Exploration through Multiple Linked Views (MLV)

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The Visualization Goal, and the MLV soln.

- …a dialogue between the user and data.
- The goal is to find information & make sense of large volume of potentially diverse datasets of multiple components and types.
  - Understand trends, anomalies
  - Isolate and reorganise information
  - Compare and make clear differences/similarities
  - Tryout scenarios, develop hypothesis
  - Systematic search
- The solution is to develop Highly Interactive Visualization Environment to enable information finding & discovery (so called MLV environments)
  - Sense–making environments
  - Insight is often formed through interaction

This talk…

1. Visual Exploration,
2. Multiple Views,
3. Linked Views
4. MLV Additional considerations…
   - Lightweight, Managed, Extensible…
5. Towards a MLV *Visual Analytic*

1. Exploration - Example,

- Looking for a London hotel, close to the conference but both cheaper and within walking distance.
- Using web:
  - Visit conference page, to find appropriate hotels, gather keywords. (e.g. postcode, conference hotel name, pricing, nearest tube).
  - Google search “London Hotels”
  - Jump to Expedia to find hotels and pricing, geographic info hard
  - Goto multimap to find location
  - Discover “Google Local”, type in postcode Pricing still hard to conference venue
  - After browsing - find an appropriate hotel
  - Book hotel via expedia
  - Find local tube station from information on hotel website
  - Plan rail route, from looking at railtrack.co.uk
  - Print geographic map and rail plan and timings

Reveal Questions

Confirm Relations

Generalise Findings

Presentation

1. Exploration

- Reveal the questions
  - become familiar with by testing, experimenting, understanding, acquire skill, Learning the hypothesis or model
- Confirming relations
  - Compare, relate, Prove disprove a hypothesis, comparison, examine minutely,
- Generalization of findings
  - identify features, summarize, abstract
- Presentation
  - teaching, demonstration

Visual Exploration

- Try out some parameters

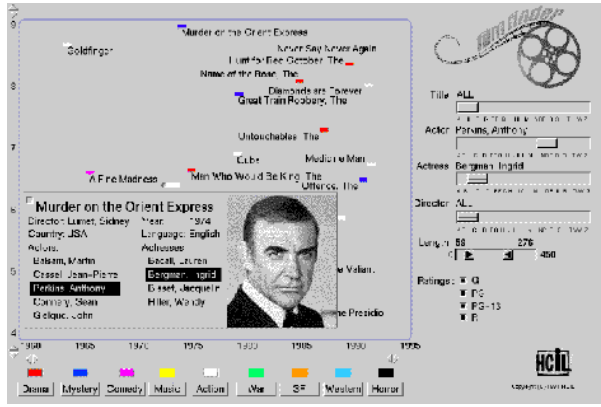
-> generate a view

Generate, Compare, Relate, Manipulate, Generate

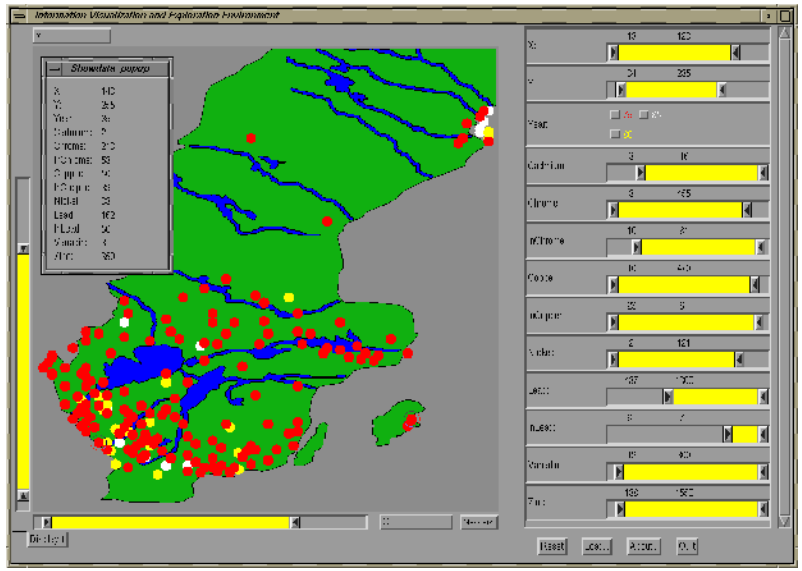
- Exploration needs highly interactive systems

Dynamic queries

- Instant update
  - Direct manipulation
  - Sliders/buttons



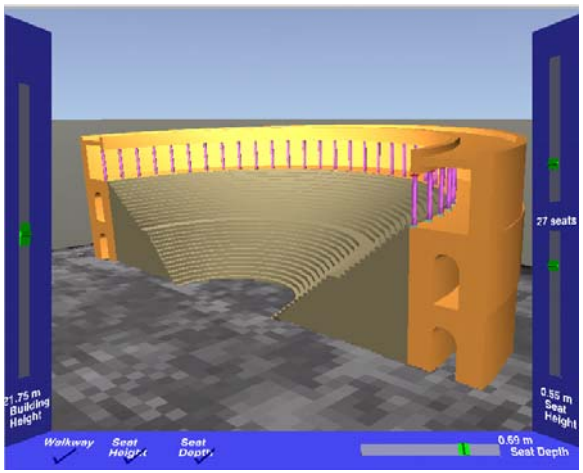
FilmFinder: Ahlberg, Shneiderman

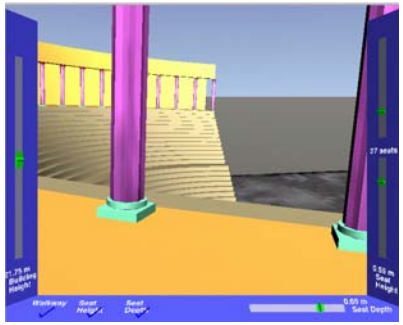


Example of a dynamic queries environment created with IVEE *Measurements of heavy metals in Sweden*

Zoom

- To focus, Select (or highlight) a *feature set* of information
  - Zoom: telephoto-lens, reduced field of view
  - 3D clipping
  - Semantic zoom





Alternate Representations [Roberts, Ryan]

Filter and Extract

- Visual extraction
  - constant quantity of information
  - brush and highlight
    - visually altered to stand out (colour, size ...)
  - sliders (1 < highlight < 4 ...)
- Subset (filter) of the data
  - extract portions of the dataset
  - Specialize
    - semi-automatic/manual (seed-point, selection)
    - neighborhood / global operations

