Topic Notes

Visual Analytics 2

CS 7450 - Information Visualization
November 20, 2013
John Stasko

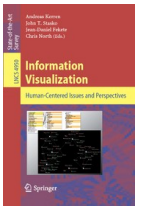
Agenda

- Last time
  - Overview of what the term means and how it relates to information visualization
  - Some example VA research projects
- Today
  - Specific example, Jigsaw, helping investigative analysis
  - Related systems

Review

VA 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

Application Area

- Investigative & Intelligence Analysis
  - Gather information from various sources then analyze and reason about what you find and know
  - Analyze situations, understand the particulars, anticipate what may happen

Definitions

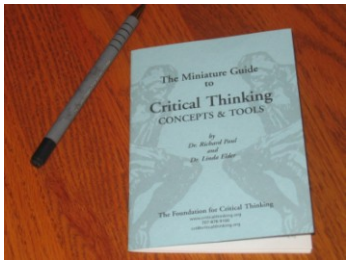
- Thinking[1] - or reasoning - involves objectively connecting present beliefs with evidence in order to believe something else
- Critical Thinking[1] is a deliberate meta-cognitive(thinking about thinking) thinking act whereby a person reflects on the quality of the reasoning process simultaneously while reasoning to a conclusion.
- Intelligence[1] is a specialized form of knowledge, an activity, and an organization. As knowledge, intelligence informs leaders, uniquely aiding their judgment and decision-making. …

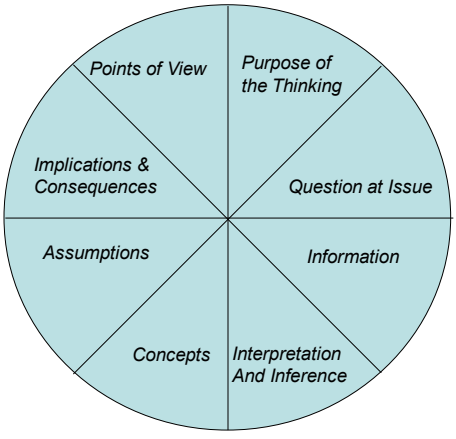
1. *Critical Thinking and Intelligence Analysis: David Moore*

Critical Thinking*

"…the quality of our life and that of what we produce, make, or build depends precisely on the quality of our thoughts."

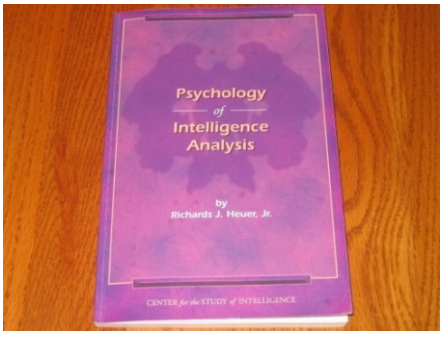
Elements of thought:





* Foundations of Critical Thinking www.criticalthinking.org

Example: Heuer's Central Ideas



- "Tools and techniques that gear the analyst's mind to apply higher levels of critical thinking can substantially improve analysis… structuring information, challenging assumptions, and exploring alternative interpretations."

Intelligence Process

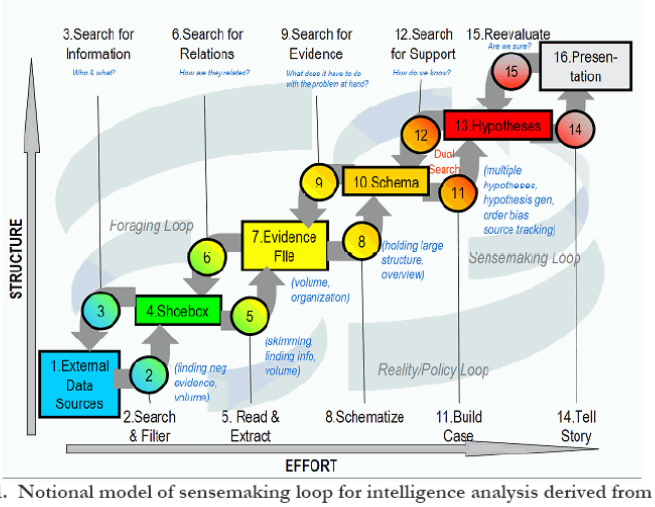
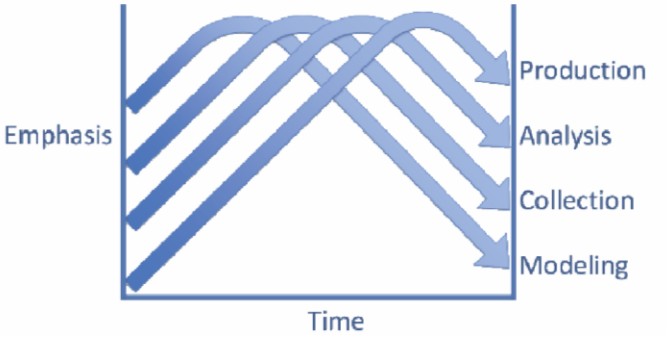


Figure 2.1. Notional model of sensemaking loop for intelligence analysis derived from CTA.

Pirolli & Card
Intl Conf Intelligence Analysis '05

Intelligence Process



Wheaton
In preparation

Pain Points

- Cost structure of scanning and selecting items for further attention
- Analysts' span of attention for evidence and hypotheses

Jigsaw

Stasko, Görg, Liu
Information Visualization '08

Görg et al
TVCG '13

Visualization for Investigative Analysis across Document Collections

- Law enforcement & intelligence community
- Fraud (finance, accounting, banking)
- Academic research
- Journalism & reporting
- Consumer research

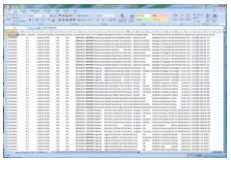
"Putting the pieces together"

Analogy

Problem Addressed

Help "investigators" explore, analyze and understand large document collections

Articles & reports



Spreadsheets

Blogs

XML documents

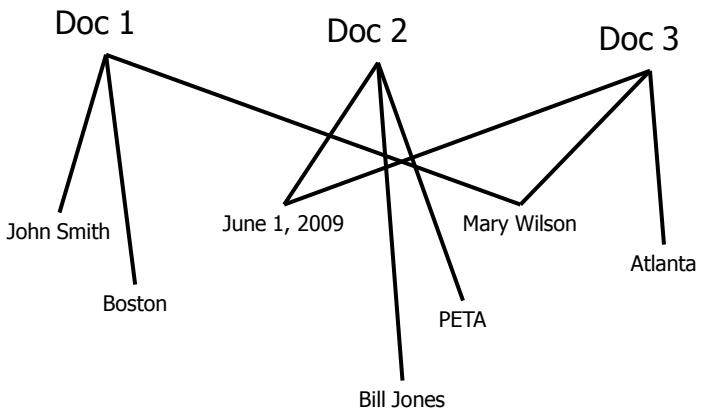
The Jigsaw Team

Carsten Görg
Zhicheng Liu
Youn-ah Kang
Jaeyeon Kihm
Jaegul Choo
Chad Stolper
Anand Sainath

and many others

Our Focus

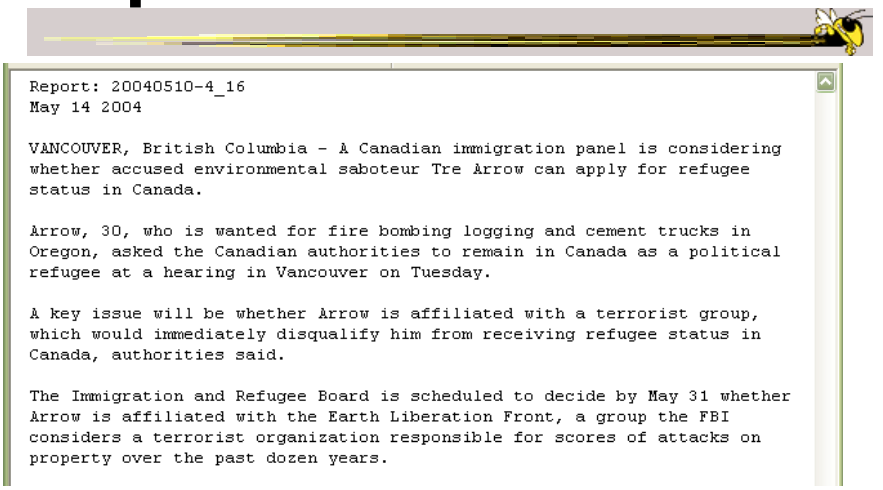
- Entities within the documents
  - Person, place, organization, phone number, date, license plate, etc.
- Thesis: A story/narrative/plot/threat within the documents will involve a set of entities in coordination



