA



- Growing concern from some that infovis was straying from practical, real world analysis problems
 - Is it helping people enough?
- Infovis typically not applied to massive data sets
- Infovis “competes” with other computational approaches to data analysis
 - Statistics, data mining, machine learning

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Important Paper



- Shneiderman suggests combining computational analysis approaches such as data mining with infovis – Discovery tools
 - Too often viewed as competitors in past
 - Instead, can complement each other
- Each has something valuable to contribute

Shneiderman
Information Visualization '02

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Issues



- Issues influencing the design of discovery tools:
 - Statistical Algorithms vs. Visual data presentation
 - Hypothesis testing vs. exploratory data analysis
- Pro's and Con's?

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Differing Views



- Hypothesis testing
 - Advocates:
By stating hypotheses up front, limit variables and sharpens thinking, more precise measurement
 - Critics:
Too far from reality, initial hypotheses bias toward finding evidence to support it
- Exploratory Data Analysis
 - Advocates:
Find the interesting things this way, we now have computational capabilities to do them
 - Skeptics:
Not generalizable, everything is a special case, detecting statistical relationships does not infer cause and effect

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Recommendations



- Integrate data mining and information visualization
- Allow users to specify what they are seeking
- Recognize that users are situated in a social context
- Respect human responsibility

Further Questions



- Are information visualizations helping with exploratory analysis enough?
- Are they attempting to accomplish the right goals?

Another Important Paper



- Information visualization systems inadequately supported decision making:
 - Limited Affordances
 - Predetermined Representations
 - Decline of Determinism in Decision-Making
- “Representational primacy” versus “Analytic primacy”
 - Telling the truth about your data versus providing analytically useful visualizations

Covered earlier this term

Amar & Stasko
InfoVis '04 Best Paper
TVCG '05

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Task Level



- Don't just help “low-level” tasks
 - Find, filter, correlate, etc.
- Facilitate analytical thinking
 - Complex decision-making, especially under uncertainty
 - Learning a domain
 - Identifying the nature of trends
 - Predicting the future

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More Motivation



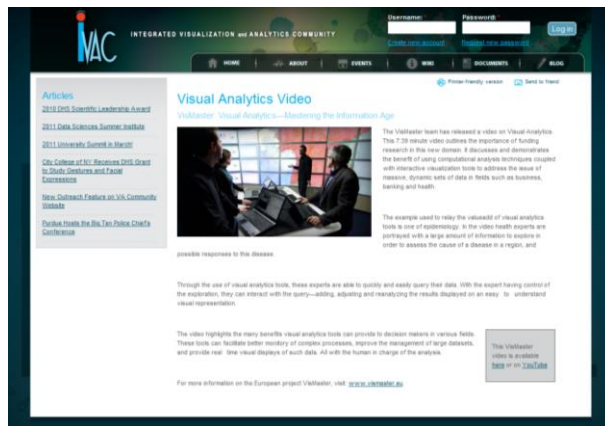
- Increasing occurrences of situations and areas with large data needing better analysis
 - DNA, microarrays
 - 9/11 security
 - Business intelligence
 - ...

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Articulating the Motivation



Video

<http://videothèque.inria.fr/videothèque/doc/635>

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Visual Analytics



- A new term for something that is familiar to all of us
- Informal description:
 - Using visual representations to help make decisions
 - Sounds like infovis, no?
 - Let's be more precise...

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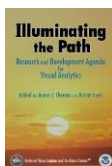
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Visual analytics is the science of analytical reasoning facilitated by interactive visual interfaces.

People use visual analytics tools and techniques to

- Synthesize information and derive insight from massive, dynamic, ambiguous, and often conflicting data
- Detect the expected and discover the unexpected
- Provide timely, defensible, and understandable assessments
- Communicate assessment effectively for action.



