CSE 332
Introduction to Visualization

Visual Analytics & The Visual Sense Making Process

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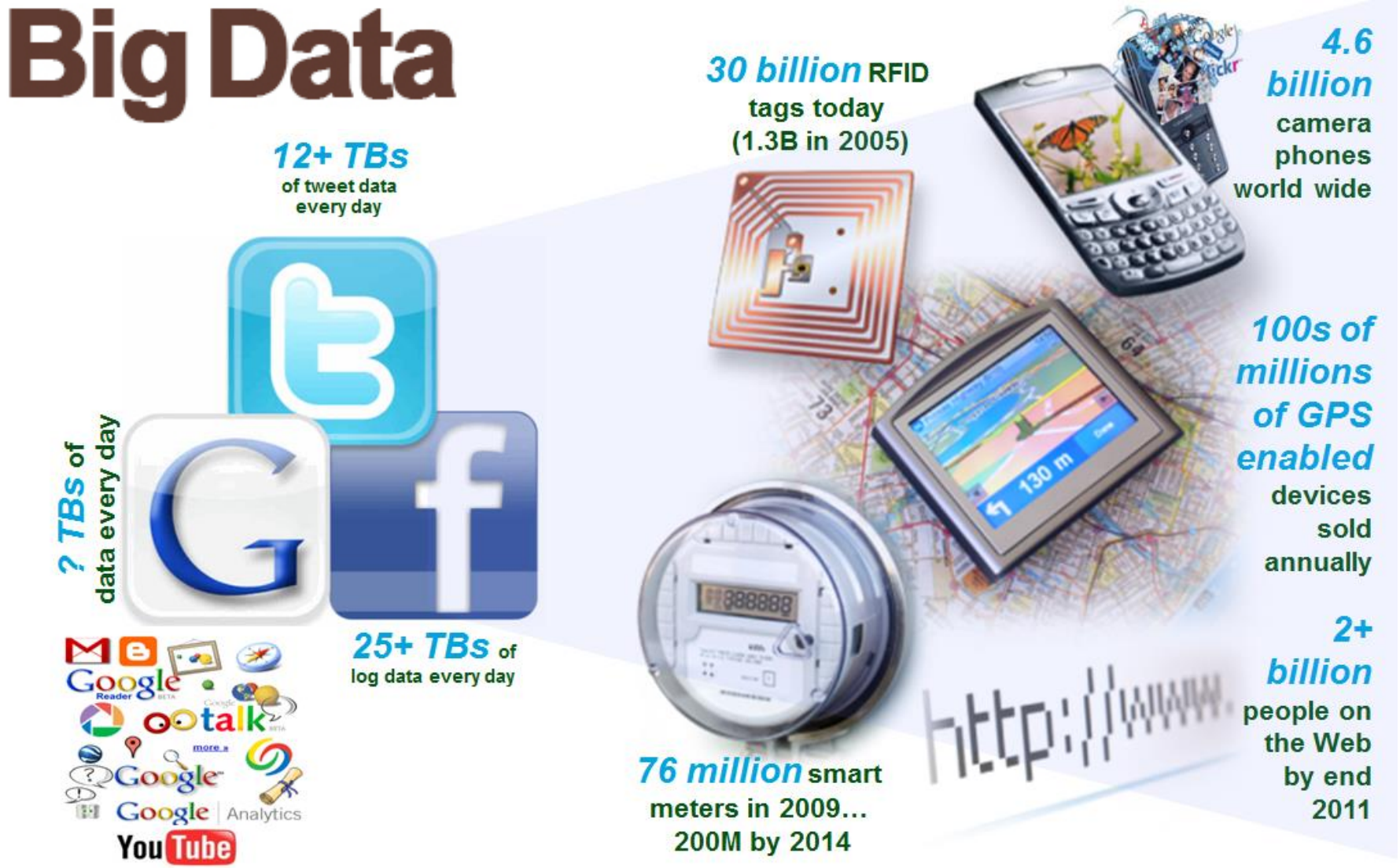
Lecture	Topic	Projects
1	Intro, schedule, and logistics	
2	Applications of visual analytics, data, and basic tasks	
3	Data preparation and reduction	Project 1 out
4	Data preparation and reduction	
5	Data reduction and similarity metrics	
6	Dimension reduction	
7	Introduction to D3	Project 2 out
8	Bias in visualization	
9	Perception and cognition	
10	Visual design and aesthetics	
11	Cluster and pattern analysis	
12	High-Dimensional data visualization: linear methods	
13	High-D data vis.: non-linear methods, categorical data	Project 3 out
14	Principles of interaction	
15	Visual analytics and the visual sense making process	
16	VA design and evaluation	
17	Visualization of graphs and hierarchies	
18	Visualization of time-varying and time-series data	Project 4 out
19	Midterm	
20	Maps and geo-vis	
21	Computer graphics and volume rendering	
22	Techniques to visualize spatial (3D) data	Project 4 halfway report due
23	Scientific and medical visualization	
24	Scientific and medical visualization	
25	Non-photorealistic rendering	
26	Memorable visualizations, visual embellishments	Project 5 out
27	Infographics design	
28	Projects Hall of Fame demos	

Why Visual Analytics?



Visual Analytics

Problems With Scalability

Must be scalable to

- number of data points
- number of dimensions
- data sources
- diversity of data sources (heterogeneity)
- number of users
- diversity of users and tasks
- quality of the data

Visual Analytics comes to the rescue…

The Goal of Visualization

Ease understanding of the data by providing an effective visual representation

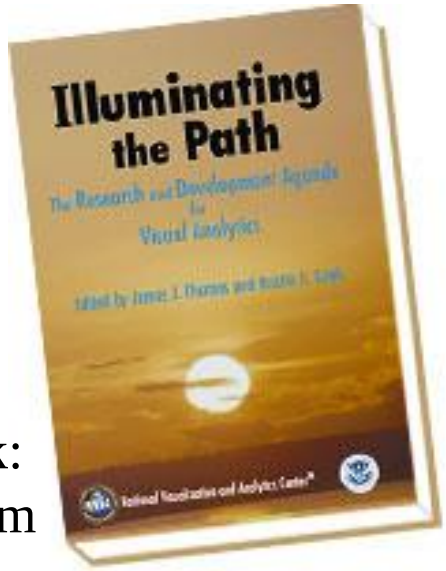
Amplify Perception

Detect the Expected, Discover the Unexpected™

What is Visual Analytics

Visualization plus…

- interaction (HCI)
- data processing (analytics)
- story telling
- scientific approach



