Applicability of Visual Analytics to Defence and Security Operations

(Presentation #42)

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Presentation Plan

- Information Overload

- Introduction to Visual Analytics

- Key Organisations

- Advanced Visual Analytics Concepts

- Application to Defence and Security Operations

- Visual Analytics Resources

Information Overload – Scale of Things to Come

- Information (IDC, 2007):

  - In 2002, recorded media and electronic information flows generated about 22 EB (10^{18}) of information

  - In 2006, the amount of digital information created, captured, and replicated was 161 EB

  - In 2010, the amount of information added annually to the digital universe will be about 988 EB (almost 1 ZB)

IDC (2007), The Expanding Digital Universe - A Forecast of Worldwide Information Growth through 2010

Kielman, J. and Thomas, J.J. (2008), Visual Analytics: A Global Collaboration

Information Overload – Scale of Things to Come

- Drivers of digital universe:

  - 70% of the universe is being produced by individuals

  - Organizations (businesses, agencies, governments, universities) produce 30% :

    - Walmart has a database of 0.5 PB; it captures 30,000,000 transactions/day

  - The growth is uneven

    - Today the United States accounts for 41% of the Universe; by 2010, the Asia Pacific region will be growing 40% faster than any of the other regions

IDC (2007), The Expanding Digital Universe - A Forecast of Worldwide Information Growth through 2010

Kielman, J. and Thomas, J.J. (2008), Visual Analytics: A Global Collaboration

Information Overload – Scale of Things to Come

- Kinds of data:

  - About 2 GB of digital information is being produced per person per year

  - 95% of the Digital Universe's information is unstructured

    - 25% of the digital information produced by 2010 will be images

  - By 2010, the number of e-mailboxes will reach 2 billion

    - The users will send 28 trillion e-mails/year, totaling about 6 EB of data

IDC (2007), The Expanding Digital Universe - A Forecast of Worldwide Information Growth through 2010

Kielman, J. and Thomas, J.J. (2008), Visual Analytics: A Global Collaboration

Visual Analytics Definition

examine evidence, infer meaning, test truth

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

Thomas, J.J. and Cook, K.A., eds. (2005), Illuminating the Path: The Research and Development Agenda for Visual Analytics

ask questions, test hypothesis, filter results, explore information, record thinking process

take advantage of human brain's aptitude for visual pattern recognition

Visual Analytics R&D

Detecting the Expected --
Discovering the Unexpected[TM]
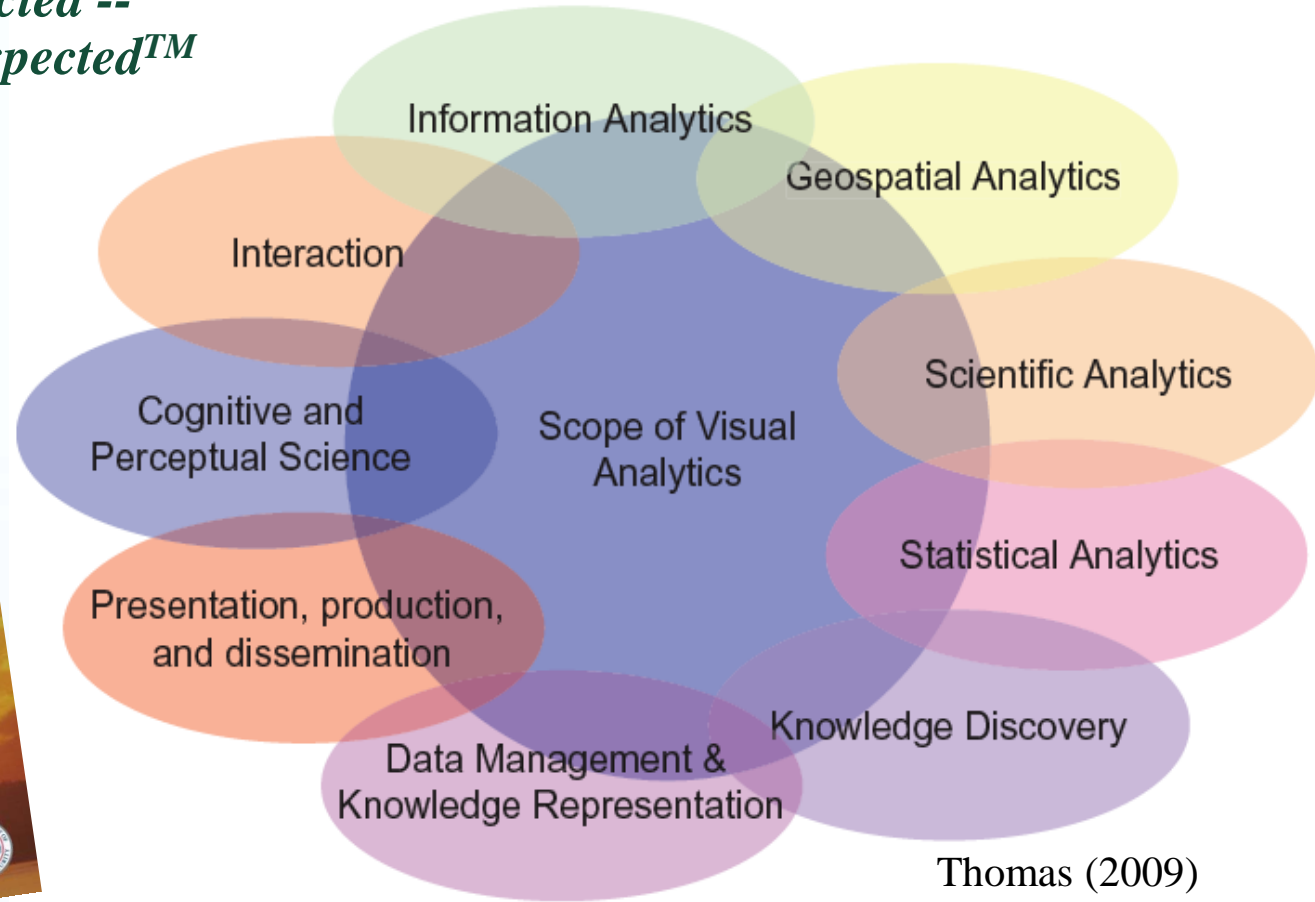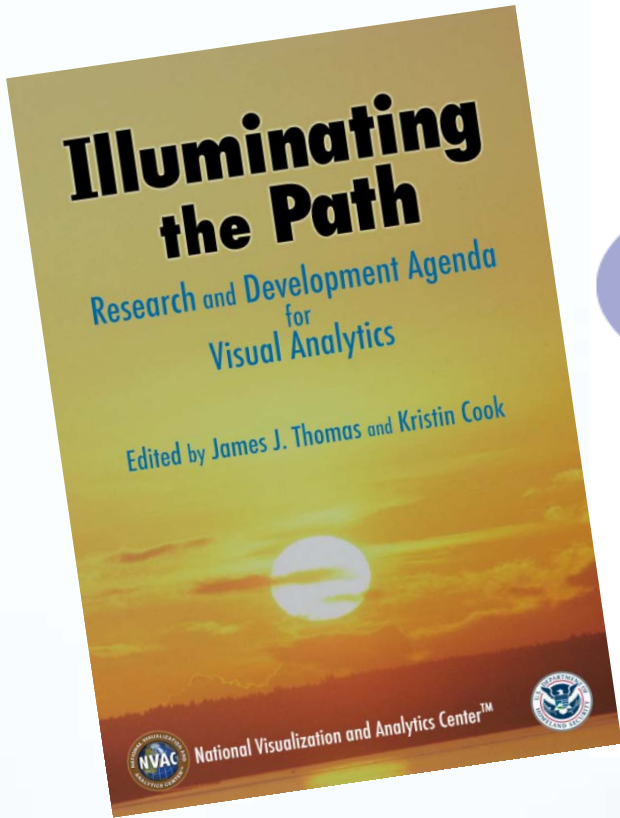
Thomas (2009)

Key Organisations

VAC Views (2010)