Entity Identification

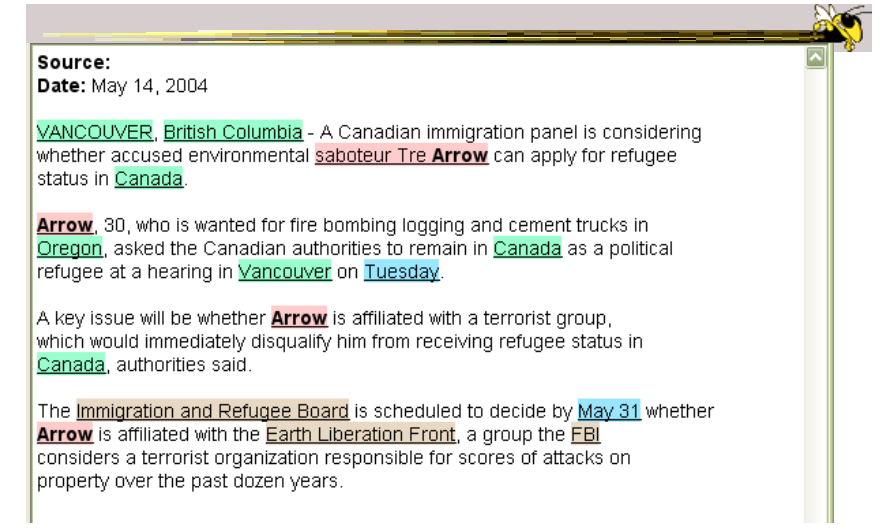
- Must identify and extract entities from plain text documents
  - Crucial for our work
- Not our main research focus – We use tools from others

Sample Document



```
Report: 20040510-4_16
May 14 2004

VANCOUVER, British Columbia - A Canadian immigration panel is considering
whether accused environmental saboteur Tre Arrow can apply for refugee
status in Canada.

Arrow, 30, who is wanted for fire bombing logging and cement trucks in
Oregon, asked the Canadian authorities to remain in Canada as a political
refugee at a hearing in Vancouver on Tuesday.

A key issue will be whether Arrow is affiliated with a terrorist group,
which would immediately disqualify him from receiving refugee status in
Canada, authorities said.

The Immigration and Refugee Board is scheduled to decide by May 31 whether
Arrow is affiliated with the Earth Liberation Front, a group the FBI
considers a terrorist organization responsible for scores of attacks on
property over the past dozen years.
```


Entities Identified



Source:
Date: May 14, 2004

VANCOUVER, British Columbia - A Canadian immigration panel is considering whether accused environmental saboteur Tre **Arrow** can apply for refugee status in Canada.

Arrow, 30, who is wanted for fire bombing logging and cement trucks in Oregon, asked the Canadian authorities to remain in Canada as a political refugee at a hearing in Vancouver on Tuesday.

A key issue will be whether **Arrow** is affiliated with a terrorist group, which would immediately disqualify him from receiving refugee status in Canada, authorities said.

The Immigration and Refugee Board is scheduled to decide by May 31 whether **Arrow** is affiliated with the Earth Liberation Front, a group the FBI considers a terrorist organization responsible for scores of attacks on property over the past dozen years.

Sample Document 2

Title: Proving Columbus was Wrong
Abstract: In this work, we show the world is really flat. To do this, we build a bunch of ships. Then we…
PI: Amerigo Vespucci
Co-PI: Vasco de Gama, Ponce de Leon
Organization: Northwest Central Univ.
Amount: 123,456
Program Mgr: Ephraim Glinert
Division: IIS
ProgramElementCode: 2860

Entities Already Identified

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Abstract: In this work, we show the world is really flat. To do this, we build a bunch of ships. Then we…
PI: Amerigo Vespucci
Co-PI: Vasco de Gama, Ponce de Leon
Organization: Northwest Central Univ.
Amount: 123,456
Program Mgr: Ephraim Glinert
Division: IIS
ProgramElementCode: 2860

Entities

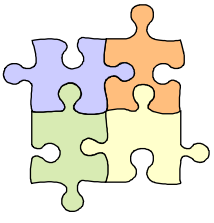
Connections

- Entities relate/connect to each other to make a larger "story"
- Connection definition:
  - Two entities are connected if they appear in a document together
  - The more documents they appear in together, the stronger the connection

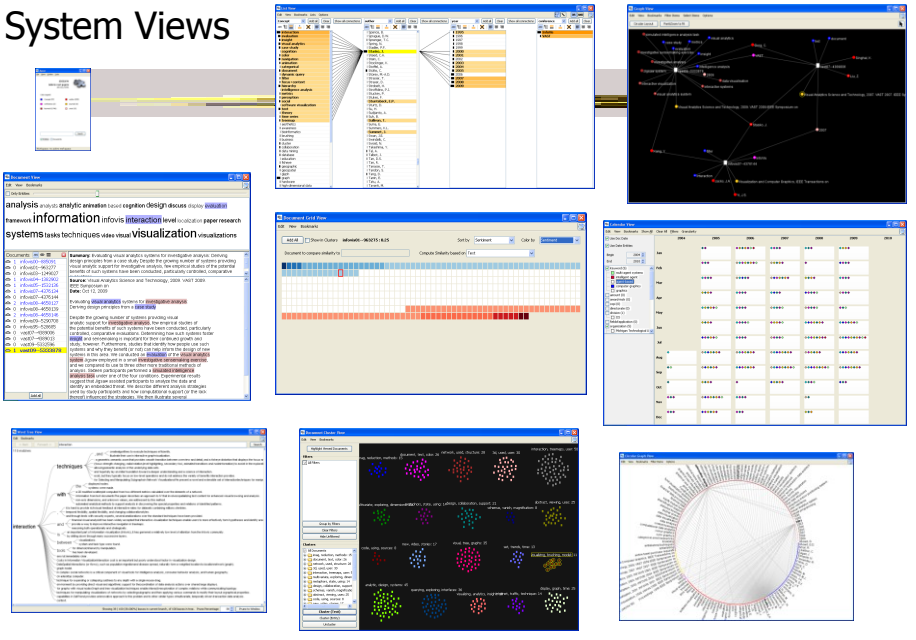
Jigsaw

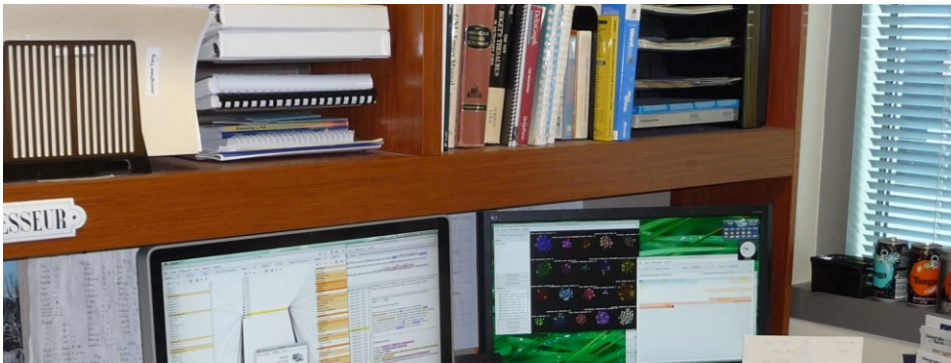
"Putting the pieces together"