Agenda setting book:
http://nvac.pnl.gov/agenda.stm

but also…

- intelligent computing (AI, machine learning)
- behavioral psychology (cognitive science, human factors)

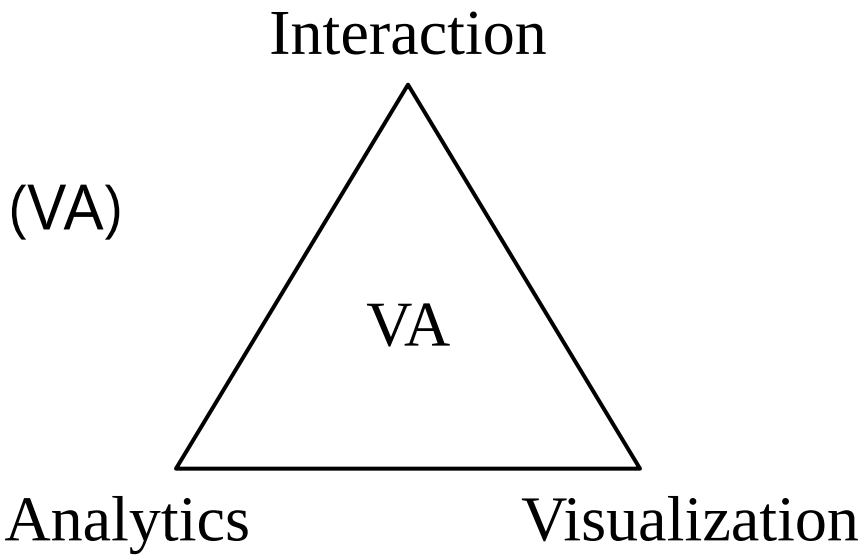
Visual Analytics is the science of analytical reasoning supported by a highly interactive visual interface

Visual Analytics Paradigm

The Daniel Keim Mantra of Visual Analytics

“Analyze First - Show the Important –
Zoom, Filter and Analyze Further -
Details on Demand"

The triangle of Visual Analytics (VA)



Intelligence Analysis

Intelligence analysis is challenging

Huge amounts of data

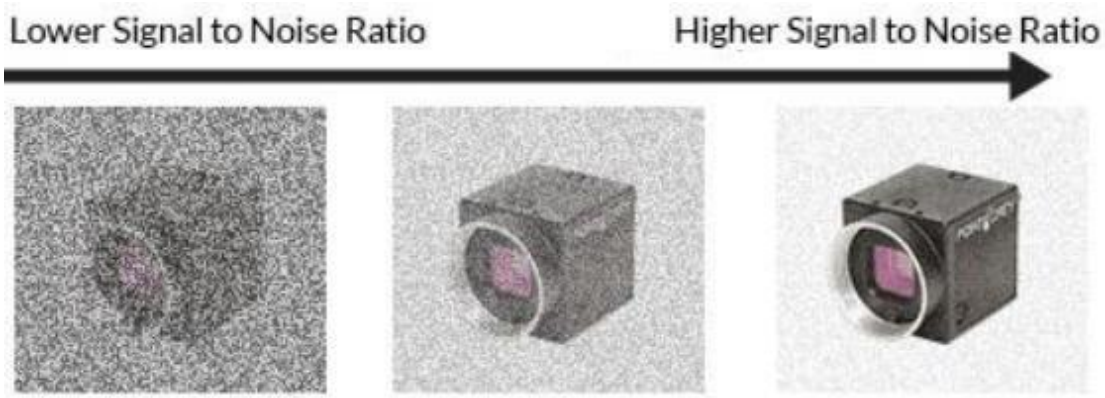
Many data type: text, images, video, sensor data, etc.

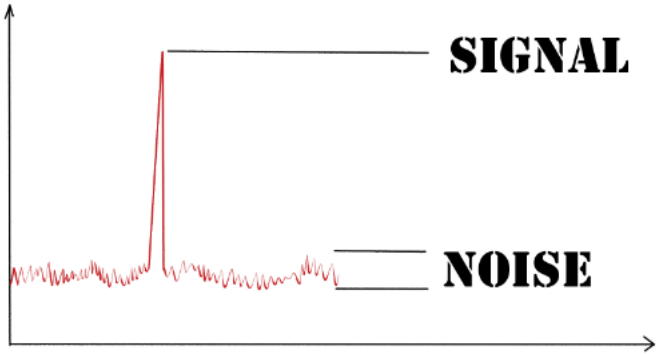
Uncertainty

Contradictions

Omissions

Low signal to noise ratio (SNR)





Use of Visualization

Visual perception

- high bandwidth
- fast screening of a lot of data
- pattern recognition
- higher-level cognition

Interaction

- direct manipulation
- two-way communication

Recall intro lecture on the human visual system…

Use of Visualization

Visual perception

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Recall intro lecture on the human visual system…

But… humans are imperfect

Humans Are Imperfect

Humans tend to overlook/ignore non-focus (and unexpected) objects even when very close and obvious