Napoleon's Invasion of Russia
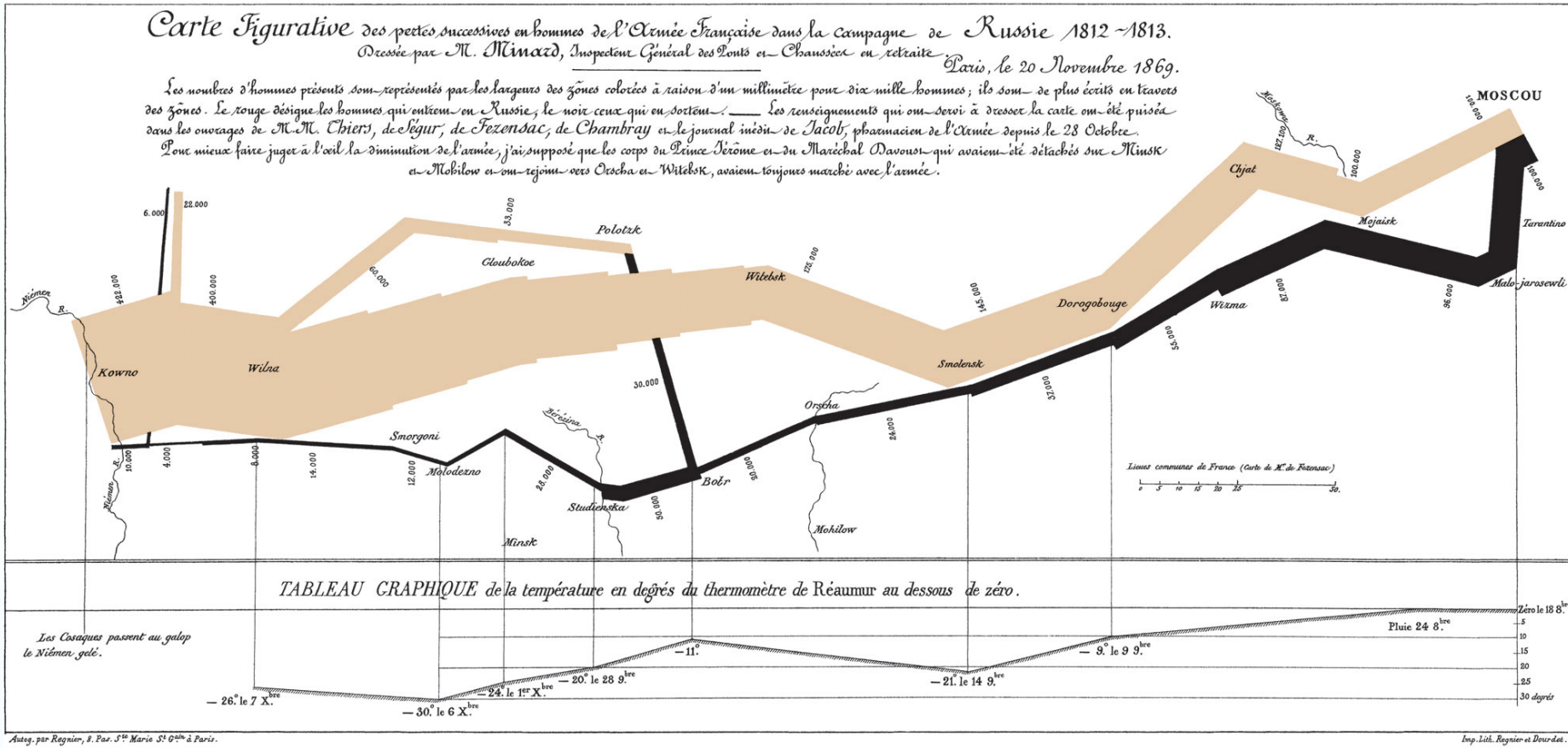
Minard (1869)

Information Visualization:
London Subway Map

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Mappery.com (2011)
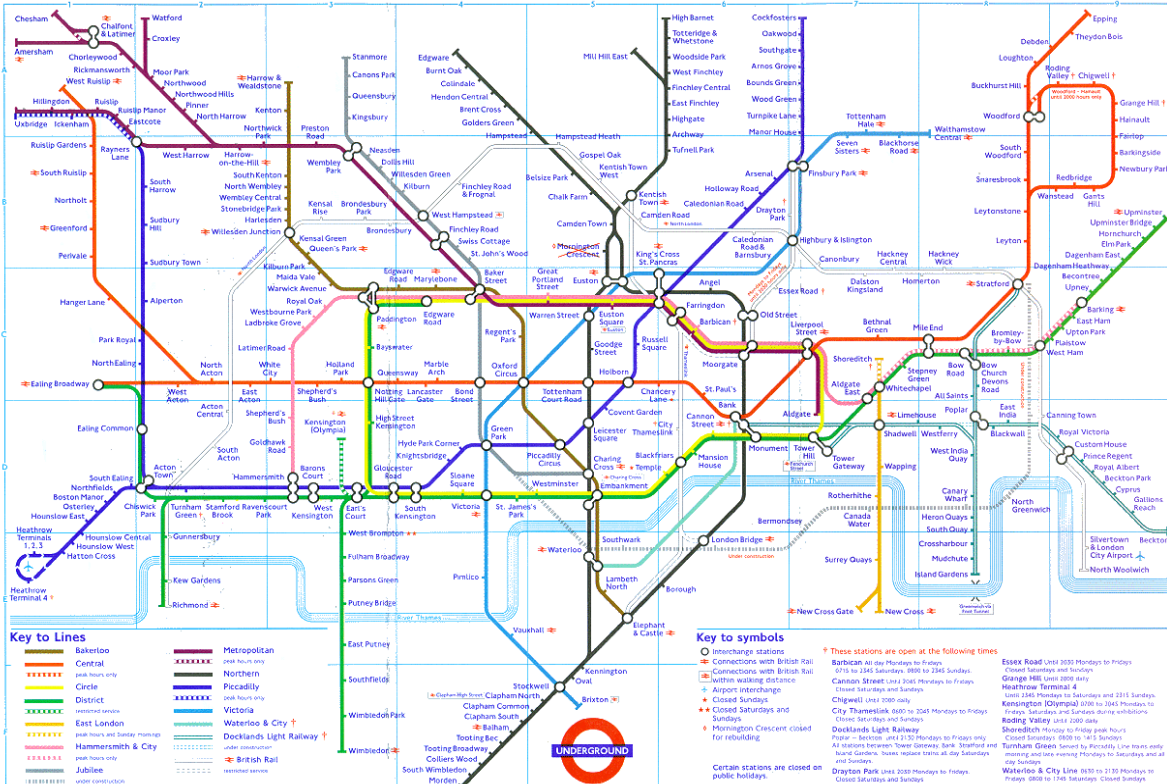
Visual Perception
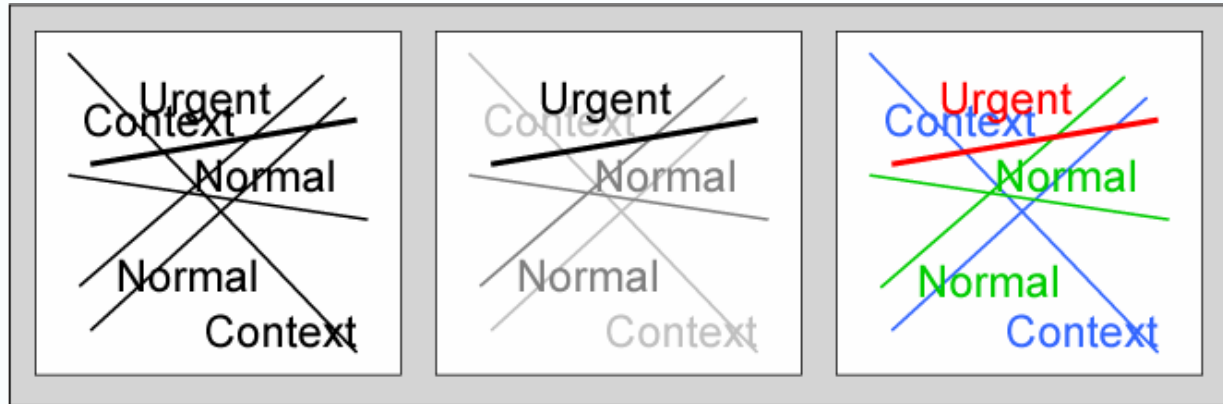
Color Matters

Stone (2006)

Preattentive Processing
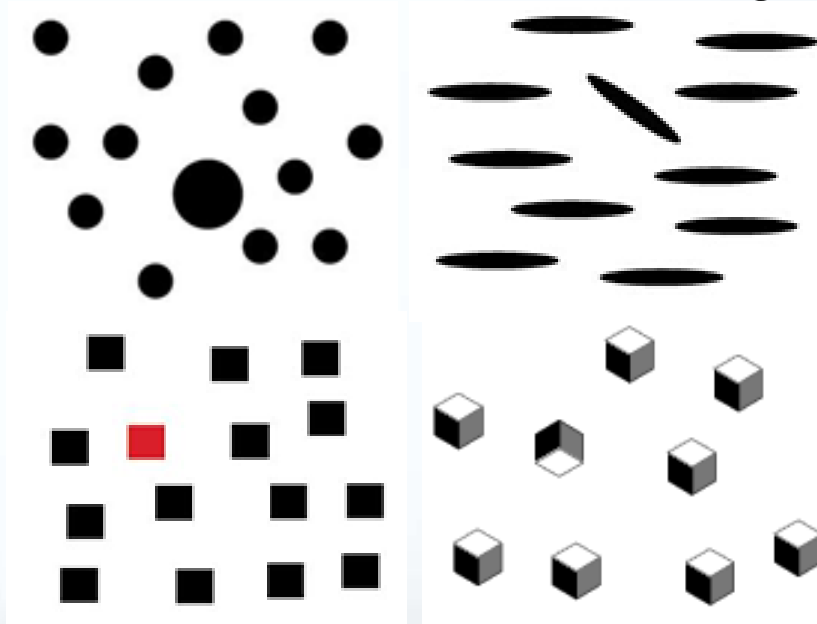
adapted from Healey (2009)