1	1	1	1	1
1	2	3	2	1
1	3	9	3	1
1	2	3	2	1
1	1	1	1	1

1	1	1	1	1
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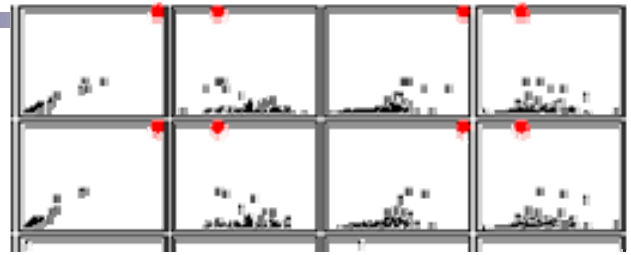

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1	2	**3**	2	1
1	**3**	9	**3**	1
1	2	**3**	2	1
1	1	1	1	1

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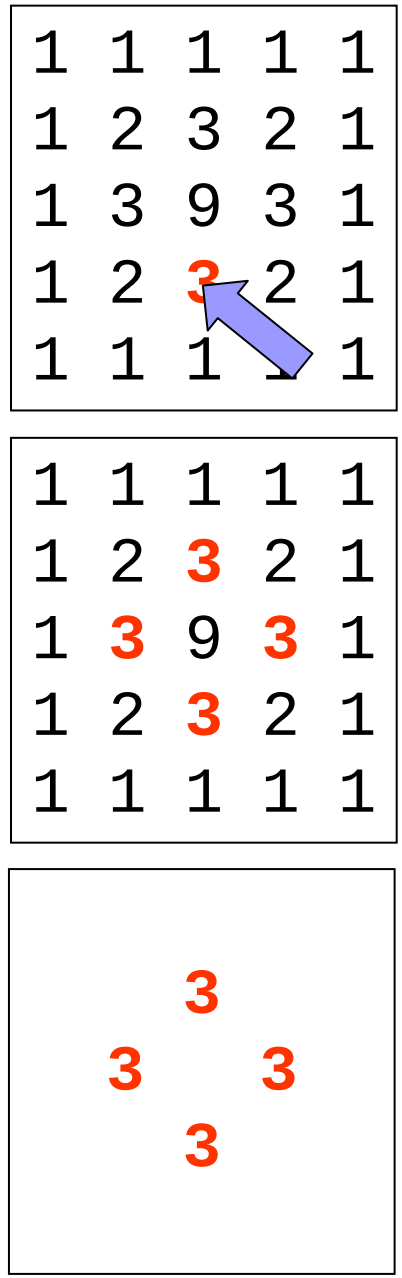
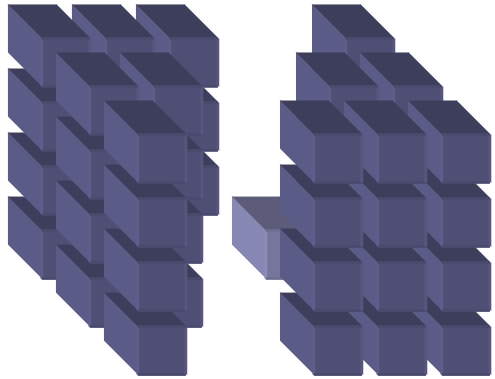
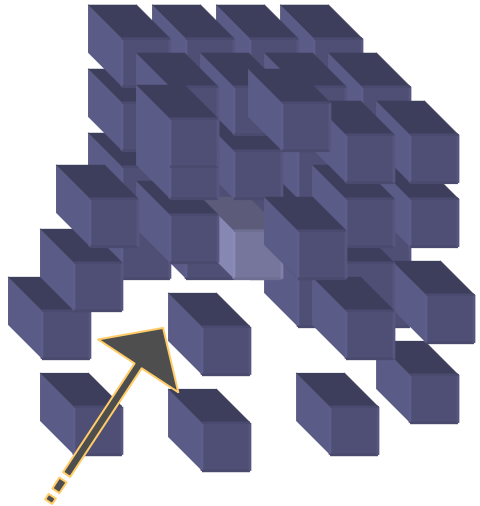


Manipulation

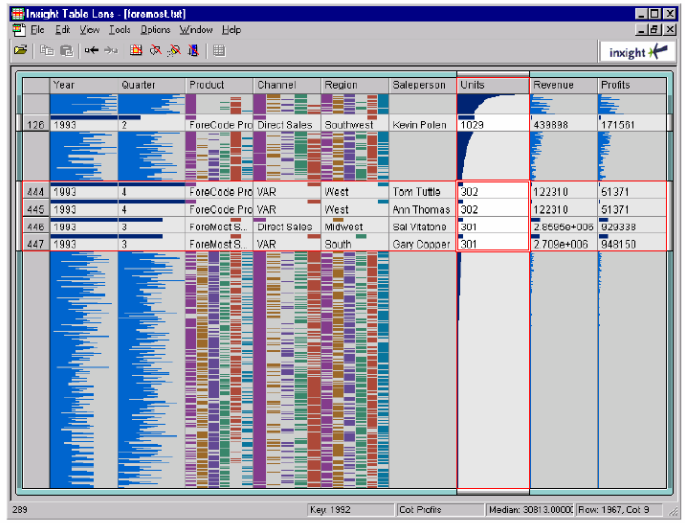
- 3D
  - rotation of views, objects
  - moving objects/parts away (separation)
- Query/Investigate
  - probe (point, line, area..)
    - what is the value here...
  - augment (position)
  - clip/cut-out objects