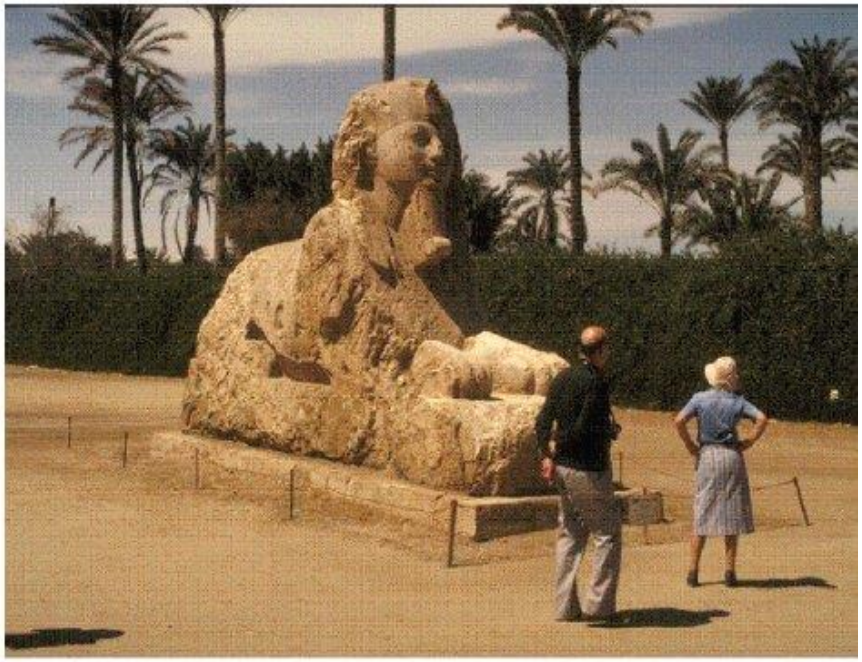
- note the Visual Analytics slogan: *Detect the Unexpected*

Humans also have limited working memory

- fine details are quickly forgotten when focus changes
- big effect in animated or interactive visualizations
- need to preserve temporal context

Example #1

Spot a difference?



This is called change blindness

Example #2

In this video you will do some counting.

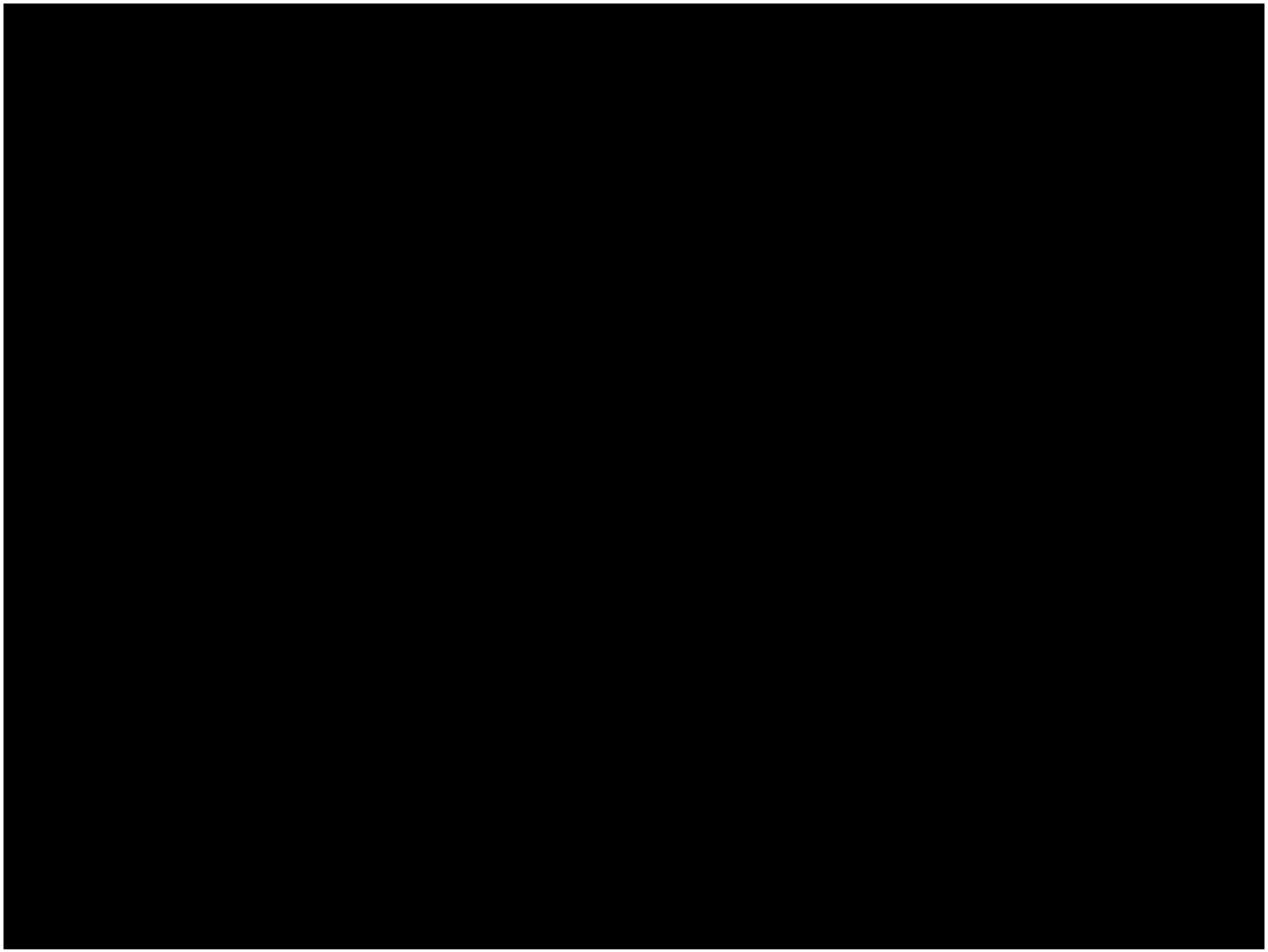
It is very important that you get the right number!

Ready?