Kosara *et al*., 2001

Interaction – Response Time

- Three categories of responsiveness for interactivity:

  Miller (1968), Card *et al*. (1991)

- 0.1 s : perceived as instantaneous

  - 1.0 s : uninterrupted flow of though but perceived delays

    - 10 s : for delay longer than that, users will want to do something else while waiting for the computer

Analytics
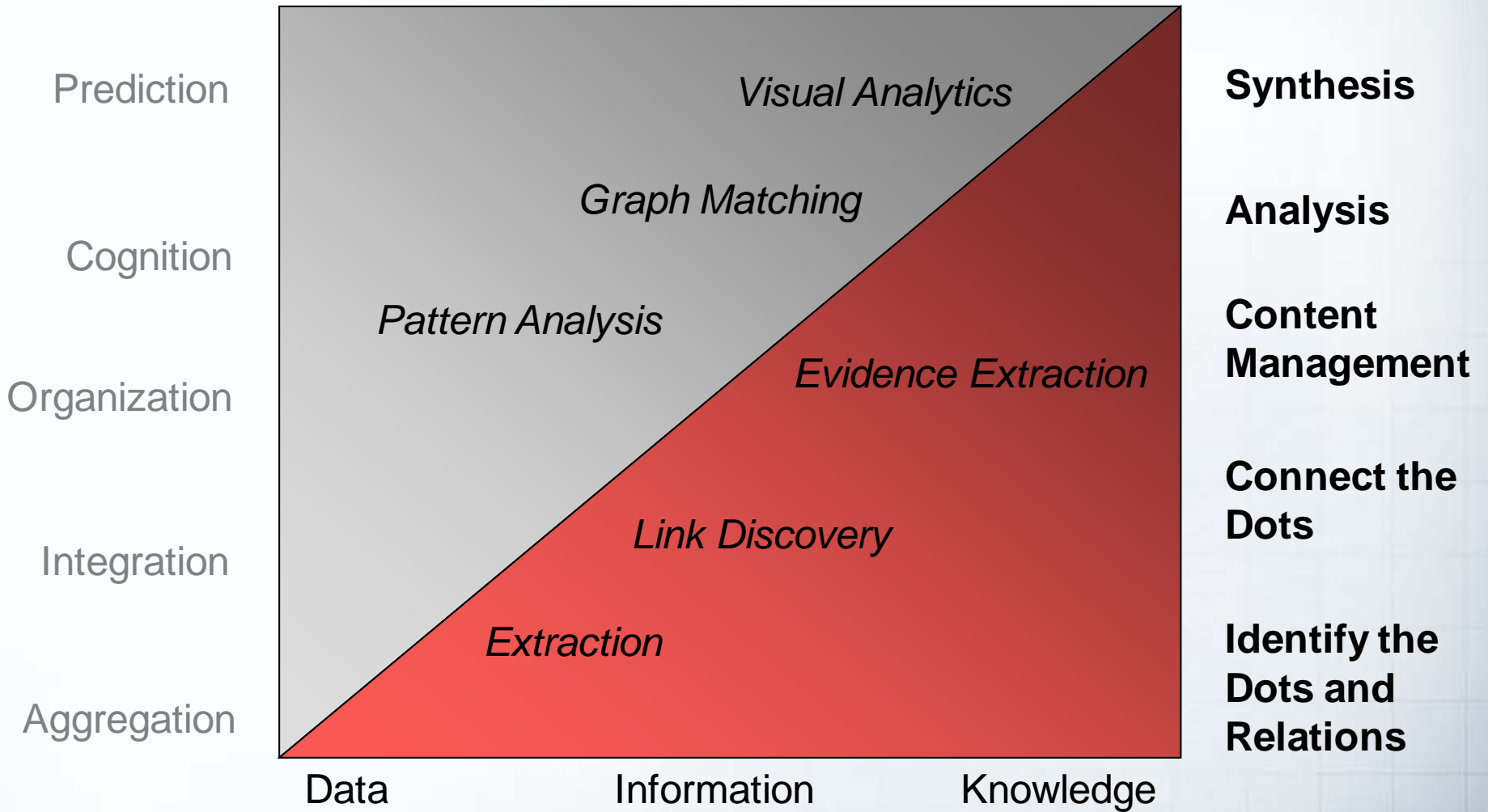
Kielman and Thomas (2008)

Geovisual Analytics

Linked Animal-Human Visual Analytics (LAHVA)

Maciejewski *et al*. (2008)
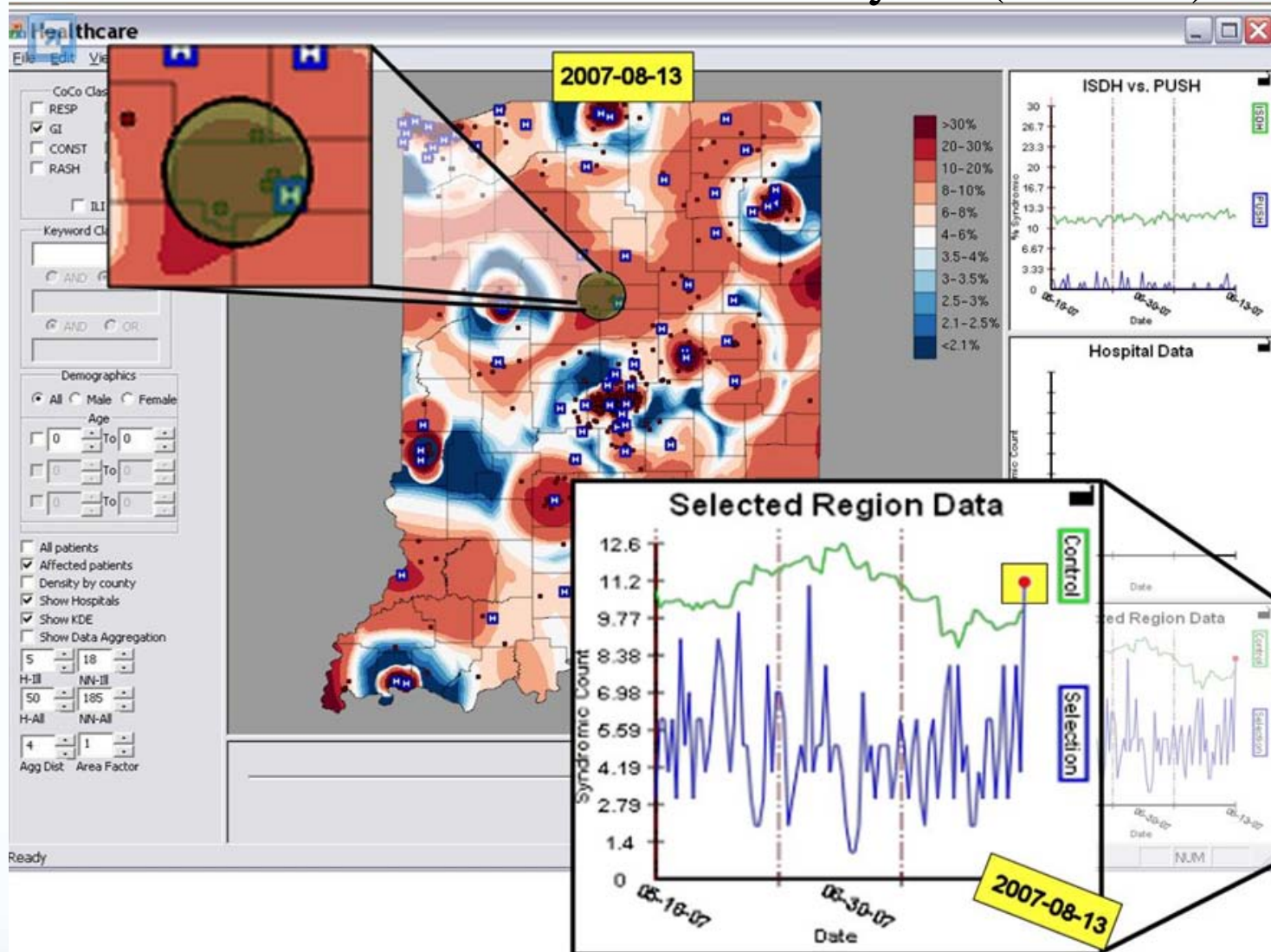
Network Visualization

