

Information Representation

The Value of Data Visualization

Spot the 7s...

<http://vimeo.com/29684853>

Beyond Simple Screen Design

What are the characteristics of good representations?

What are the characteristics of good information visualization?

What role do metaphors play?

How can the use of direct manipulation help us?

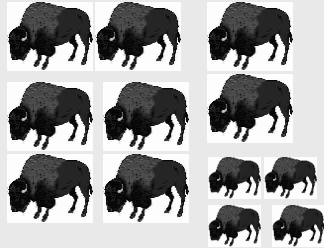
Good information visualization...

- ...supports making discoveries.**
- ...supports making decisions.**
- ...supports discovering patterns.**
- ...supports finding relevant information.**
- ...capture essential elements of events.**
- ...deliberately leaves out (or at least mutes) irrelevant data.**
- ...is appropriate to the person viewing the data.**
- ...is appropriate to the task being performed.**

With good visualizations people can see trends, clusters, gaps, and outliers.

Use of colors, sizes, shapes, and locations all help with this.

How to represent quantity?



||||| ||||| ||
Buffalo

||||| ||||
Adults # Kids

||||| ||||| ||
Buffalo / kids

八, 四

Representations

Solving a problem simply means representing it so as to make the solution transparent ... (Simon, 1981)

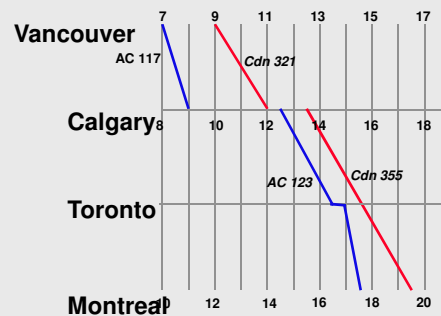
Good representations

- allow people to *find* relevant information
 - information may be present but hard to find
- allow people to *compute* desired conclusions
 - computations may be difficult or “for free” depending on representations

Which is the best flight?

length, stop-overs, switches...

		<i>depart</i>	<i>arrive</i>
AC 117	Vancouver - Calgary	7:00	9:00
Cdn 32	Vancouver - Calgary	9:00	12:00
Cdn 35	Calgary - Montreal	13:30	19:30
AC 123	Calgary - Toronto	12:30	16:30
AC 123	Toronto - Montreal	16:45	17:30
*time zone: +1 van-cal, +2 cal-tor, mtl			



When do I take my drugs?

Inderal:	1 tablet 3 times a day
Lanoxin:	1 tablet every A.M.
Carafate:	1 tablet before meals and at bedtime
Zantac:	1 tablet every 12 hours (twice a day)
Quinag:	1 tablet 4 times a day
Couma:	1 tablet a day

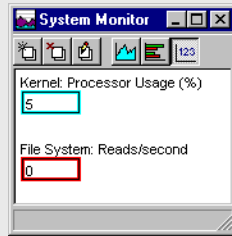
Note: There are high error rates in taking pills, even with pillbox organizers, for a number of reasons.

	<u>Breakfast</u>	<u>Lunch</u>	<u>Dinner</u>	<u>Bedtime</u>
Lanoxin	*			
Inderal	*	*		*
Quinag	*	*	*	*
Carafate	*	*	*	*
Zantac		*		*
Couma				*

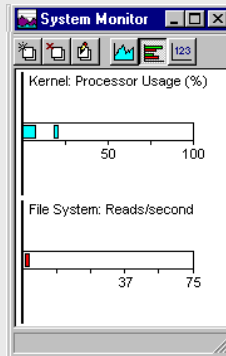
<u>Breakfast</u>	<u>Lunch</u>	<u>Dinner</u>	<u>Bedtime</u>
Lanoxin			
Inderal	Inderal		Inderal
Quinag	Quinag	Quinag	Quinag
Carafate	Carafate		Carafate Carafate
	Zantac		Zantac
			Couma

Note: A better solution might feel like a technology-enhanced pill bottle system, but there are a variety of human-centric factors in that ideas as well as technology failure issues...

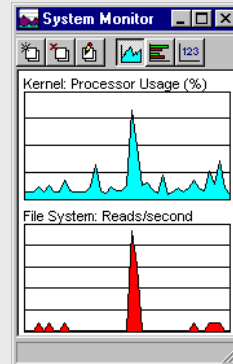
Which representation is best? Depends on task...



Do you want to know the precise value is now?



Do you want to know how the performance is now compared to its peak?



Do you want to know how performance changed over time?

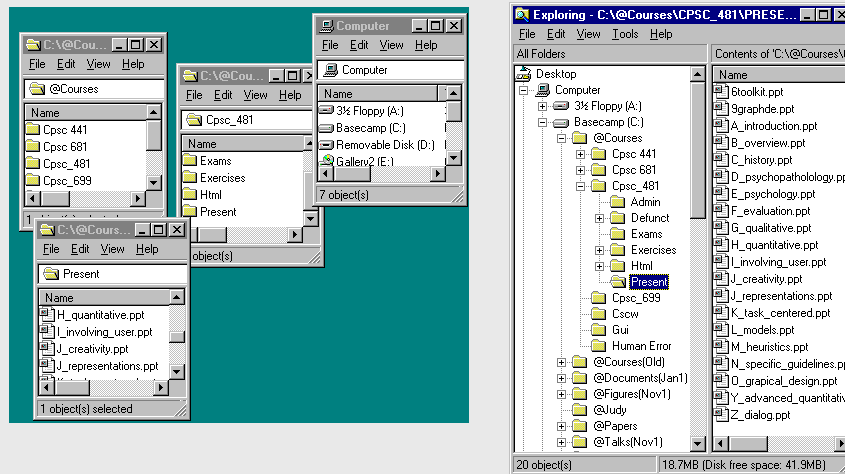
Where am I? (Geographic Navigation)

