

Grundlagen methodischen Arbeitens

Informationsvisualisierung

[WS0809 | 01]

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The screenshot displays the Protégé 3.1.1 interface with two overlapping windows. The top window is titled 'tourismA Protégé 3.1.1' and shows a Class Browser for 'tourismA' on the left and a Graph Browser for 'tourismA' on the right. The Class Browser shows a hierarchy starting from 'owl:Thing' down to 'p1:Urlaub'. The Graph Browser shows a network graph with nodes of various colors (green, orange, yellow, red) connected by edges. The bottom window is titled 'tourismB Protégé 3.1.1' and shows a Class Browser for 'tourismB' on the left and a Graph Browser for 'tourismB' on the right. The Class Browser shows a hierarchy starting from 'owl:Thing' down to 'p1:Veranstaltung'. The Graph Browser shows a network graph with nodes of various colors (green, orange, yellow, red) connected by edges. The interface includes a menu bar (File, Edit, Project, OWL, Code, Window, ALViz, Tools, Help), a toolbar, and various view tabs (OWLClasses, Properties, Forms, Individuals, Metadata, Foam, ALViz). The Graph Browser tabs are Concepts, Data Properties, Object Properties, and Instances. The Relation dropdown is set to 'IsA'.

[Lanzenberger et al., 2006]



- Motivation - Examples
- Definitions and Goals
- Knowledge Crystallization
- Exploration Techniques
- Visual Encoding Techniques
- Summary

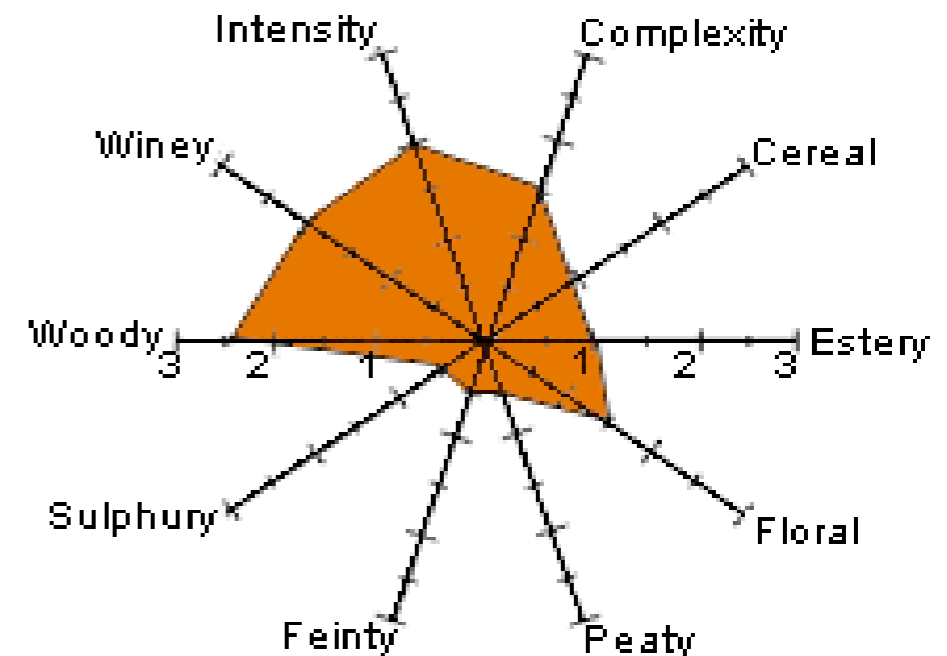
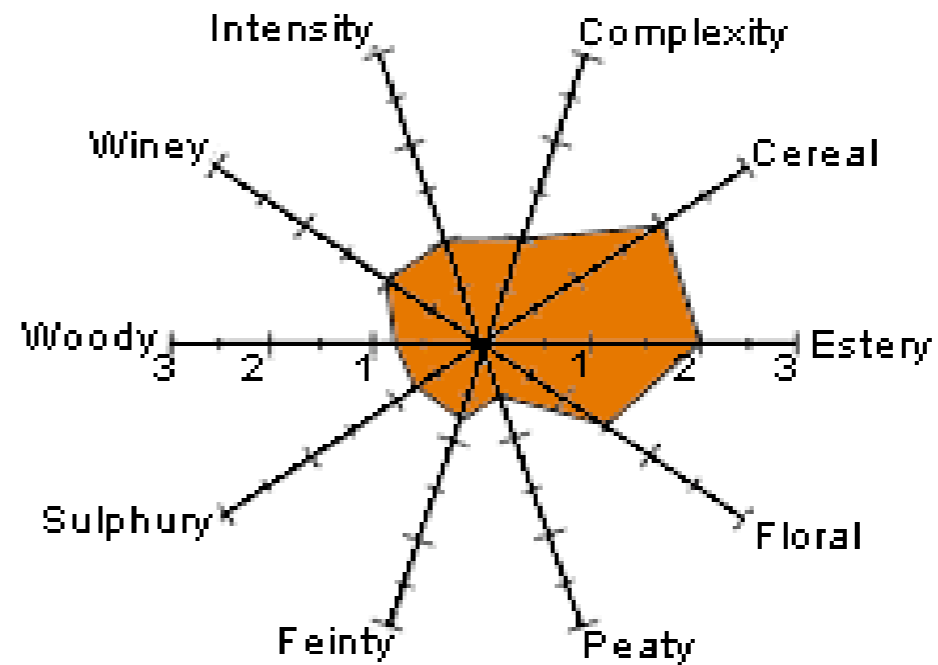
- Taste is very abstract
- 10 basic tastes
- Intensity [0, 3]

Wheel chart

Points - form a polygon

Polygon's properties give quick access to the represented taste

Glenfiddich



The Balvenie (12 y.)

[<http://www.scotchwhisky.com>]

Periodic Table

- Invented 1869 by Dimitri Mendeleev and Lothar Meyer
- Structured and classified Representation of all chemical elements and their properties
- Predicted the existence of several elements before they were discovered

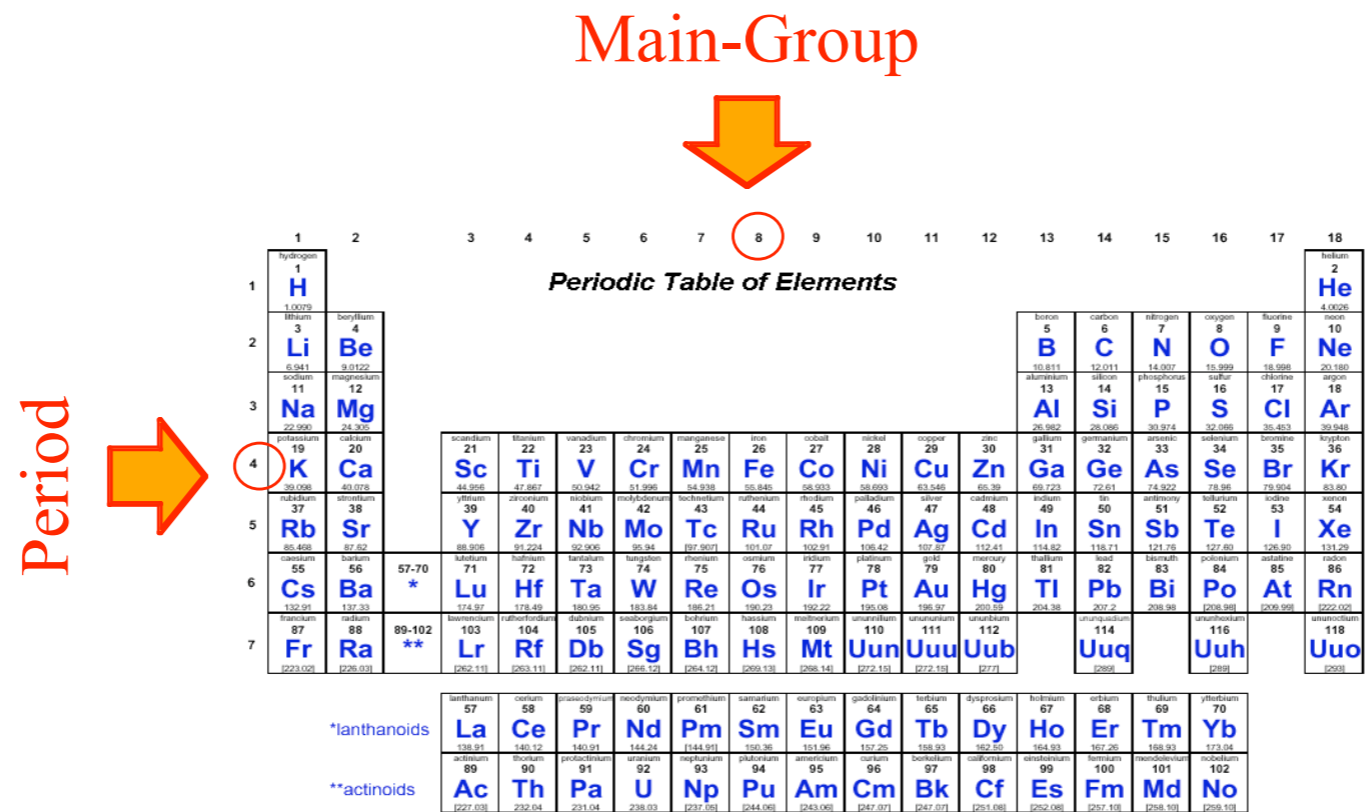


Periodic Table of Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1 hydrogen 1 H 1.0079																	2 helium 2 He 4.0026	
2 lithium 3 Li 6.941	beryllium 4 Be 9.0122											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180	
3 sodium 11 Na 22.990	magnesium 12 Mg 24.305											aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948	
4 potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80	
5 rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [97.907]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29	
6 cesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 * lanthanum 57 La 138.91	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [222]	radon 86 Rn [222.018]
7 francium 87 Fr [223.021]	radium 88 Ra [226.025]	89-102 ** actinium 89 Ac [227.028]	lawrencium 103 Lr [262.109]	rutherfordium 104 Rf [261.108]	dubnium 105 Db [262.108]	seaborgium 106 Sg [266.107]	bohrium 107 Bh [264.107]	hassium 108 Hs [269.103]	meitnerium 109 Mt [268.103]	unnilium 110 Uun [272.103]	ununium 111 Uuu [272.103]	unbibium 112 Uub [277]	untrium 113 Uut [284.107]	unquadrium 114 Uuq [289]	unpentium 115 Uup [288.107]	unhexium 116 Uuh [289]	unseptium 117 Uus [288.107]	unoctium 118 Uuo [289]
		*lanthanoids	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [144.913]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04		
		**actinoids	actinium 89 Ac [227.028]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237.048]	plutonium 94 Pu [244.064]	americium 95 Am [243.061]	curium 96 Cm [247.070]	berkelium 97 Bk [247.070]	californium 98 Cf [251.083]	einsteinium 99 Es [252.083]	fermium 100 Fm [257.103]	mendelevium 101 Md [258.103]	nobelium 102 No [259.103]		

[Pictures: Miksch Slide]

Example 2: Chemical Elements



Key:

element name
atomic number
symbol
atomic weight (mean relative mass)

[Pictures: Miksch Slide]

Example 2: Chemical Elements

Periodic Table of the Elements

1	2																	10
3	4																	10
11	12																	18
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
87	88	89	104	105	106	107	108	109	110	111	112							

Naming conventions of new elements

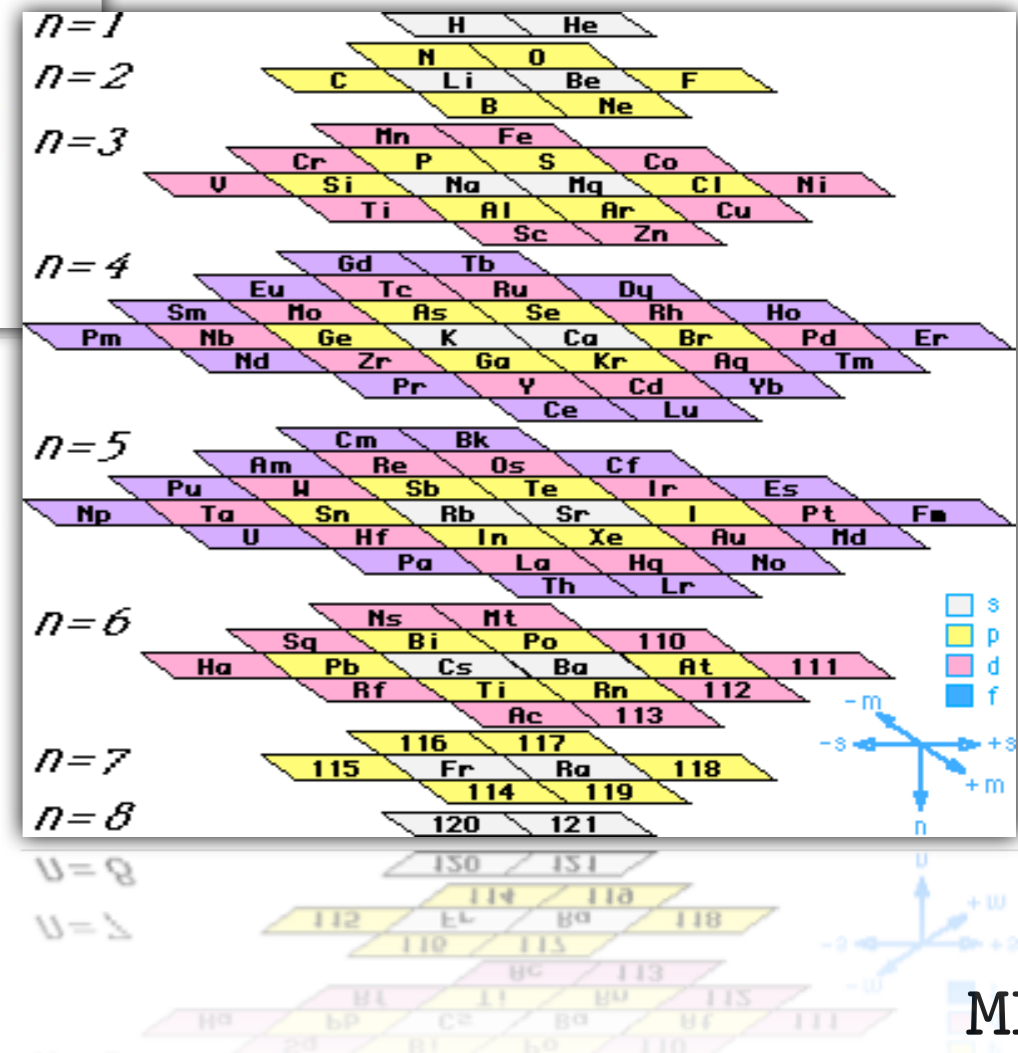
* Lanthanide Series
 + Actinide Series

1	2																	10
3	4																	10
11	12																	18
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
87	88	89	104	105	106	107	108	109	110	111	112							