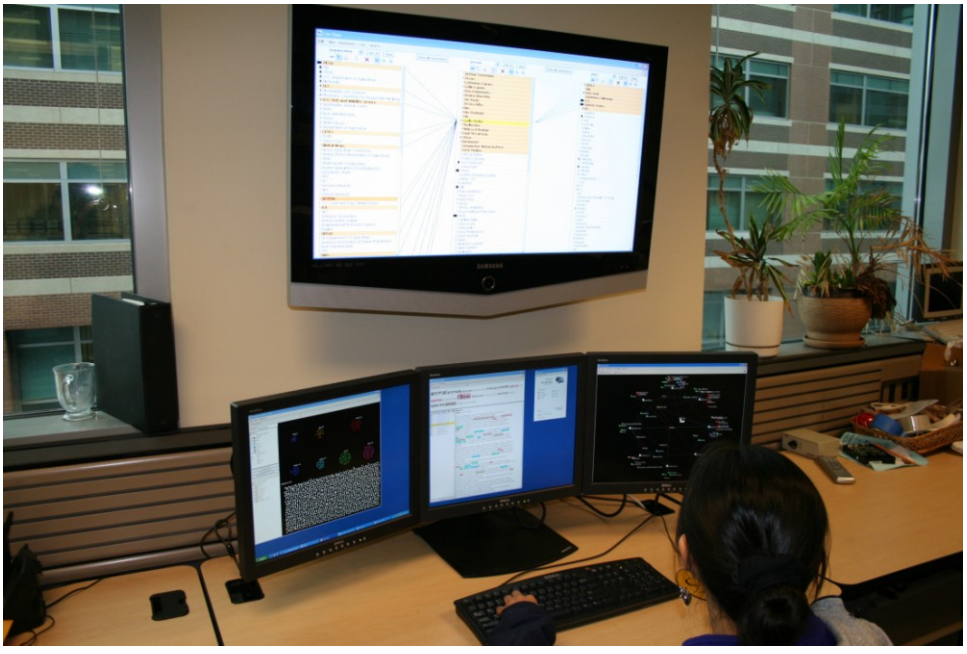
- Computational analysis of document text
  - Entity identification, document similarity, clustering, summarization, sentiment
- Multiple visualizations (views) of documents, analysis results, entities and their connections
- Views are highly interactive and coordinated

