Multiple and Coordinated Views

Hauptseminar “Information Visualization - Wintersemester 2008/2009"

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16. Februar 2009

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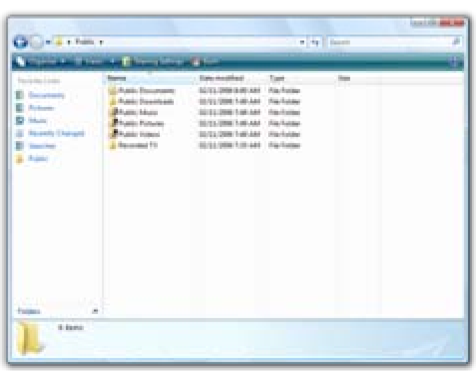
Introduction

- Information visualization is more than a mere mapping of “raw data” to pixels
- Different mappings allow for different perspectives and approaches to a given visualization
- Multiple views on data both counter bias of one single visualization choice and reveal relationships in the data
- Coordinating these multiple views improves usability and facilitate mentioned relationship discovery, yet also entail various performance issues

- “Non-scientific” examples of multiple and coordinated views (MCV):



Microsoft Windows Vista Explorer

Apple iTunes 7

Blender

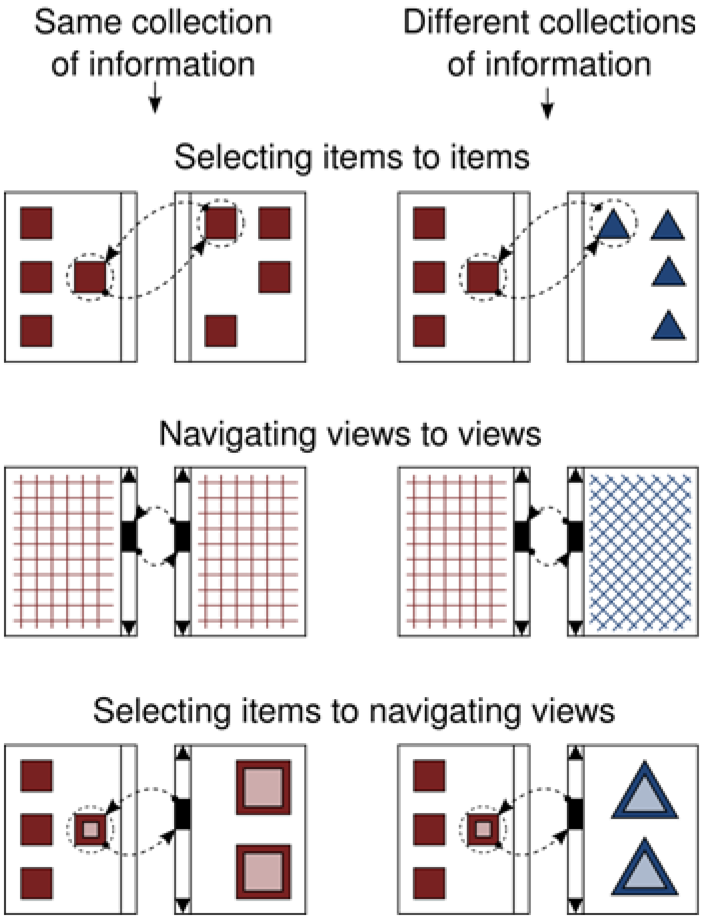
Multiple Views

- *Single view* – combination of a set of data together with display specifications
  - *Form* – display type (e.g. list, scatter plot, various charts, …)
- *Multiple views* – representation of data in multiple views
  - *Multiform* – using several forms to display (the same) data
  - *Distinct views* – term used when two or more views enable users to learn about different aspects