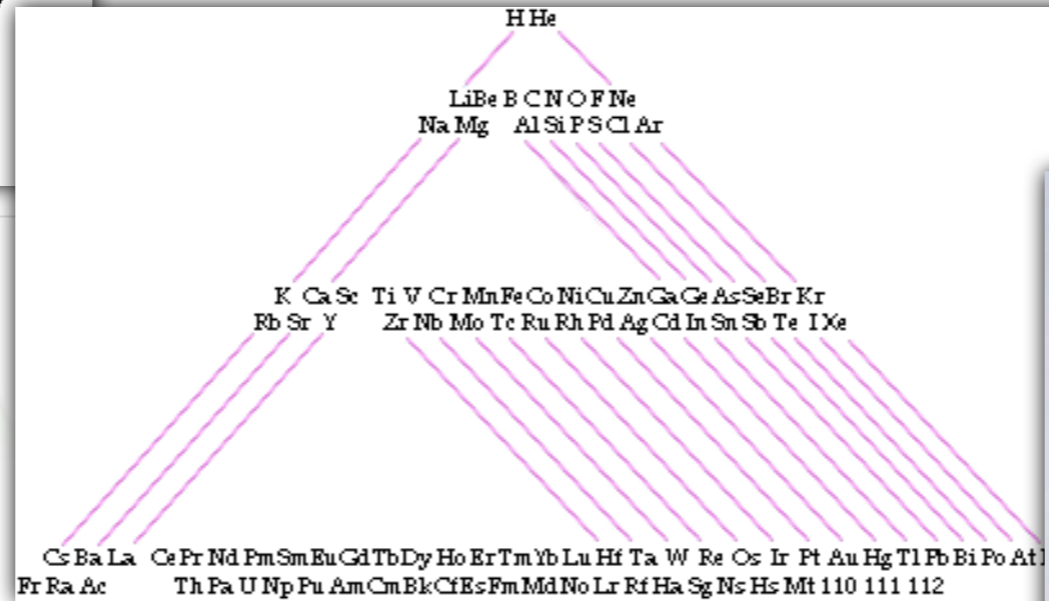
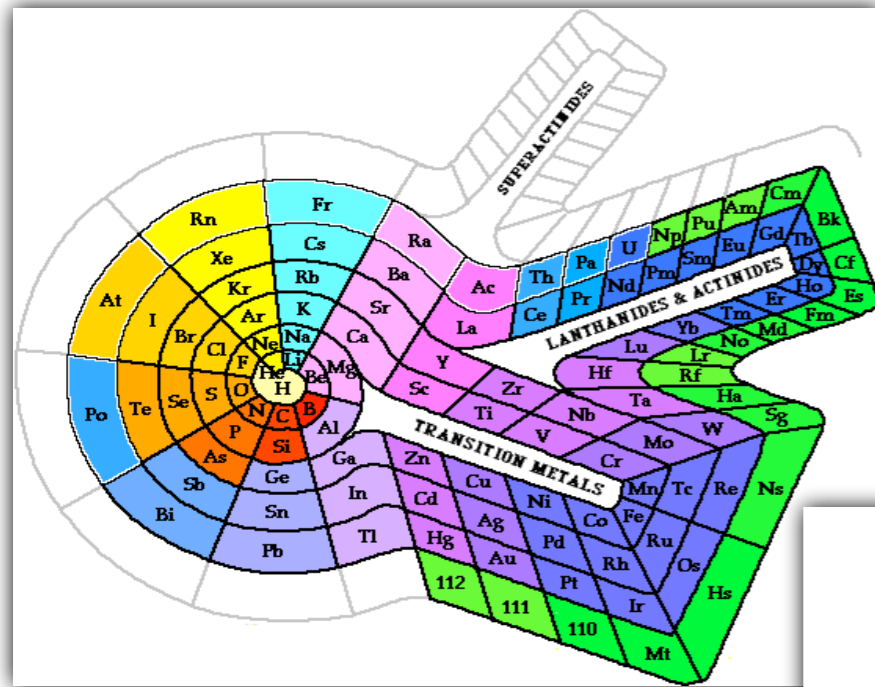
Legend

Li Solid	Cs Liquid	Ar Gas	Nb Synthetic
Alkali metals	Alkali earth metals	Transition metals	Rare earth metals
Other metals	Noble gases	Halogens	Other nonmetals

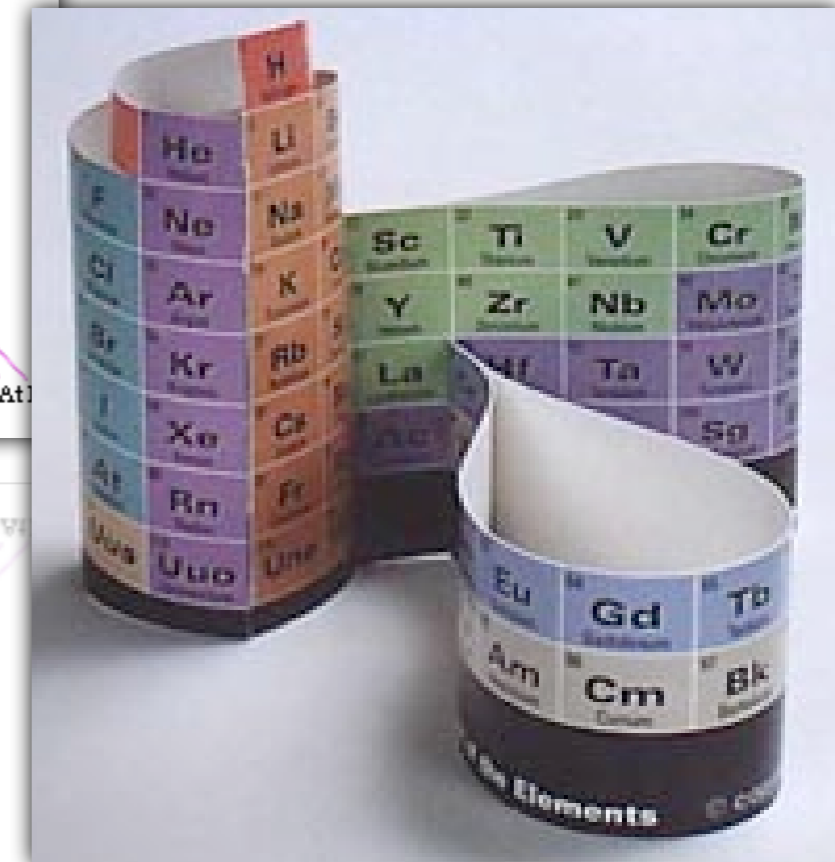
[Pictures: Miksch Slide]



Example 2: Chemical Elements



[Pictures: Miksch Slide]



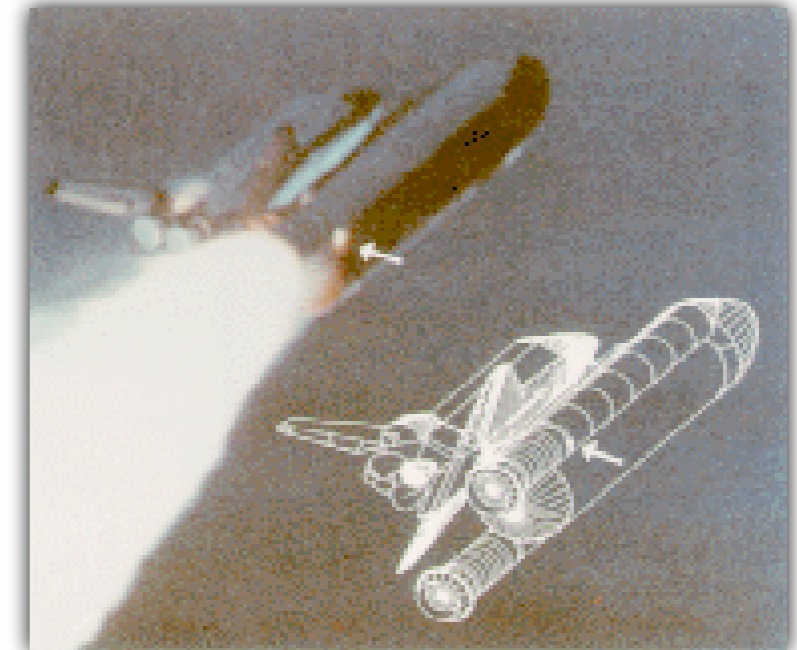
January 27, 1986 -
Space shuttle Challenger explodes 72 seconds after
launch.

Sealing-rings in the right booster were damaged due
to weather conditions.

Reliability-problems of the so called O-rings were
known.

The manufacturer of the boosters warned NASA
before launch that the expected cold temperatures
might be an extra risk.

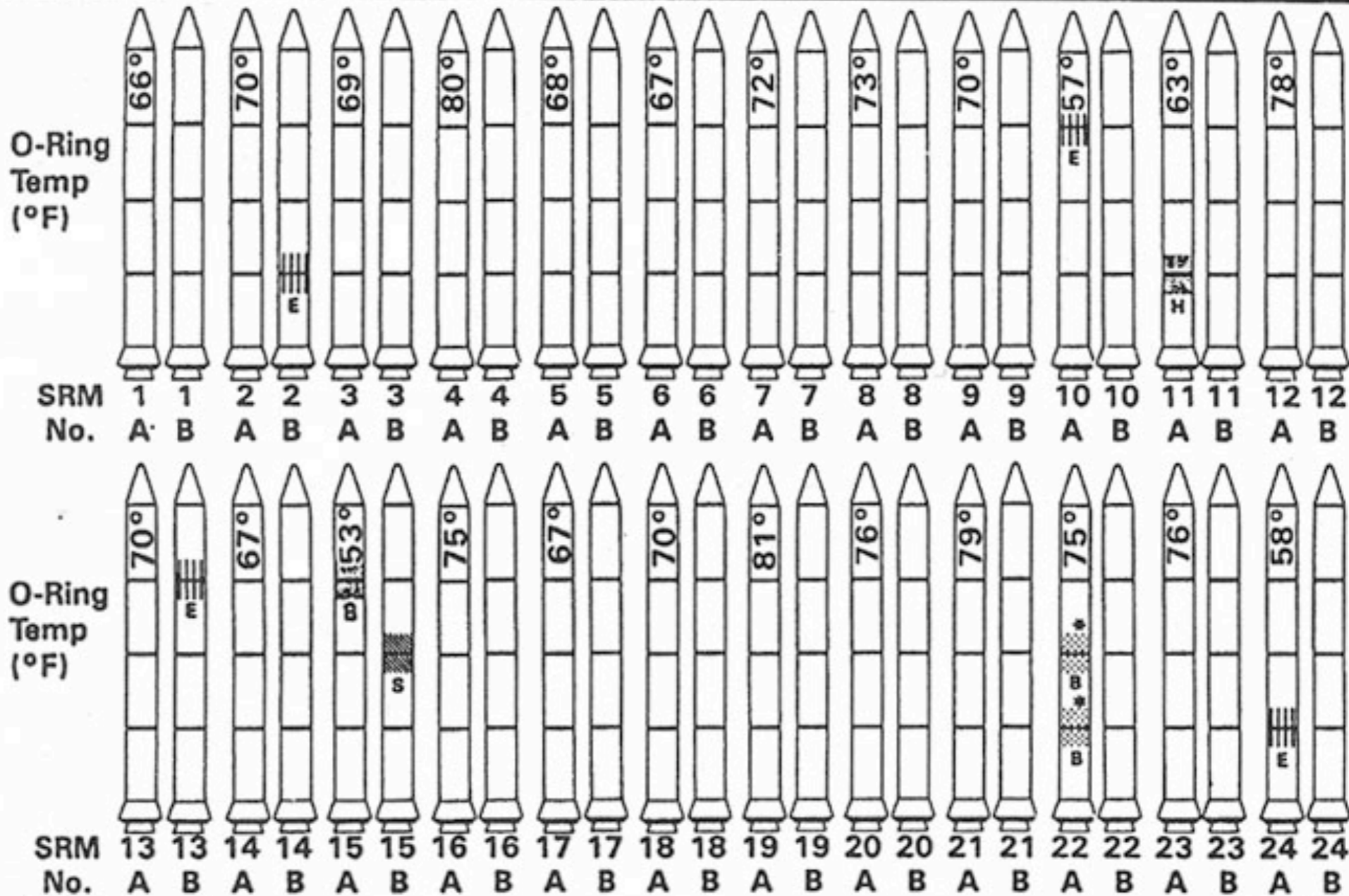
NASA did not see any correlation between the failing
of O-rings and the temperatures.