NodeTrix Social Network Visualization
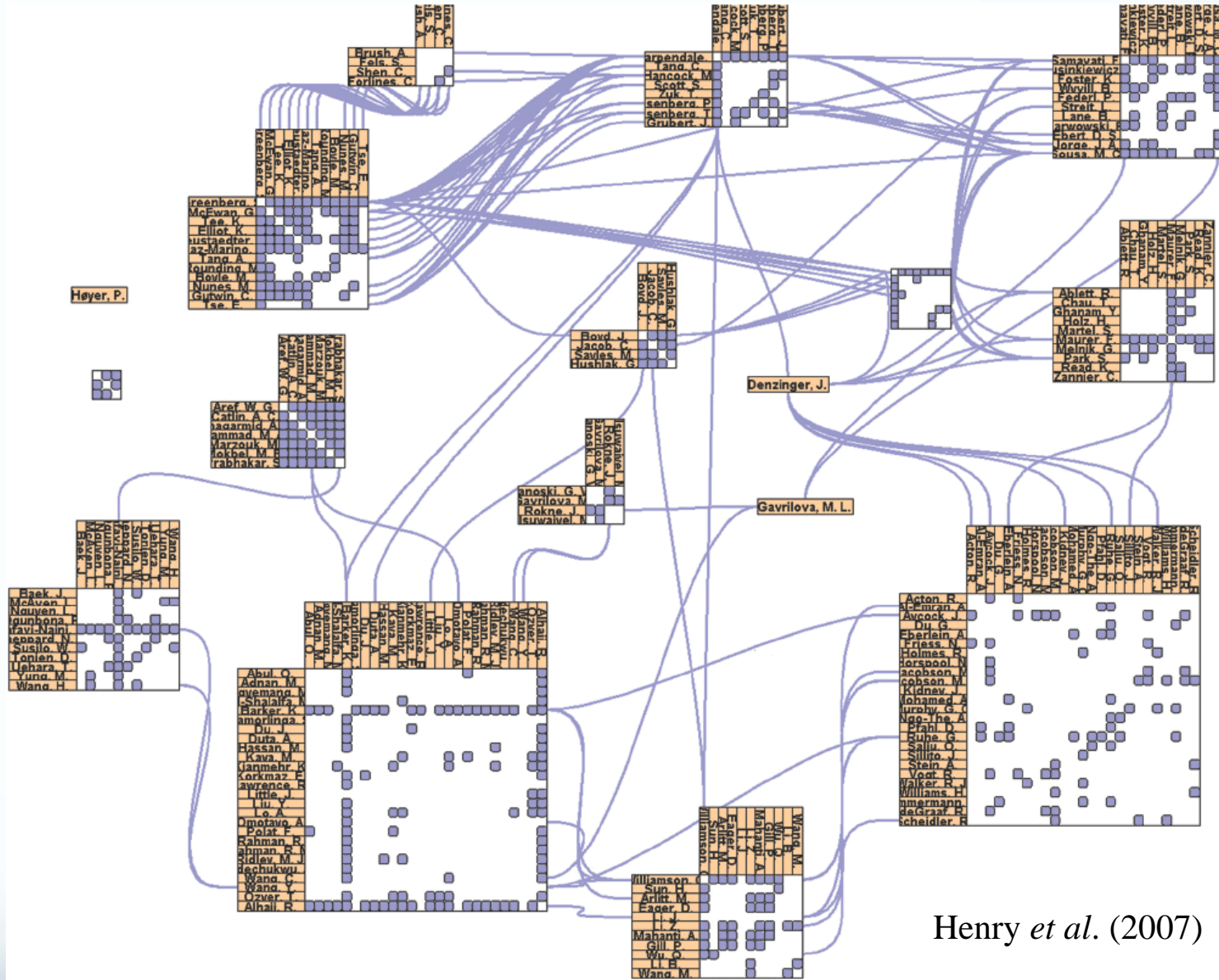
Henry *et al.* (2007)

Hierachical Display

Stocks Treemap
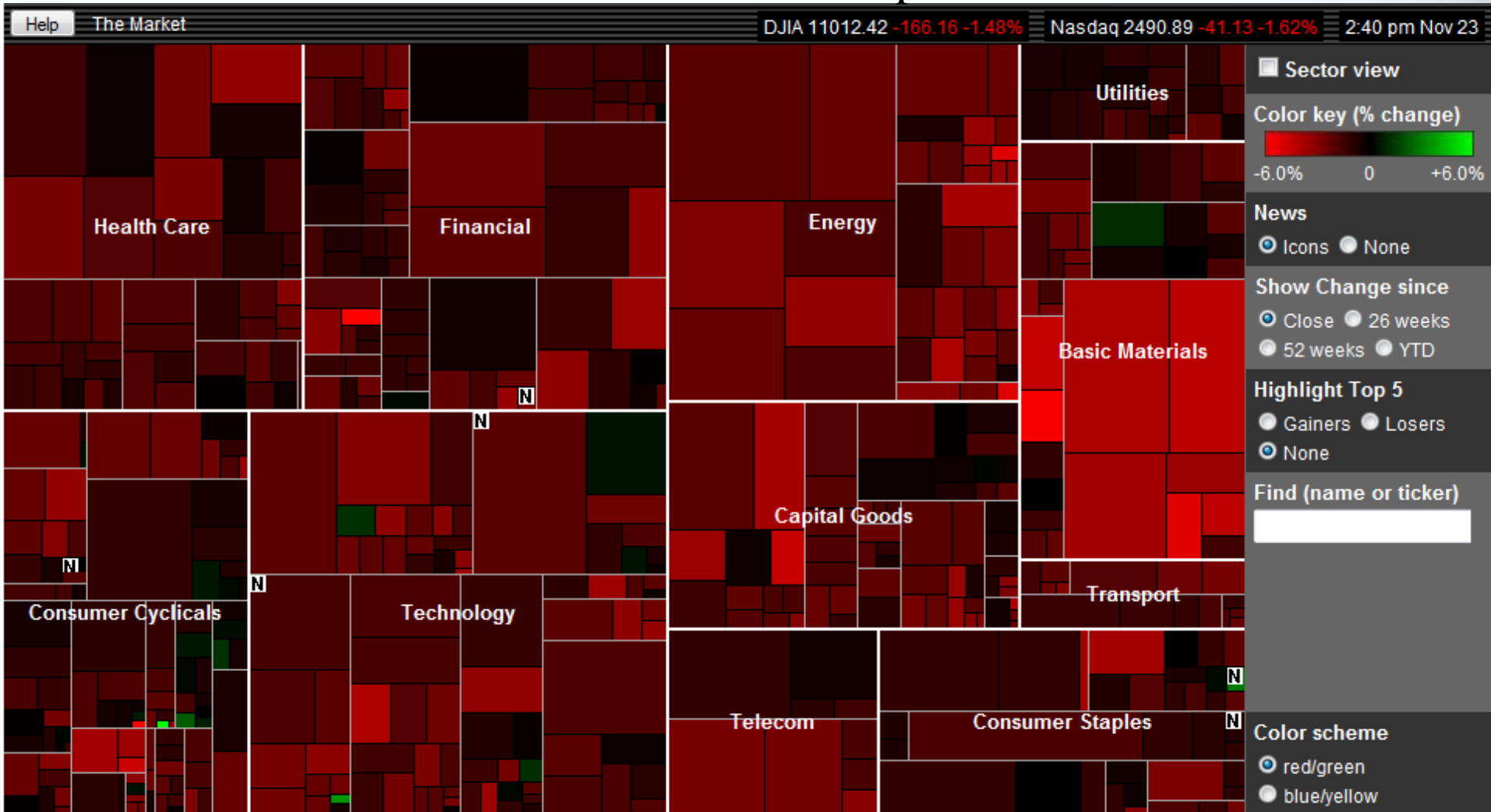
SmartMoney (2010)

Temporal Visualization

NFL Drive Chart

Gunderson (2009)