Detailed navigation plus precision

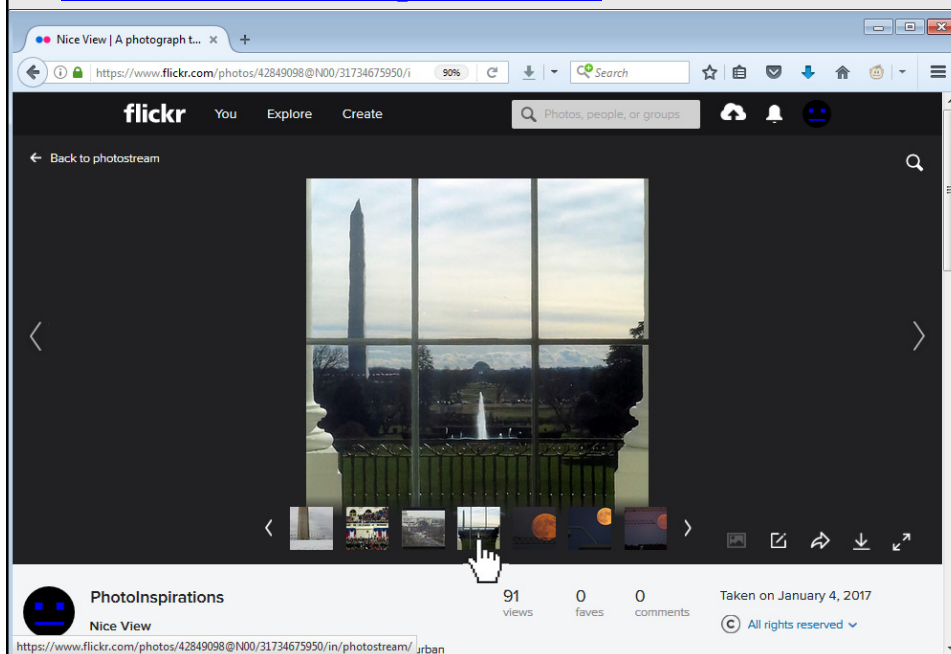


General navigation plus orientation

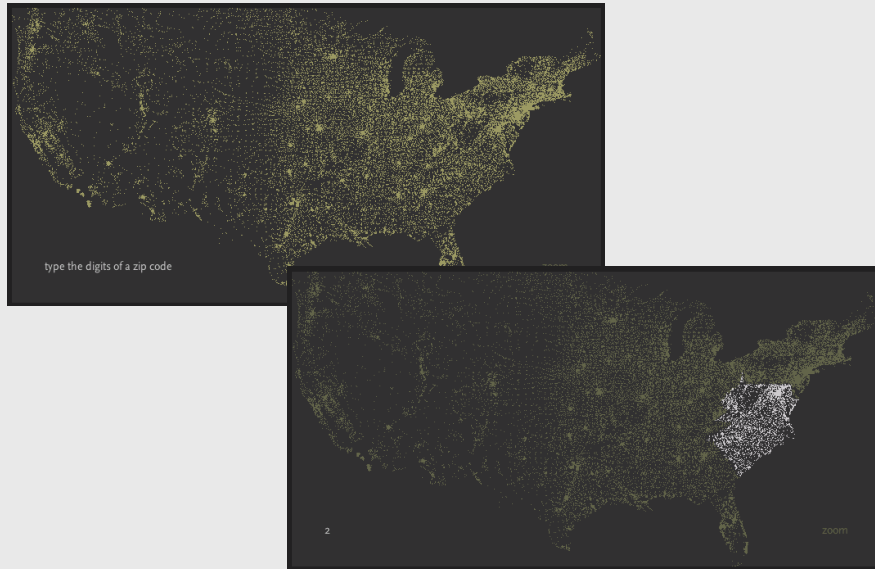
Where am I? (File System Navigation)



Where am I? (Detail plus context)

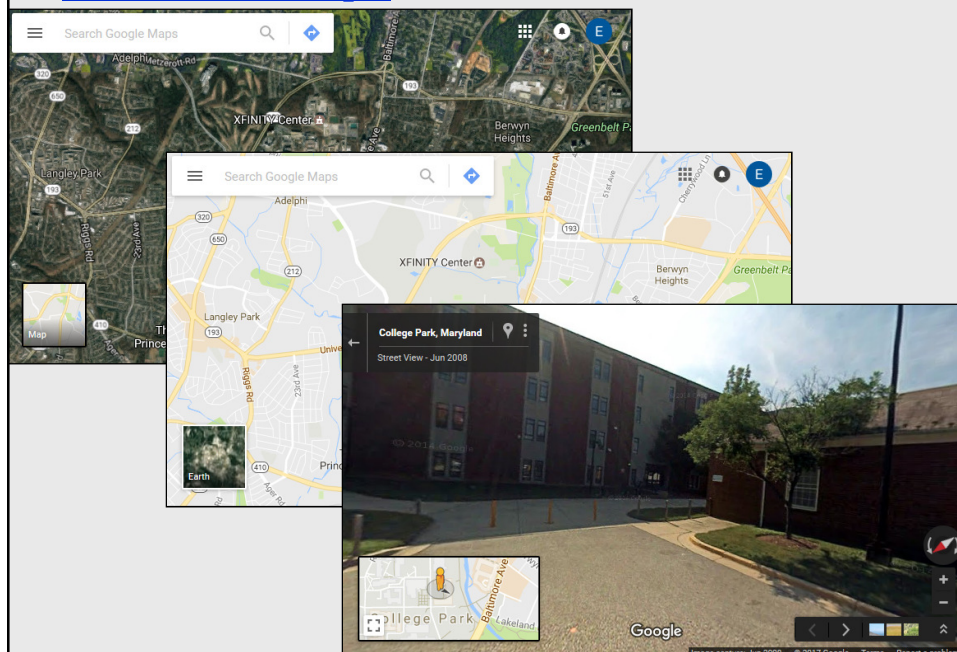


Where am I? (Revealing Patterns Interactively)