[Pictures: Miksch Slide]



History of O-Ring Damage in Field Joints (Cont)



MORTON THIOKOL, INC.
Wasatch Operations

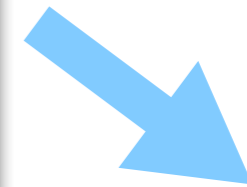
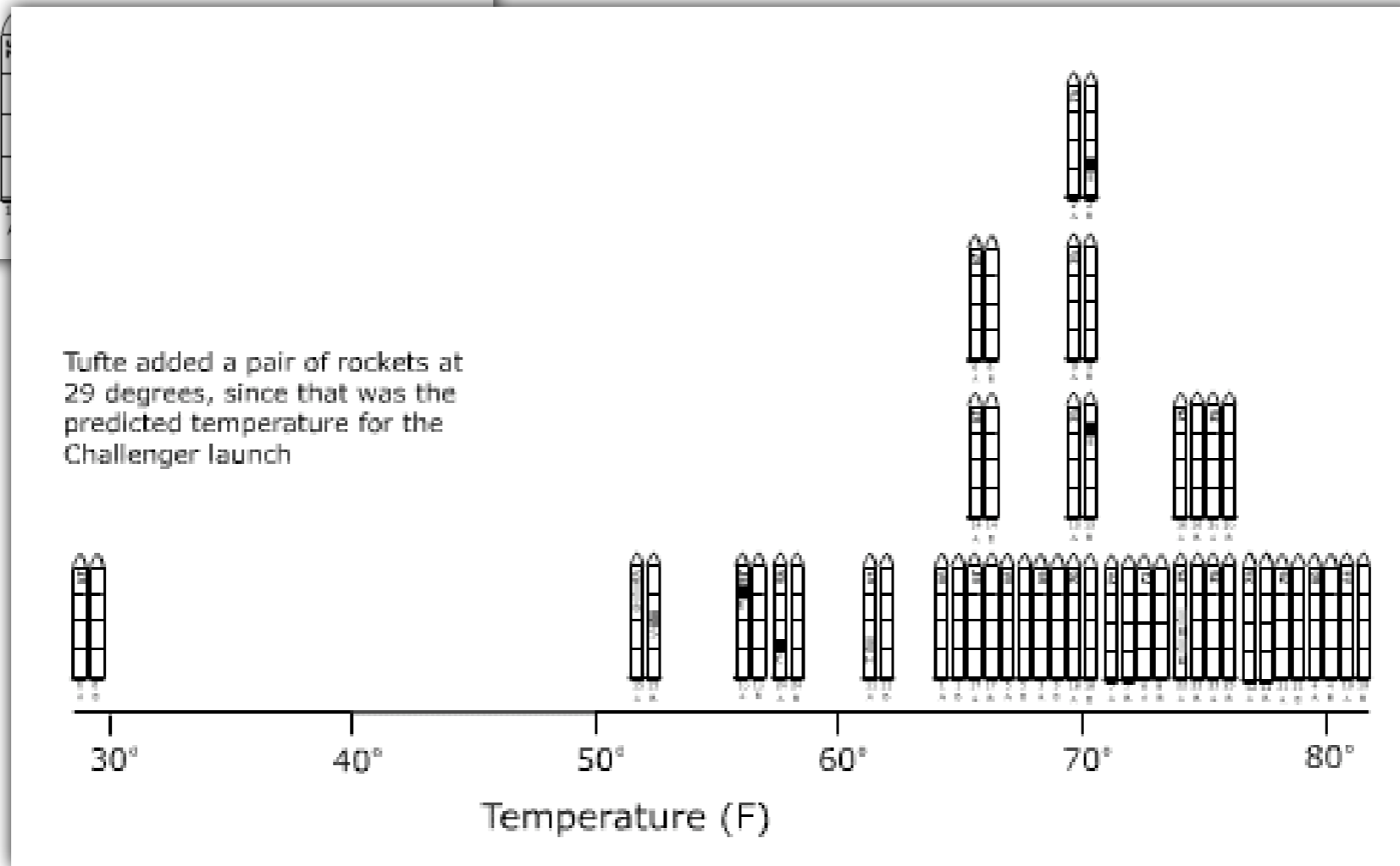
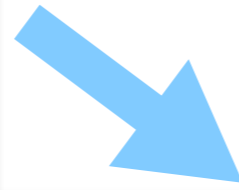
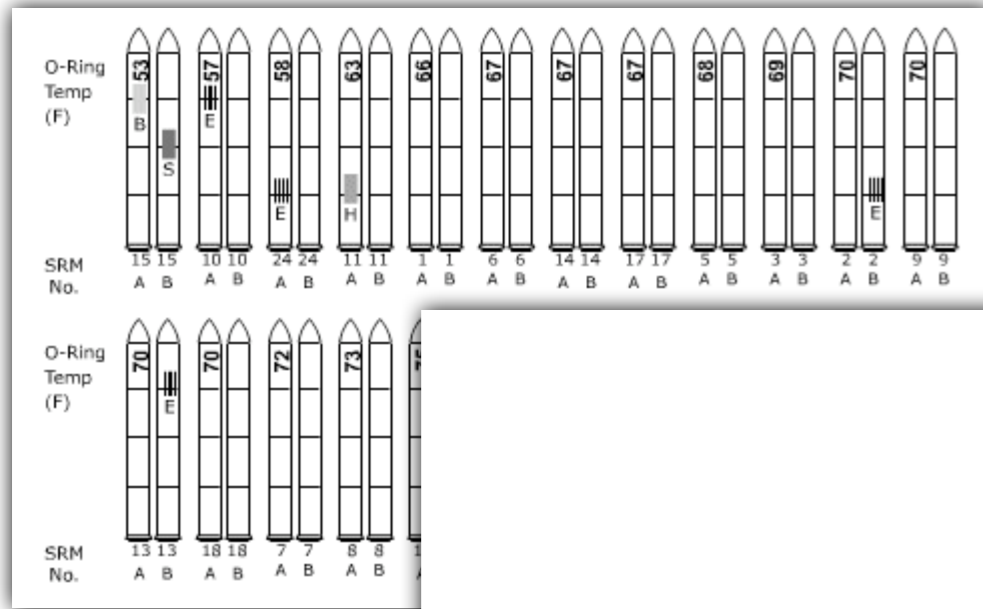
* No Erosion

04406-1E

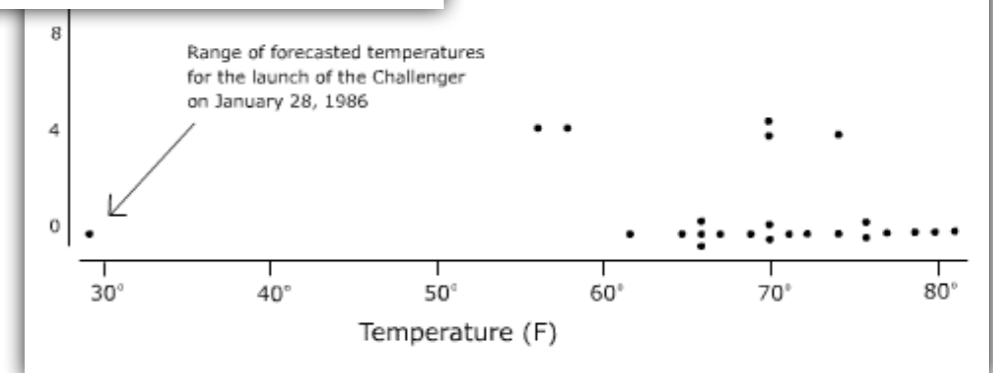
INFORMATION ON THIS PAGE WAS PREPARED TO SUPPORT AN ORAL PRESENTATION AND CANNOT BE CONSIDERED COMPLETE WITHOUT THE ORAL DISCUSSION

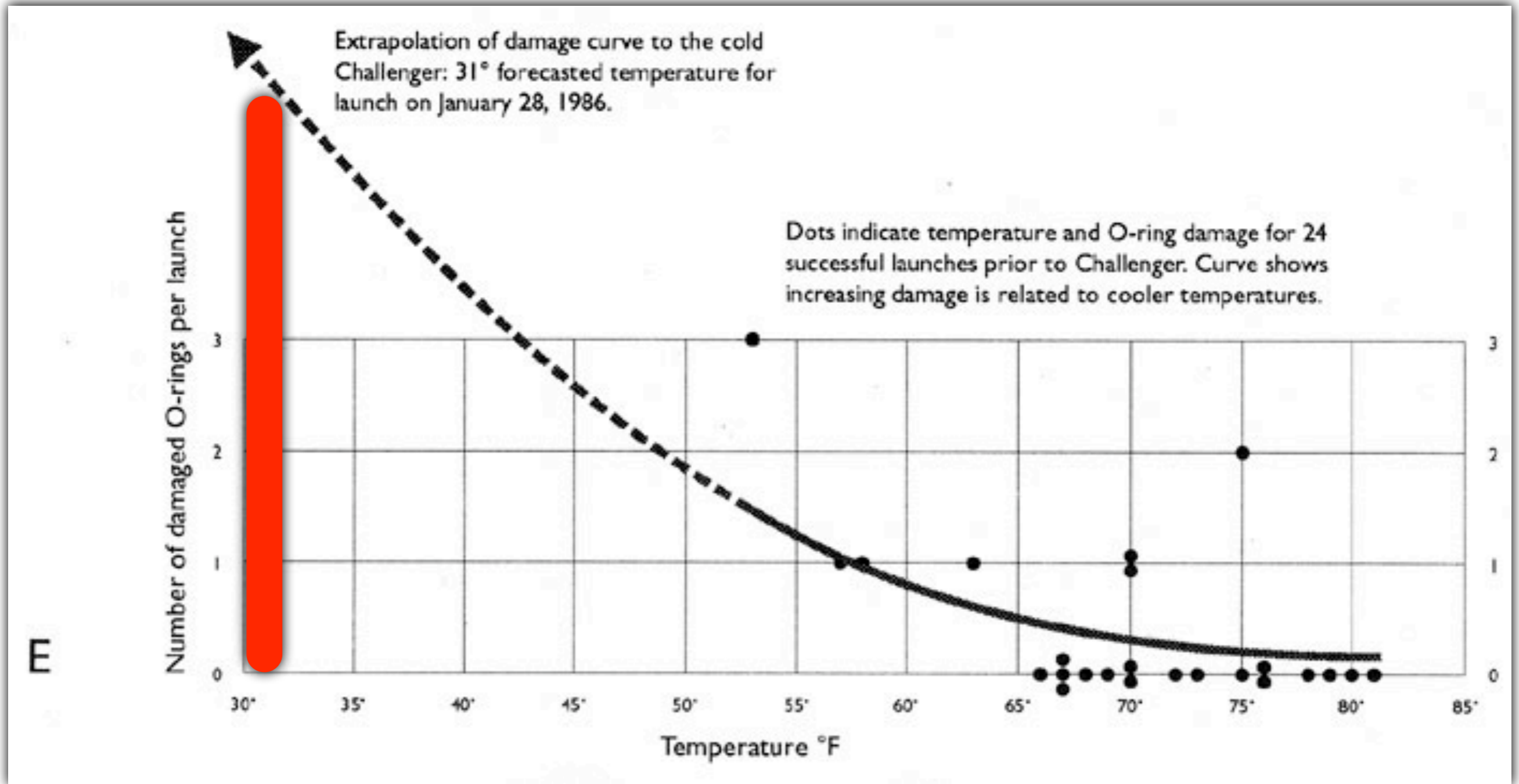
[Picture: Miksch Slide]

Example 3: The Challenger Disaster



[Pictures: Miksch Slide]





[Pictures: Rester Slide]

Example 1: inxight TableLens

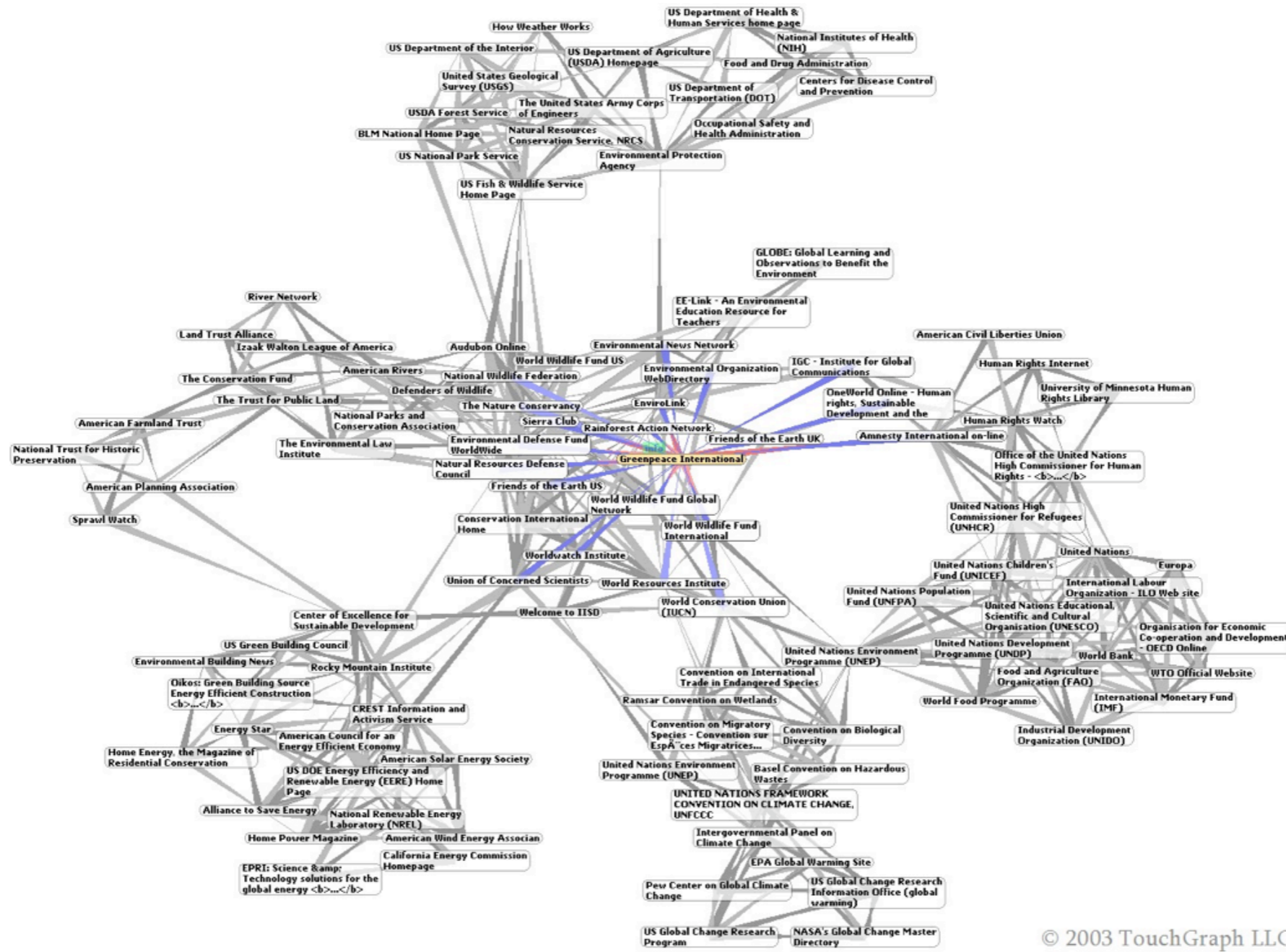
The screenshot shows the inxight TableLens interface. At the top right, the 'inxight' logo is visible. The table below has the following columns: Price (\$), Status, Bedroom, Baths, Square Foot, Address, City, Zip, Realtor, and MLS#. The first three rows are highlighted with red borders. The 'Price (\$)' column has a blue area chart overlay. The 'Status' column has a green area chart overlay. The 'Bedroom' column has an orange area chart overlay. The 'Baths' column has a blue area chart overlay. The 'Square Foot' column has a blue area chart overlay. The 'City' and 'Zip' columns have vertical scatter plots. The 'Realtor' column has a vertical scatter plot. The 'MLS#' column has a vertical scatter plot. The interface includes a toolbar at the top left with icons for zoom, pan, and other navigation functions.