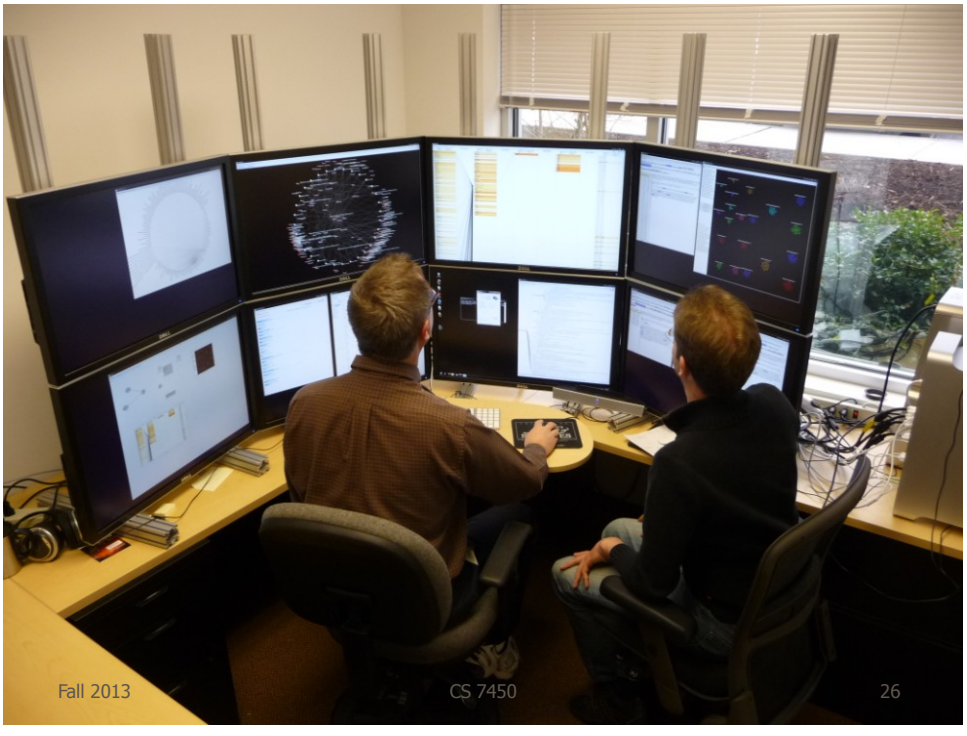


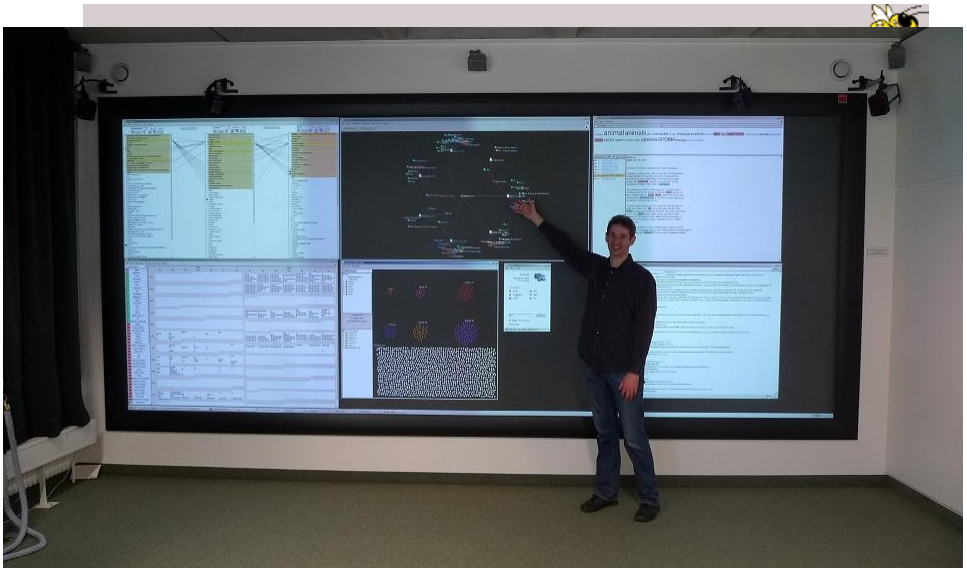
System Views





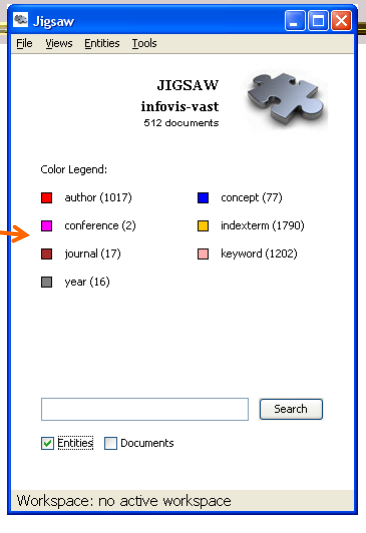




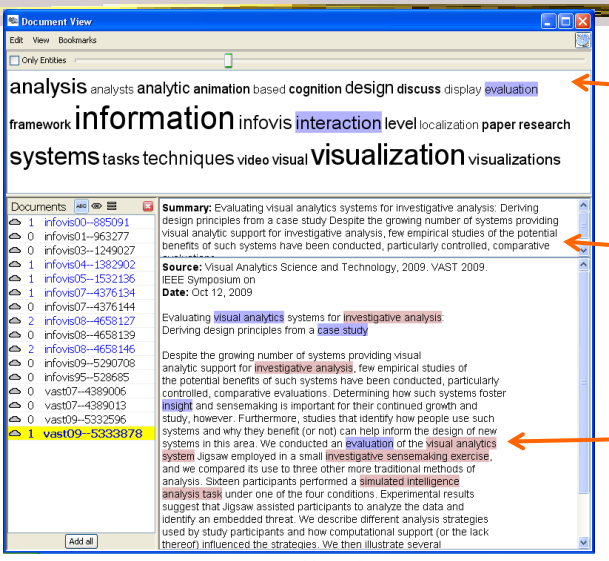


Console

Entity types

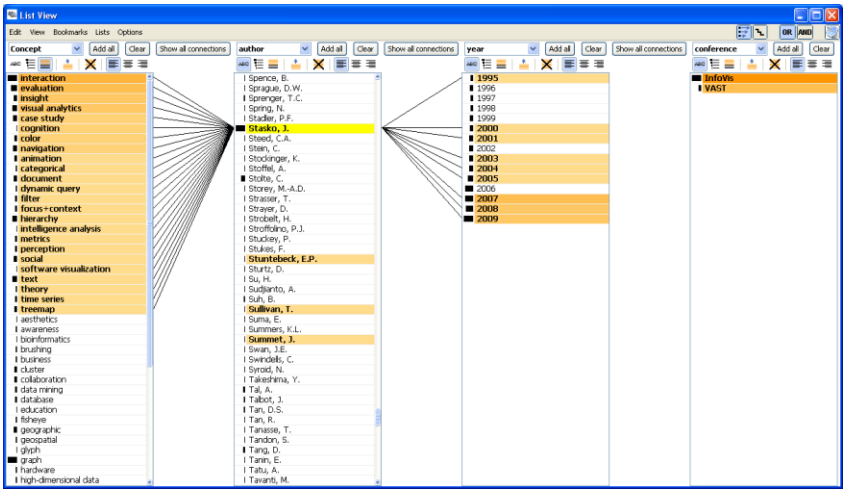


Document View



List View

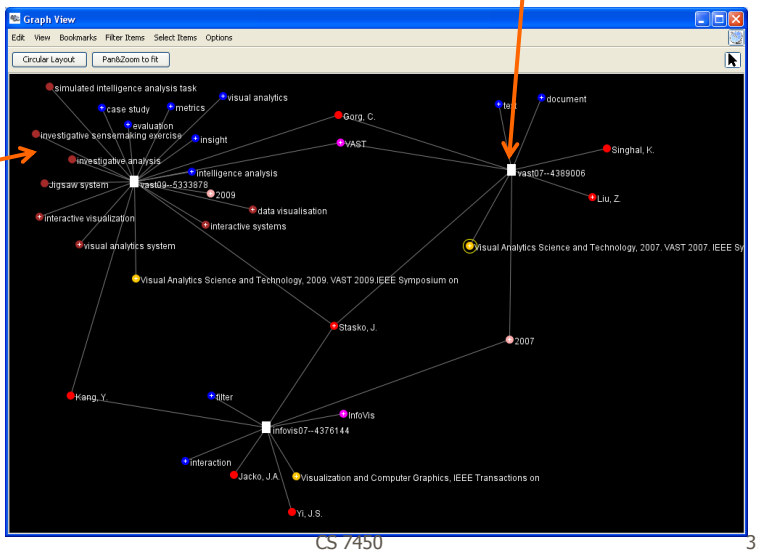
Lists of entities by type
Connections highlighted