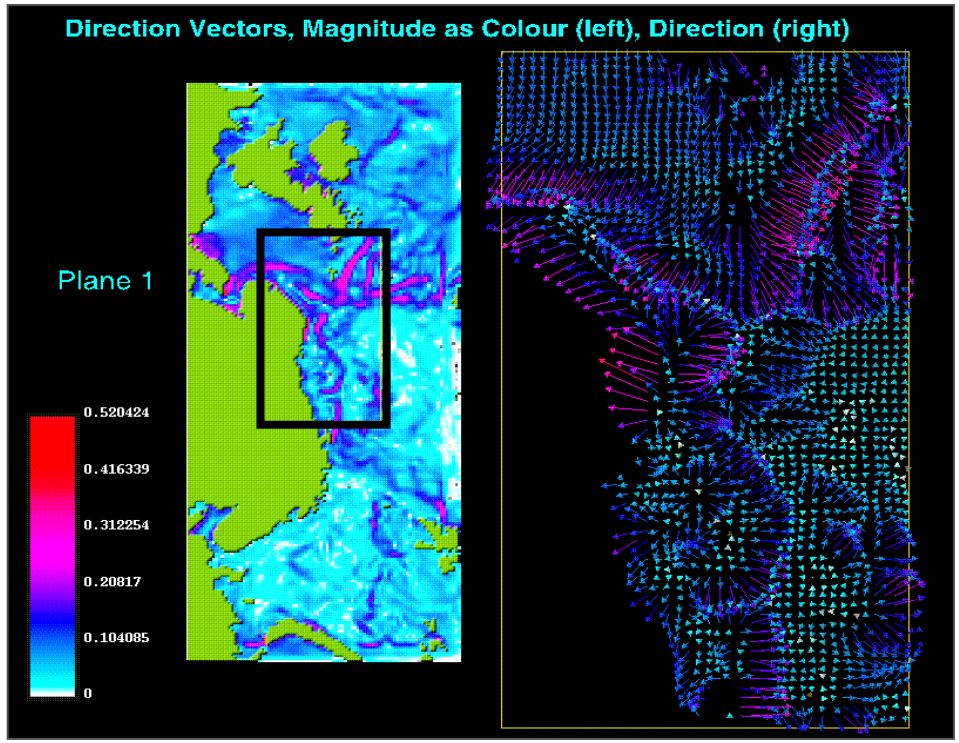
Focus + Context

Table Lens



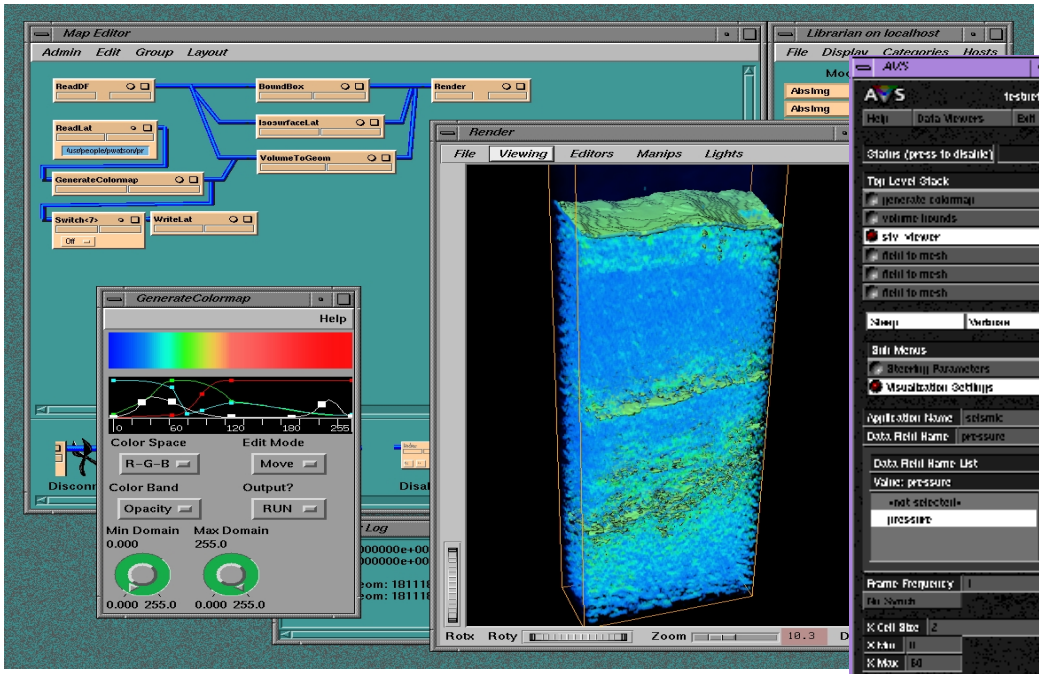
- Dual Views - Many variants:
  - Master slave; popup view
  - View on a bat (in VR)
  - Overview/detail view (focus +context)

- Data and table
- Scatterplot/parallel coordinates

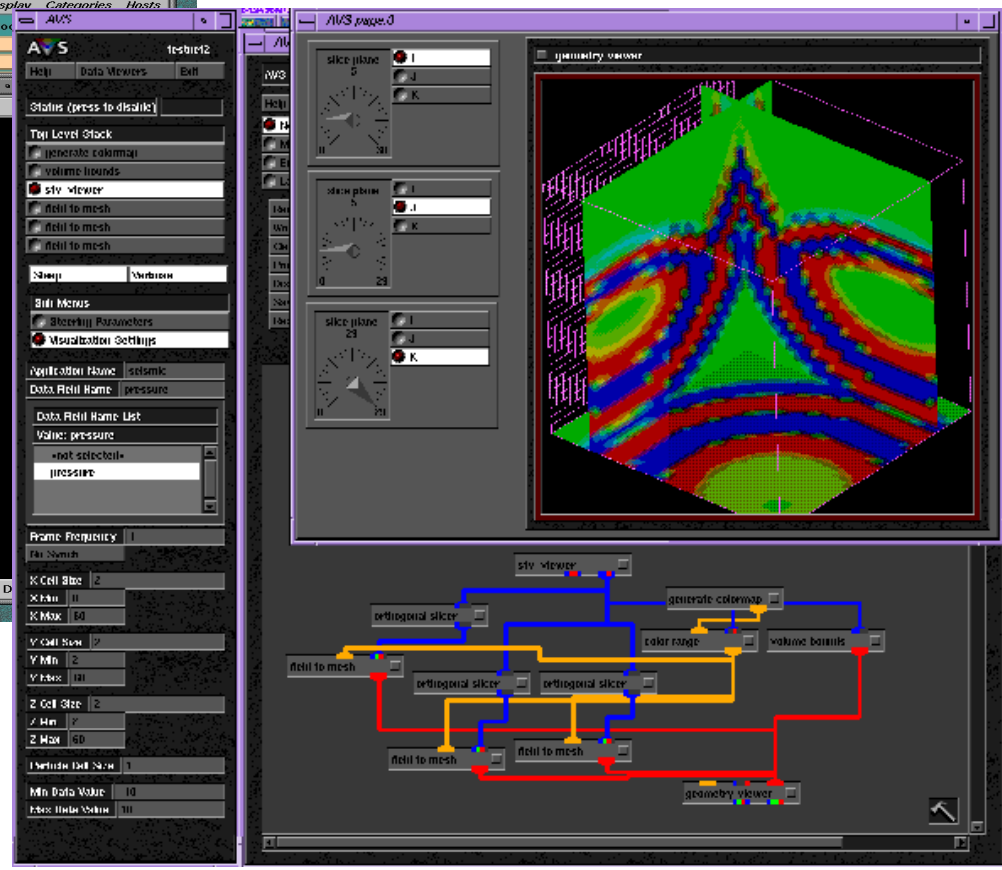


Dual views [Roberts]