	Price (\$)	Status	Bedroom	Baths	Square Foot	Address	City	Zip	Realtor	MLS#
87	2,750,000		4	3	2508	RIDGECRE...	Monte Sereno	95030	ALAIN PINE...	29090
88	2,750,000		5	4	5107	993 DAY RD	Gilroy	95020	COLDWELL...	101094
90	2,700,000		5	3.5	2700	RAMONA ST	Palo Alto	94306	COLDWELL...	50445
646	699,000	Sale Pending	3	2	1737	DUNNOCK ...	Sunnyvale	94087	CENTURY ...	100249
651	699,000		3	2	1504	WESTPARK...	San Jose	95124	CENTURY ...	50542
658	699,000		3	2	1200	10281 JOHN...	Cupertino	95014	REFERRAL...	27519

[<http://www.inxightfedsys.com/products/sdks/tl/default.asp>]



Example 2: TouchGraph GoogleBrowser (Outdated)

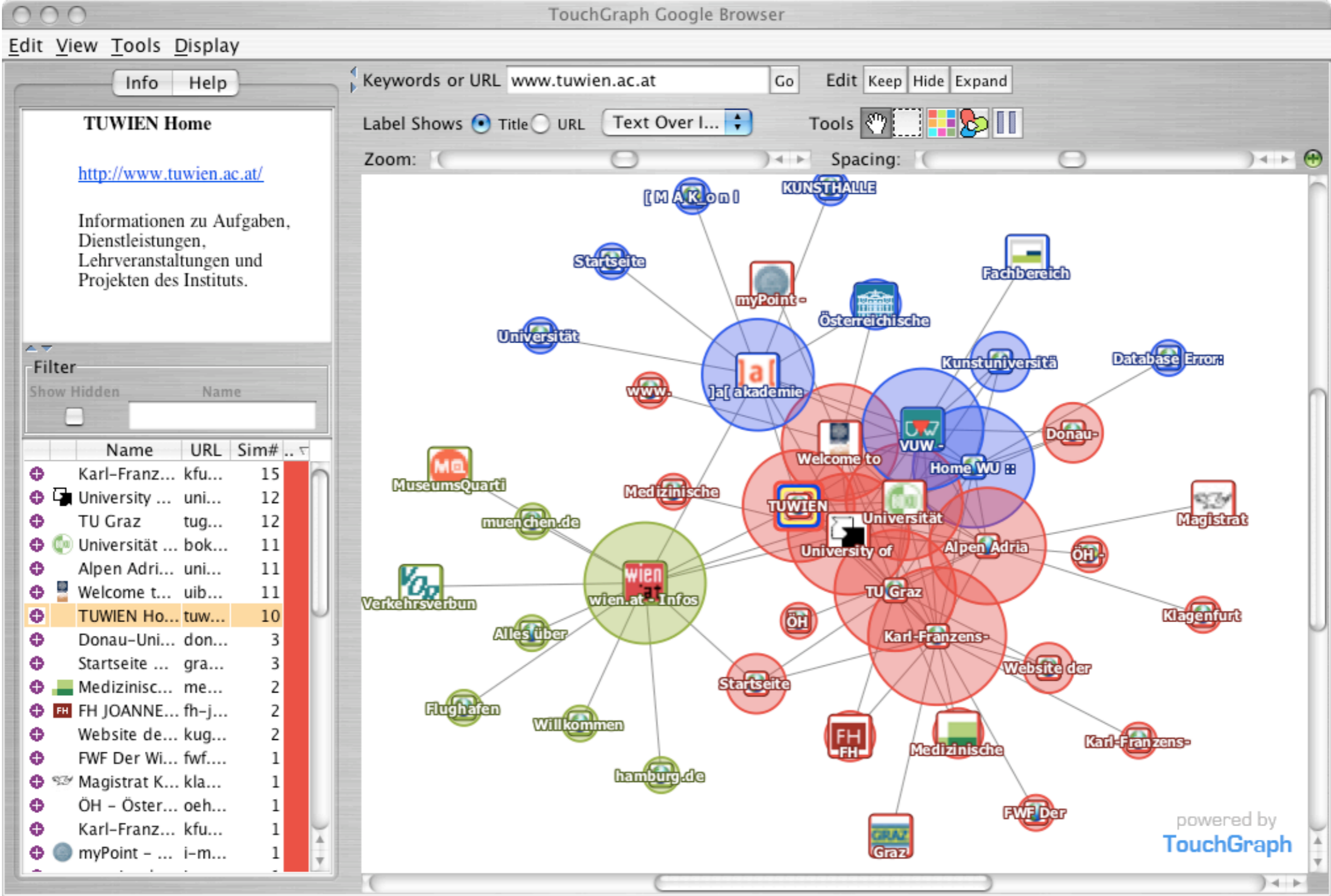


© 2003 TouchGraph LLC

© 2003 TouchGraph LLC

[<http://www.touchgraph.com/TGGoogleBrowser.html>]

Example 2: TouchGraph GoogleBrowser



[<http://www.touchgraph.com/TGGoogleBrowser.html>]

- Motivation - Examples
- **Definitions and Goals**
- Knowledge Crystallization
- Exploration Techniques
- Visual Encoding Techniques
- Summary

Data

“input signals to sensory and cognitive processes”

Information

“data with an associated meaning”

Knowledge

“the whole body of data and information together with cognitive machinery that people are able to exploit to decide how to act, to carry out tasks and to create new information”

[Schreiber et al., 2000]

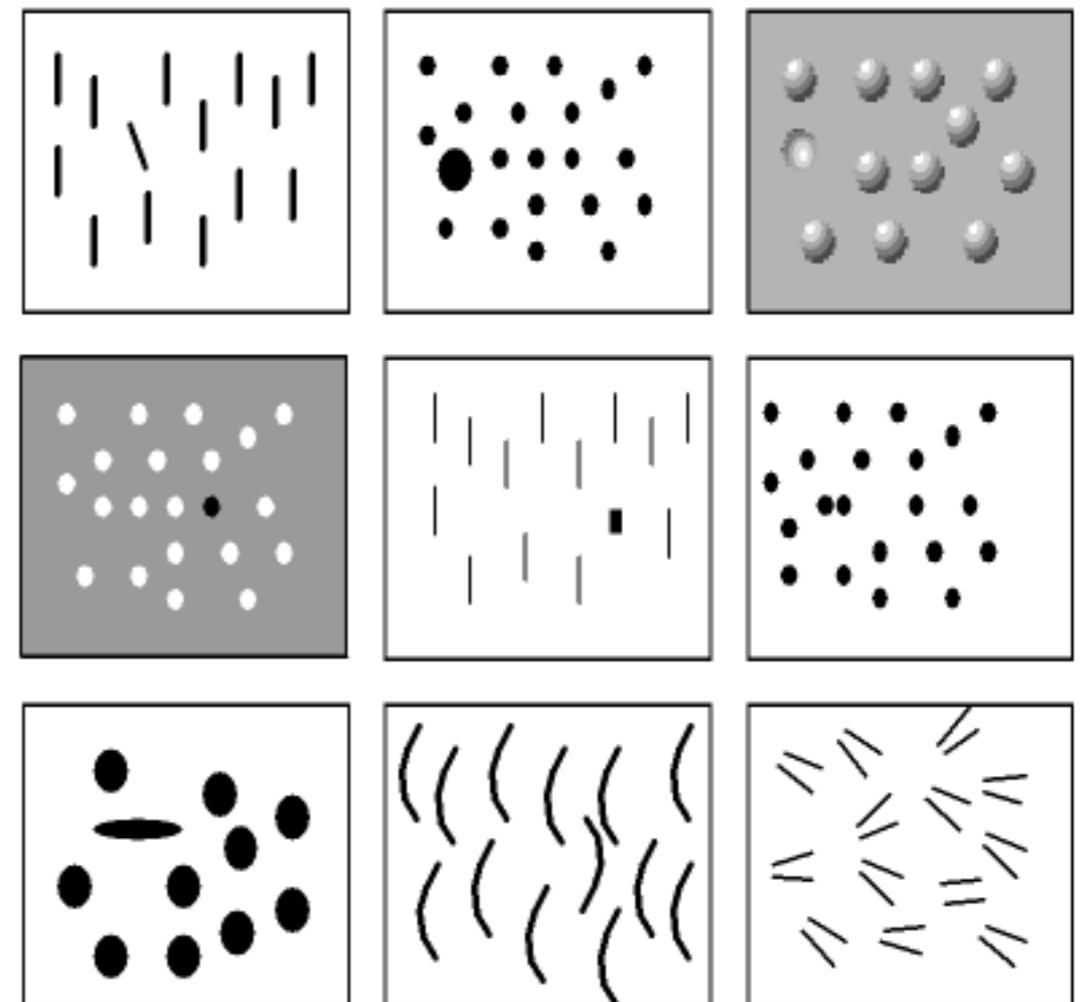
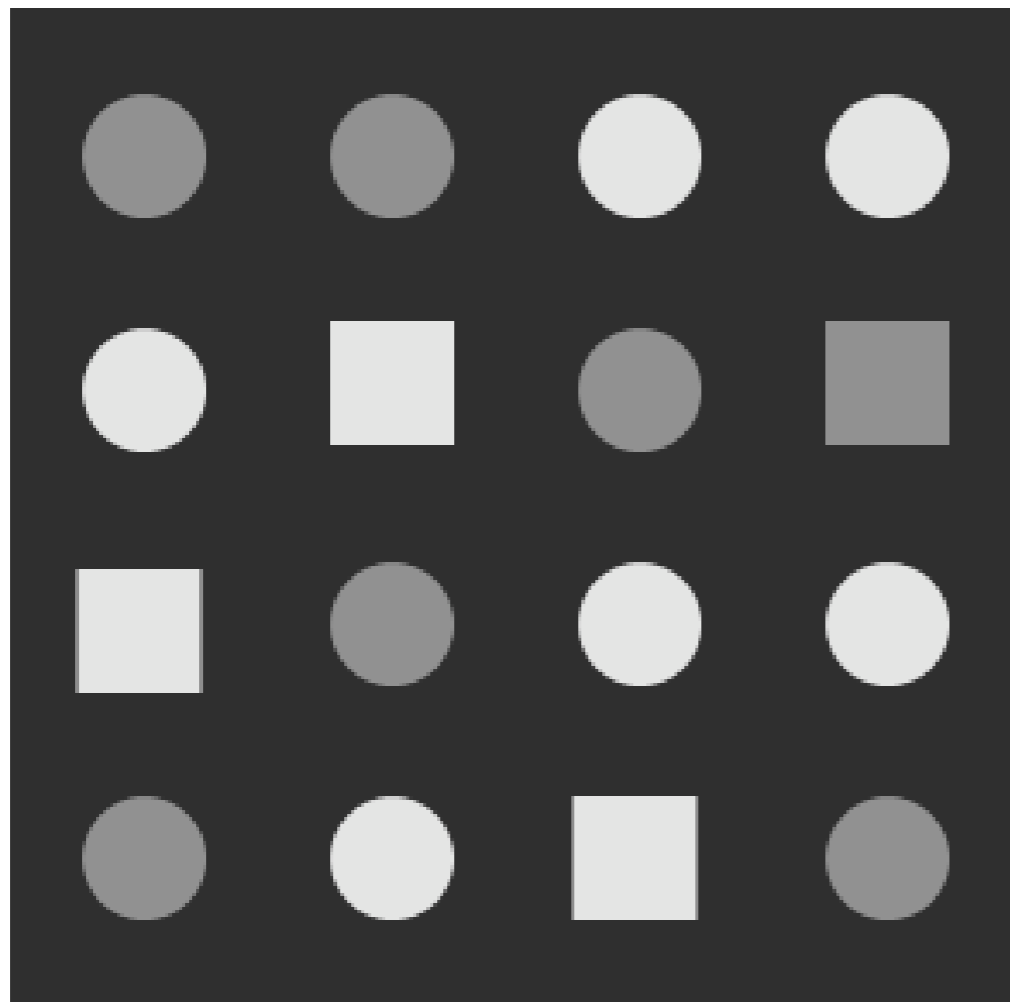
InfoVis is ...