Temporal Analytics

Lifelines2

Wang (2010)
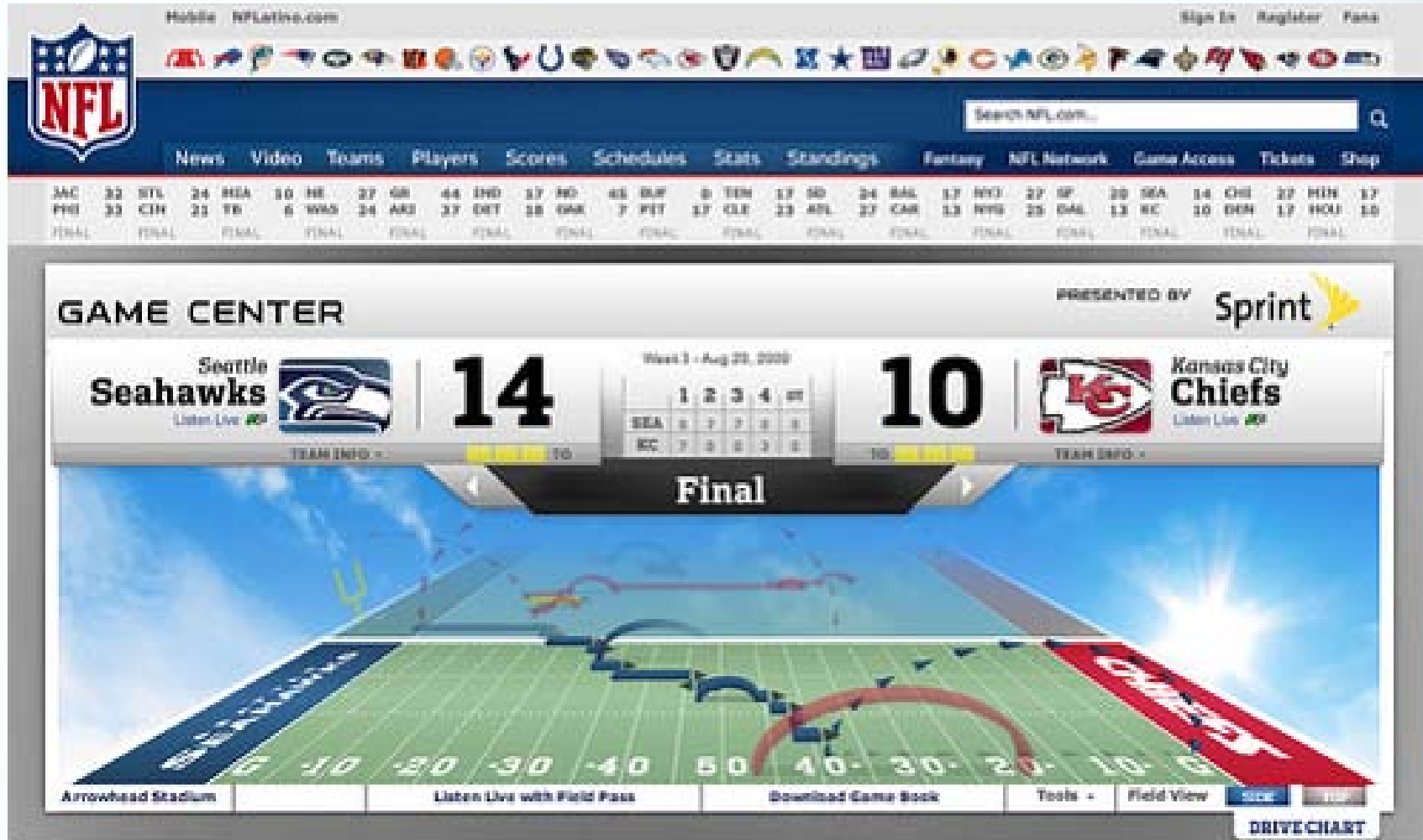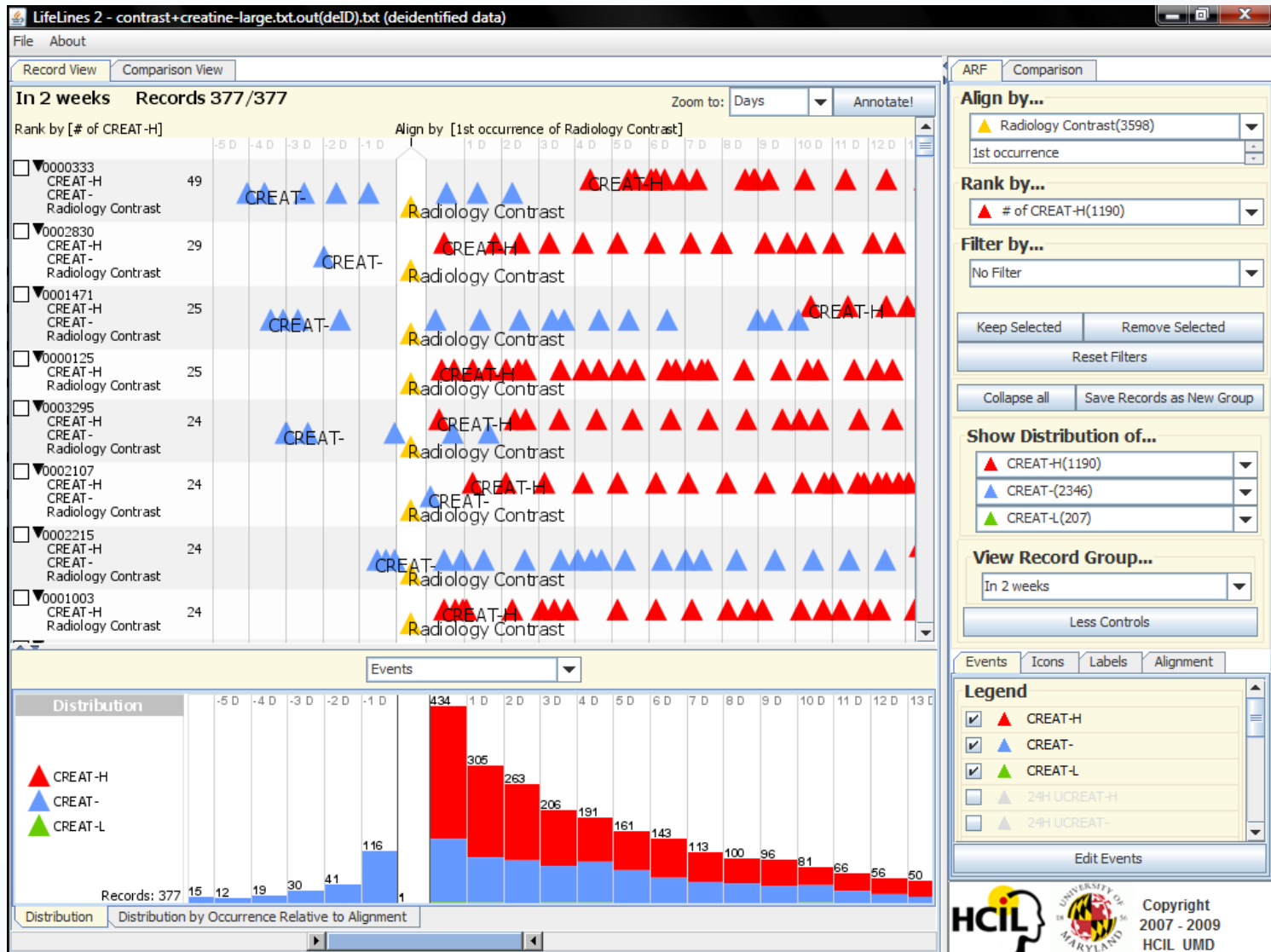
Multimedia and Video Analytics

New Streams Event River

Savvy
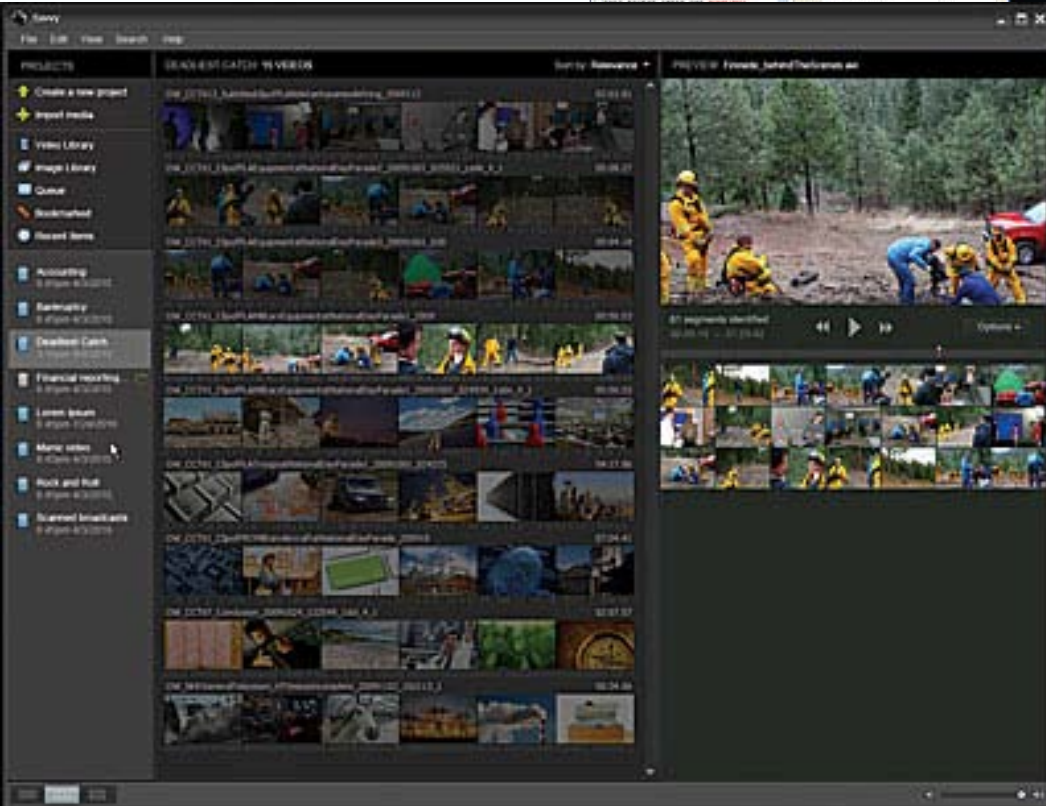
Ribarsky (2009)

Video Analytics tools
are starting to emerge

Payne (2011)