- Common types of multiple views (according to side-by-side relationship):
  - *Overview & detail* – one view displaying the whole (or large portion of) the dataset and another view displaying part of the dataset in greater detail
  - *Focus & context* – similar to the above but different in stressing of detail (focus) and limiting the overview (context) to just enough to be able to roughly "locate" the detail in the big picture
  - *Difference views* – highlighting of differences, usually achieved by merging several views together
  - *Small-multiples* – small graphics arranged in a big matrix, useful for discovering relationships while one variable changes as in developments along a timeline

Coordination

- Desirability of reflecting and controlling relationships between views (as in the above side-by-side relationships)
- Realization by mapping changes in one view to changes in another:
  - *Coupling functions*
  - *Propagation model*
- Interaction:
  - *Brushing*
  - *Dynamic querying*
  - *Navigational slaving*
- “2x3 taxonomy of multiple window coordinations”
  - Implicit vs. explicit relationships



Modified after C. North: *Generalized, robust, end-user programmable, multiple-window coordination*, 1997

Issues and Guidelines

- Issues:
  - *Learning time and effort* required to learn the system.
  - *Load* on user's working memory
  - *Comparison effort* required when using the system
  - *Context switching effort* required when using the system
  - *Computational power* required by the system
  - *Display space* required by the system
  - *Design, implementation and maintenance resources* required by the system
- Baldonado et al.'s guidelines
  - Eight rules with both positive and negative impacts to be balanced

Rule of …	Major positive impacts on utility	Major negative impacts on utility
… diversity	memory	learning, comp. & displ. overhead
… complimentary	memory, comparison, context switching	learning, comp.& displ. overhead
… decomposition	memory, comparison	learning, comp.& displ. overhead
… parsimony	learning, comp.& displ. overhead	memory, comparison, context switching
… space/time resource optimization	learning, comp.& displ. overhead	memory, comparison, context switching
… self-evidence	learning, comparison	computational overhead
… consistency	learning, comparison	computational overhead
… attention management	memory, context switching	computational overhead

Snap-Together Visualization (1)

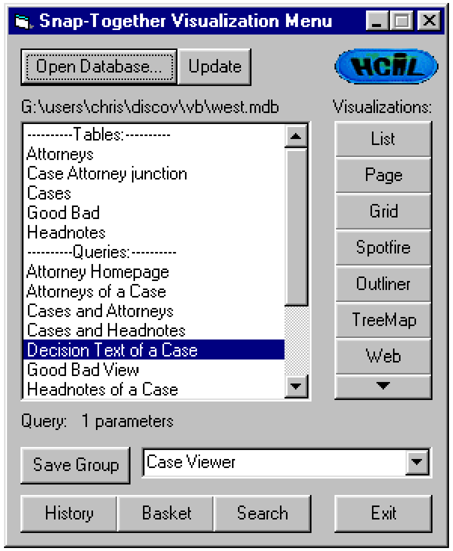
(*North and Schneiderman*)

- Ideas and Goals
  - Users might be interested in coordinations unforeseeable (for all possible tasks) by a developer
  - Simple on-the-fly coordination opposed to common static MCV systems or the rare systems that at least required custom programming for custom coordination
  - Easy integration (into third party visualization applications)
- Terms
  - Information units, called *objects* are represented as tuples in a relational database (holding *information*)
  - Sets of objects can be retrieved from the database and visualized in so called *visualizations* (views)
  - *Coordination* is defined on *user actions* (i.e. *select, navigate, query*)
- Usage
  - Helper application serves as front-end to a database and handles creation of views and coordinations

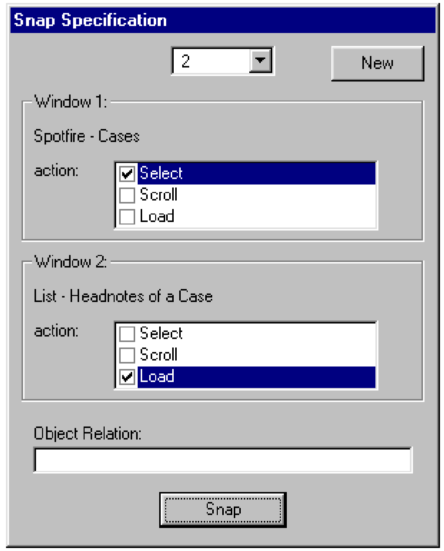
  1. User queries database and thus creates view or updates existing views
  2. Coordination is established by choosing to applications and define their coordination from a predefined set of choices ("snapping visualizations together")

Snap-Together Visualization (2)

1.