Module Visualization Environments



IRIS Explorer

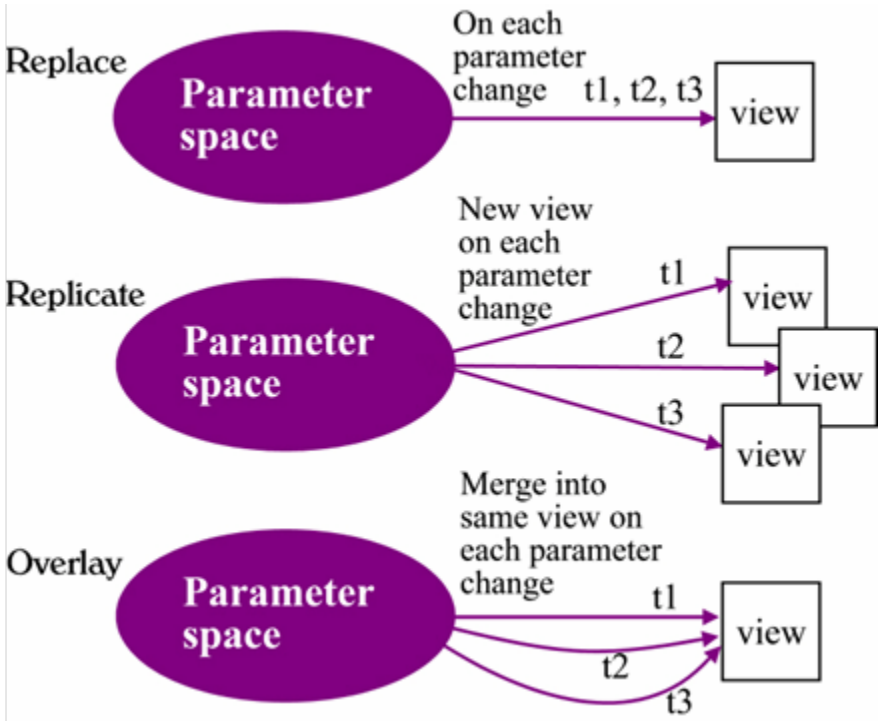


AVS

2. Exploration through Multiple Views

- Exploration is merely an exploration through parameter space!
  - Change the parameter, generate a new view…
  - Change the parameter, generate a new view…
- 3 models of Multiple-Views
  - Replace
  - Replicate
  - Overlay

Sifting through cards



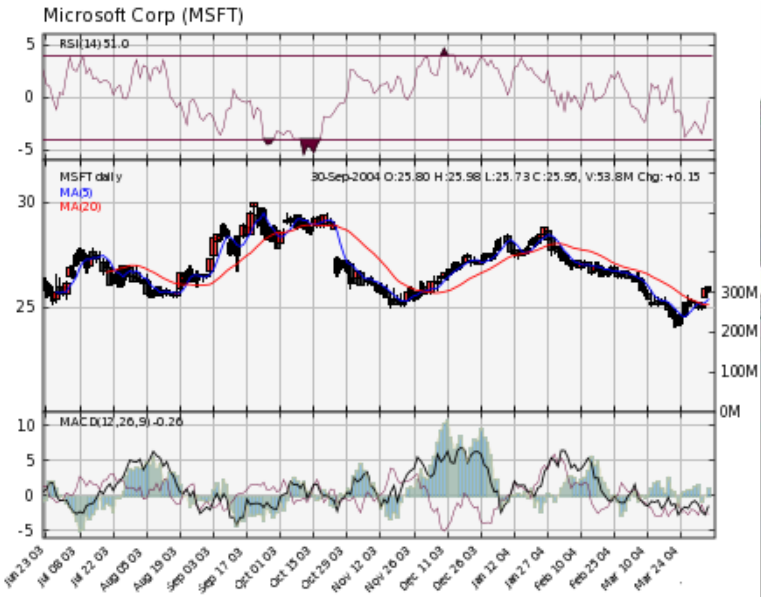
Multiple view model [Roberts]

Multiple Views

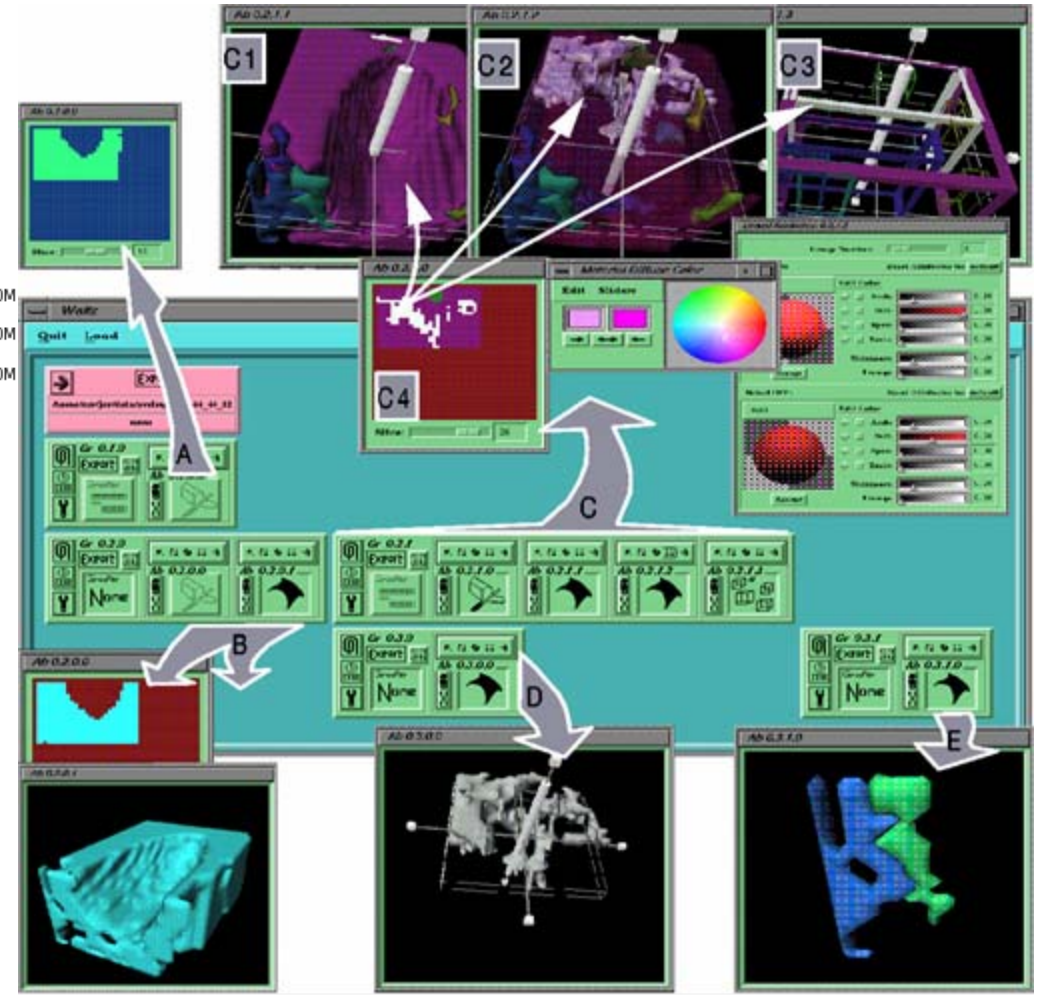
- Don't rely on one visualization
  - (standard, easy to generate, traditional…)
- Otherwise we may be missing out on the richness of the data?
  - and maybe misunderstanding the information?