Thomas & Cook
2005

**“The beginning of knowledge is the discovery of something we do not understand.”
~Frank Herbert (1920 - 1986)**

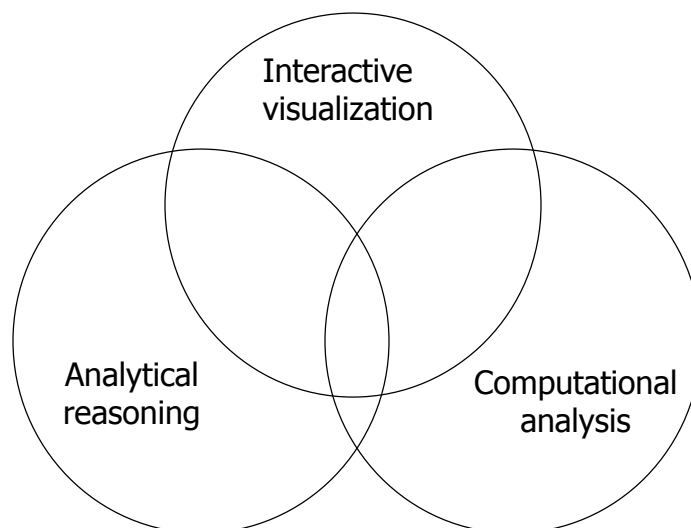
Slide courtesy of Jim Thomas

Visual Analytics



- Not really an “area” per se
 - More of an “umbrella” notion
- Combines multiple areas or disciplines
- Ultimately about using data to improve our knowledge and help make decisions

Main Components



VA-related Research Topics



- Visualization
 - InfoVis, SciVis, GIS
- Data management
 - Databases, information retrieval, natural language
- Data Analysis
 - Knowledge discovery, data mining, statistics
- Cognitive Science
 - Analytical reasoning, decision-making, perception
- Human-computer interaction
 - User interfaces, design, usability, evaluation

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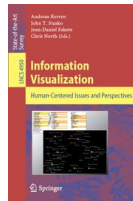
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Alternate Definition



- Visual analytics combines automated analysis techniques with interactive visualizations for an effective understanding, reasoning and decision making on the basis of very large and complex data sets



Keim et al, chapter in
*Information Visualization:
Human-Centered
Issues and Perspectives*, 2008

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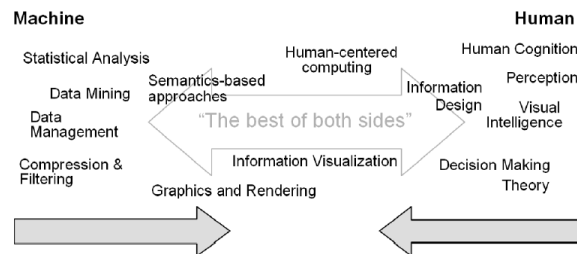
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Synergy



- Combine strengths of both human and electronic data processing
 - Gives a semi-automated analytical process
 - Use strengths from each



From Keim

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InfoVis Comparison



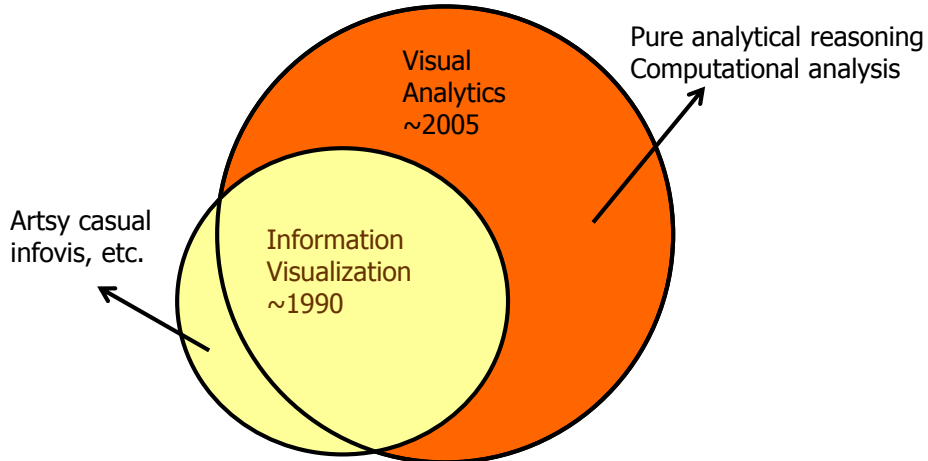
- Clearly much overlap
- Perhaps fair to say that infovis hasn't always focused on analysis tasks so much and that it doesn't always include advanced data analysis algorithms
 - Not a criticism, just not focus
 - InfoVis has a more narrow scope
 - (Some of us actually do believe that infovis has/should include those topics)