2.



Both retrieved from http://hcil.cs.umd.edu/trs/99-10/99-10.html (January 26th, 2009)

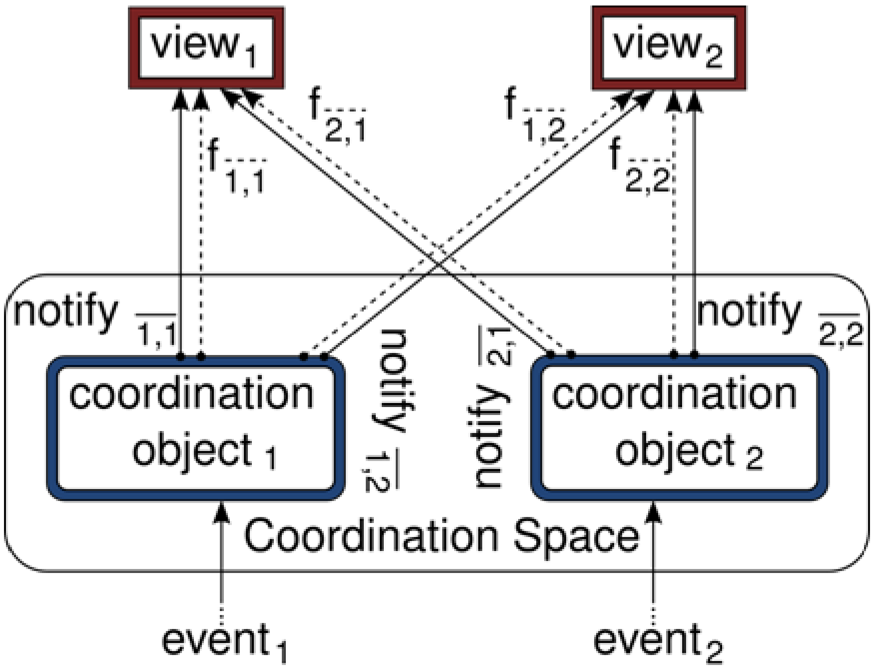
- Architecture
  - Mapping of two visualizations:
    $(vis_a, action_a, objectid_a) \Leftrightarrow (vis_b, action_b, objectid_b)$
  - Stored in a so called coordination graph (nodes – visualization, links – mappings for incident visualizations)
  - Hooks need to be implemented in third party applications (i.e. initialization, action notification, action invocation, load)

- Evaluation
  - Participants in a user-study were able to quickly acquire the ability to use the system in an efficient and creative way adjusting it to their own needs
  - They did “not have problems grasping the cognitive concept of coordinating views [and] were able to generate designs by duplication and by abstract task description”

A Coordination Model for Exploratory Multiview Visualization (1)

(*Boukhelifa et al.*)