- ***Multiple view & multiform representations enable the user to better understand the information.***
  - Different views = multiple viewpoints
  - Alternative representations
  - Seeing information from different angles, perspectives, additional insight, adding context, overcome misrepresentations, alternate viewpoints.
  - Being provocative
  - Allow representation & re-representation of information
    - Swap columns orders, rows etc.
- Not just multiple views, but information linked
  - Linked navigation, Linked selection

Forms…Multiforms (bar chars, histograms..)



SeeSoft



specialization

generalization

Waltz [Roberts]

3. Linked Views…

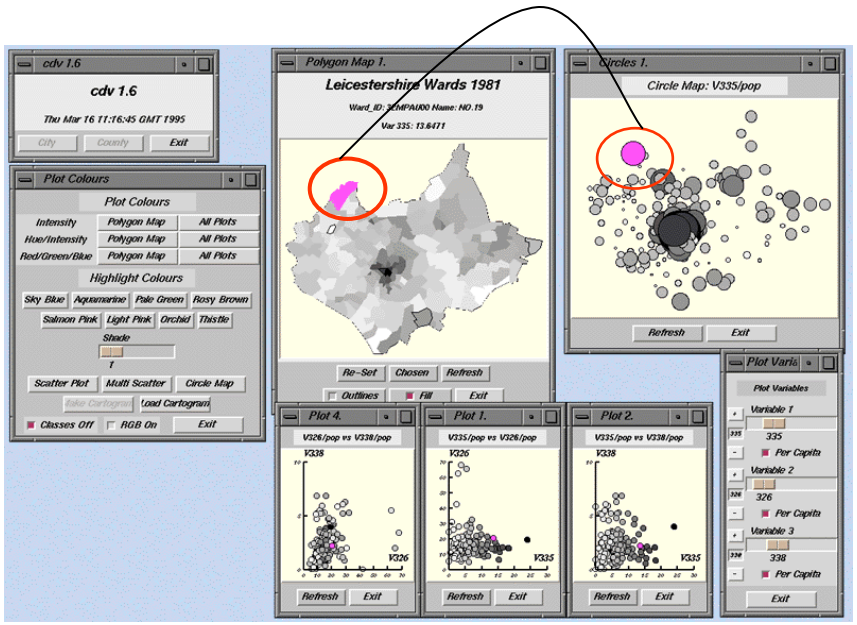
Chris North & Ben Shneiderman