Multivariate Analysis

Parallel Sets
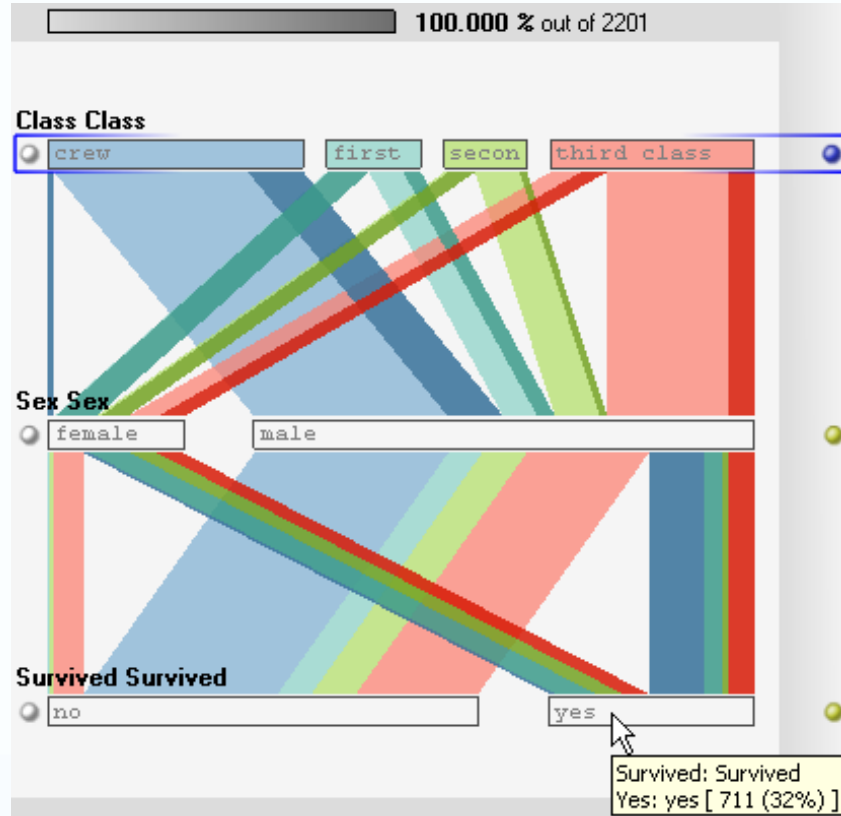
Bendix *et al.* (2005)

Dust & Magnets
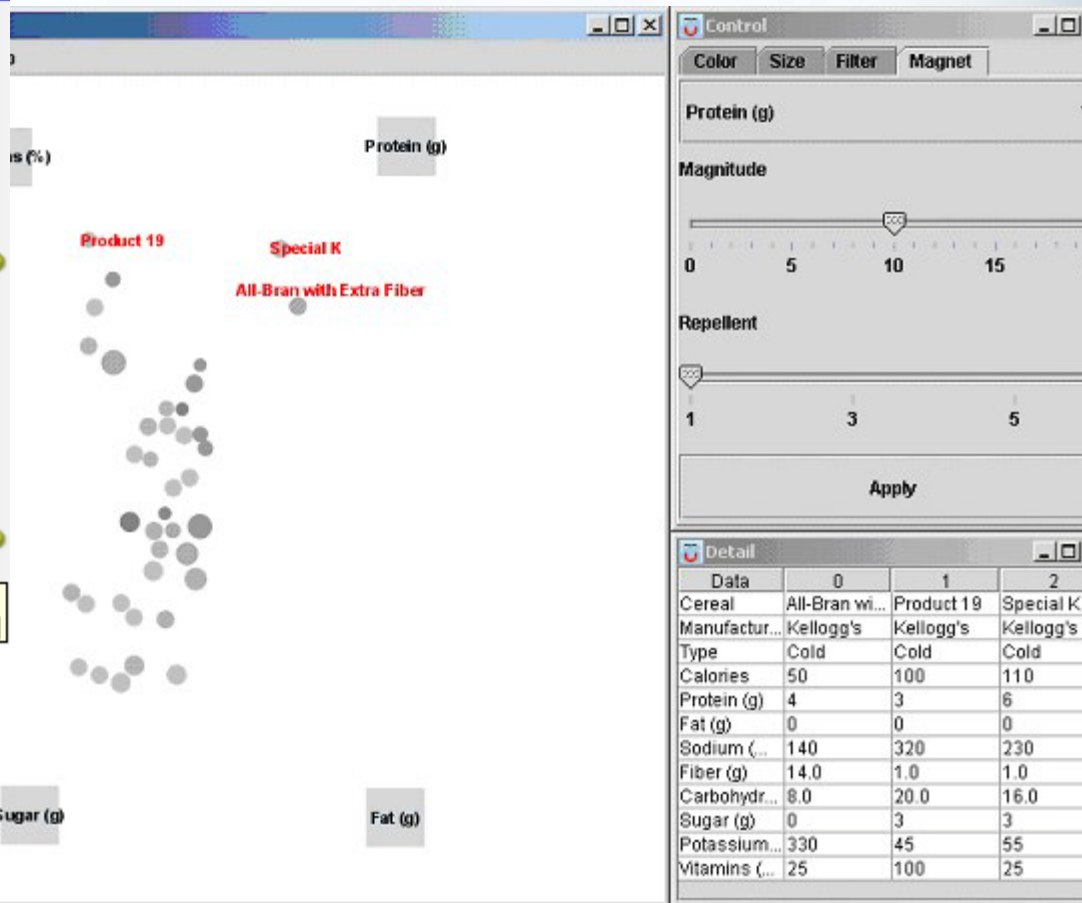
Soo Yi *et al.* (2005)