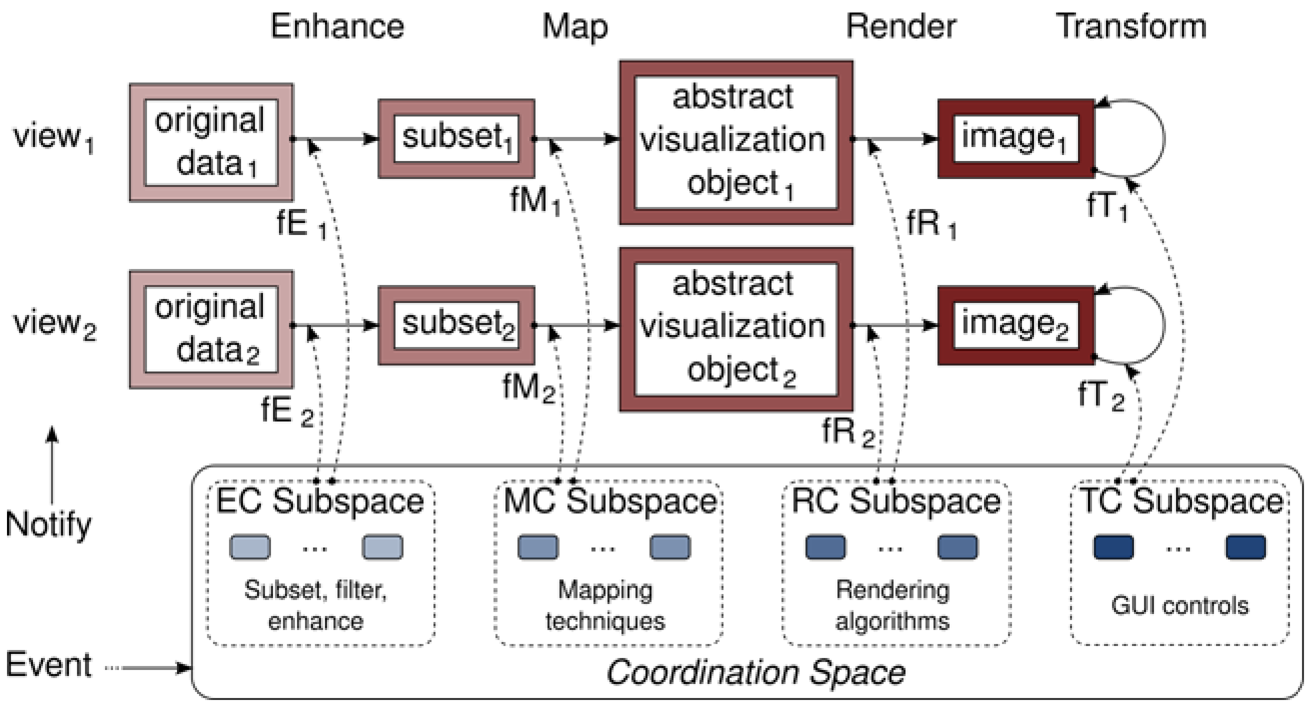
- Addresses limitations of simplified customization as in Snap
- More general, abstract approach to coordination
- Simple model
  - *Coordination objects* (residing in *coordination space*) are the main entities
  - One coordination object for each *type* of coordination
  - Views are coordinated when linked to a common coordination object (by translation functions and notifications)
  - Views can be added and removed independent from coordination objects or other views



Modified after Boukhelifa et al.: *A Coordination Model for Exploratory Multiview Visualization*, 2003

A Coordination Model for Exploratory Multiview Visualization (2)

- Layered model
  - Application of simple model to the so called *dataflow* paradigm of visualization
  - *Abstract parameters*, *translations*, *notifications*, *events*



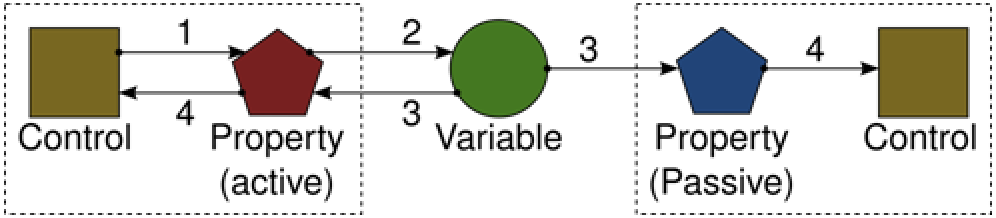
Modified after Boukhelifa et al.: *A Coordination Model for Exploratory Multiview Visualization*, 2003

Improvise (1)