YouTube

Video by Dan Simons (U Illinois)

Attention Experiment



Example #3

Another distraction experiment

YouTube

Video by Dan Simons (U Illinois)

Distraction Experiment

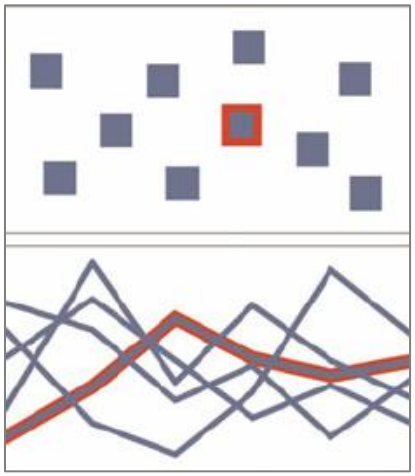
Change Blindness

Thoroughly studied by Dan Simons (U Illinois)

- see http://www.dansimons.com/index.html

Visual Analytics tools

- help human analysts cope with insufficient memory
  → visualizations externalize memory
  → allow humans to perform *visual queries* (see C. Ware book)
- help human analysts deal with change blindness
  → analytics can detect changes
  → visualization can highlight/emphasize these changes
- we have seen many visual tools this semester
  → this lecture is more about strategy building



Human Limitations

The Magic Number Seven

- ± 2 : the number of things most people can keep in working memory at one time
- famous paper by George A. Miller (1956)
- channel capacity 2.5 bits
- applies to letters, sounds, shapes, colors, etc.
- causes problems for complicated analysis

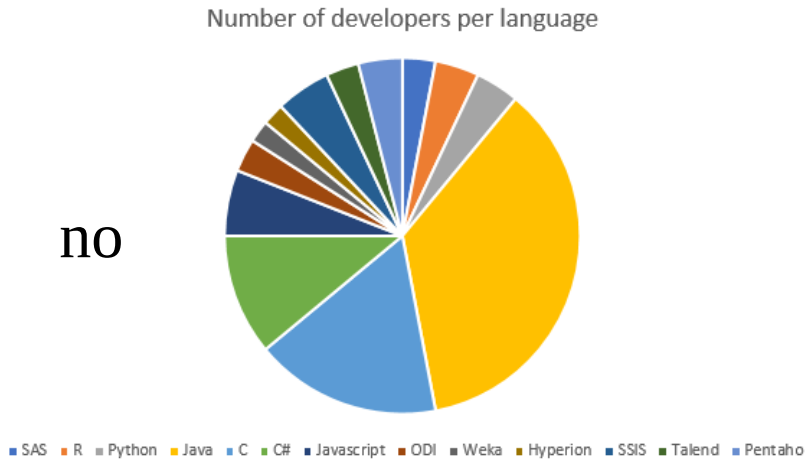
- reduce the problem by chunking
- words (vs. letters), bytes (vs. bits), clusters (vs. points), categories (vs. individual elements(), ….
- hierarchical decomposition, multi level of detail

Human Limitations

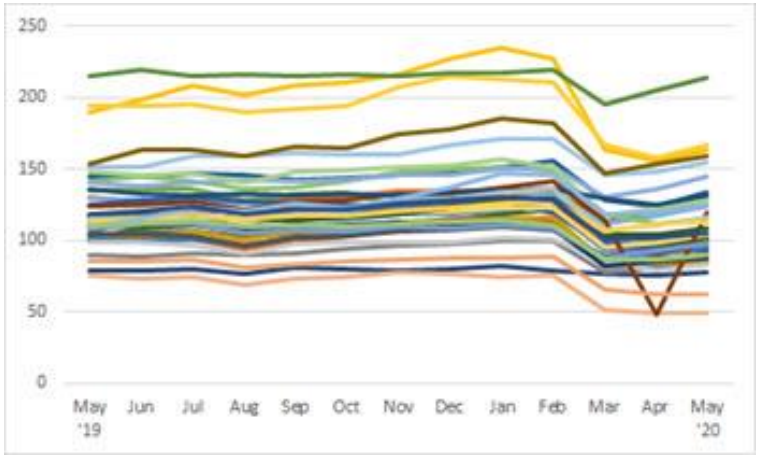
The Magic Number Seven (7) for visualization

- not more than 7 segments in a pie chart
- not more than 7 colors in a line chart
- and so on

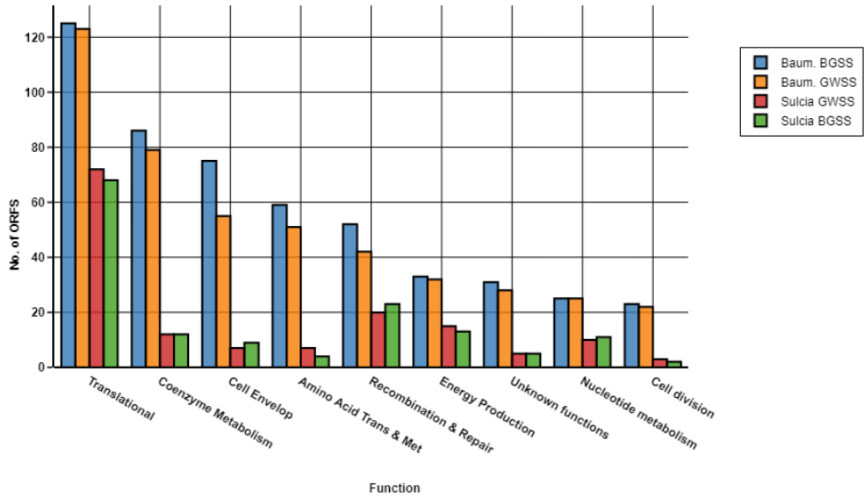
no



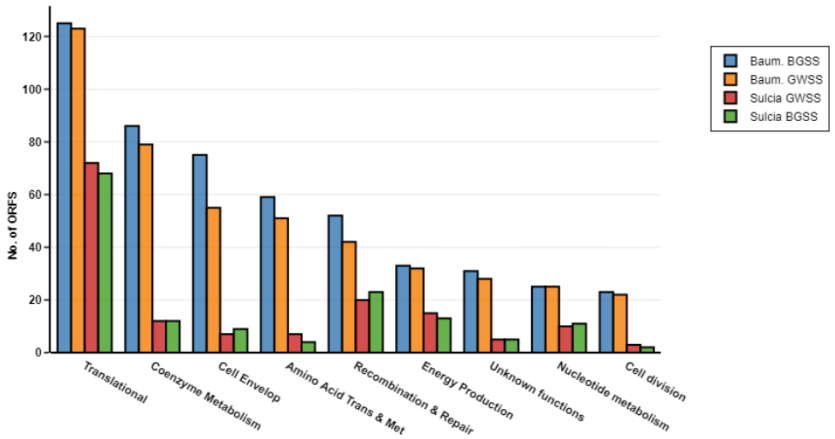
no



Visual Complexity



do I need these grid lines?



maybe not

"Perfection is achieved not when there is nothing more to add, but when there is nothing left to take away."