- ... the process of transforming data, information, and knowledge into visual form making use of humans' natural visual capabilities.
- ... the computer-assisted use of visual processing to gain understanding.
- ... providing the user with an overview first and then details on demand (<-> text).

- ... based on pre-attentive features (< 200ms).

[Card & Mackinlay, 1997, Gershon, Eick, Card, 1998, Ware, 2000]

Information Visualization is ...



... based on pre-attentive features (< 200ms).

[Card & Mackinlay 1997, Gershon, Eick, Card:1998, Ware, 2000]

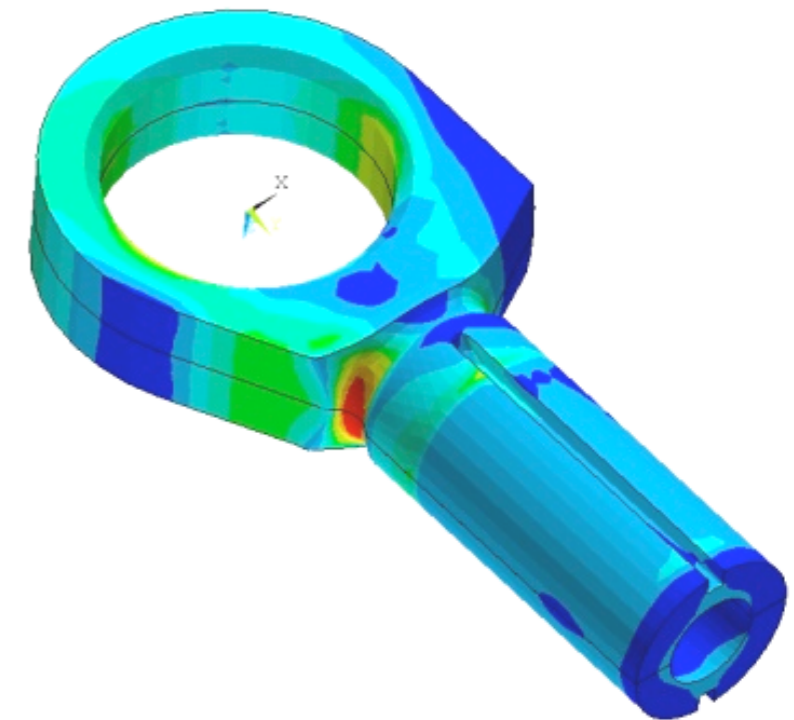
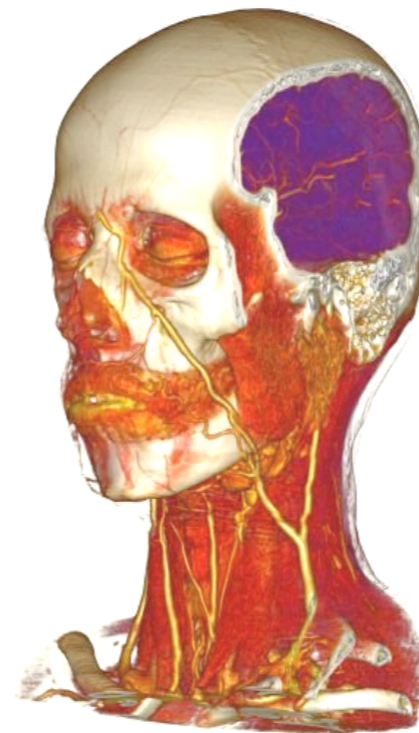
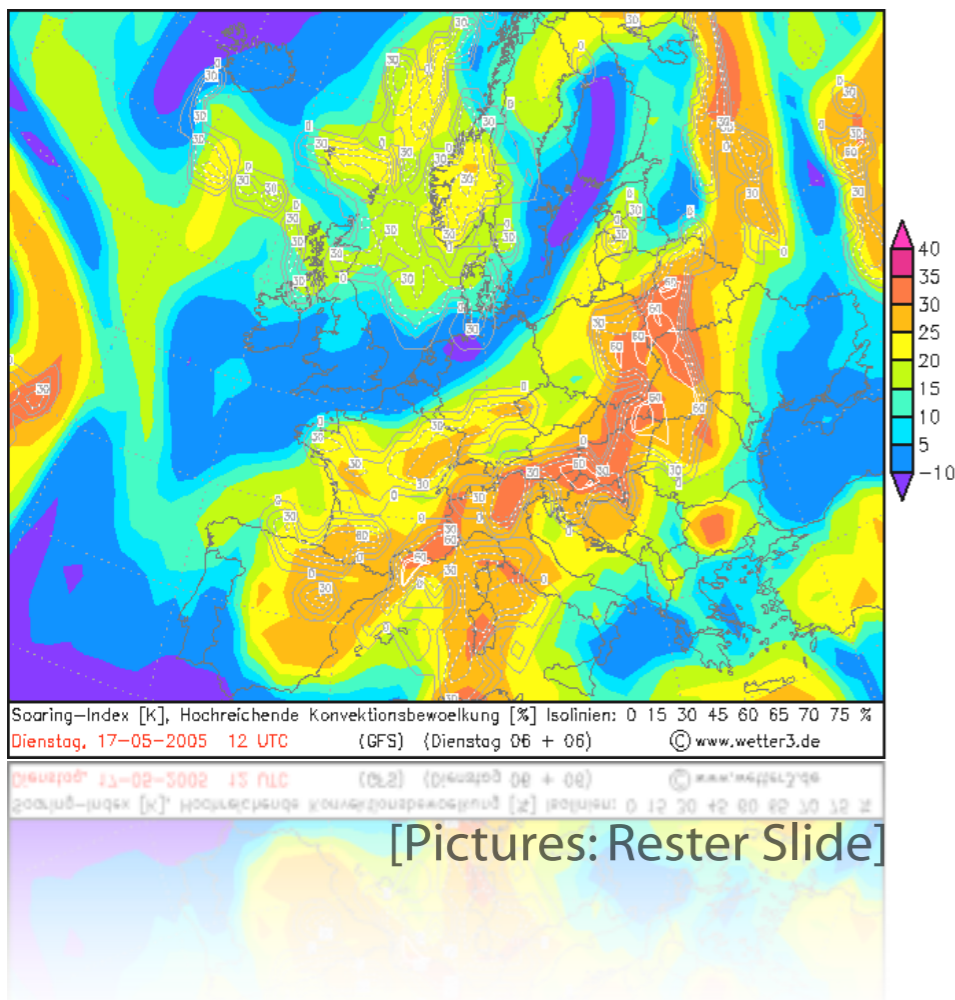
„It is important to distinguish information visualization from scientific visualization (SciVis).

In scientific visualization what is seen primarily relates to, and represents visually, something physical. Thus, the flow of a water in a pipe or the nature of the weather in a mountainous area [...] are displayed directly superimposed on or at least close to a realistic representation of the physical thing.

By contrast, information visualization tends to deal with abstract quantities such as baseball scores, connections between known criminals, fluctuating exchange rates and electrical voltages.„

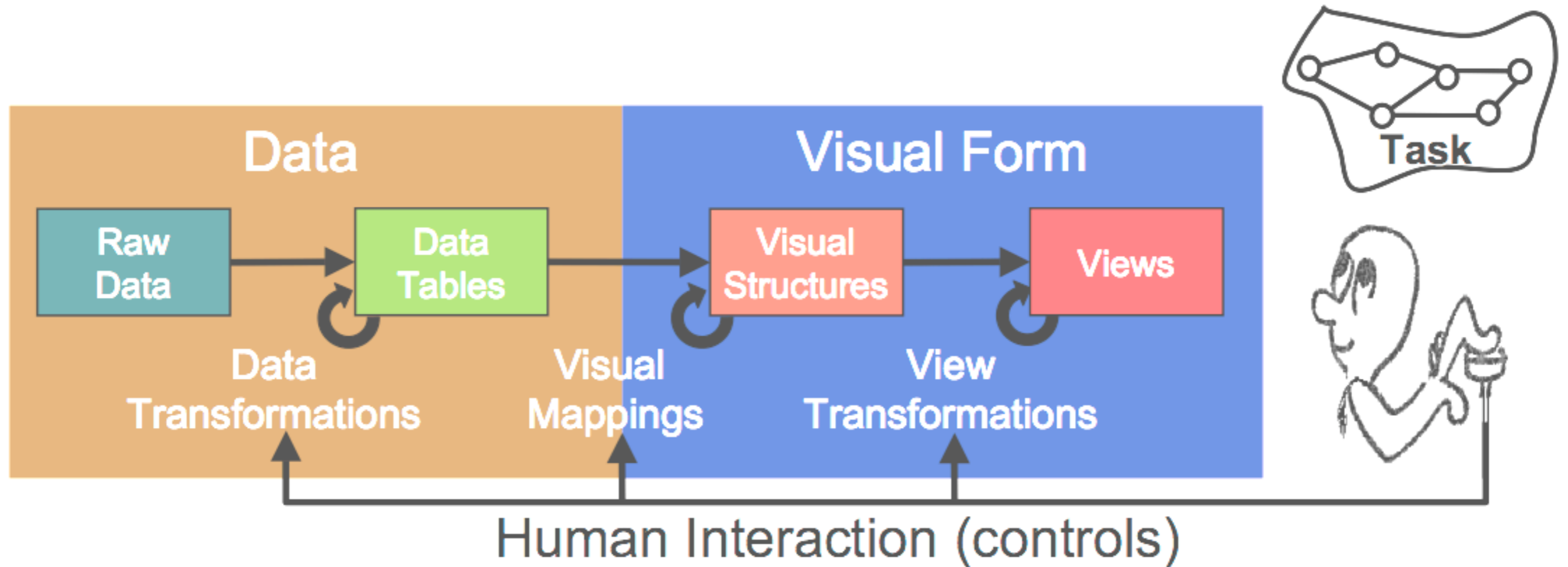
[Spence: Information Visualization. 2001]

- deals with physical data (e.g., human body, tourist maps, molecules, weather forecast, ...)
- abstract data may be involved
- spatial reference is determined



- Visualization of abstract data (e.g., financial transactions, insurance risks, etc.) means to find spatial representations (2D, 3D).
- No inherent spatial structure available, so the designer / user needs to decide which dimensions are represented by space: Mapping.

Visualization Reference Model



[Mackinlay, 2000][Card et al.,1999]

- Entities (e.g., people, terms) and relations (e.g., part-of, is-a)
- Both can have sets of attributes (duration, color, time, etc.)
- Types of attributes
 - Category data (nominal),
 - Integer data (ordinal),
 - Real-number data (interval & ratio)
- High-frequency versus high-structural

[Ware: Information Visualization, 2000]

Multi-Dimensionality

... contain more than three dimensions and are multi-variate

Multi-Modality

... a combination of data from different sources

Structural Complexity

... ranging from low-structured (simple data structure, but many instances, e.g., flow data, volume data) to high-structured data (complex data structure, but only a few instances, e.g., business data)

Disparity

... contain different types of information in the different dimensions

Largeness

... consist of at least hundreds of thousands of data points

Spatiality

... contain at least one (non-scalar) spatial component and non-spatial data

Time-Dependency

... data is given at several points in time

Visualizations are characterized by their purpose for ...

Exploration

the user searches for structures and unknown relations which provide her or him with new insights about the data under investigation.

Analysis

starting with certain hypotheses about the data the user tries to prove them by goal-oriented investigations.

Presentation

static visualization of facts which are fixed a priori.

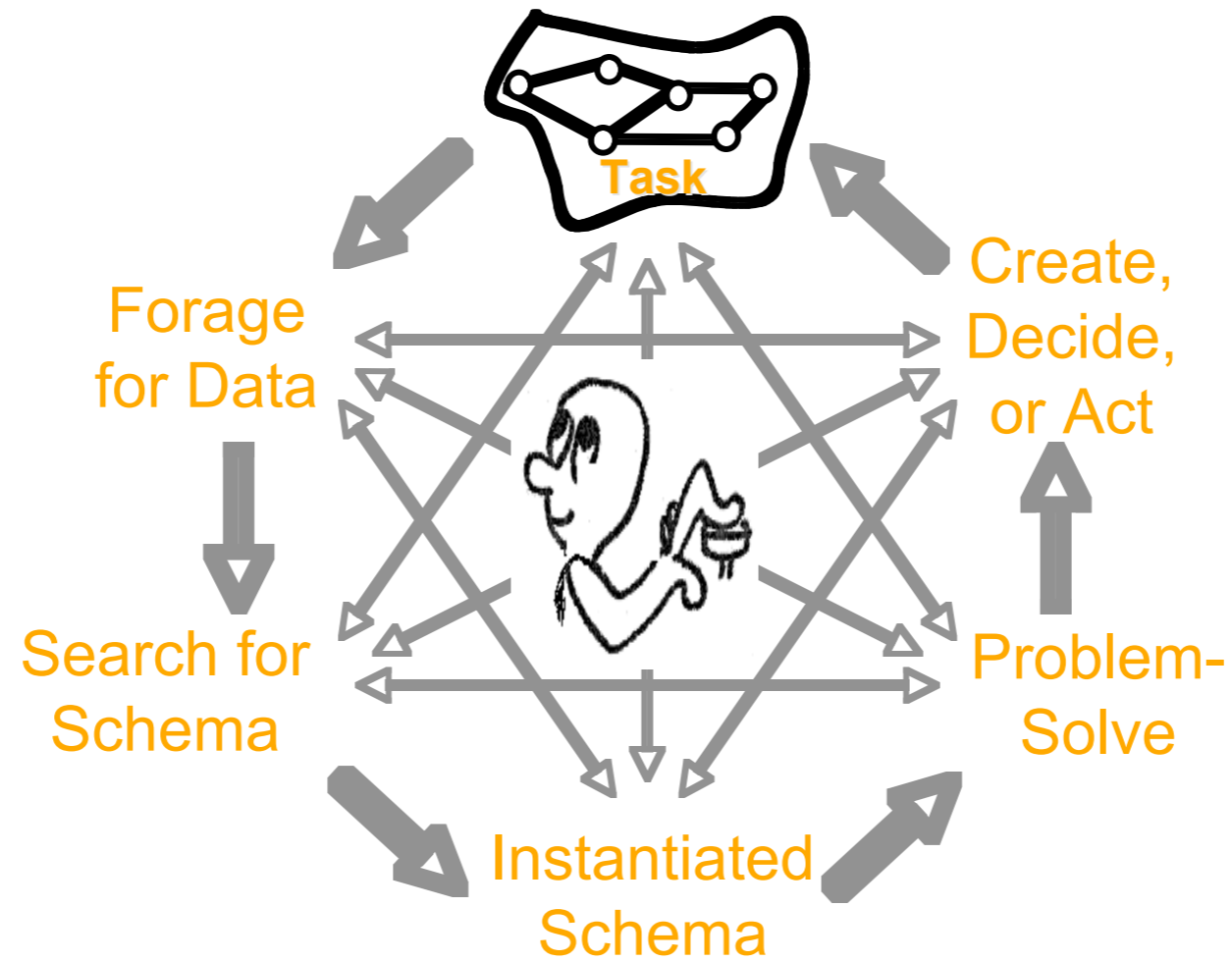
[Schumann et al., 2000]

Visualization can facilitate cognition by ...