(*Weaver*)

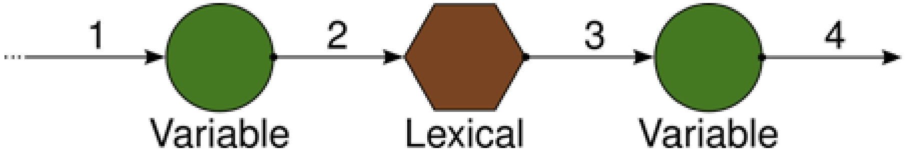
- Combination of several approaches to balance coordination tradeoff (advanced coordination requires complicated customization methods, easy-to-use customization methods imply limited coordination ability)

- Two main concepts:
  - *Live properties*



Modified after Weaver.: *Building Highly-coordinated Visualizations in Improvise*, 2004

  - *Coordinated queries*



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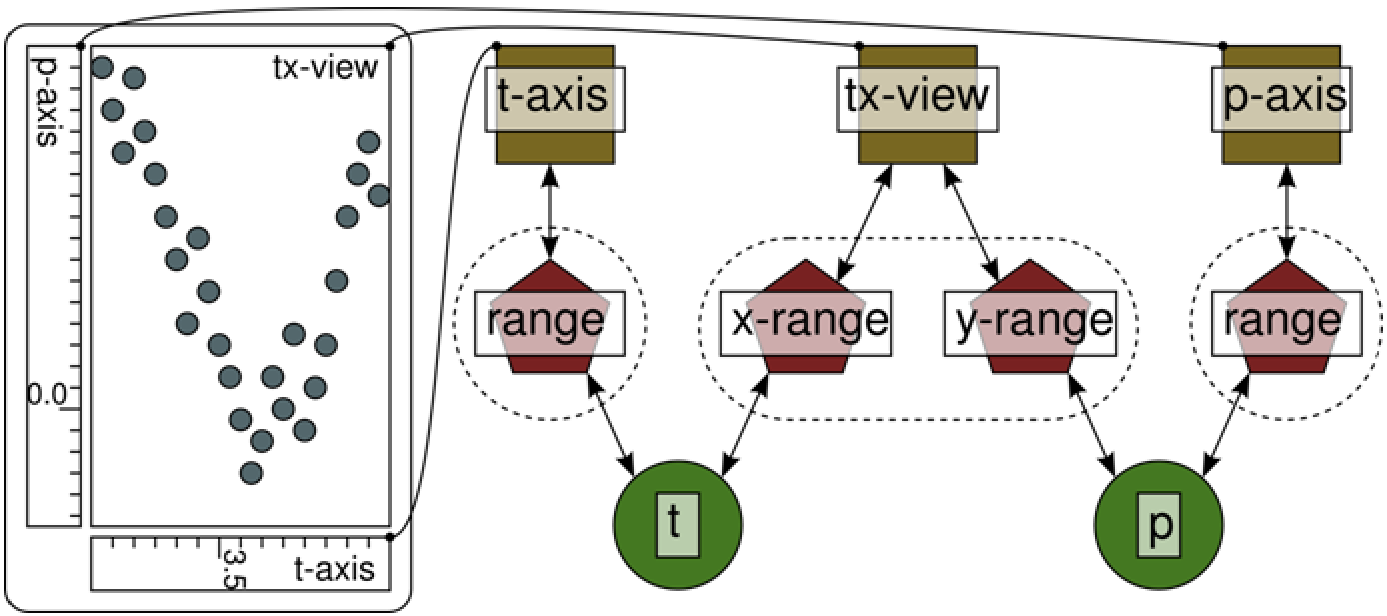
Improvise (2)