Graph View

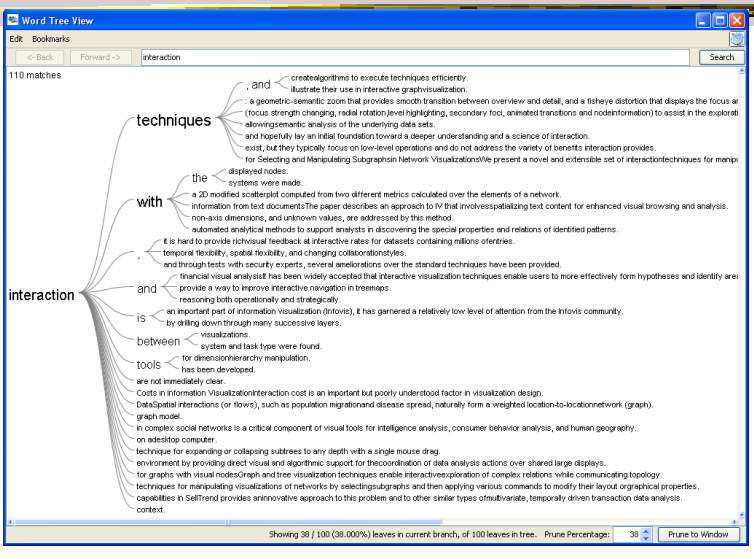
Document

Entities



WordTree View

Context of a word in the collection

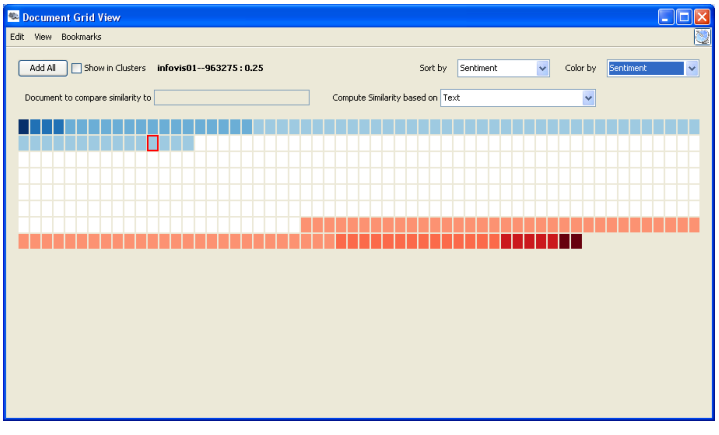


Document Cluster View

Clustered by document text or by entities

Summarized by three words

Document Grid View

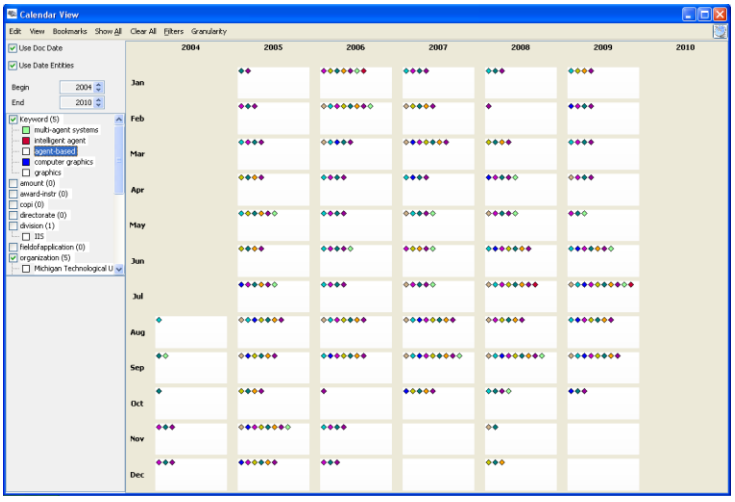


User controls order and color

Sentiment analysis shown here

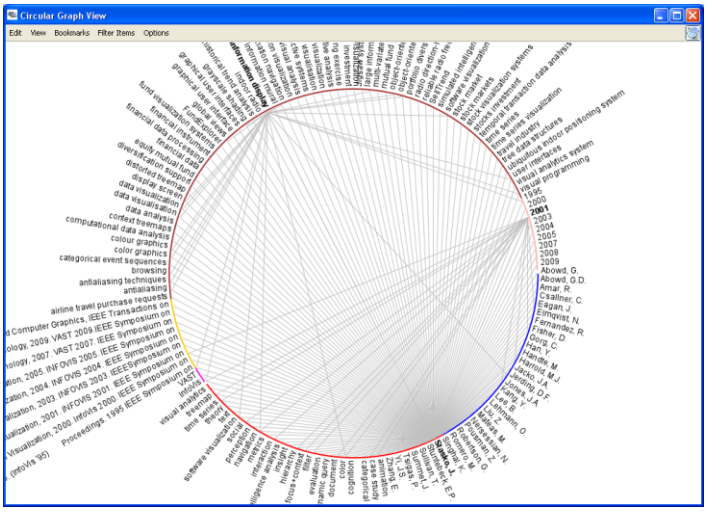
Calendar View

Showing connections between entities and dates



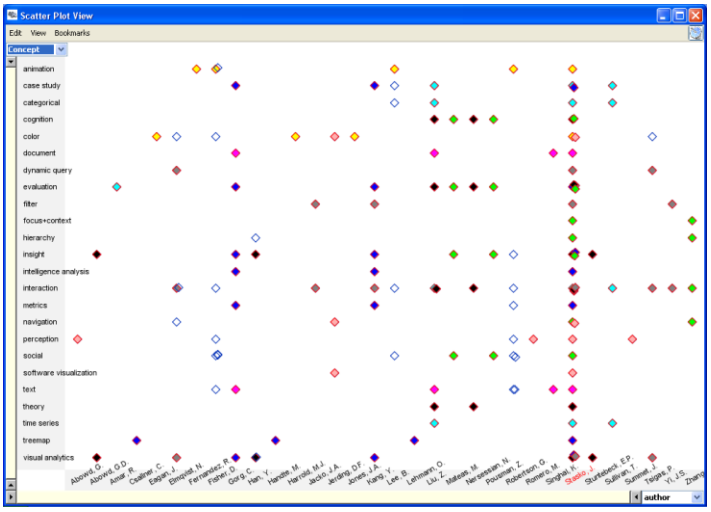
Circular Graph View

Connections between entities



Scatterplot View

Documents containing pairs of entities



Demo 1

- Car reviews
  - Text: Consumer's comments
  - Entities: Various ratings (1-10), car features, other makes & models

Demo 2

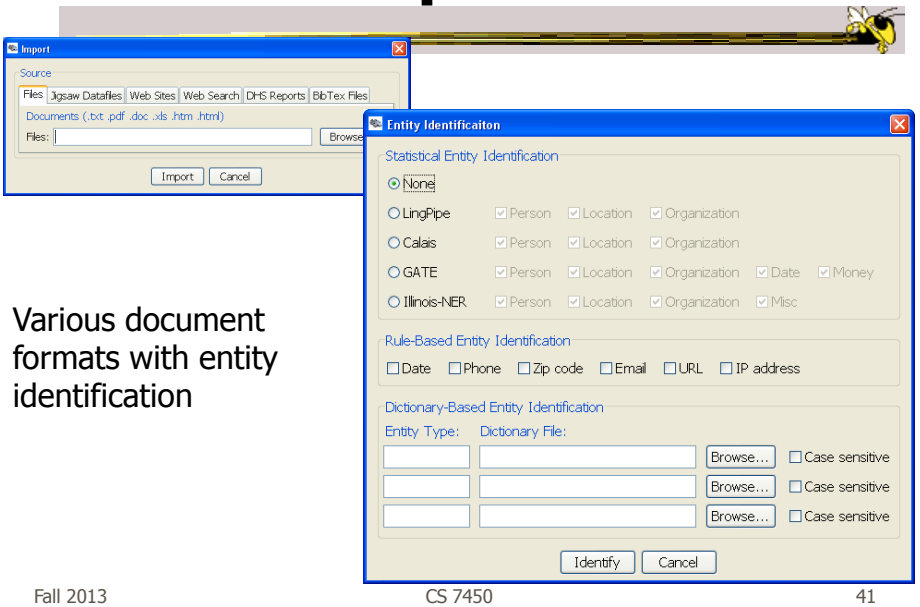
- InfoVis & VAST papers
  - Text: paper title and abstract
  - Entities: author, keyword, year, conference, "concept"

Computational Analyses

- Document summarization
- Document similarity
- Document clustering by content
  - Text or entities
- Sentiment analysis

Görg et al
TVCG`13

Document Import



Various document formats with entity identification

Input Data Formats

- Text, pdf, Word, html, Excel
- Jigsaw data file format
  - Our own xml
- DB?
  - Go to Excel
  - Go to text, transform to Jigsaw data file

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Scraped XML


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    Data Analysis and Visualization) Lead research team at the Georgia Institute of Technology provides unified
    expertise in the critical areas for providing leadership of the FODAVA effort, including machine learning and
    computational statistics, information visualization, massive-dataset algorithms and data structures, and
    optimization theory.  The team is focused on the fundamental theory and approaches to make breakthroughs in data
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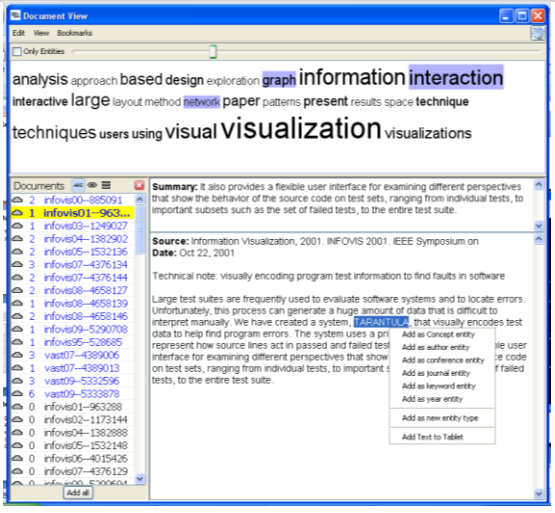
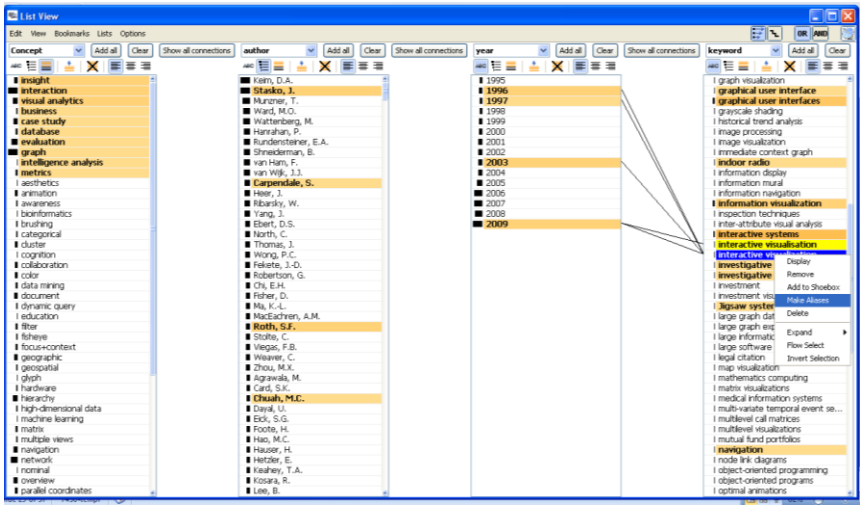
Jigsaw Datafile Format