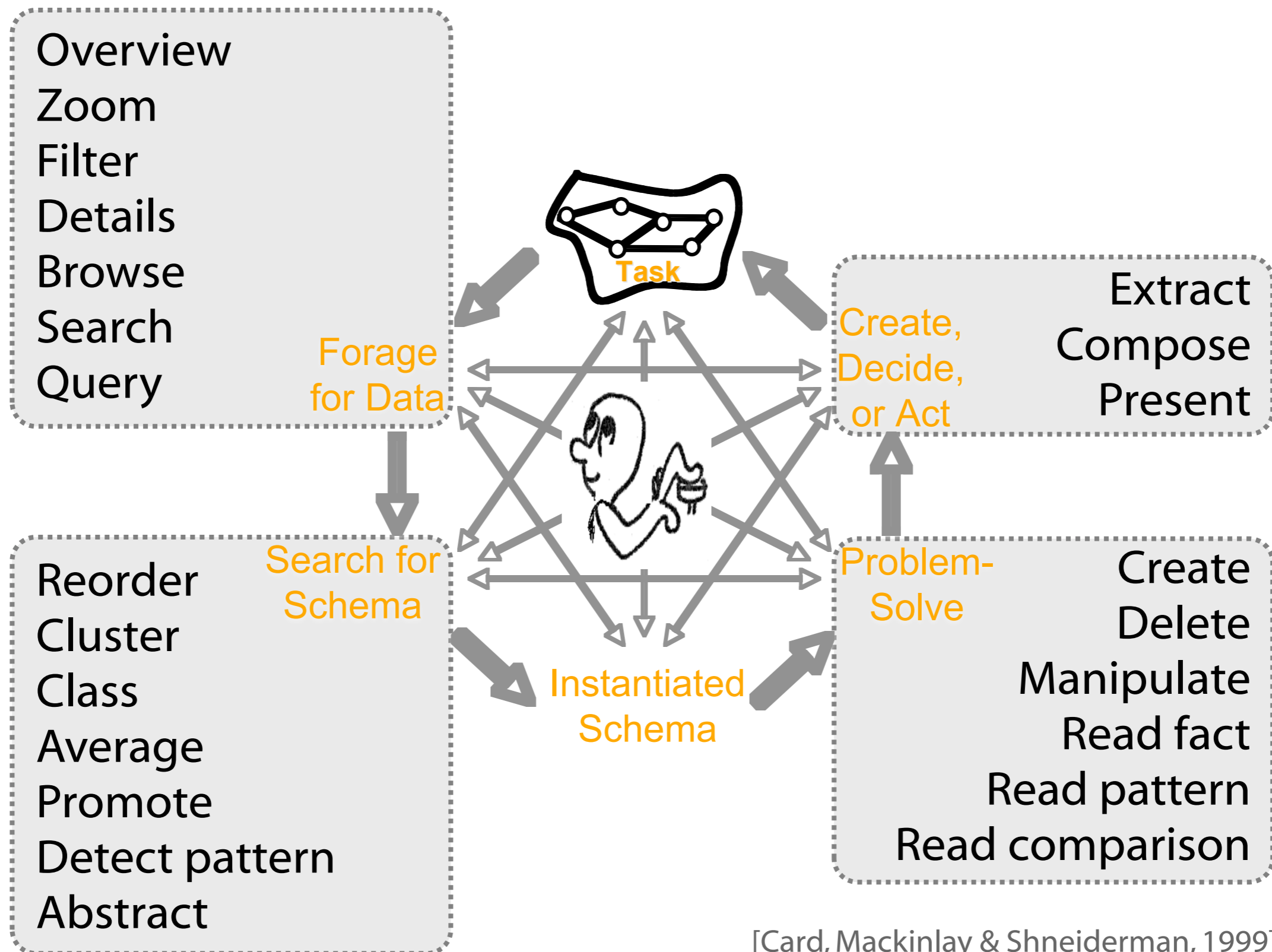
- ... increasing the memory and processing resources available to the user.
- ... reducing the search for information.
- ... using visual representations to enhance the detection of patterns.
- ... enabling perceptual inference operations.
- ... using perceptual attention mechanisms for monitoring.
- ... encoding information in a manipulable medium.

[Card, Mackinlay, Shneiderman: Readings in Information Visualization, 1999]

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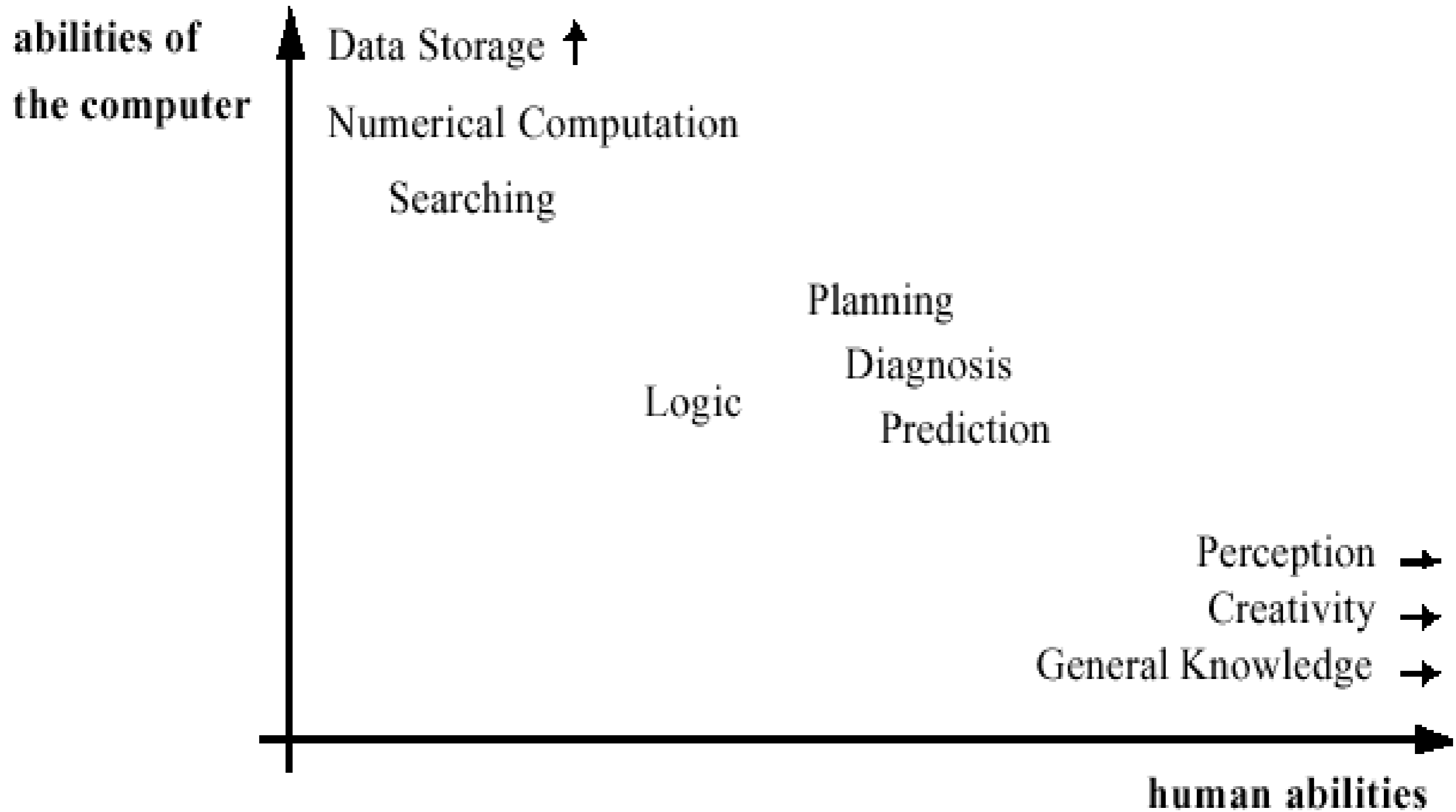


[Card, Mackinlay & Shneiderman, 1999]



[Card, Mackinlay & Shneiderman, 1999]

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[Keim, 2001]

High-level Tasks

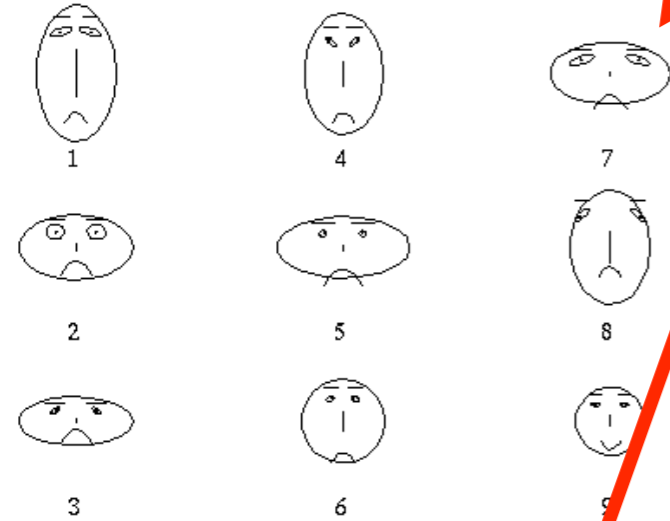
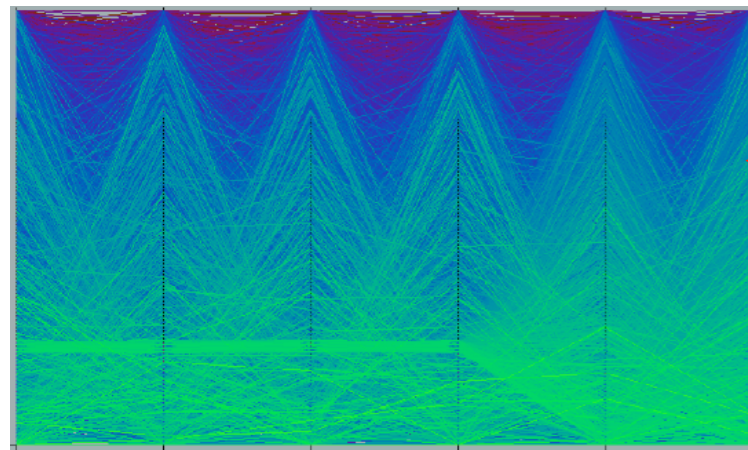
1	overview	gain an overview of the entire set of data
2	zoom	adjust the size of items of interest
3	filter	remove uninteresting items
4	details-on-demand	select one or more items and get details
5	relate	identify relationships between items
6	history	keep a history of actions to support undo/redo
7	extract	extract subsets of items for separate analysis

[Shneiderman: The eyes have it, 1996]

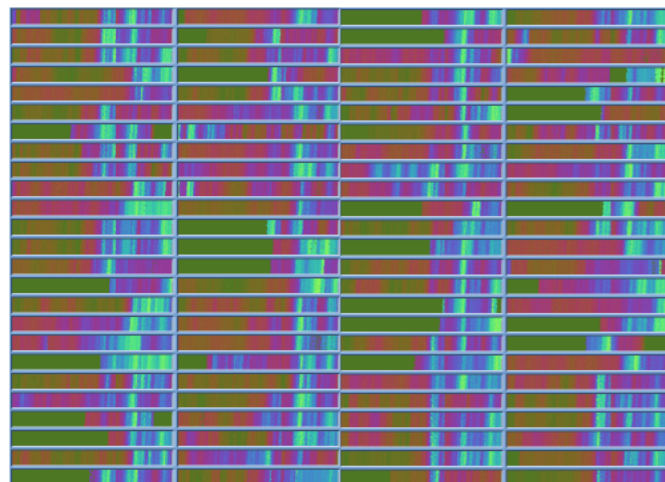
"There are many visual design guidelines but the basic principle might be summarized as the Visual Information Seeking Mantra:

Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !
Overview first, zoom and filter, then details-on-demand !