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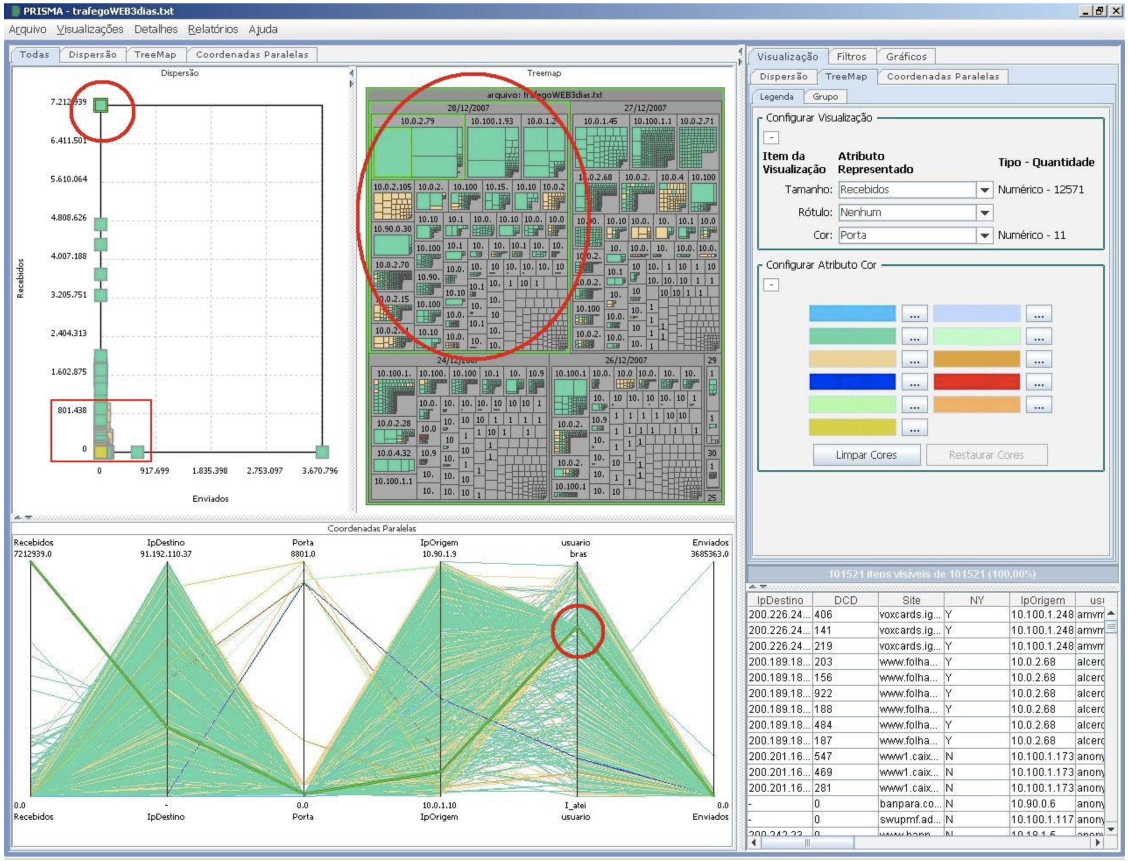
Applications of MCV (1)

- Da Silva Kauer et al.: *An Information Tool with Multiple Views for Network Traffic Analysis*



See da Silva Kauer et al.: *An Information Tool with Multiple Views for Network Traffic Analysis*, 2008

Applications of MCV (2)