Maritime Domain Awareness

Shipping Density Landscapes
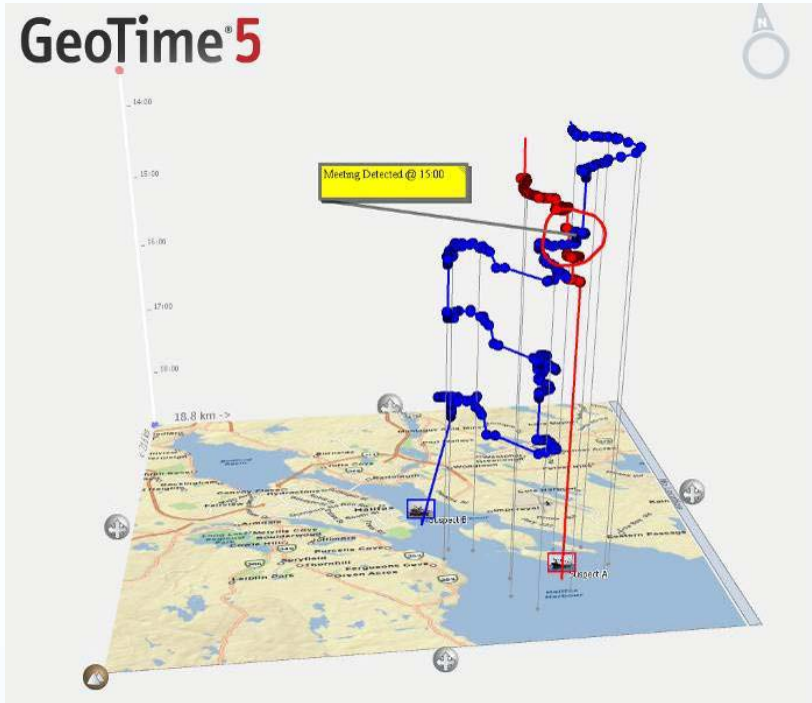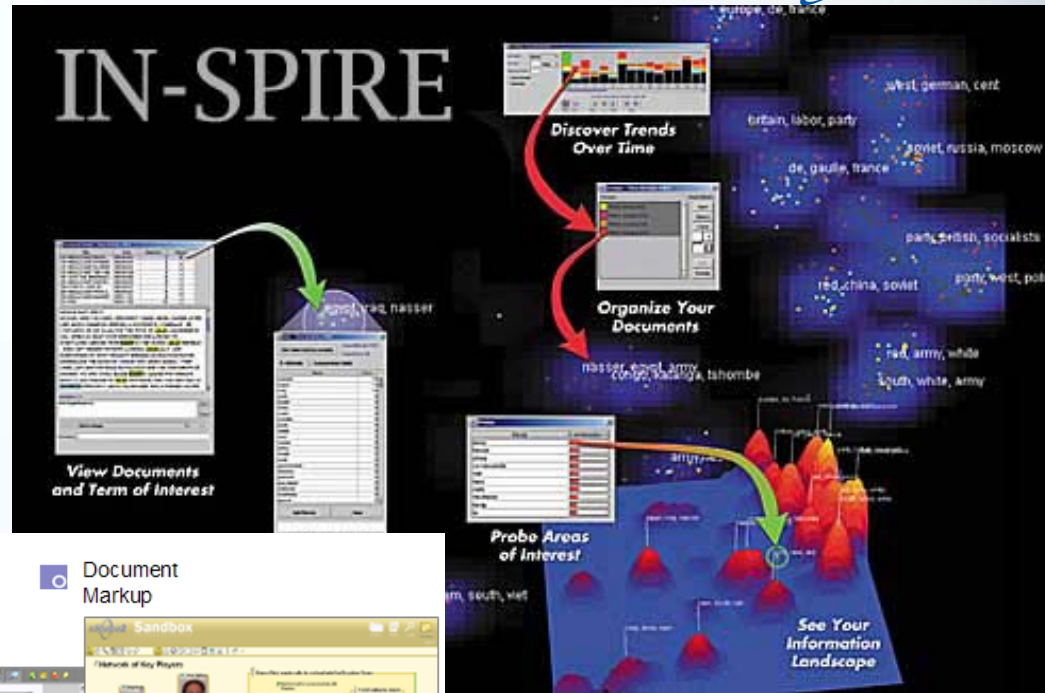
Oculus Info Inc
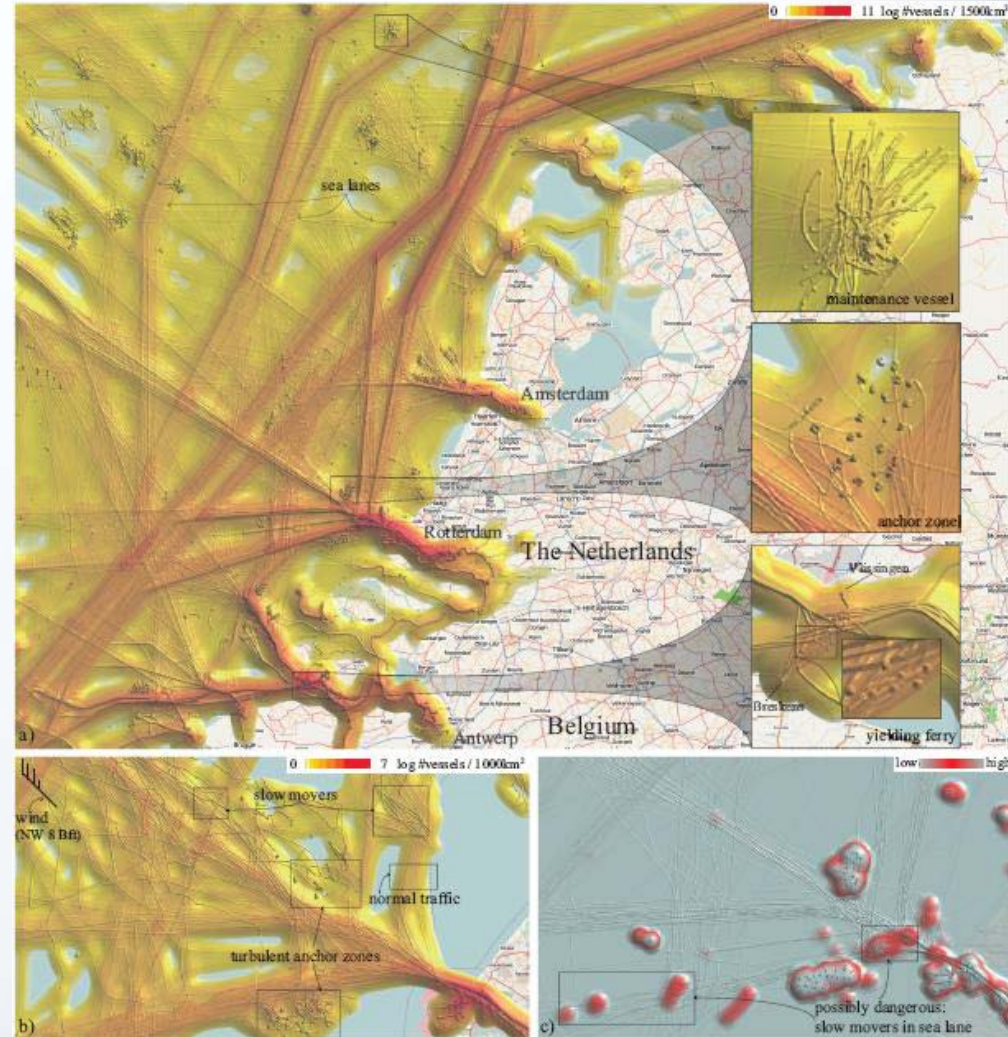
Willems *et al.* (2009)

Military Intelligence

nSpace

PNNL (2011)

Oculus Info Inc

Emergency Management

Precision Information Environments

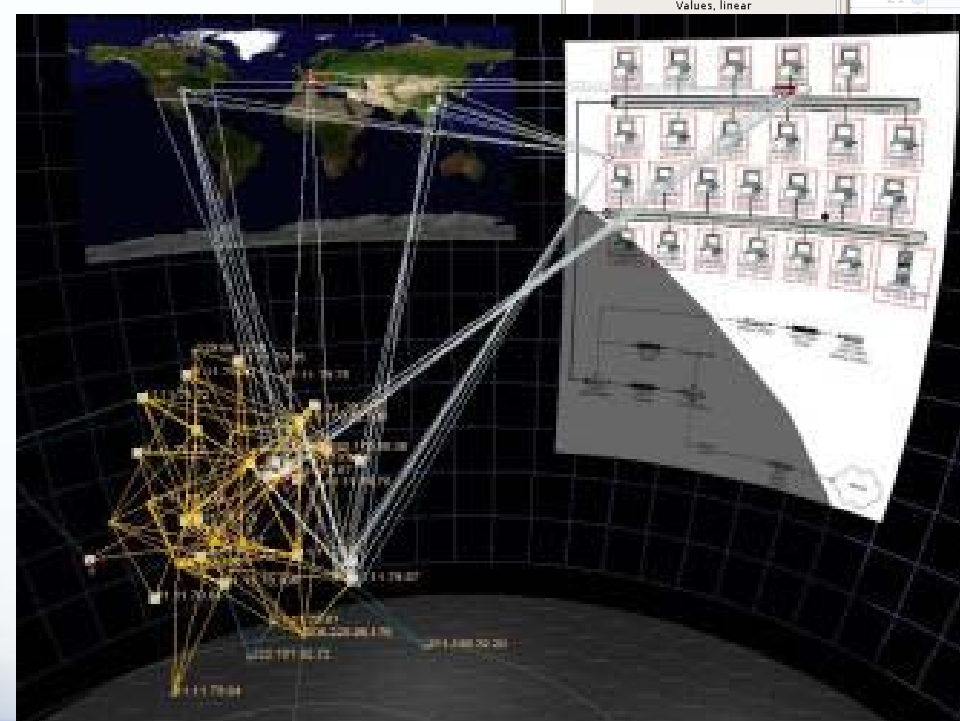http://www.precisioninformation.org

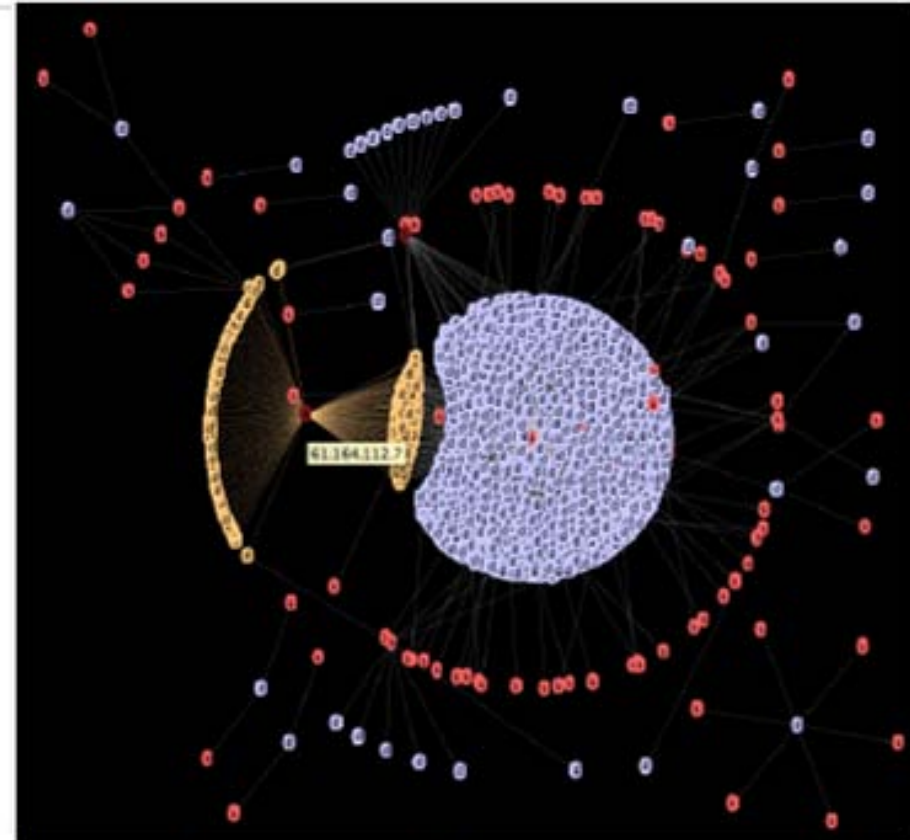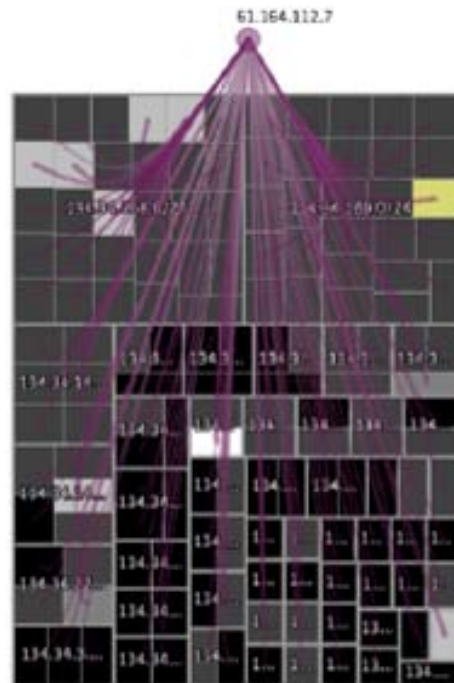# Cyber Warfare