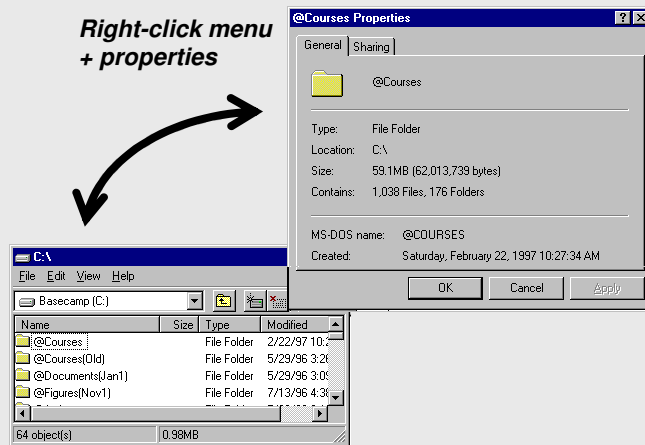


<http://acg.media.mit.edu/people/fry/zipdecode/>

Where am I? (maps)

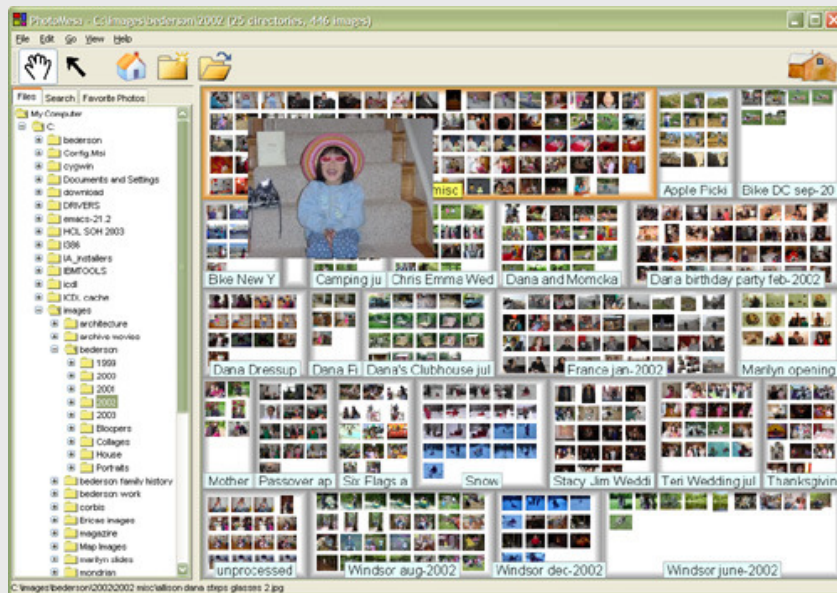


Which folder has the most documents or largest size?



Why can't I sort folders by size like I can sort files by size?

Which folder has the most photos?



Which folder has the most bytes of photos?

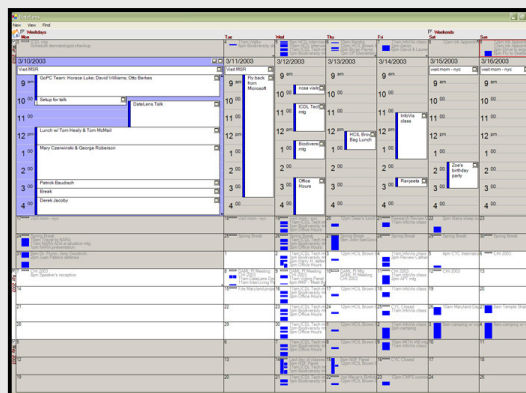
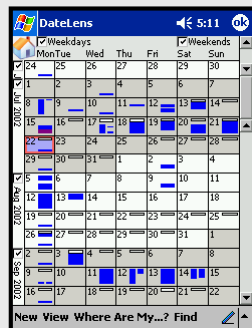
TreeSize Free - C:\MyPictures\ on [Windows7_OS] - V3.3.2 (outdated)