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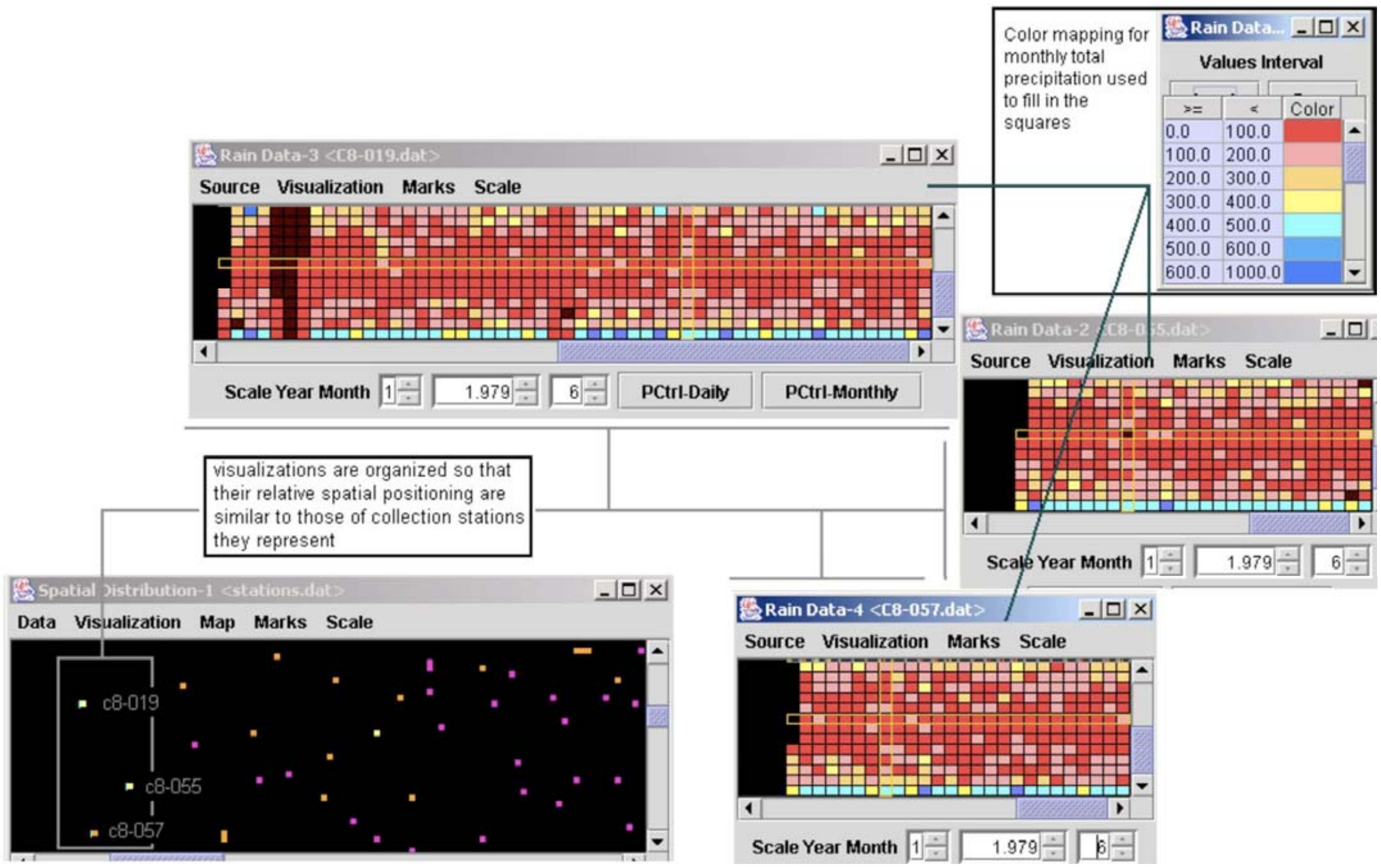
- Shimabukuro et al.: *Coordinated Views to Assist Exploration of Spatio-Temporal Data*



See Shimabukuro et al.: *Coordinated Views to Assist Exploration of Spatio-Temporal Data: A Case Study*, 2004