— Antoine de Saint-Exupery.

Strategies for Dealing with Complexity

Decomposition

- decompose a complex problem into simpler problems
- get your thinking straight in these simpler problems

Externalization

- get the decomposed problem out of your head and down on paper or on a computer screen in some simplified form
- show the main variables, parameters, or elements of the problem and how they relate to each other

Recall principles of information visualization

- overview and detail
- focus and context
- analyze, filter, zoom,…

200 Years Ago… Ben Franklin's Letter

Mentioned his method of solving decision problems

Why is the decision problem so difficult?

- folks cannot keep all pros and cons in mind at the same time

Solution?

- write down all the pros and cons onto paper in some visible, shorthand form
- allows you make a global judgment effectively

The Sense-Making Loop

Support visualization with computations for data processing

Form a loop: visualize - refine

Gather (forage) information

Re-represent

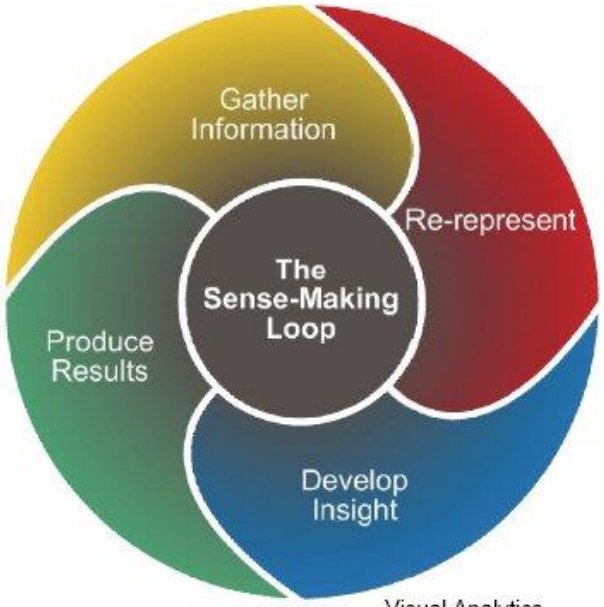
- choose a form that aids analysis

Develop insight

- through manipulation of representations

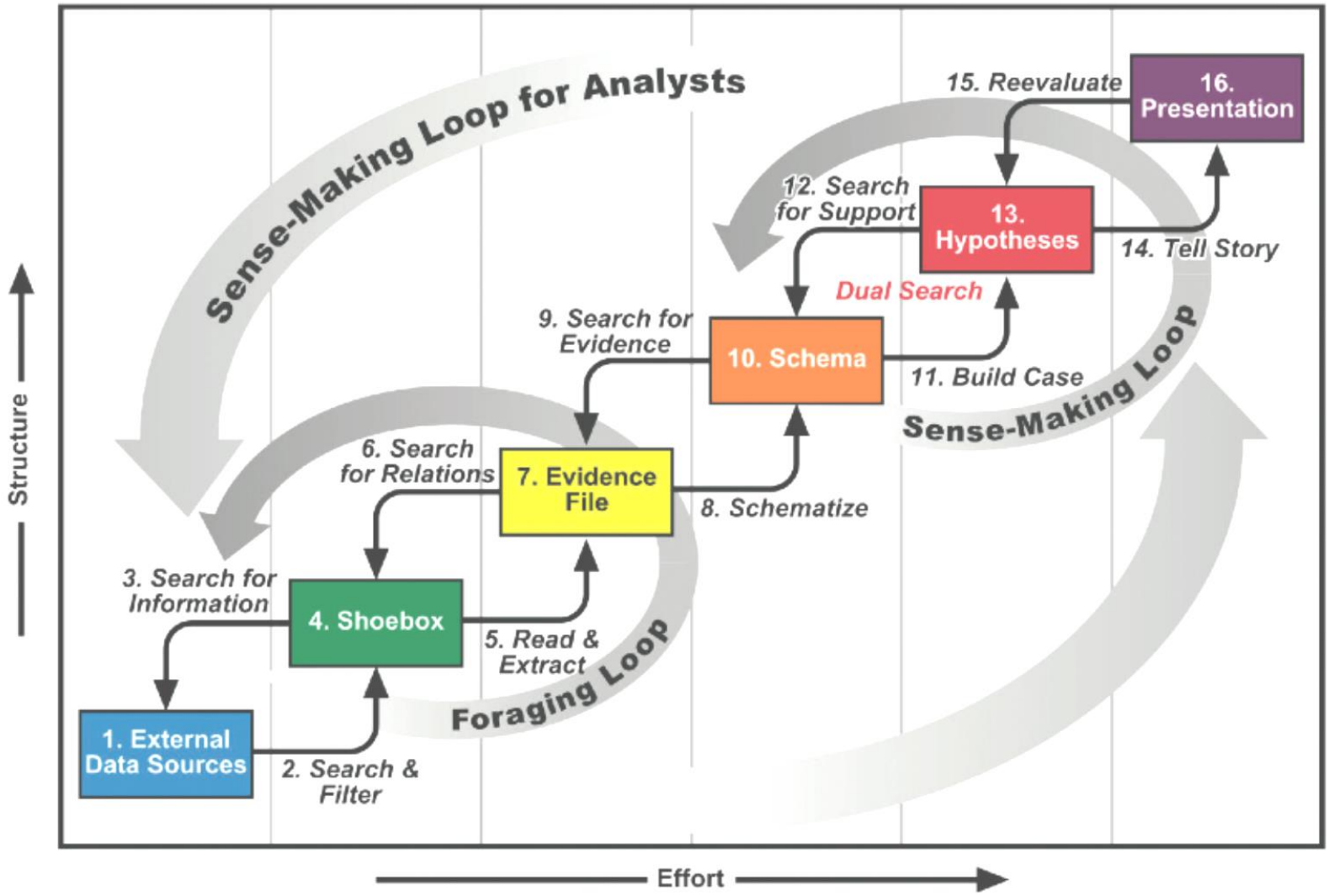
Produce results

- "product"