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Academic Context



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My interpretation

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Visual Analytics



- Encompassing, integrated approach to data analysis
 - Use computational algorithms where helpful
 - Use human-directed visual exploration where helpful
 - Not just “Apply A, then apply B” though
 - Integrate the two tightly

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Another Take



- Are you visualizing (direct) data values or models of data?
 - What does that mean?
- Model – Computationally generated values about the data

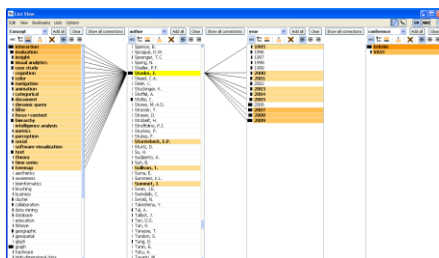
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Example

Jigsaw



List view

VS.



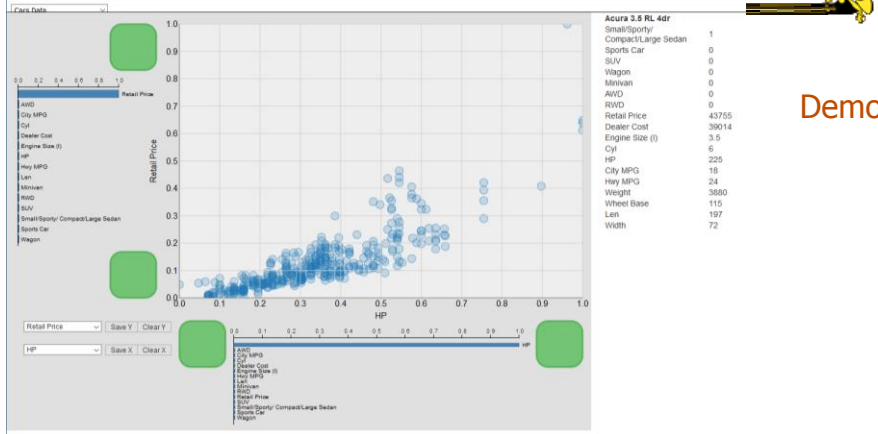
Cluster view

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InterAxis



Demo

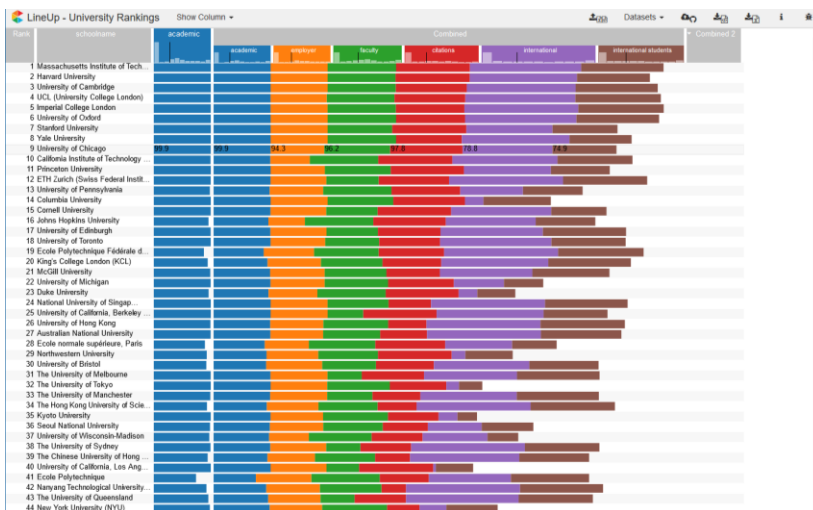
Kim et al
VAST '15

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LineUp



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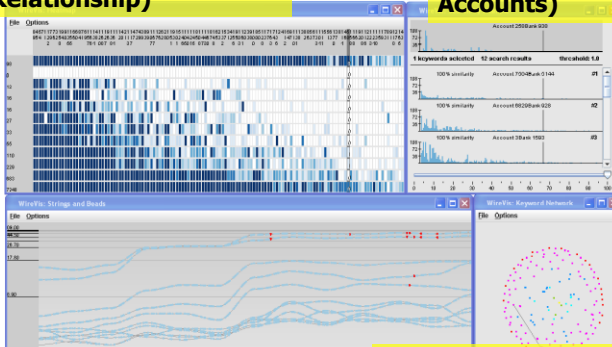
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WireVis