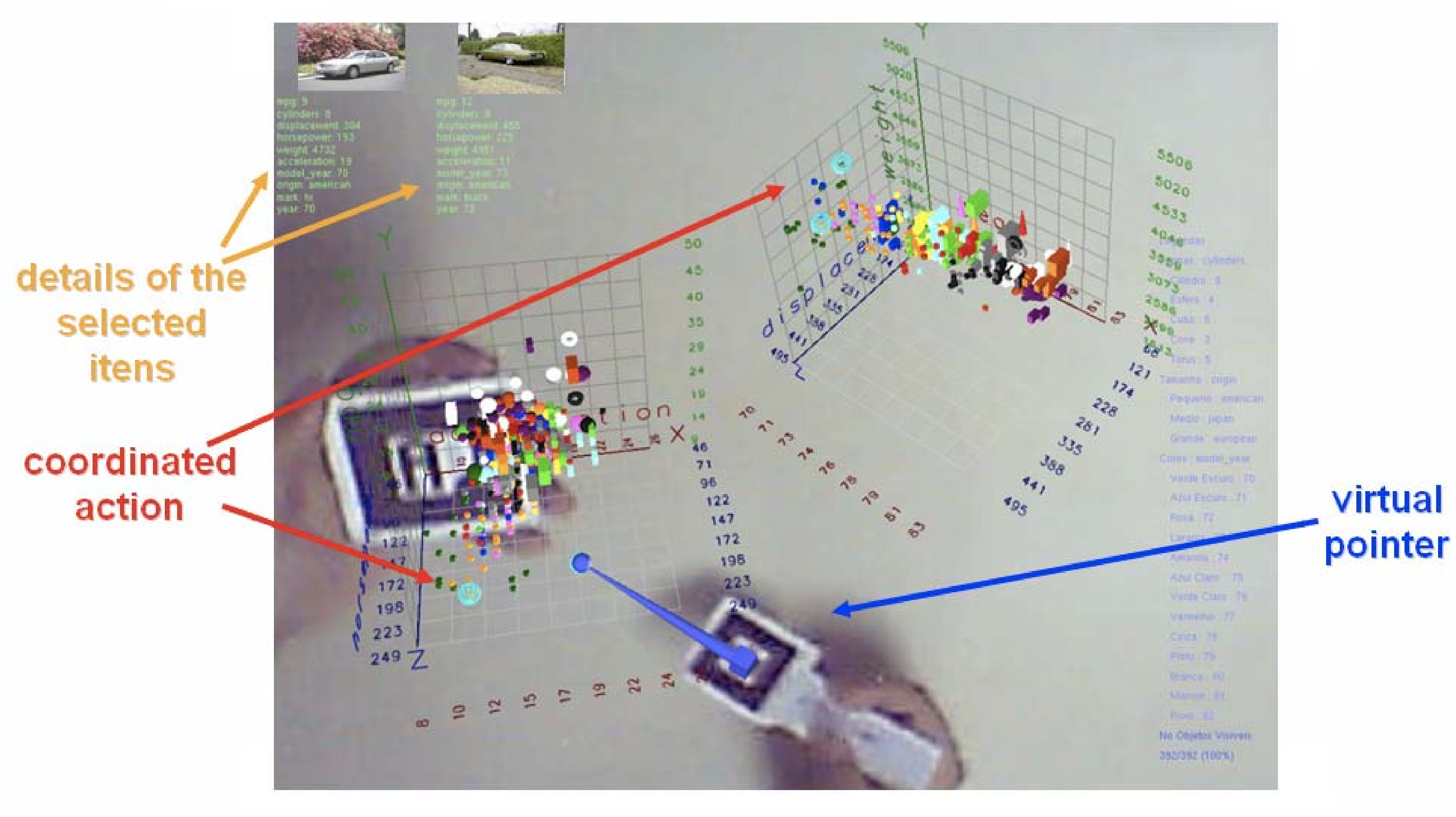
Applications of MCV (3)

- Masui et al.: Multi-View Approach for Smooth Information Retrieval

Masui et al.: *Multi-View Approach for Smooth Information Retrieval*, 1995

Applications of MCV (4)

- Do Carmo et al.: *Coordinated and Multiple Views in Augmented Reality Environment*



Do Carmo et al.: Coordinated and Multiple Views in Augmented Reality Environment, 2007

Thank you for your attention

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Questions and answers ...