- snap together

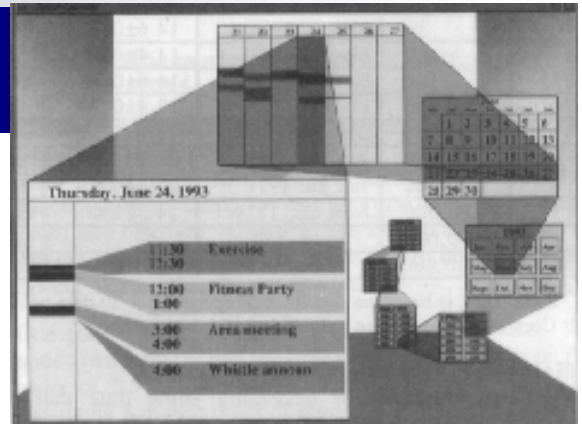
Matthew Ward

XmdvTool

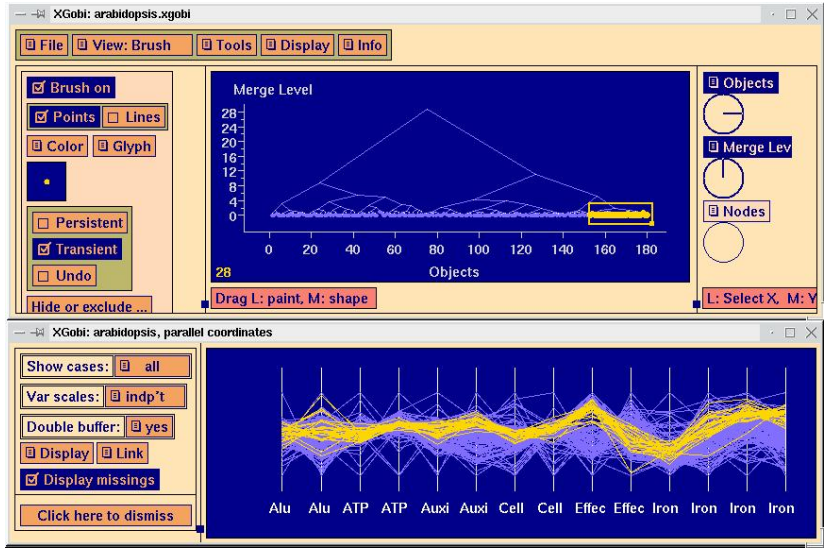
Same color



cdv - Cartographic Visualization for Enumerated Data

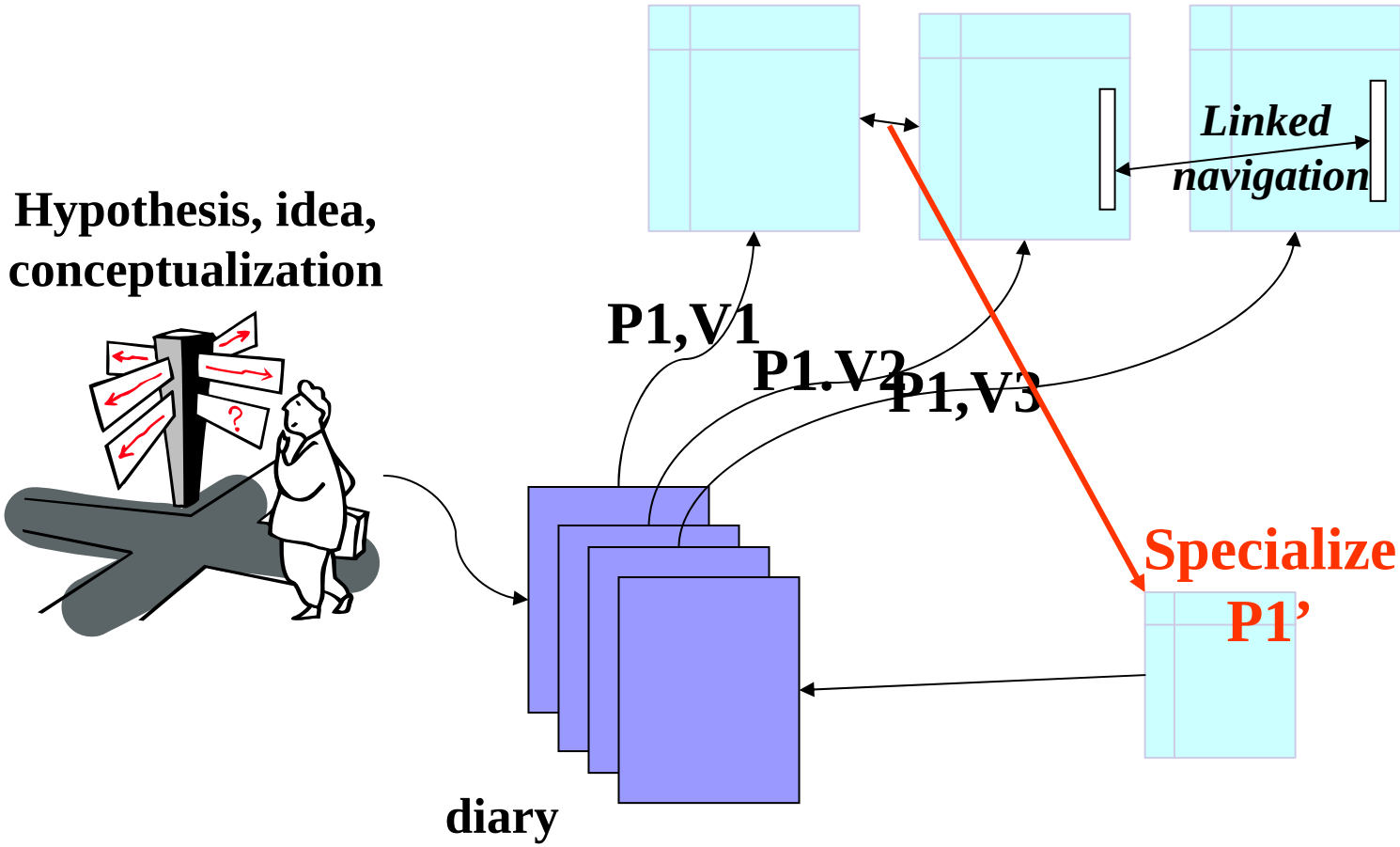


Spiral calendar



Linking dendrogram to parallel coordinate plot (gene expression data) (XGobi)

An MLV analytical environment



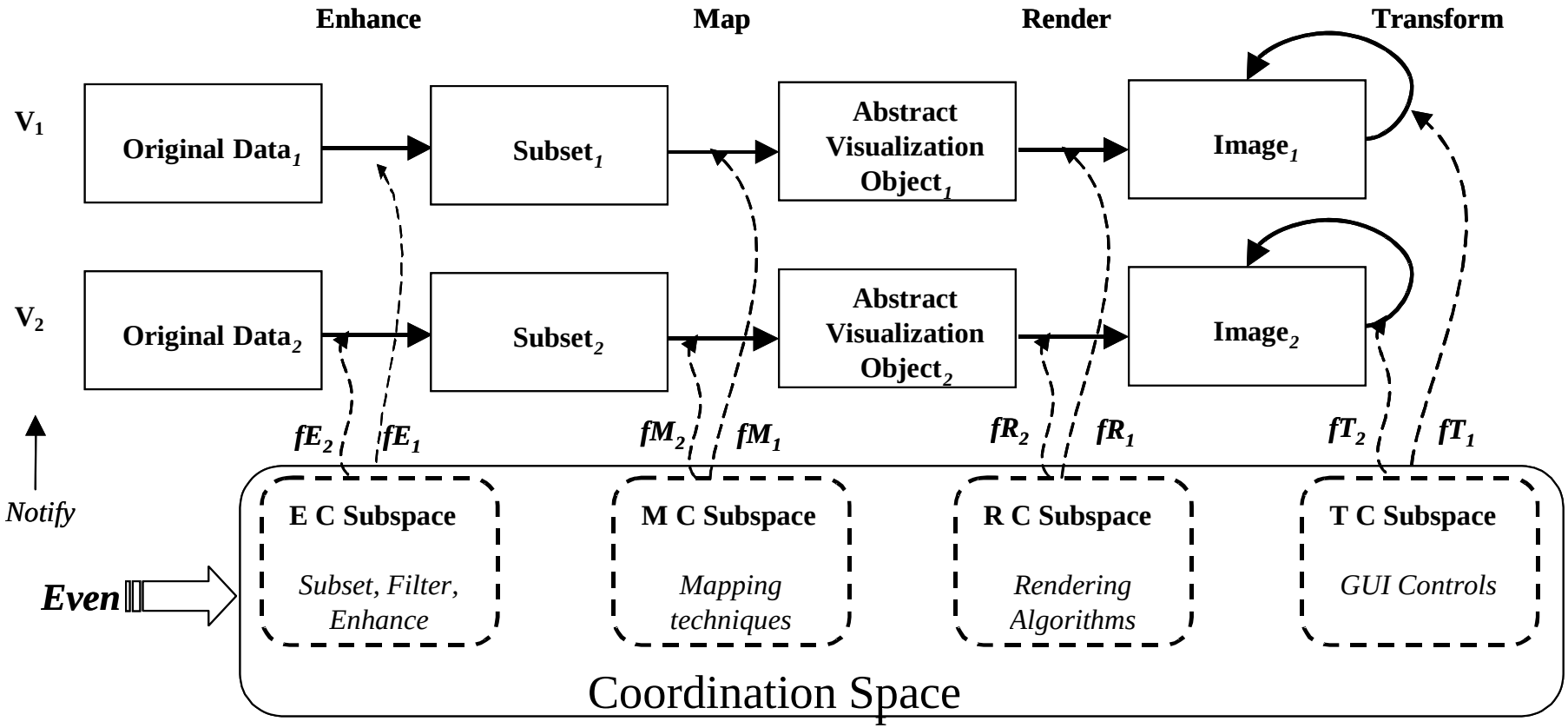
Benefits of MLV

- Correct dissemination
  - Different views `different understanding
- Generate and Overview
  - Underlying structure
- Control
  - over other views ... coupling/ brushing
  - over exploration itself ... an Exploration /view/ history
- Alternative viewpoints
- Comparison
- Collaboration potential

Linking what?