[Shneiderman: The eyes have it, 1996]

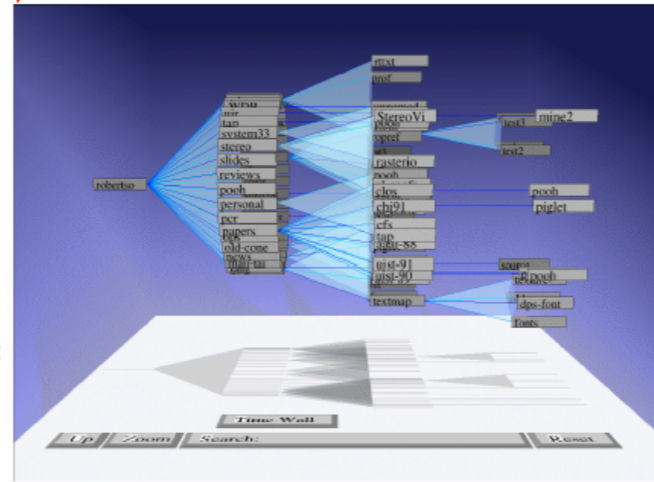


Recursive Pattern: FAZ-Index (Jan. '74 - Apr. '95)



time
of t
in t
Stoc

used by permission of S. Card, Xerox PARC



used by permission of S. Card, Xerox PARC

Data Visualization Techniques

- Geometric
- Icon-based
- Pixel-oriented
- Hierarchical
- Graph-based

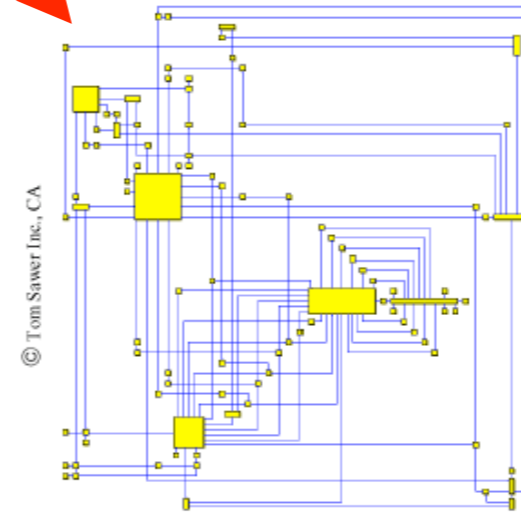
Distortion Techniques

Complex
Simple

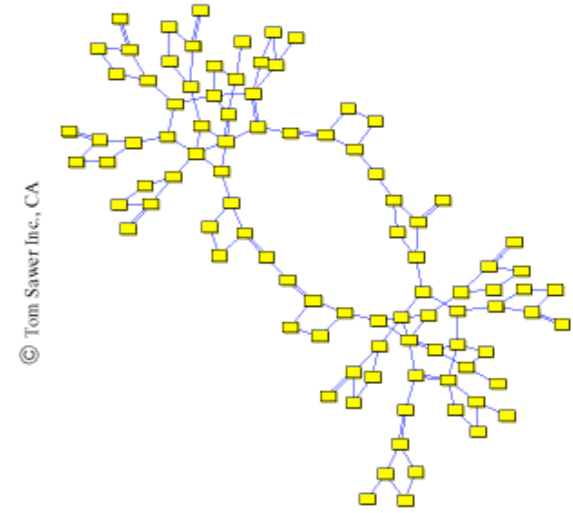
Interaction Techniques

Mapping Projection Filtering Link & Brush Zooming

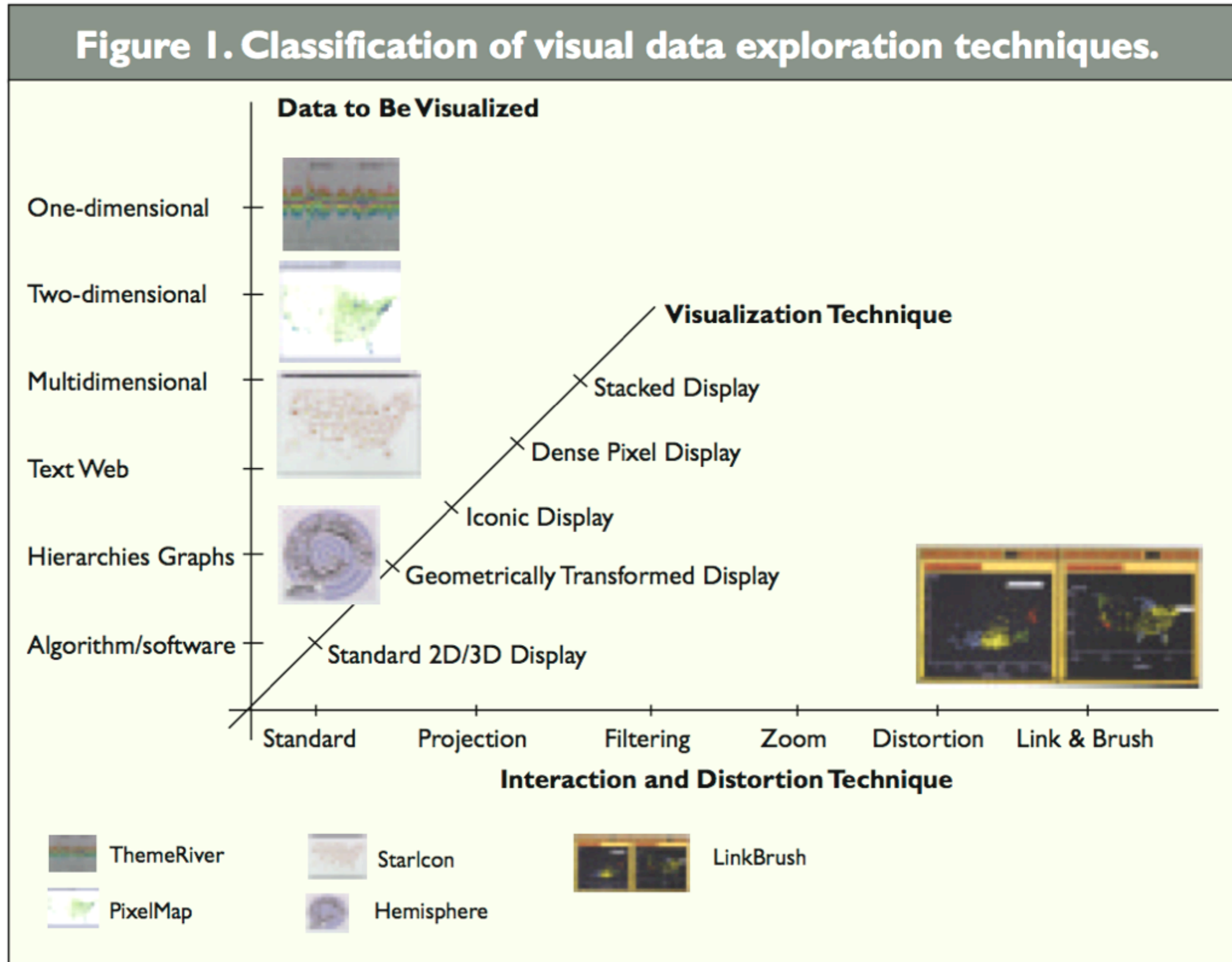
[Keim, 2001]



© Tom Sawyer Inc., CA



© Tom Sawyer Inc., CA



[Keim, 2001]

Coupling views by:

- **Slaving**
movements in one view are automatically propagated in the other views
- **Linking**
connects the data items of one view with the data items of the other views e.g., done by **brushing**: user selects and highlights items in one view and the corresponding items are highlighted automatically

[Baldonado, 2000]

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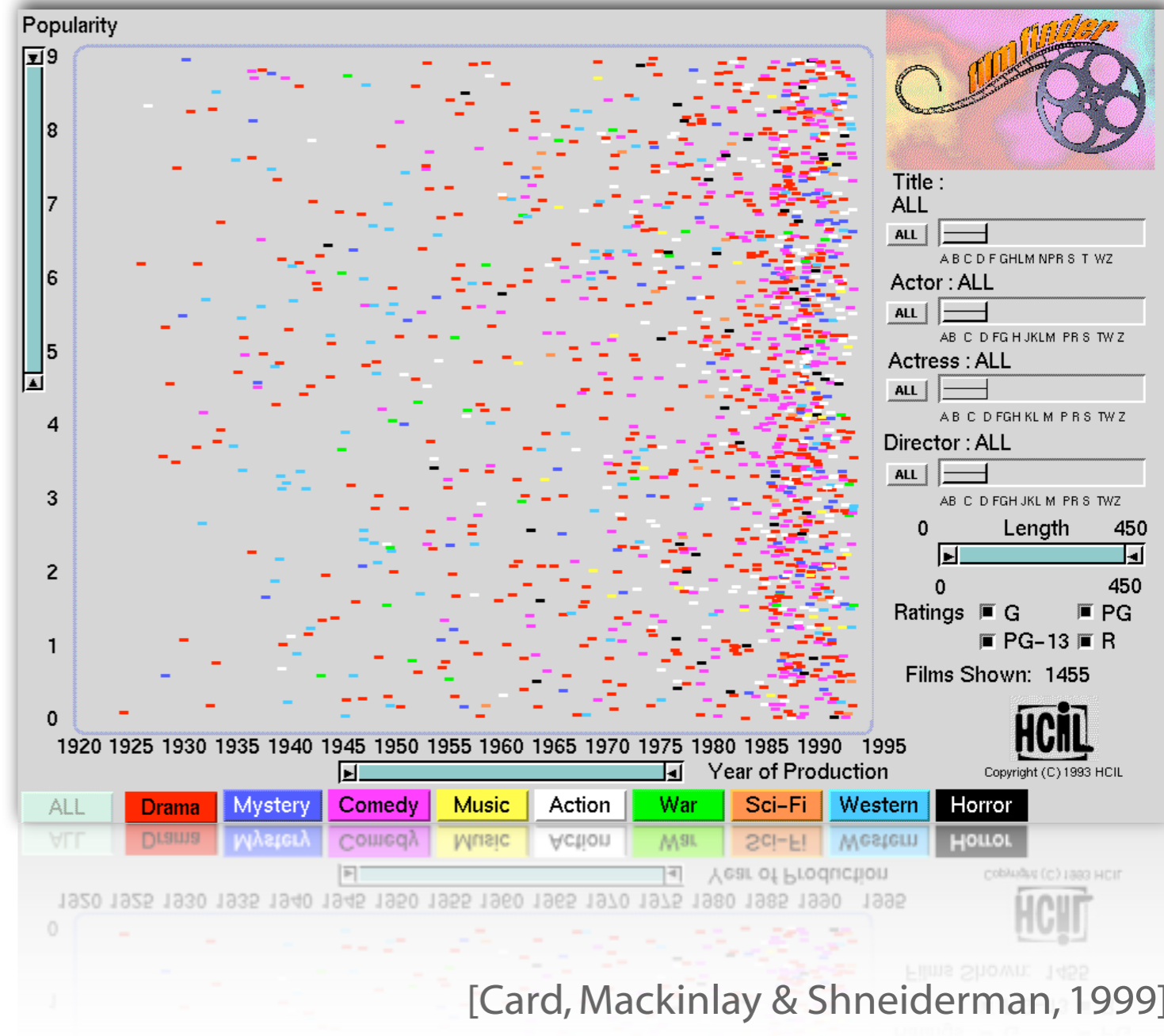
Different ways in encoding information visually:

- **Space**
(See details next slide)
- **Marks (in space)**
Points, lines, areas, volumes
- **Connections & enclosures**
- **Retinal properties**
Crispness, shape, resolution, transparency, color, grayscale
- **Temporal changes**
- **Viewpoint transformations**

[Card, Mackinlay & Shneiderman, 1999]