Many Nets
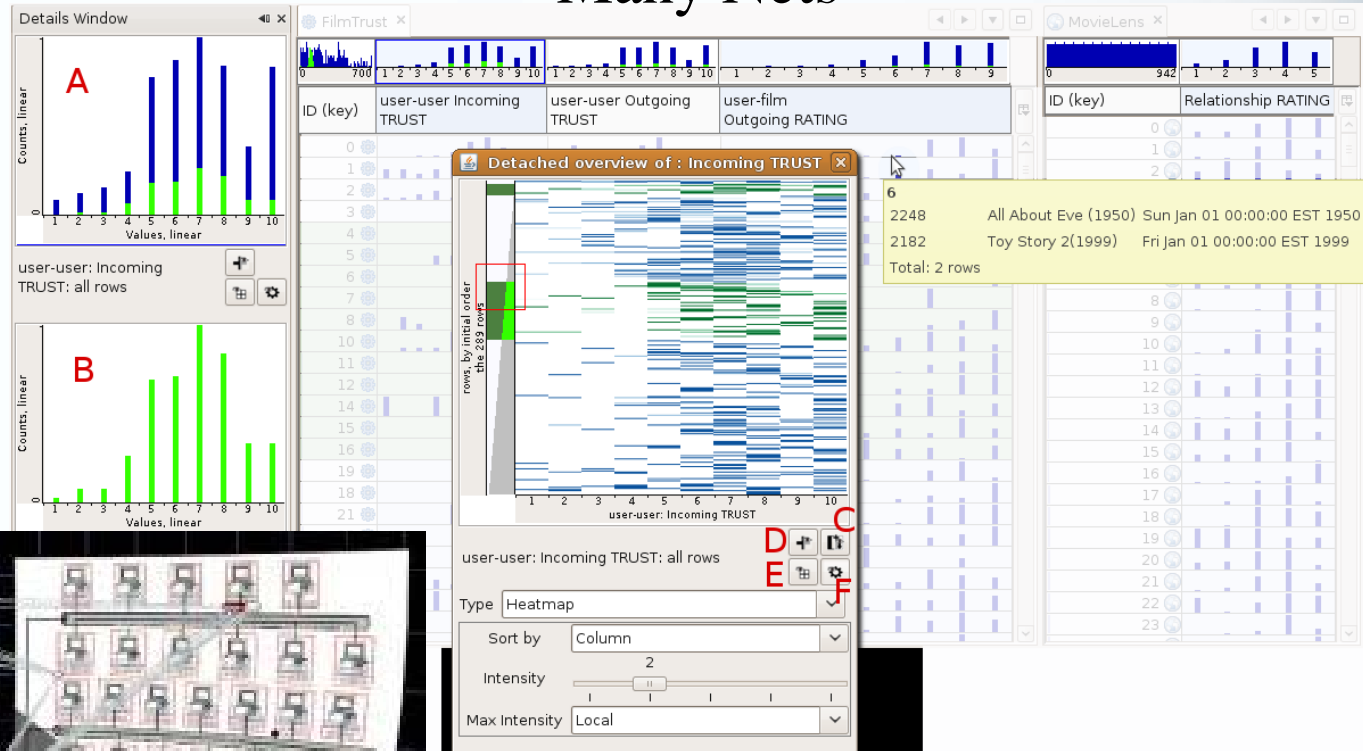
Sopan *et al.* (2010)

Starlight Visual Information System

Future Point Systems (2011)

Cyber Warfare

NFlowVis

(a) Identification of compromised hosts using threshold adjustment (red).
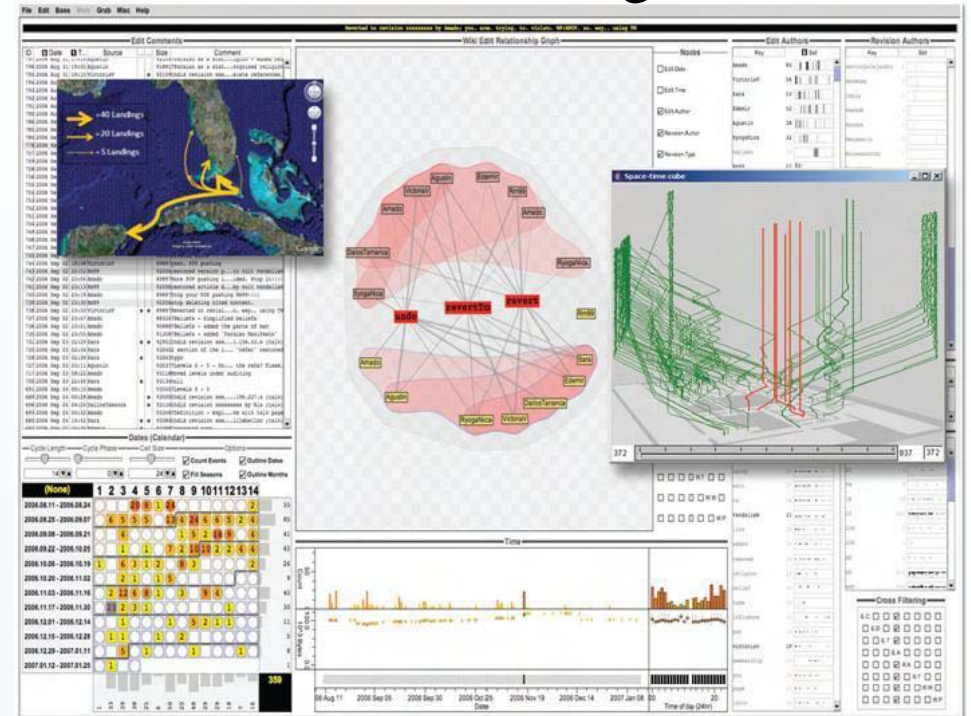
(b) Graph visualization showing communication flows between source (red) and destination hosts (blue).
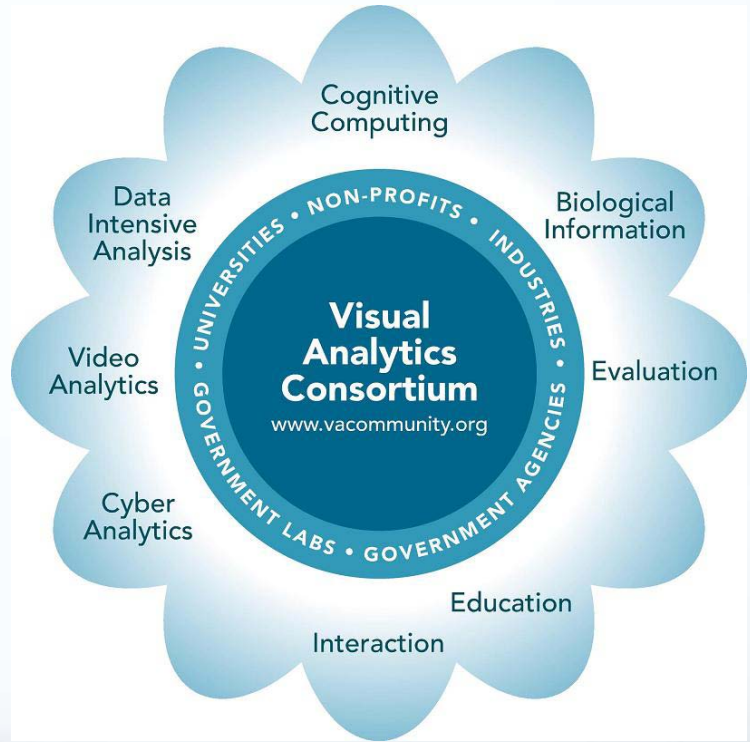
Mansmann *et al*. (2009)

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Resources

- VADL
- InfoVis:Wiki
- VAC Views
- <u>ivac.org</u>

VAST Challenges

VAST(2008)

<u>vacommunity.org</u>

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