- data transforms
- mapping
  - selections
- navigation
  - move, zoom, filter
- enquiry - label

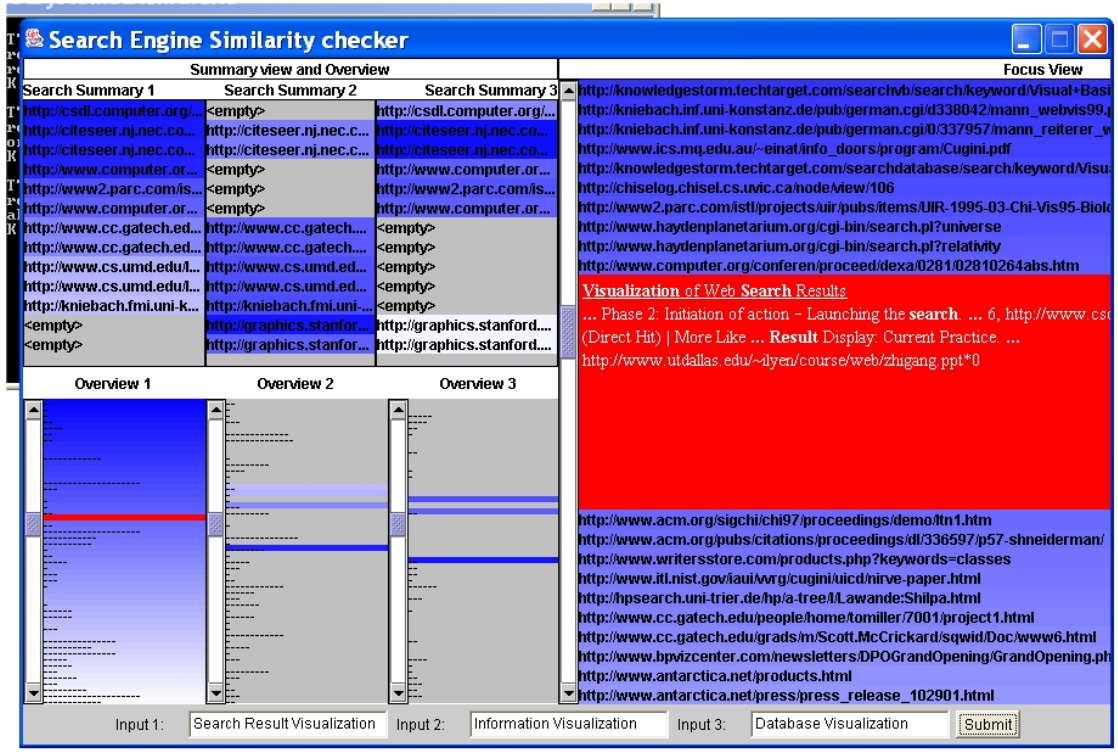
- Coordinating anything?



Coordination Model [Boukhelifa, Roberts, Rodgers]

Web search - applications

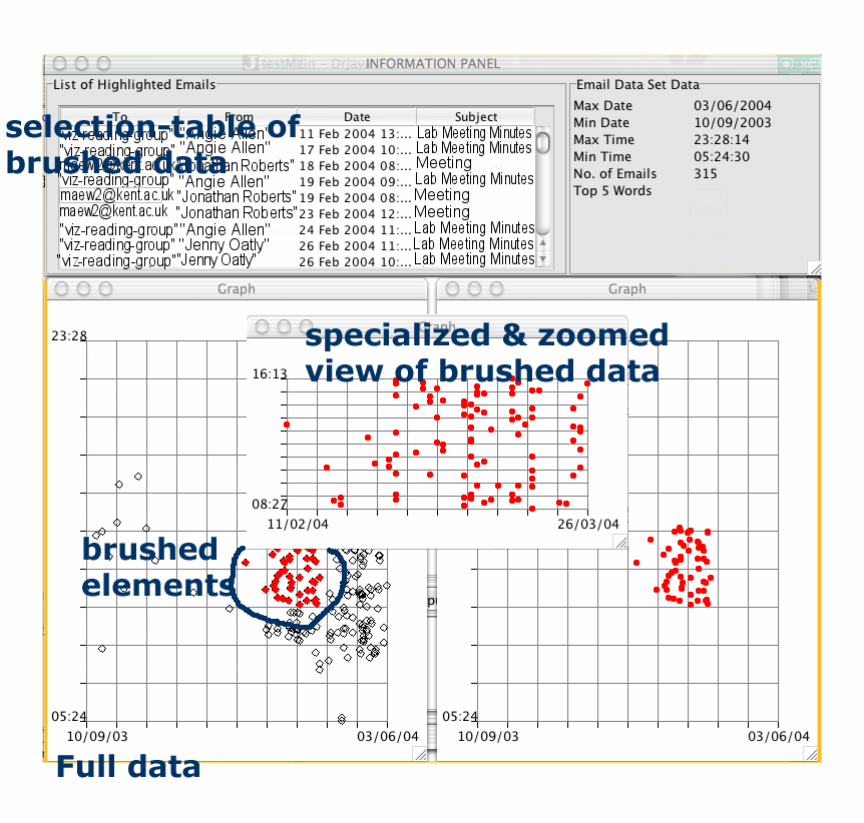
- Forms:
  - Plots, text, vdiff
  - Brushing, selection subset…