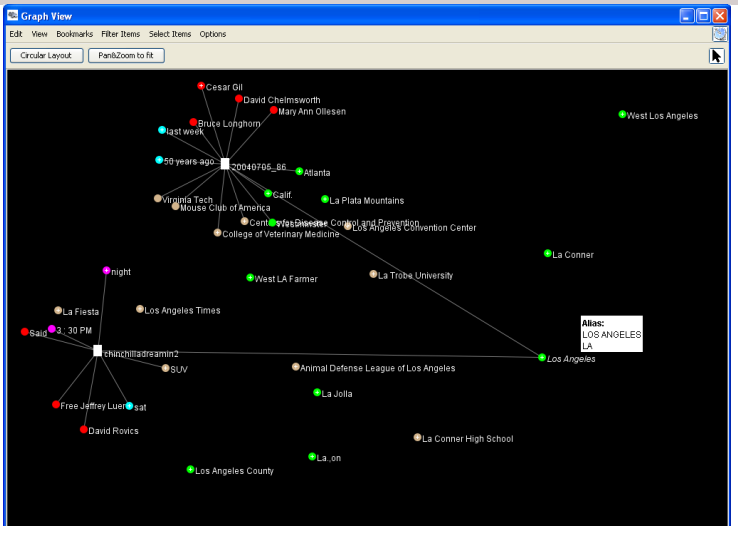
EI Correction



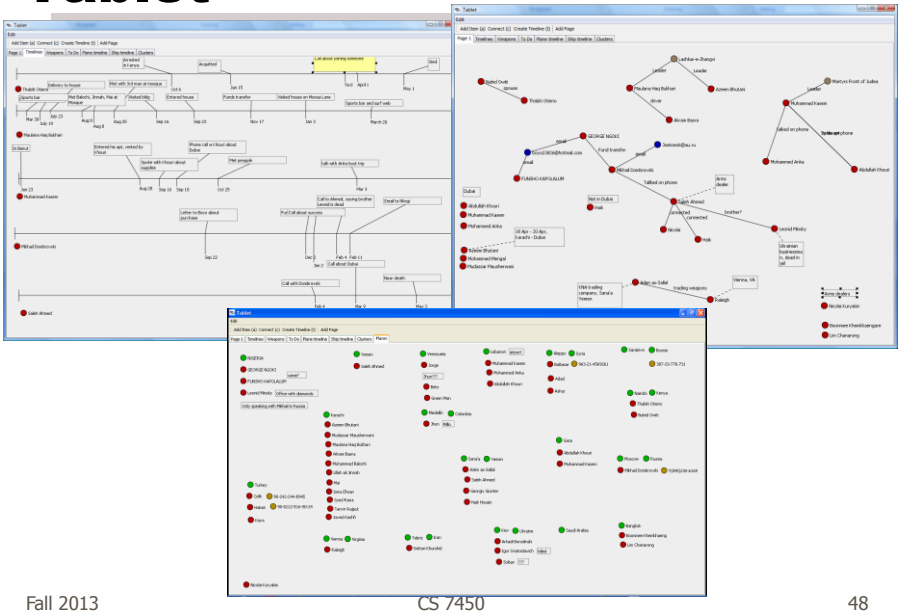
Entity Aliasing



Alias Representation



Tablet

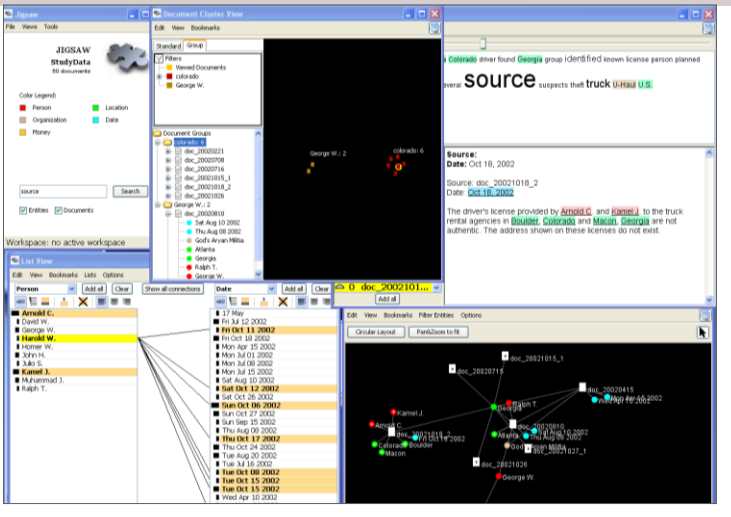


More Complex Task Eval

- Consider investigative analysis tasks involving sensemaking, awareness, and understanding
- Research questions
  - How do people use systems?
  - What characteristics matter?
  - What should we measure/observe?
- Exploring methods for utility evaluation

Kang et al
VAST '08 & *TVCG*'11

System Examined - Jigsaw



Study Design

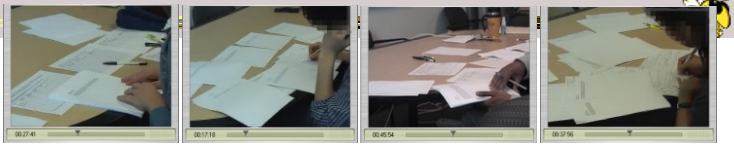
- Task and dataset Your HW 7
  - 50 simulated intelligence case reports
    - Each a few sentences long
    - 23 were relevant to plot
  - Identify the threat & describe it in 90 minutes

Source: doc017
Date: Oct 22, 2002

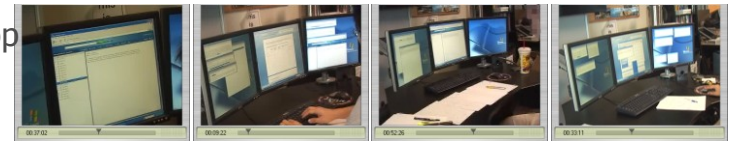
Abu H., who was released from custody after the September 11 incidents and whose fingerprints were found in the U-Haul truck rented by Arnold C. [see doc033] holds an Egyptian passport. He is now known to have spent six months in Afghanistan in the summer of 1999.

Study Design - Settings

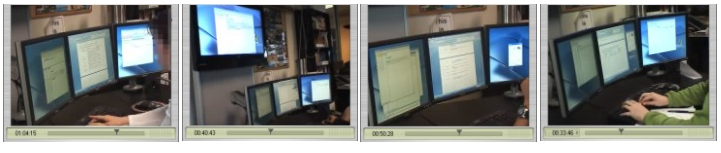
1: Paper



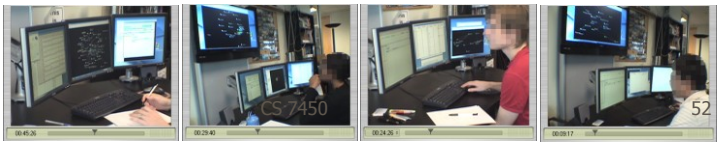
2: Desktop

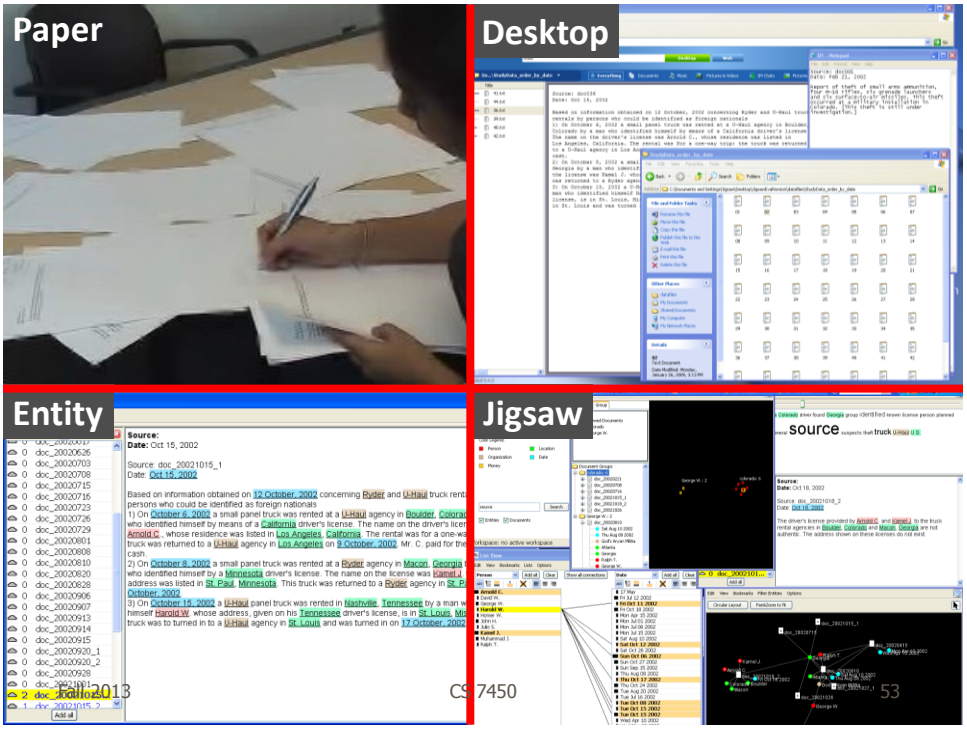


3: Entity



4: Jigsaw





Performance Measures

- Task sheets (like VAST Contest)
  - Three components (relevant people, events, locations)
  - +1 for correct items, -1 for a misidentified items
- Summary narrative
  - Subjective grading from 1 (low) to 7 (high)
- Two external raters
- Normalized, each part equal, mapped to 100-point scale