File Scan View Expand Options Help TreeSize Professional

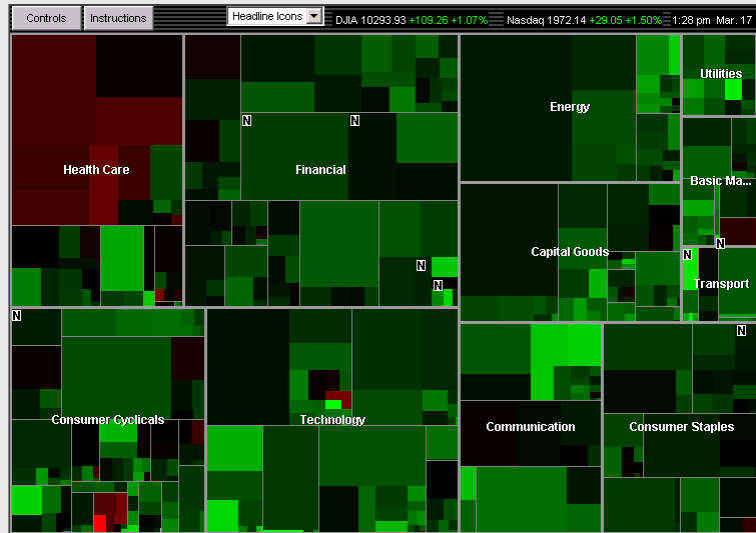
Name	Size	Allocated	Files	Folders	% of Paren...	Last Cha
310.6 GB C:\MyPictures\ on [Windows7_OS]	310.5 GB	310.6 GB	36,795	1,901	100.0 %	4/6/2
171.8 GB _40D Camera Pics	171.7 GB	171.8 GB	14,084	749	55.3 %	4/3/2
52.9 GB _FIA-CanonSX50	52.9 GB	52.9 GB	1,869	177	17.0 %	4/2/2
23.0 GB _FZ30 Camera Pics	23.0 GB	23.0 GB	5,931	219	7.4 %	8/14/
12.2 GB _Thetas	12.2 GB	12.2 GB	1,628	17	3.9 %	4/2/2
12.0 GB _HCIL-Canon Camera Pics	12.0 GB	12.0 GB	1,348	65	3.9 %	3/8/2
9.1 GB _S50 Camera Pics	9.1 GB	9.1 GB	2,585	103	2.9 %	3/15/
4.2 GB _PresidentialInauguration2017	4.2 GB	4.2 GB	305	6	1.4 %	3/19/
3.5 GB _KodakPixPro	3.5 GB	3.5 GB	19	3	1.1 %	11/28
3.5 GB Panoramas	3.5 GB	3.5 GB	635	29	1.1 %	8/14/
2.5 GB Fireworks	2.5 GB	2.5 GB	1,274	21	0.8 %	1/12/
1.9 GB _CheapCameras	1.9 GB	1.9 GB	1,637	94	0.6 %	9/13/
1.7 GB _NikonKeyMission360	1.7 GB	1.7 GB	99	10	0.6 %	4/4/2
1.6 GB _Lytro	1.6 GB	1.6 GB	314	89	0.5 %	7/25/
1.3 GB _HCIL-Kodak Camera Pics	1.3 GB	1.3 GB	397	16	0.4 %	8/14/
1.3 GB FlashTests	1.3 GB	1.3 GB	676	36	0.4 %	8/14/
1.3 GB _D30	1.3 GB	1.3 GB	497	18	0.4 %	10/30
1.2 GB Lighting102	1.2 GB	1.2 GB	503	44	0.4 %	2/27/
1.1 GB _20D	1.1 GB	1.1 GB	192	18	0.4 %	4/6/2
956.5 MB KEAQ	956.1 MB	956.5 MB	215	9	0.3 %	8/14/
635.4 MB _D5000-2010	635.3 MB	635.4 MB	116	3	0.2 %	3/15/

Free Space: 44.9 GB (of 465 GB) 36,795 Files 4096 Bytes per Cluster (NTFS)

What do I have to do?



What stock is doing best?

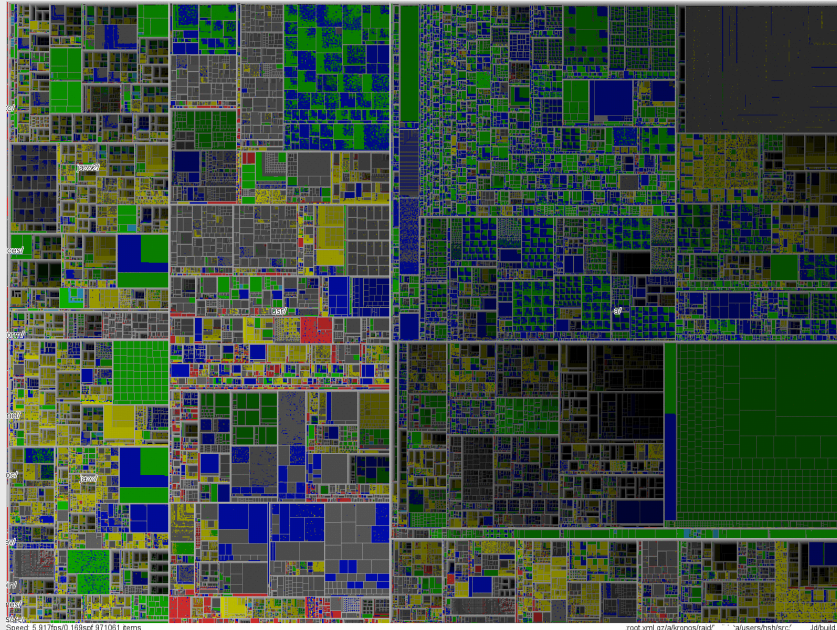


Historic snapshot from <http://www.smartmoney.com/marketmap/>

Current site using similar idea:

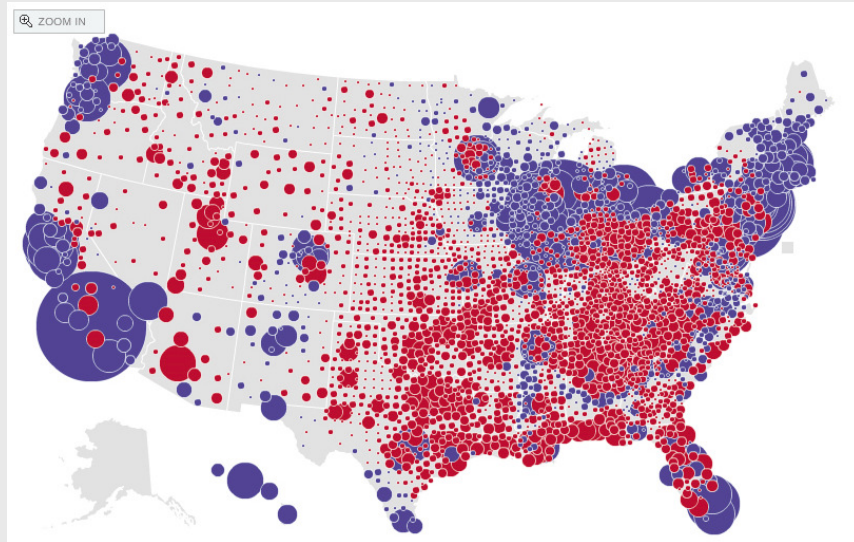
<https://research.capitaloneinvesting.com/Research/main/Stock-Market/Heatmap>

Which folder is using the most drive space?



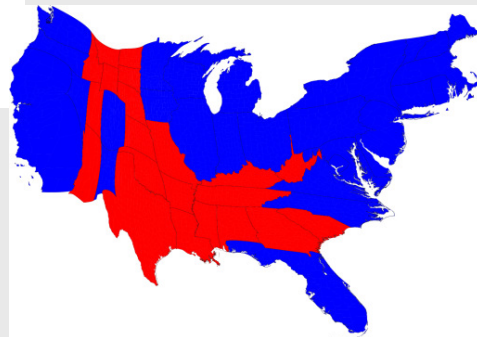
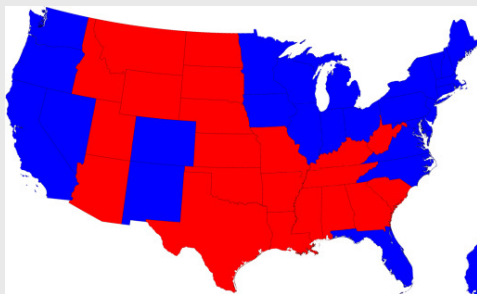


Who won the 2008 Presidential elections, by how much?



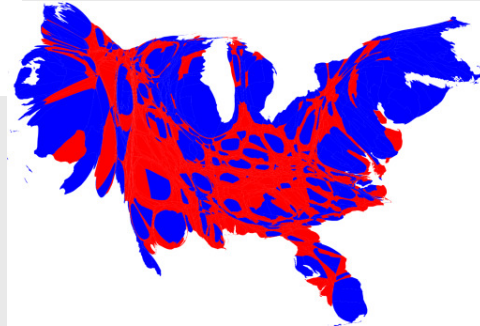
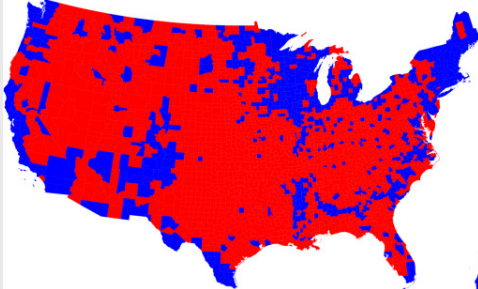
Who won the 2008 Presidential elections, by how much?

By state...



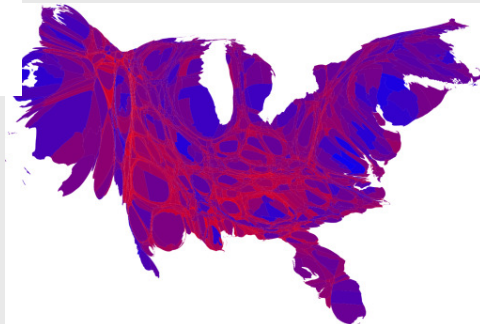
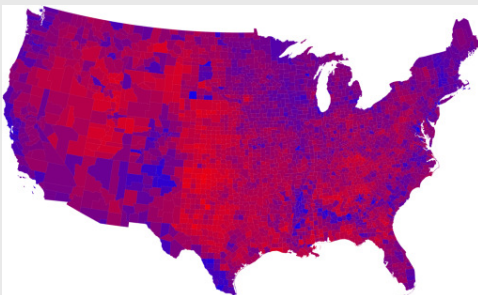
Who won the 2008 Presidential elections, by how much?

By county...

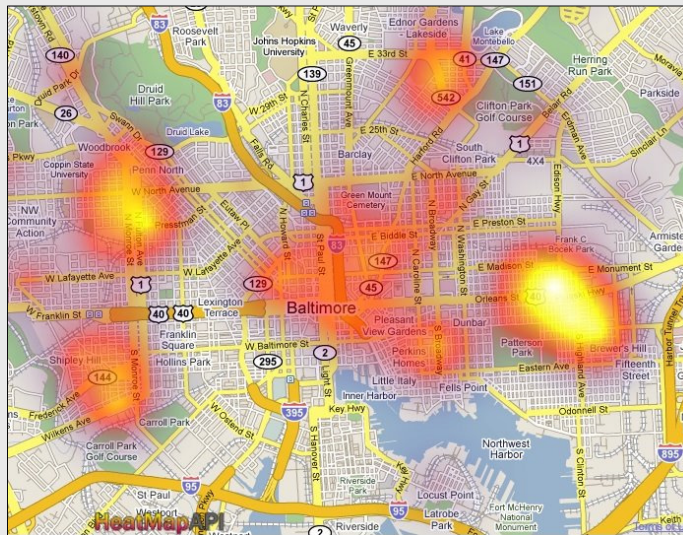


Who won the 2008 Presidential elections, by how much?