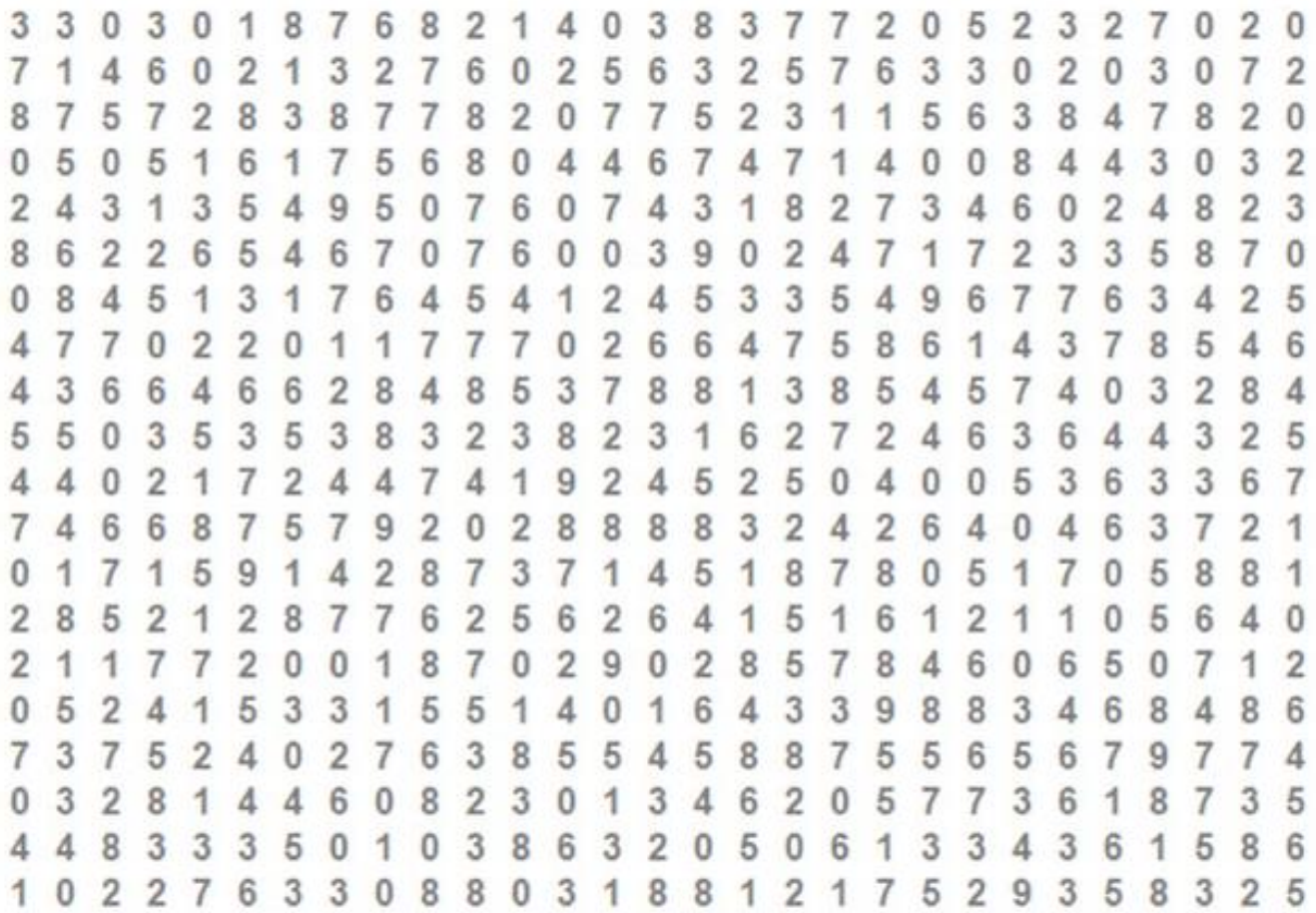
Visual Analytics
http://www.viscenter.uncc.edu/courses/visanalytics.html