Results

	Paper				Desktop				Entity				Jigsaw			
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
Final Score	22.87	65.00	24.26	87.08	62.08	67.13	42.13	29.41	52.23	15.00	29.26	81.19	95.05	58.07	75.20	90.00
Performance	Fair	Very good	Fair	Excel-lent	Very good	Very good	Good	Fair	Good	Poor	Fair	Excel-lent	Excel-lent	Good	Very good	Excel-lent
Average Score	49.80				50.19				44.42				79.59			
Documents Viewed	50	50	50	50	50	50	50	50	49	31	45	50	31	50	46	23
# of Queries					19	18	48	8	23	61	59	91	44	4	26	8
First Query					40:49	19:55	2:47	12:41	1:31	0:29	0:59	3:12	0:18	5:35	25:37	4:18
Amount of Notes	Many	None	Many	Some	Many	Some	Few	Some	Some	None	None	Few	Some	Few	Few	Few
First Note Taking	0:07		0:05	0:16	1:53	19:57	2:47	8:20	2:37			3:14	0:48	0:32	5:15	78:45
First Task Sheet	43:20	32:53	70:13	3:25	61:35	20:26	7:33	64:11	28:09	0:52	2:55	7:20	48:26	41:48	43:00	5:33

Results

	Paper				Desktop				Entity				Jigsaw			
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
Final Score	22.87	65.00	24.26	87.08	62.08	67.13	42.13	29.41	52.23	15.00	29.26	81.19	95.05	58.07	75.20	90.00
Performance	Fair	Very good	Fair	Excel-lent	Very good	Very good	Good	Fair	Good	Poor	Fair	Excel-lent	Excel-lent	Good	Very good	Excel-lent
Average Score	49.80				50.19				44.42				79.59			
Documents Viewed	50	50	50	50	50	50	50	50	49	31	45	50	31	50	46	23
# of Queries					19	18	48	8	23	61	59	91	44	4	26	8
First Query					40:49	19:55	2:47	12:41	1:31	0:29	0:59	3:12	0:18	5:35	25:37	4:18
Amount of Notes	Many	None	Many	Some	Many	Some	Few	Some	Some	None	None	Few	Some	Few	Few	Few
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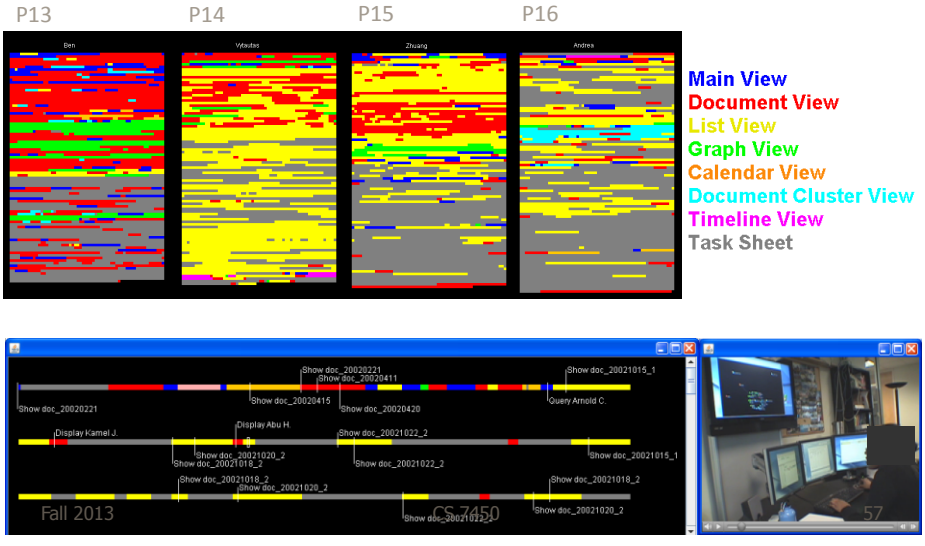
Jigsaw Usage Patterns



Investigative Strategies

1. Overview, filter and detail (OFD)
2. Build from detail (BFD)
3. Hit the keyword (HTK)
4. Find a clue, follow the trail (FCFT)

P16: "*I like this people-first approach. Once I identify key people, then things that are potentially important come up, too. I'm an impatient person and don't want to read all documents chronologically.*"

Results by Strategy

	Paper				Desktop				Entity				Jigsaw			
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
Strategy Used	OFD	OFD	BFD	OFD	OFD	OFD	FCFT	BFD	BFD	HTK	HTK	FCFT	FCFT	HTK	OFD	FCFT
Performance	Fair	Very good	Fair	Excel-lent	Very good	Very good	Good	Fair	Good	Poor	Fair	Excel-lent	Excel-lent	Good	Very good	Excel-lent
Documents Viewed	50	50	50	50	50	50	50	50	49	31	45	50	31	50	46	23

Results by Strategy

	Paper				Desktop				Entity				Jigsaw			
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
Strategy Used	OFD	OFD	BFD	OFD	OFD	OFD	FCFT	BFD	BFD	HTK	HTK	FCFT	FCFT	HTK	OFD	FCFT
Performance	Fair	Very good	Fair	Excel-lent	Very good	Very good	Good	Fair	Good	Poor	Fair	Excel-lent	Excel-lent	Good	Very good	Excel-lent
Documents Viewed	50	50	50	50	50	50	50	50	49	31	45	50	31	50	46	23

Results by Strategy

	Paper				Desktop				Entity				Jigsaw			
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
Strategy Used	OFD	OFD	BFD	OFD	OFD	OFD	FCFT	BFD	BFD	HTK	HTK	FCFT	FCFT	HTK	OFD	FCFT
Performance	Fair	Very good	Fair	Excel-lent	Very good	Very good	Good	Fair	Good	Poor	Fair	Excel-lent	Excel-lent	Good	Very good	Excel-lent
Documents Viewed	50	50	50	50	50	50	50	50	49	31	45	50	31	50	46	23

Results by Strategy

	Paper				Desktop				Entity				Jigsaw			
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Strategy Used	OFD	OFD	BFD	OFD	OFD	OFD	FCFT	BFD	BFD	HTK	HTK	FCFT	FCFT	HTK	OFD	FCFT
Performance	Fair	Very good	Fair	Excel-lent	Very good	Very good	Good	Fair	Good	Poor	Fair	Excel-lent	Excel-lent	Good	Very good	Excel-lent
Documents Viewed	50	50	50	50	50	50	50	50	49	31	45	50	31	50	46	23

Results by Strategy

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Strategy Used	OFD	OFD	BFD	OFD	OFD	OFD	FCFT	BFD	BFD	HTK	HTK	FCFT	FCFT	HTK	OFD	FCFT
Performance	Fair	Very good	Fair	Excel-lent	Very good	Very good	Good	Fair	Good	Poor	Fair	Excel-lent	Excel-lent	Good	Very good	Excel-lent
Documents Viewed	50	50	50	50	50	50	50	50	49	31	45	50	31	50	46	23

Tool Design Implications

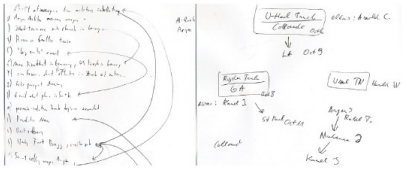
- Support finding starting points/clues
- Guide the analyst to follow the right trail
- Support different strategies of SM process
- Support smooth transition between SM stages
- Provide a workspace
- Allow flexibility in organizing
- Support to find next steps when dead-end
- Facilitate further exploration

Jigsaw's Influence

- Supporting different strategies
- Showing connections between entities

- Helping users find the right clue
- Helping users focus on essential information

- Reviewing hypotheses
- Increasing motivation



Evaluation Recommendations

- Compare system usage to traditional methods
- Collect qualitative data, support with quantitative data
- Consider questions to be answered
- Possible metrics
  - Number of documents viewed
  - When note-taking initiated
  - The quantity of representations created
  - Amount of time and effort in organizing
  - Time spent in reading/processing relevant information