By percentage...



Where are the most shootings in Baltimore?



<https://spotcrime.files.wordpress.com/2009/03/baltimoreshootingsheatmap.jpg>

Information Visualization

Graphics should reveal the data...

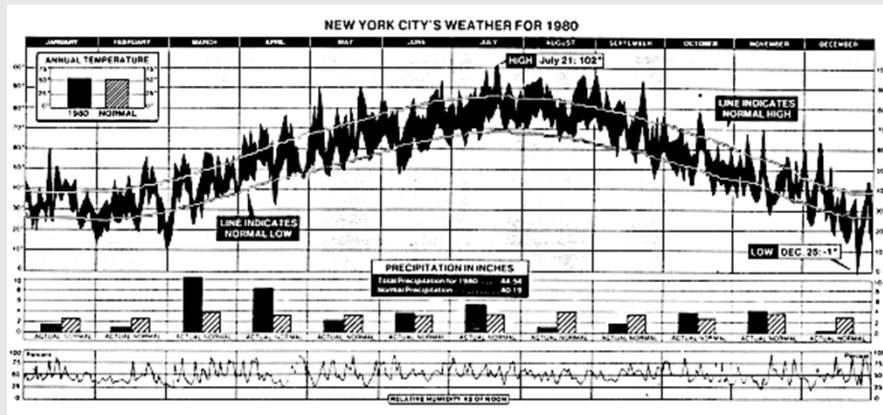
- show the data
- not get in the way of the message
- avoid distortion
- present many numbers in a small space
- make large data sets coherent
- encourage comparison between data
- supply both a broad overview and fine detail
- serve a clear purpose

Note: many visual examples on the following slides are taken from Tufte's books such as Visual Display of Quantitative Information

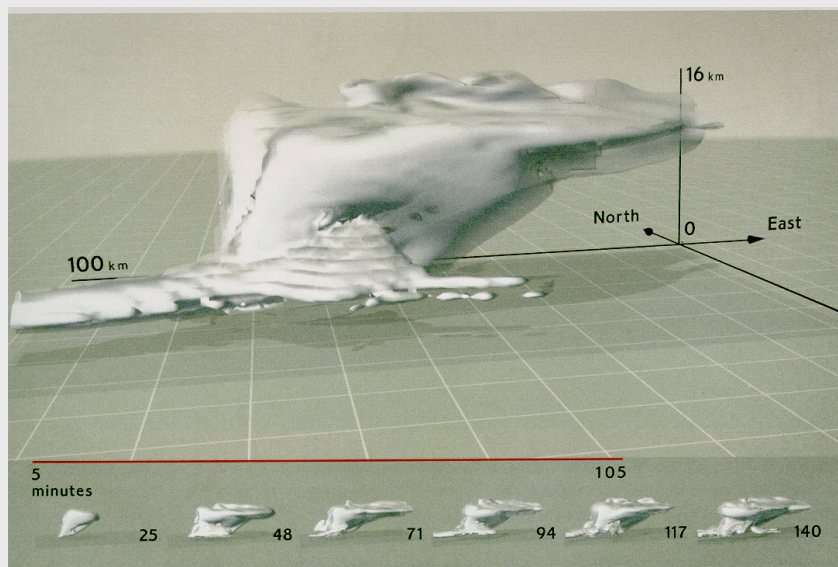
Data Density

New York Weather History

- 181 numbers/sq inch



Small Multiples: Showing Time and Change



Data Ink & Chart Junk: A common error

Information display is not *just* pretty graphics

graphical re-design by amateurs on computers can give us things like “fontitis” and “chart-junk” in visuals

Dear Sir,

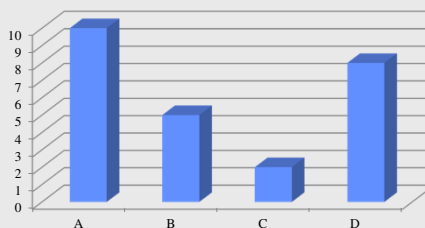
There is a ***really exciting*** opportunity!

Will you take advantage of it ?

Average

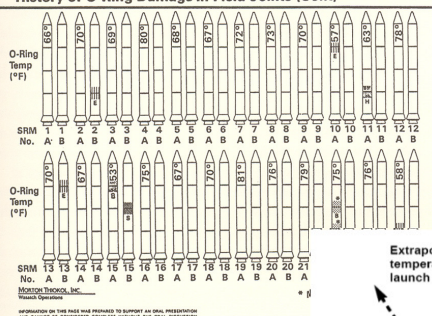


Average



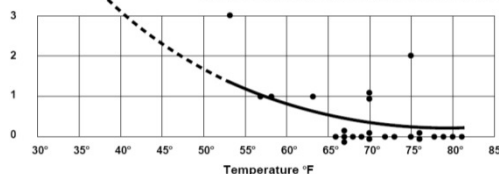
Showing the Right Data: Challenger

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



Extrapolation of damage curve to the 31° F temperature forecast for Challenger's launch on January 28, 1986.

Dots indicate temperature and O-ring damage for 24 successful launches prior to Challenger. Curve shows that increasing damage is related to cooler temperature.