Nominal Sense-Making Process

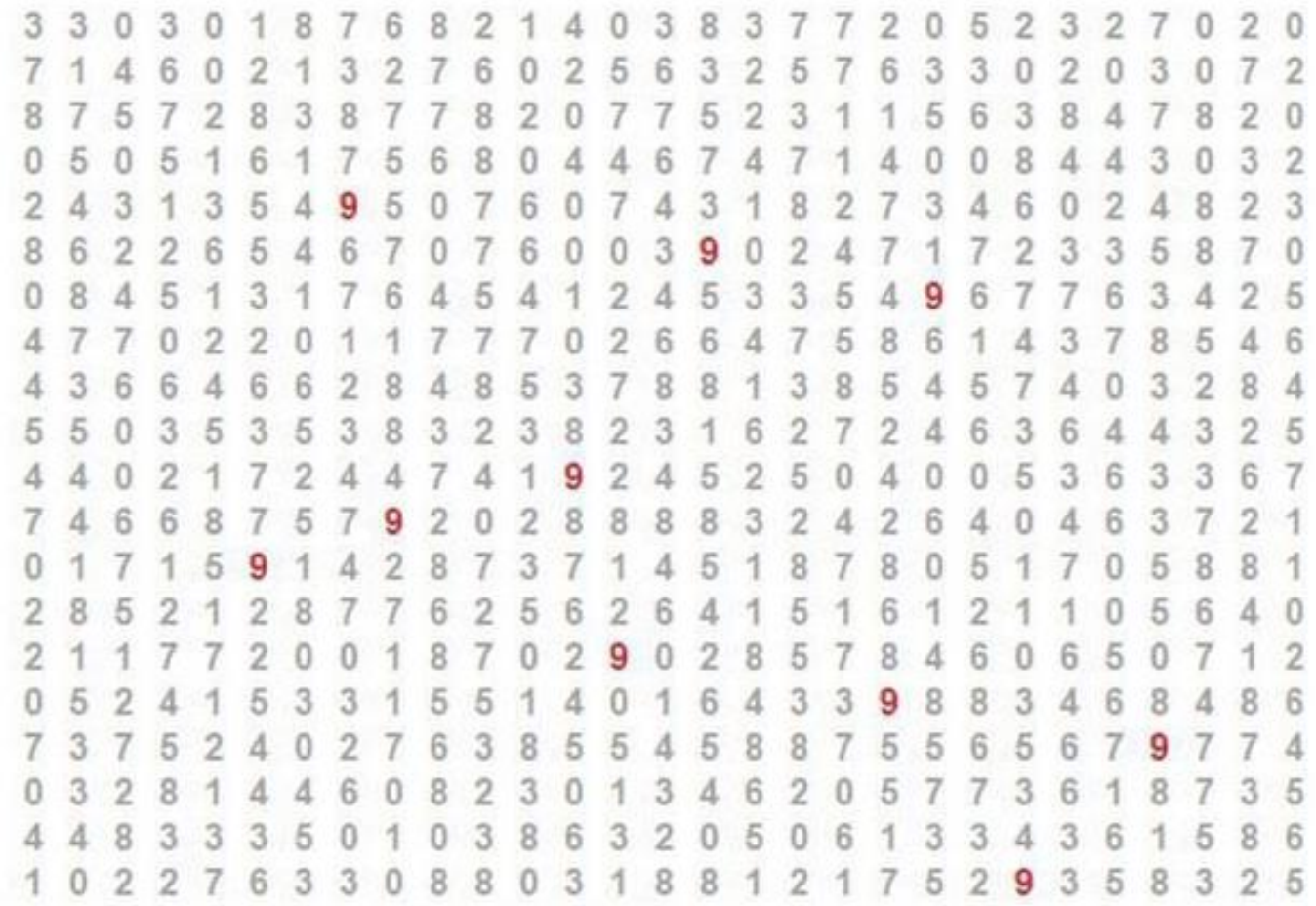


Use Visualizations to Evoke The Right Thoughts

How Many 9s Do You See?



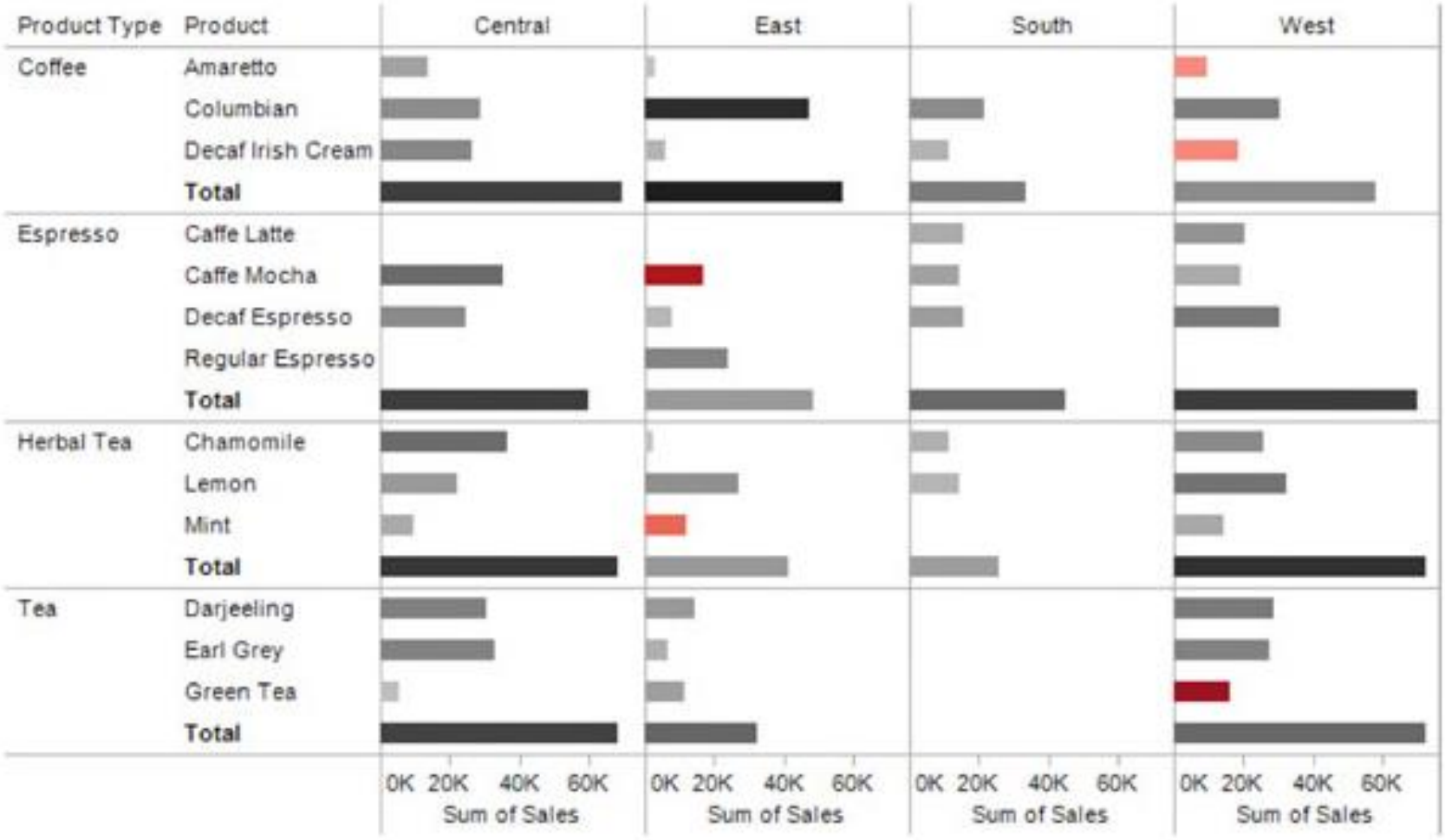
How Many 9s Do You See?



Who has the best profit and who has the worst sales?