Application Domains

- Intelligence & law enforcement
  - Police cases
  - Won 2007 VAST Contest
  - Stasko et al, *Information Visualization* '08
- Academic papers, PubMed
  - All InfoVis & VAST papers
  - CHI papers
  - Görg et al, KES '10
- Investigative reporting
- Fraud
  - Finance, accounting, banking
- Grants
  - NSF CISE awards from 2000
- Topics on the web (medical condition)
  - Autism
- Consumer reviews
  - Amazon product reviews, edmunds.com, tripadvisor.com
  - Görg et al, HCIR '10
- Business Intelligence
  - Patents, press releases, corporate agreements, …
- Emails
  - White House logs
- Software
  - Source code repositories
  - Ruan et al, SoftVis '10

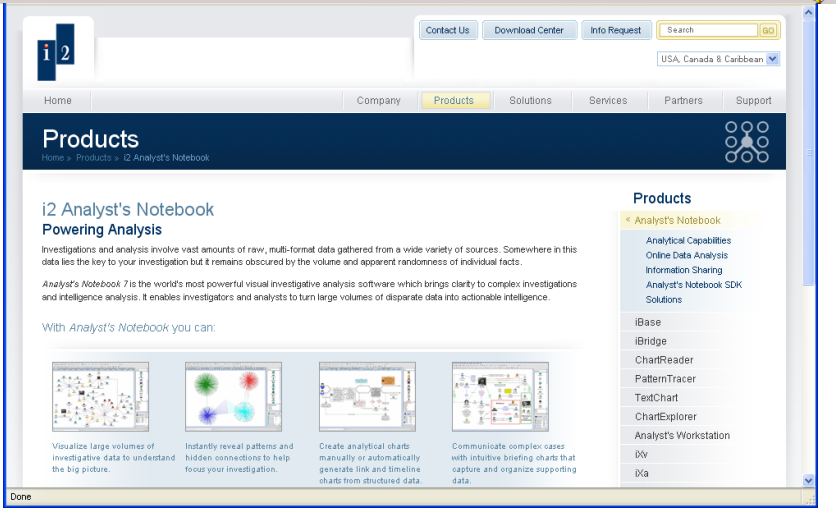
Potential Jigsaw Future Work

- Collaborative capabilities
- Improved evidence marshalling
- Present/browse investigation history
- Scalability upward
- Web document ingest
- Implement network algorithms
- DB import
- Wikipedia & Intellipedia
- Geospatial view
- Better timeline capabilities
- Reliability/uncertainty
- Other types of data
- Active crawling/RSS ingest
- Try it on display wall
- Deployment to real clients

Room to Improve

- What Jigsaw doesn't do so well now
  - The end-part of the Pirolli-Card model
    Helping the analyst take notes, organize evidence, generate hypotheses, etc.
    (The Tablet is a first step)
  - Sometimes called "evidence marshalling"
  - Others have focused more on that aspect…

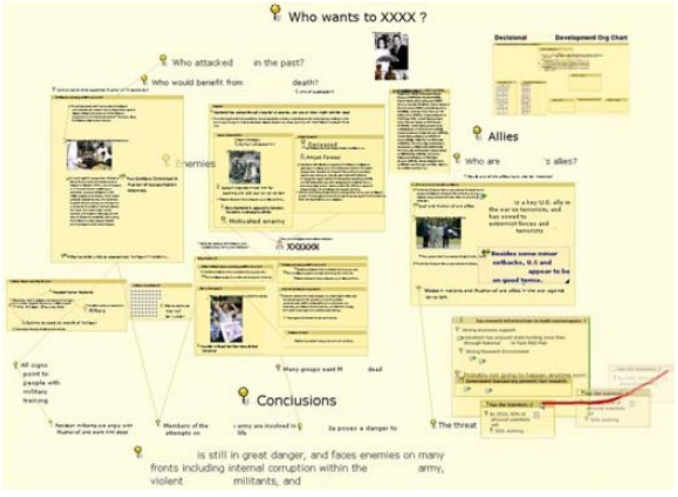
i2's Analyst Notebook



Analyst's Notebook

- Leading commercial tool in this space (law enforcement and intelligence agencies)
- Large zooming workspace where analyst creates networks of entities and notes
- Often used to produce presentation or story of analysis done

Oculus' Sandbox



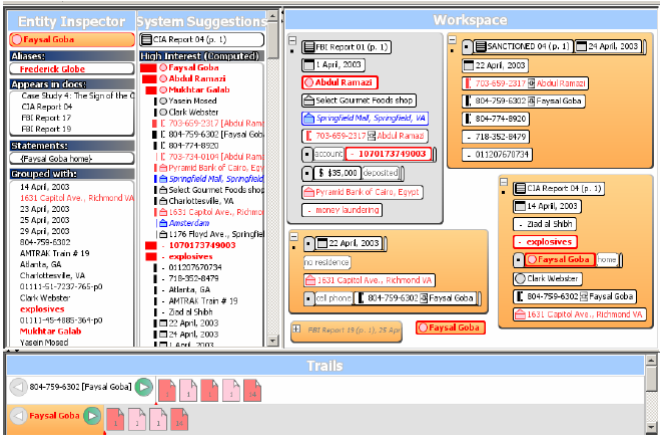
Video

Wright et al CHI '06

Sandbox

- Flexible space for inserting text and graphics
- Objects can be dragged-and-dropped from their other analysis tools
- Flexible level of detail
- Flexible gestures for making space, inserting, etc.
- Assertions with evidence gates
- Reasoning templates

PARC's Entity Workspace



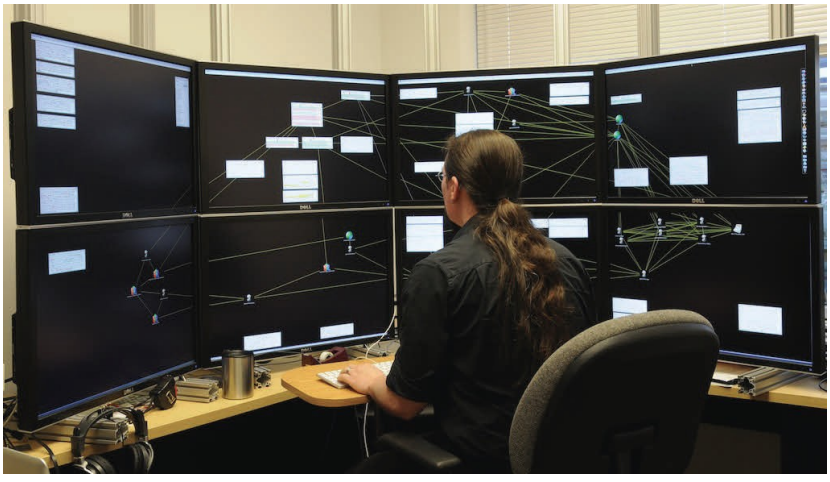
Video

Bier, Card & Bodnar
VAST '08

Entity Workspace

- Tools for rapid ingest of entities from documents
- Can snap together entities into groups
- Can indicate level of interest in objects
- Four main view panels, with zooming UI

VT's Analyst's Workspace



Video

Analyst's Workspace

- Uses spatial affordances from a large display area for benefit in sensemaking
- Analysts move around and arrange items (documents, entities, search results) to externalize the thinking process
  - Like working with pieces of paper on a conference table, but with computational capabilities

Andrews & North
VAST '12

Related Area of Interest

- Sensemaking
- A general term that has been used in a number of different contexts
  - E.g., How large corporations make decisions
- To me, ultimately about people working with data and information to understand it better

Sensemaking

Nice definition:

"A motivated , continuous effort to understand connections (which can be among people, places, and events) in order to anticipate their trajectories and act effectively."

– Klein, Moon and Hoffman
IEEE Intelligent Systems '06

Alternate Definition

"The process of creating situation awareness in situations of uncertainty"

– D. Leedom, '01 SM Symp. Report

Situation awareness:
"It's knowing what's going on so you know what to do"

– B. McGuinness, quoting an Air Force pilot

This Topic

- I work on it a lot now
- Interested in getting more work in this area started

HW 7

- Be an intelligence analyst
  - Use Jigsaw (available on web)
  - Documents on t-square
- Turn in: Your paragraph description of "threat" + process description (and any materials you want to submit)
- Due Tuesday 26th @ 4pm
  - 1 hardcopy, not email

Upcoming

- Time series data
  - Reading
    - Aigner et al '08
- Evaluation
  - Reading
    - Carpendale '08