Interaction

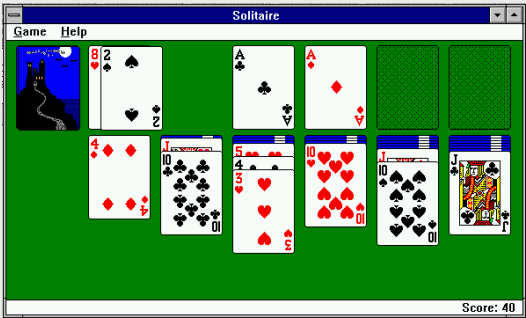
If a picture is worth a thousand words, then an interactive visualization is worth a thousand pictures.....

Metaphors (I)

Pervade excellent interfaces

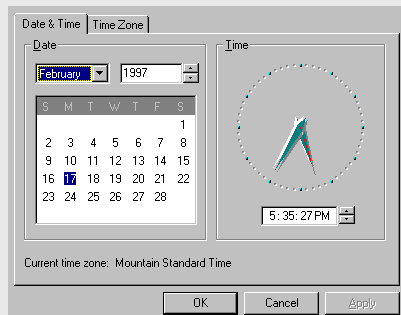
	A	B	C	D
1	Market value	Land	Improvement	Total assess
2	140.0	65,850.	73,120.	138,970.
3	147.0	77,780.	72,070.	149,850.
4	151.0	74,850.	88,740.	163,590.
5	152.0	80,110.	99,410.	179,520.
6	155.0	79,050.	109,130.	188,180.
7	170.0	94,750.	50,960.	145,710.
8	172.0	82,150.	106,250.	188,400.
9	178.0	78,560.	132,660.	211,220.
10	180.0	92,840.	105,670.	198,510.
11	180.0	80,090.	103,130.	183,220.
12	182.0	76,650.	115,210.	191,860.
13	185.0	75,590.	152,710.	228,300.
14	185.0	85,870.	105,330.	191,200.
15	185.0	80,060.	113,600.	193,660.
16	193.4	80,140.	131,340.	211,480.
17	194.5	73,400.	176,210.	249,610.
18	197.0	84,960.	129,800.	214,760.
19	203.0	91,600.	119,170.	210,770.
20	205.0	79,460.	137,250.	216,710.
21	213.0	87,060.	124,350.	211,410.
22	221.0	97,330.	167,500.	264,830.
23	225.0	87,160.	157,290.	244,450.
24	245.0	79,520.	144,840.	224,360.
25	248.0	89,470.	183,500.	272,970.
26	278.0	82,150.	168,720.	250,870.
27	302.5	118,500.	109,800.	228,300.
28	308.0	65,100.	141,730.	224,830.

spreadsheet (actuary sheet)



games (literal world)

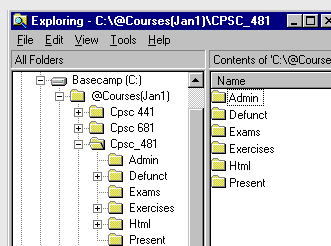
Metaphors (II)



Control Panels with familiar controls from non-digital tech.

Name: _____
Address: _____
City: _____
Province: _____
Postal Code: _____

Forms



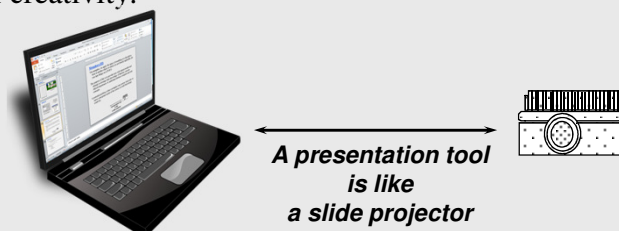
Hierarchical Folders

Metaphors (III)

Via metaphor, we apply the name of something or a descriptive term to another object to which it is not literally applicable (do you tape things on a DVR?).

The purpose of this is to provide users with natural models and attempt to leverage their knowledge of familiar, concrete objects/experiences to understand abstract computer and task concepts.

A potential problem is that a metaphor may portray an outdated or inaccurate or naive conceptual model of the system or could limit design creativity.



Generating Metaphors

Use metaphors that matches user's conceptual task

- desktop metaphor for office workers
- paintbrush metaphor for artists...

Ensure emotional tone is appropriate to users

file deletion metaphor possible options:

trashcan
black hole
paper shredder
recycle bin
furnace

Given a choice, choose the metaphor close to the way the system works...

Evaluating Metaphors

Consider probable consequences

- will metaphor restrict what people could actually do?
eg: strict file/folder hierarchy vs system allows links between directories
- will metaphor believe that people can do more than what is possible?
eg: agent-based systems, Eliza...

Consider how metaphors can evolve

is metaphor extensible to new features?
when is the metaphor no longer useful?

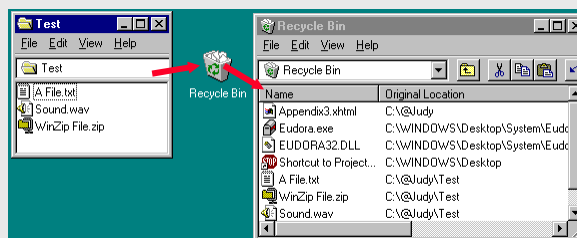
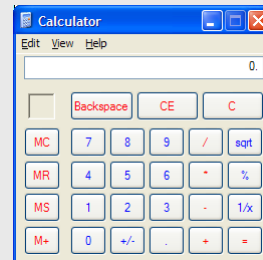
Overdoing Metaphors

Caveat

- metaphors can be overdone!