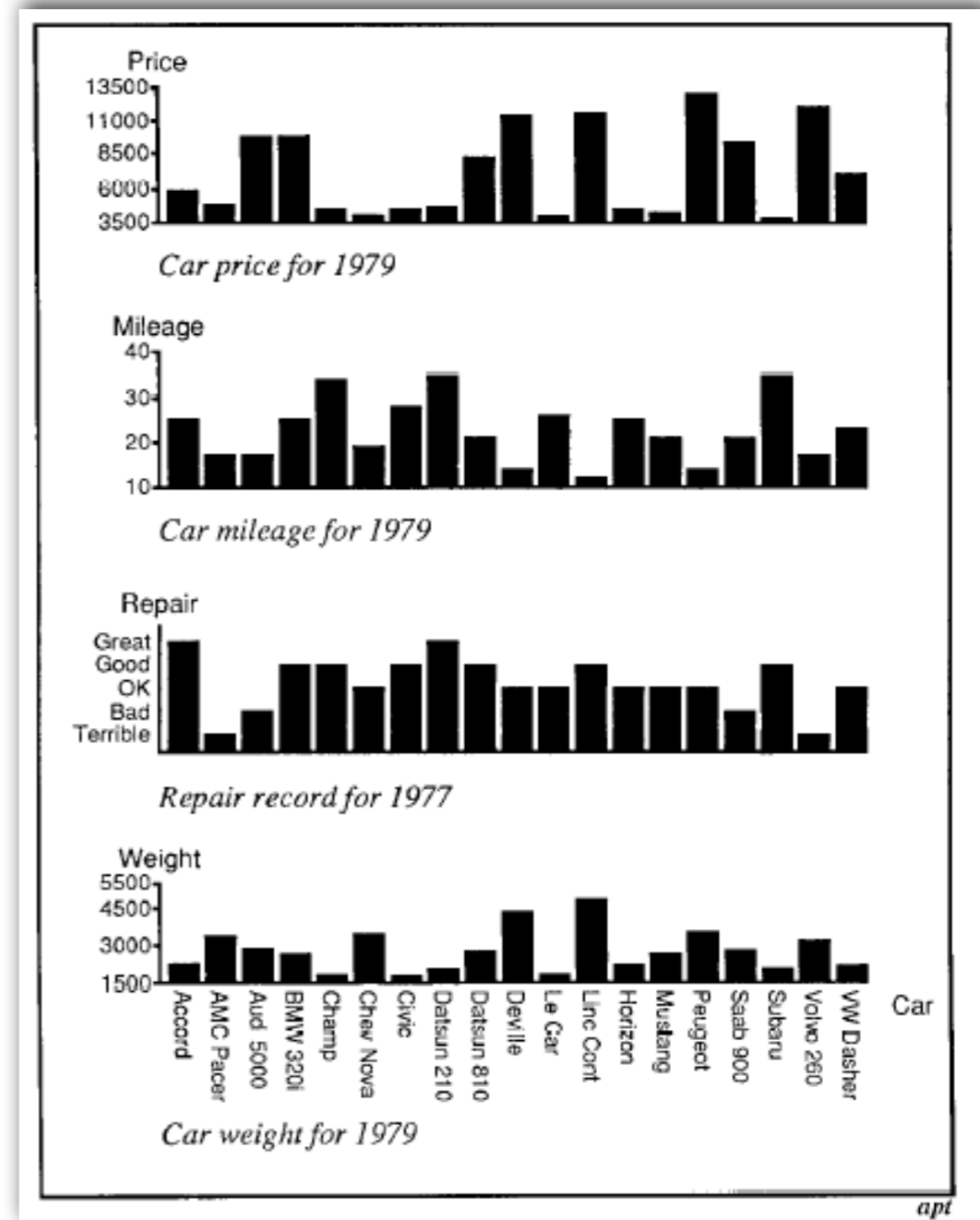
- **Composition**

The orthogonal placement of axes, creating a 2D metric space



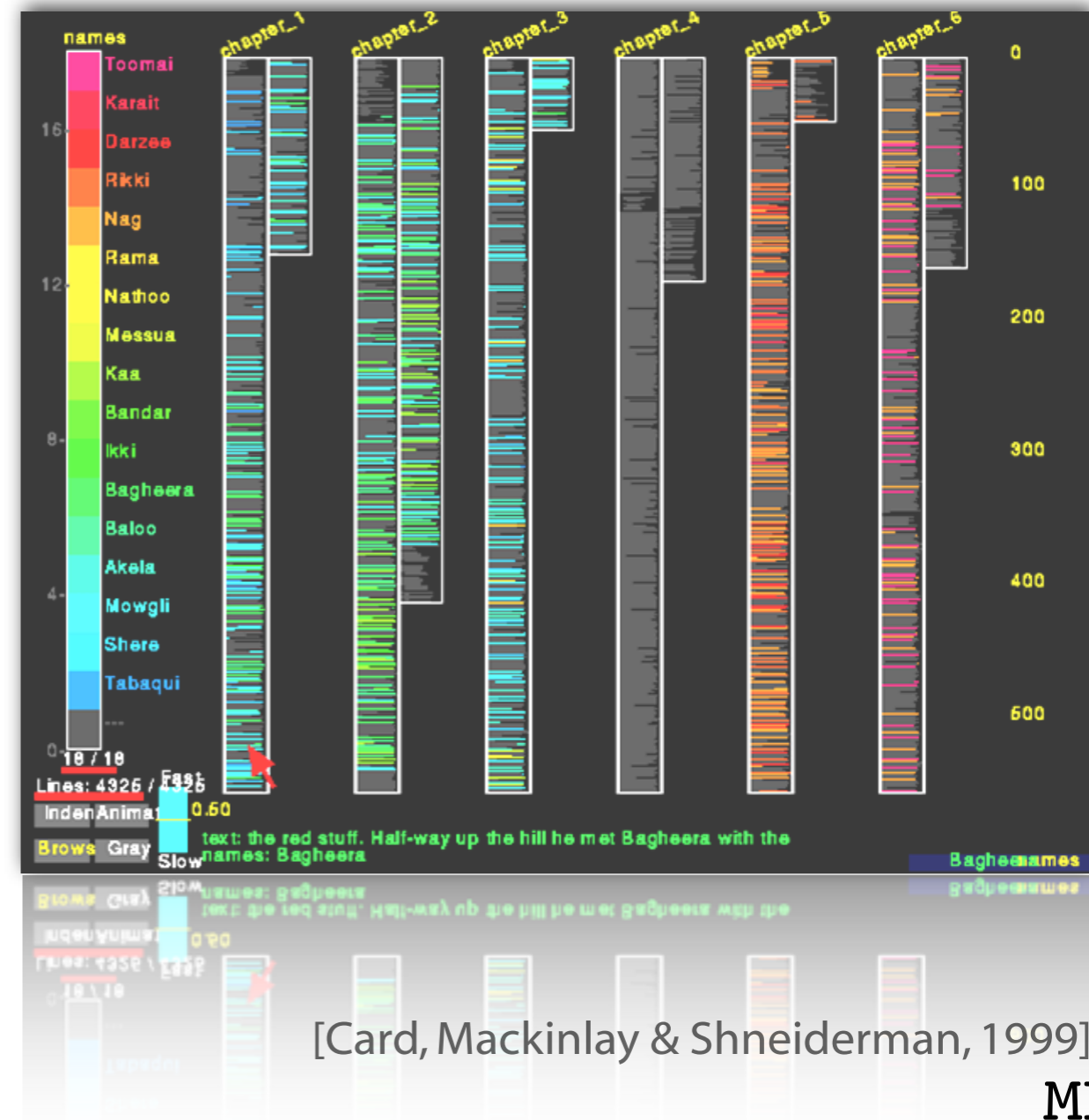
[Card, Mackinlay & Shneiderman, 1999]

- **Composition**
The orthogonal placement of axes, creating a 2D metric space
- **Alignment**
The repetition of an axis at a different position in the space

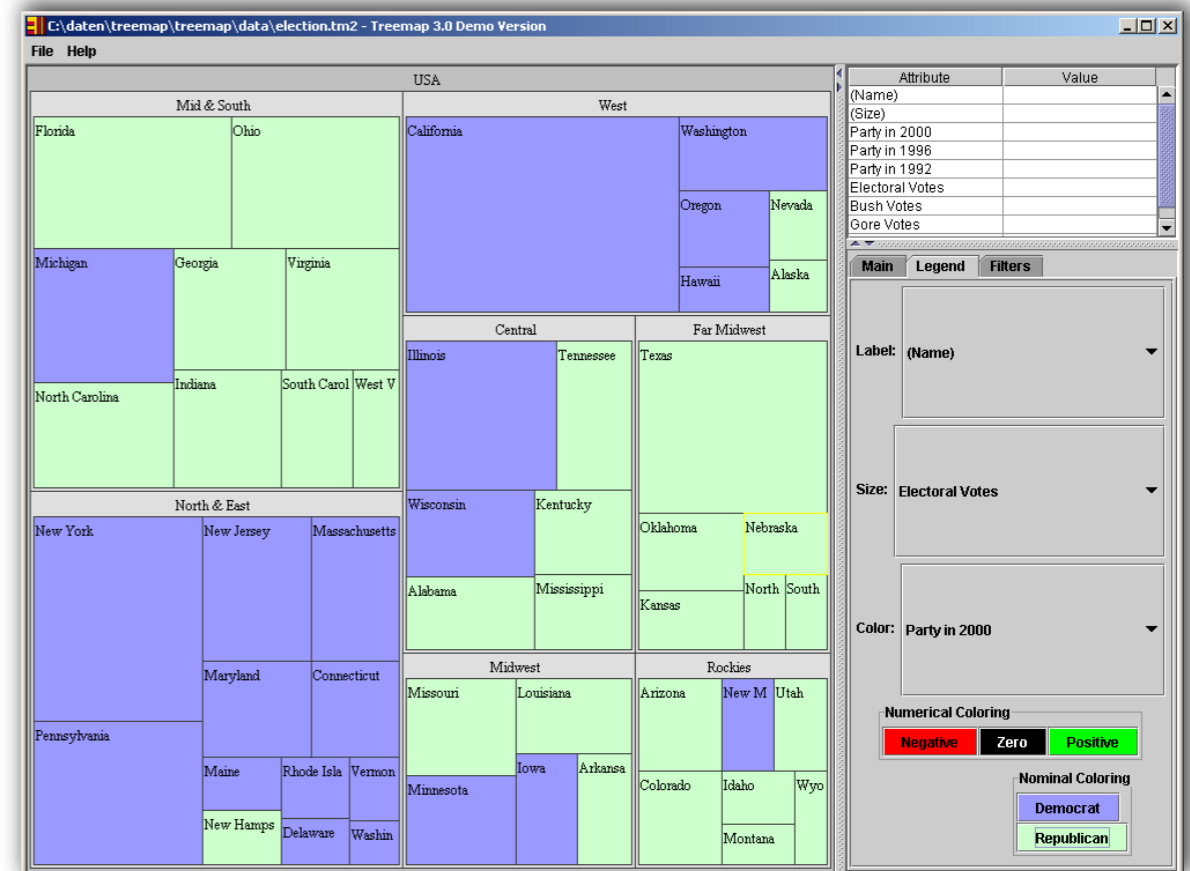


[Card, Mackinlay & Shneiderman, 1999]

- **Composition**
The orthogonal placement of axes, creating a 2D metric space
- **Alignment**
The repetition of an axis at a different position in the space
- **Folding**
The continuation of an axis in an orthogonal direction

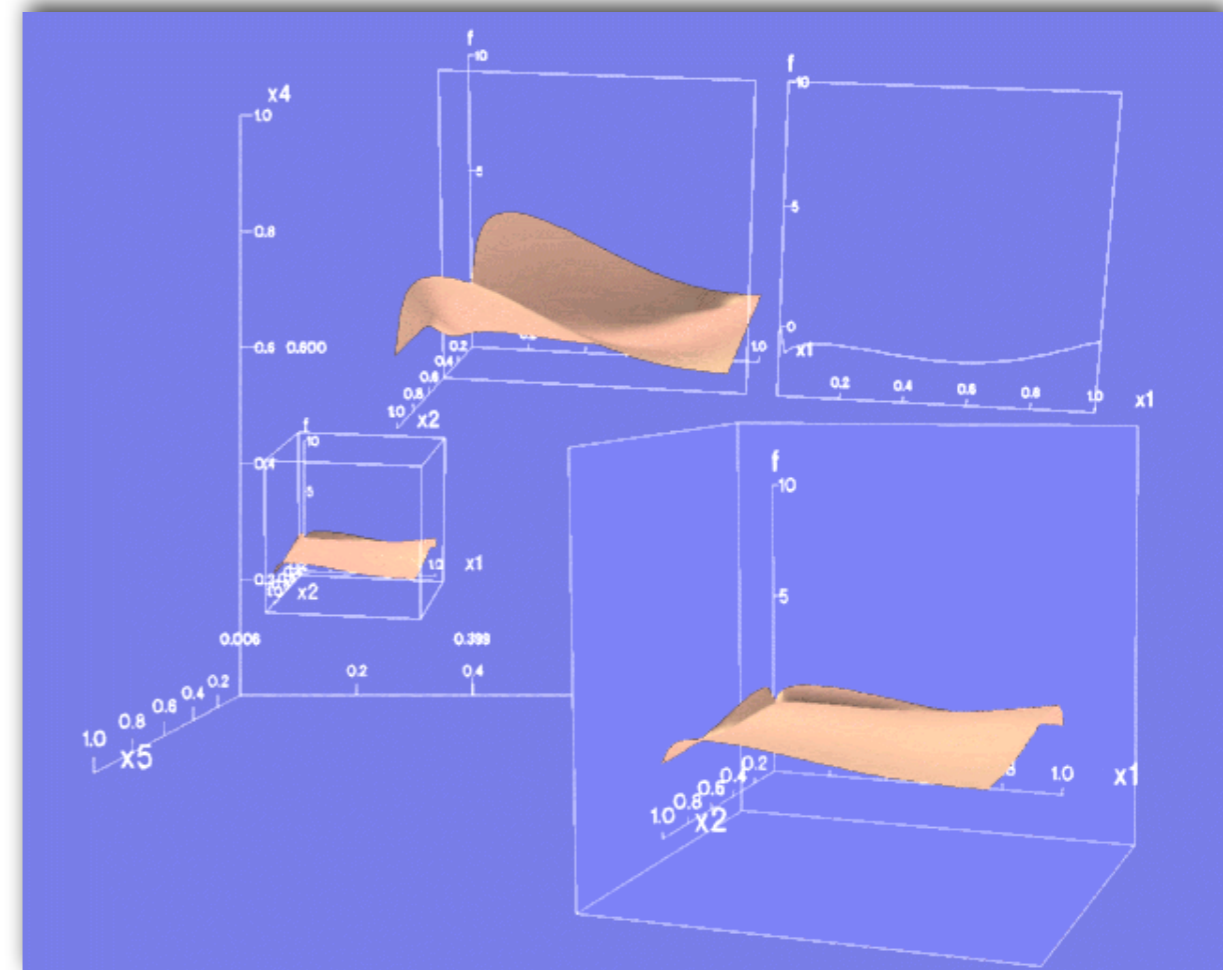


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The continuation of an axis in an orthogonal direction
- **Recursion**
The repeated subdivision of space
- **Overloading**
The reuse of the same space



[Card, Mackinlay & Shneiderman, 1999]

- Motivation - Examples
- Definitions and Goals
- Knowledge Crystallization
- Exploration Techniques
- Visual Encoding Techniques
- Summary

- is a very complex task.
- can help to get insight into data more quickly.
- is a kind of abstraction.
- requires preparation and sensible handling of the information.
- should make use of the properties of human visual perception.
- requires sensible handling, relative to the task.
- is a big challenge, if you want to do it good.

... Silvia Miksch and
... Markus Rester

for making nice slides of previous classes available.