Video

**Heatmap View
(Accounts to Keywords
Relationship)**

**Search by
Example (Find
Similar
Accounts)**



Helping Bank of America examine wire transfers of money to detect money laundering and fraud

Look for certain temporal patterns and keywords in descriptions

**Strings and Beads
(Relationships over Time)**

**Keyword Network
(Keyword
Relationships)**

Chang et al
Information Visualization '08

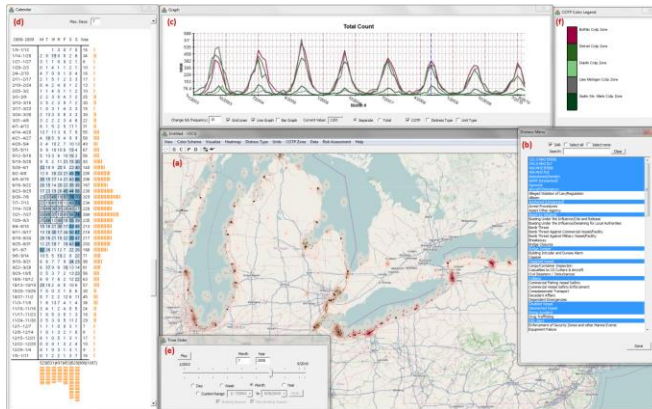
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Coast Guard Search & Rescue

Video



Shows stations, incidents, response times

Visualize historical data and support "what if" explorations

Calculate risk assessments and then communicate visually

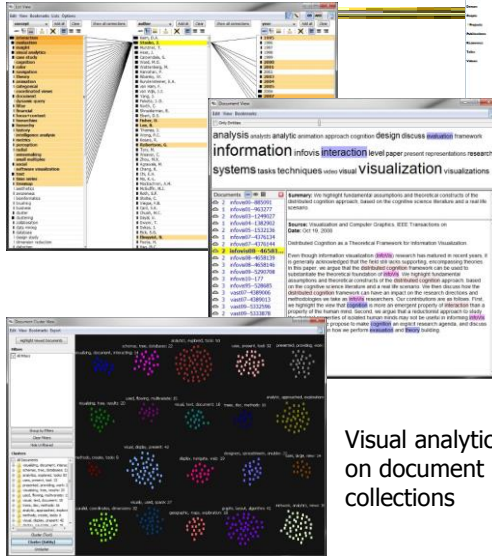
Malik et al
VAST '11

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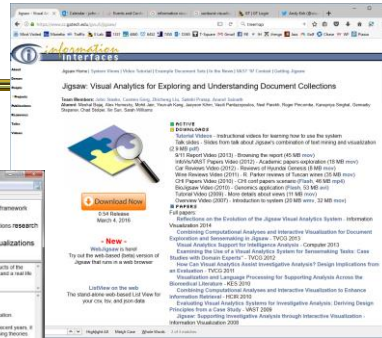
Jigsaw



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Visual analytics on document collections



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Vision of the Future

- PNNL Precision Info Environments (PIE) video
- Emergency response scenario



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Other Courses to Take



- CX 4242 (Prof. Chau)
 - Data and Visual Analytics

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Learning Objectives



- Describe motivation behind visual analytics
- Discuss differences between "statistical" and human-centered data analysis processes, including strengths of each
- Explain visual analytics
 - Define the term
 - List its components
 - Explain the differences between it and information visualization
- List and describe some visual analytics applications

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P5



- Due Friday at 11pm (zip to t-square)
- Analytic focus
- Feedback from us
- Metrics
 - Operation
 - Utility
 - Usability
 - Aesthetics
- Report (short, but important)

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Upcoming



- Lab 10: Maps and geovis
 - Prep: Murray chapter 12
- Review
- Final exam – Dec 13, 11:30-2:20

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