Common pitfalls

- overly literal
 - unnecessary fidelity
 - excessive interactions
- overly cute
 - novelty quickly wears off
- overly restrictive
 - cannot move beyond
- mismatched
 - does not match user's task and/or thinking



Direct Engagement & Direct Manipulation

Direct Engagement

- the feeling of working *directly* on the task

Direct Manipulation

- An interface that behaves as though the interaction was with a real-world object rather than with an abstract system

Central ideas

- visibility of the objects of interest
- rapid, reversible, incremental actions
- manipulation by pointing and moving
- immediate and continuous display of results

Almost always based on a metaphor

- mapped onto some facet of the real world task semantics

Direct Engagement

**Xerox Star: pioneered in late 70's and early '80s
=copied by almost everyone=**

simulates desktop with icons

- in and out baskets
- file folders and documents
- calculators
- printers
- blank forms for letters and memos

small number of generic actions applicable system wide

- move, copy, delete, show properties, again, undo, help
 - eg same way to move text, documents, etc
- property sheets
 - pop-up form, alterable by user

what you see is what you get (WYSIWYG)

Xerox Star continued

Star's observations:

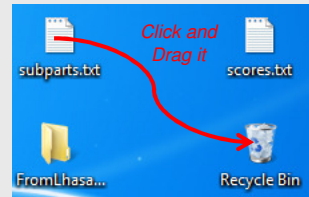
- objects understood in terms of their visual characteristics
 - affordances, constraints
- actions understood in terms of their effects on the screen
 - causality
- intuitively reasonable actions can be performed at any time
 - conceptual model

***A subtle thing happens when everything is
visible:
the display becomes reality***

Object-Action

Select object, *then* do action

interface emphasizes 'nouns' (visible objects) rather than 'verbs' (actions)



Advantages

closer to real world

modeless interaction

actions always within context of object

–inappropriate ones can be hidden

generic commands

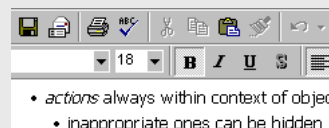
–the same type of action can be performed on the object

–eg drag 'n drop folders, files, paragraphs, text, numbers...

Action-Object

Select action, then, pick object

interface emphasizes 'verbs' (actions) rather than 'nouns' (visible objects)



Advantages

- Pick a setting and then you can reuse it easily.
- Often more efficient for user.

Touch- and Penabled- Screens and Sensors

Direct manipulation can be even MORE direct in the age of touch and penabled screens...

What new metaphors are available? How does the line between science and magic blur as we interact with information in some software on these devices?

What things in reality can you stretch with your fingers? What about on your tablet?

Evan Golub / Ben Bederson / Saul Greenberg

Is direct manipulation the way to go?

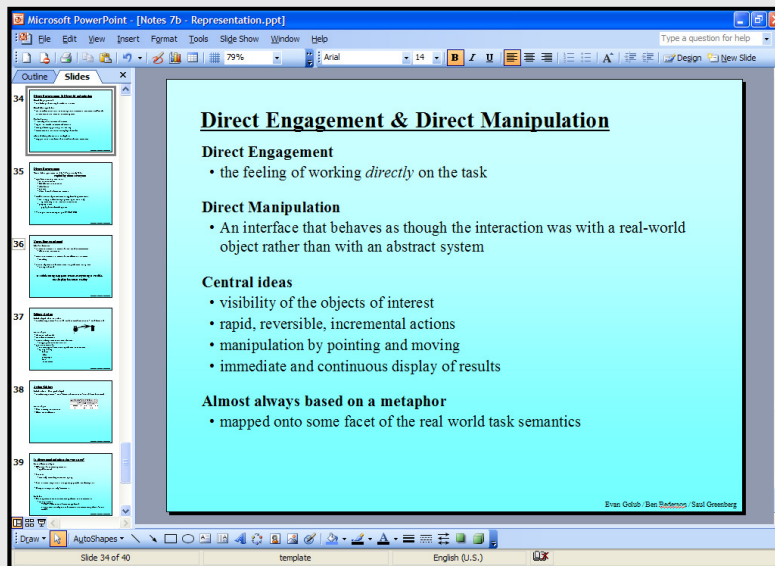
Some potential disadvantages...

- Ill-suited for abstract operations
 - spell-checker?
- Tedium
 - manually search large database vs doing a basic query
- Task domain may not have adequate physical/visual metaphor
- Metaphor may be overly-restrictive

Solutions? Most systems will combine direct manipulation and abstractions...

for example, a typical word processor application
WYSIWYG document (direct manipulation)
buttons, menus, dialog boxes (abstractions, but direct manipulation “in the small”)

Conventional Applications: A Mix



Quick Recap (not exhaustive)

Good Representations

- captures essential elements of the event / world
- deliberately leaves out / mutes the irrelevant
- appropriate for the person, their task, and their interpretation

Metaphors

- uses our knowledge of the familiar and concrete to represent abstract concepts
- need not be literal
- has limitations that must be understood

Direct manipulation

- visibility of the objects of interest
- rapid, reversible, incremental actions
- manipulation by pointing and moving
- immediate and continuous display of results
- action-object **-versus-** object-action

These three components are the foundation of a true Visual Interface

Closing Thoughts...

"If a picture is worth 1000 words, then an interface is worth 1000 pictures."

Keep user tasks and goals in mind.

Encourage exploration but don't overwhelm the users.

Overview, zoom, filter, details on demand.