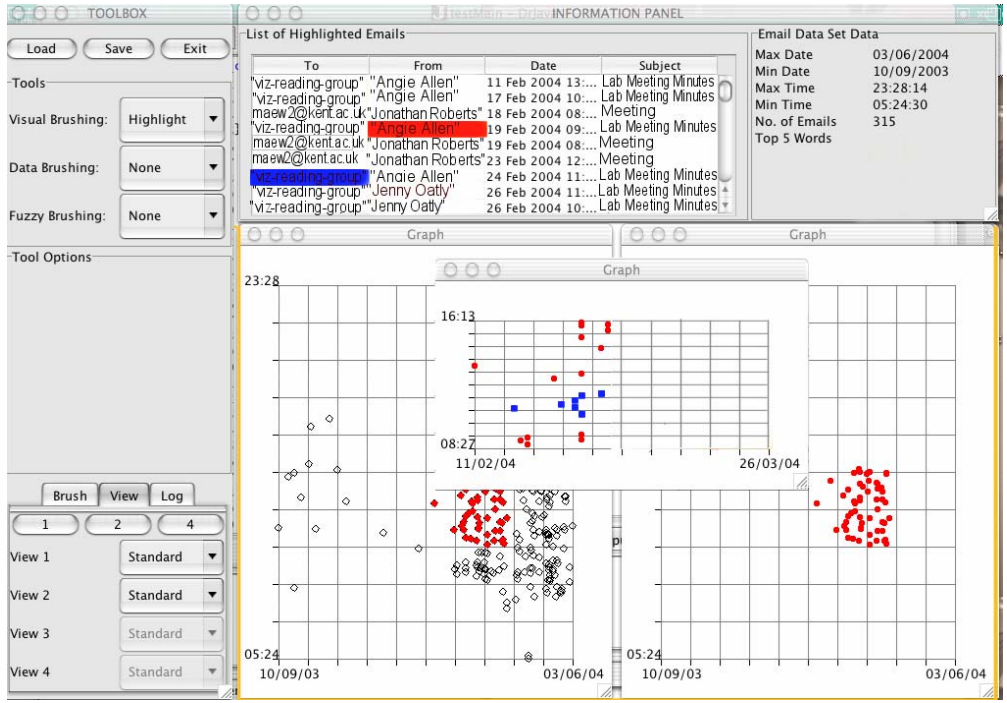


SES [Suvanaphen, Roberts]

Email visualization application

- Forms:
  - Text, plots
- Interaction
  - Brushing, linking, specialization

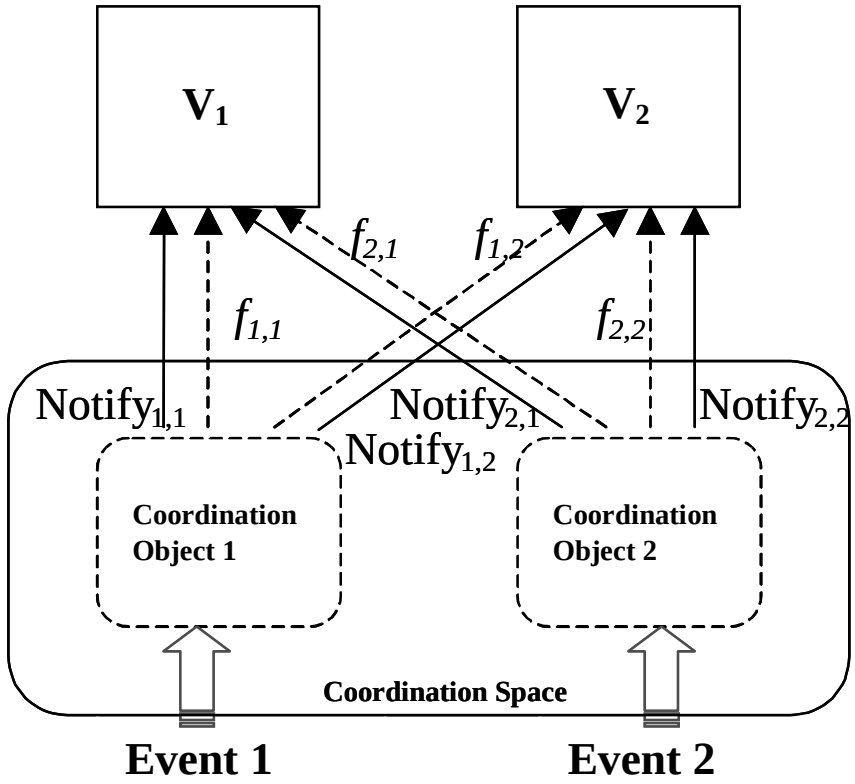




Click&Brush [Wright, Roberts]

Linking components?

- Type
  - selection; navigation
- Scope
  - neighbours, what experiment
- Lifetime
  - always on, temporarily on
- Initialisation
  - what determines the coupling.
- Update
  - 10 fps interaction



Abstract Coordination Model [Boukhelifa, Roberts, Rodgers]

4. Additional considerations

- MLV is a solution for interactive exploration…
- Managed views..
  - Linked
    - to allow instant comparison, and joint manipulation
  - a visual history of the exploration
- Lightweight components (lightweight views)
  - Easily repeatable and undoable
  - Underlying Models and systems developed in visualization for MLV (lightweight)
  - Exploration support from the system
    - memory, roll back, differences, similarity
- Ease of use
  - Don't get lost in amount of views,
  - Explanations, this does this,
- Extensible
  - Allow wide range of data to be visualized and explored
- Interoperable

Management of MLV

- Window Placement strategies
  - Fixed, user-driven, data-driven
- Challenges of clutter and Explosion of views
- Challenges of “which image relates to what parameters”

5. Visual Analytics

Exploratory Visualization provides some of the functionality:

- Reducing search, displaying large amounts of information in a small area
- Enhancing the recognition of patterns
- Exploratory visualization provides a manipulable medium
- Easy to perceive and display relationships
  - Relationships can be explicitly displayed

- What about:
  - information provenance
  - Note taking
  - Collaboration & privacy
  - Massive data sets
    - data integration & transformation
  - Production & presentation
- Need better integration

The origin of “Visual Analytics”

- Since 911, security
- US Department of Homeland Security (DHS) chartered the National Visualization and Analysis Center (NVAC) with the goal of helping to counter future terrorist attacks in the US and around the globe.
- Long term R&D effort
  - Leadership of Pacific Northwest National Laboratory PNNL, Jim Thomas
- The task
  - Integrating different forms of information
  - Testing scenarios, checking these hypothesis
  - Presenting information (cf. O-rings on Challenger)
  - Timely response – data changing, rapid update
  - Massive amounts of diverse data

Visual Analytics

- Visual analytics is the science of analytical reasoning facilitated by *interactive visual interfaces.*
  - Assist & test key observations
  - Build knowledge
  - Defend arguments
    - Collaborate
    - Compare solutions from alternative techniques
    - Use standards
  - Iterative process
  - Collaborate
  - Analysis is structured & disciplined
  - Re-representation and manipulation
- Challenges with
  - Massive scale data
  - Rapid changing datasets
  - Variety of information/types
  - Capture & record the process, add notes annotations..
- Interaction and Exploratory Visualization & MLV, are all key concepts but it integrates much more…

Summary

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END