		Central		East		South		West	
Product Type	Product	Sum of Profit	Sum of Sales	Sum of Profit	Sum of Sales	Sum of Profit	Sum of Sales	Sum of Profit	Sum of Sales
Coffee	Amaretto	$5,105	$14,011	$1,009	$2,993			($1,225)	$9,265
	Columbian	$8,528	$28,913	$27,253	$47,386	$8,767	$21,664	$11,253	$30,357
	Decaf Irish Cream	$9,632	$26,155	$2,727	$6,261	$2,933	$11,592	($1,305)	$18,235
	Total	$23,265	$69,080	$30,989	$56,640	$11,700	$33,256	$8,724	$57,856
Espresso	Caffe Latte					$3,872	$15,442	$7,502	$20,458
	Caffe Mocha	$14,640	$35,218	($6,230)	$16,646	$5,201	$14,163	$4,064	$18,876
	Decaf Espresso	$8,860	$24,485	$2,410	$7,722	$5,930	$15,384	$12,302	$30,578
	Regular Espresso			$10,062	$24,036				
	Total	$23,500	$59,703	$6,242	$48,405	$15,003	$44,989	$23,868	$69,911
Herbal Tea	Chamomile	$14,434	$36,570	$765	$2,194	$3,180	$11,186	$8,852	$25,632
	Lemon	$6,251	$21,978	$7,901	$27,176	$2,593	$14,497	$13,120	$32,274
	Mint	$4,069	$9,337	($2,242)	$11,992			$4,330	$14,380
	Total	$24,754	$67,885	$6,424	$41,362	$5,774	$25,683	$26,301	$72,285
Tea	Darjeeling	$10,772	$30,289	$6,497	$14,096			$11,780	$28,769
	Earl Grey	$10,331	$32,881	$3,405	$6,505			$10,425	$27,387
	Green Tea	$1,227	$5,211	$5,654	$11,571			($7,109)	$16,063
	Total	$22,330	$68,380	$15,557	$32,172			$15,097	$72,220

Who has the best profit and who has the worst sales?



Do The Right Analytics, Don't Just Visualize Data

Doubling down on states for strong growth

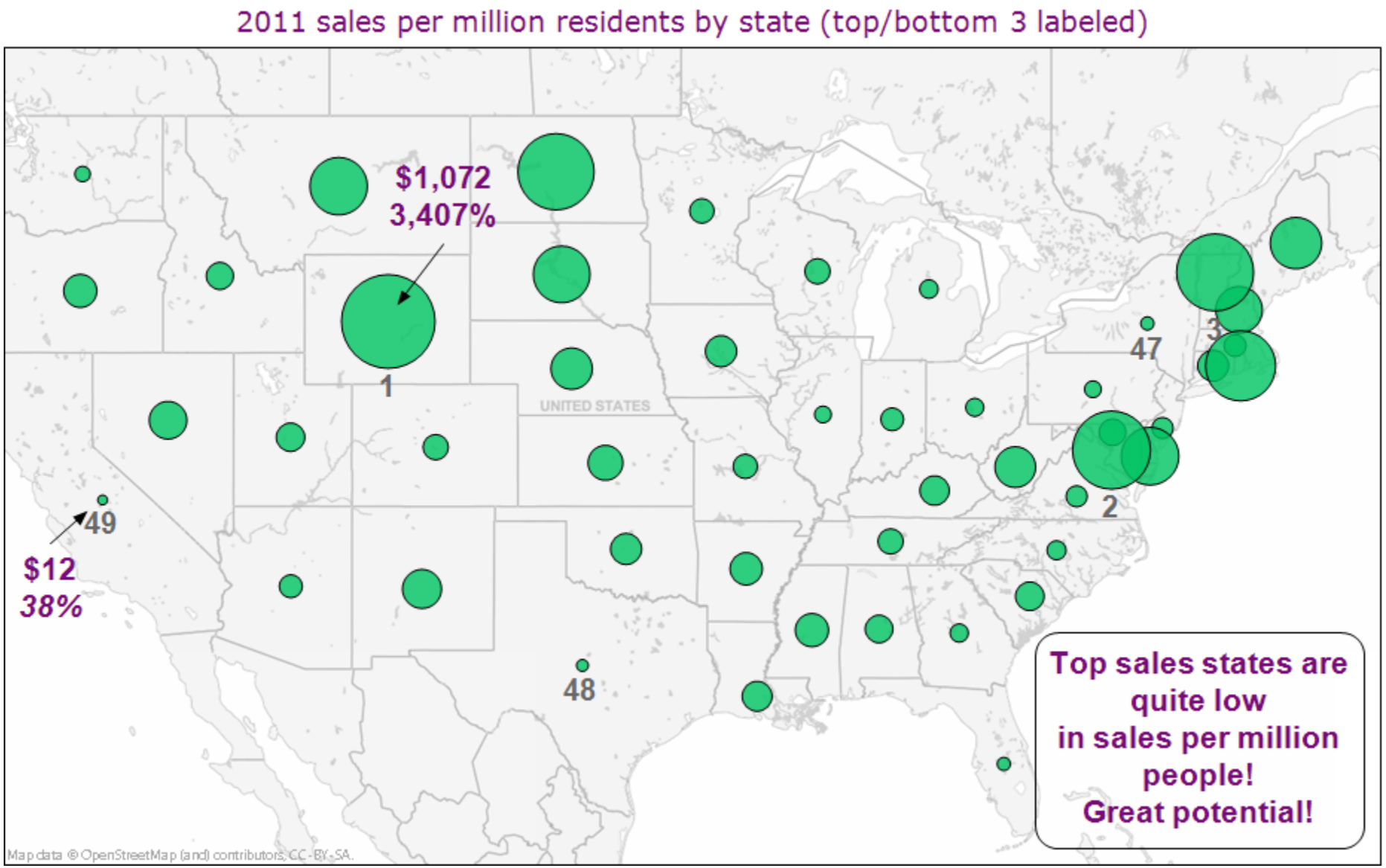
Maria
Senior Sales Analyst
March 15th, 2012

Today’s question

In which states should we invest additional marketing dollars during the upcoming campaign?

Based upon sales growth potential…

Sales per State/Capita



Potential sales by state???

+Is there a better metric?

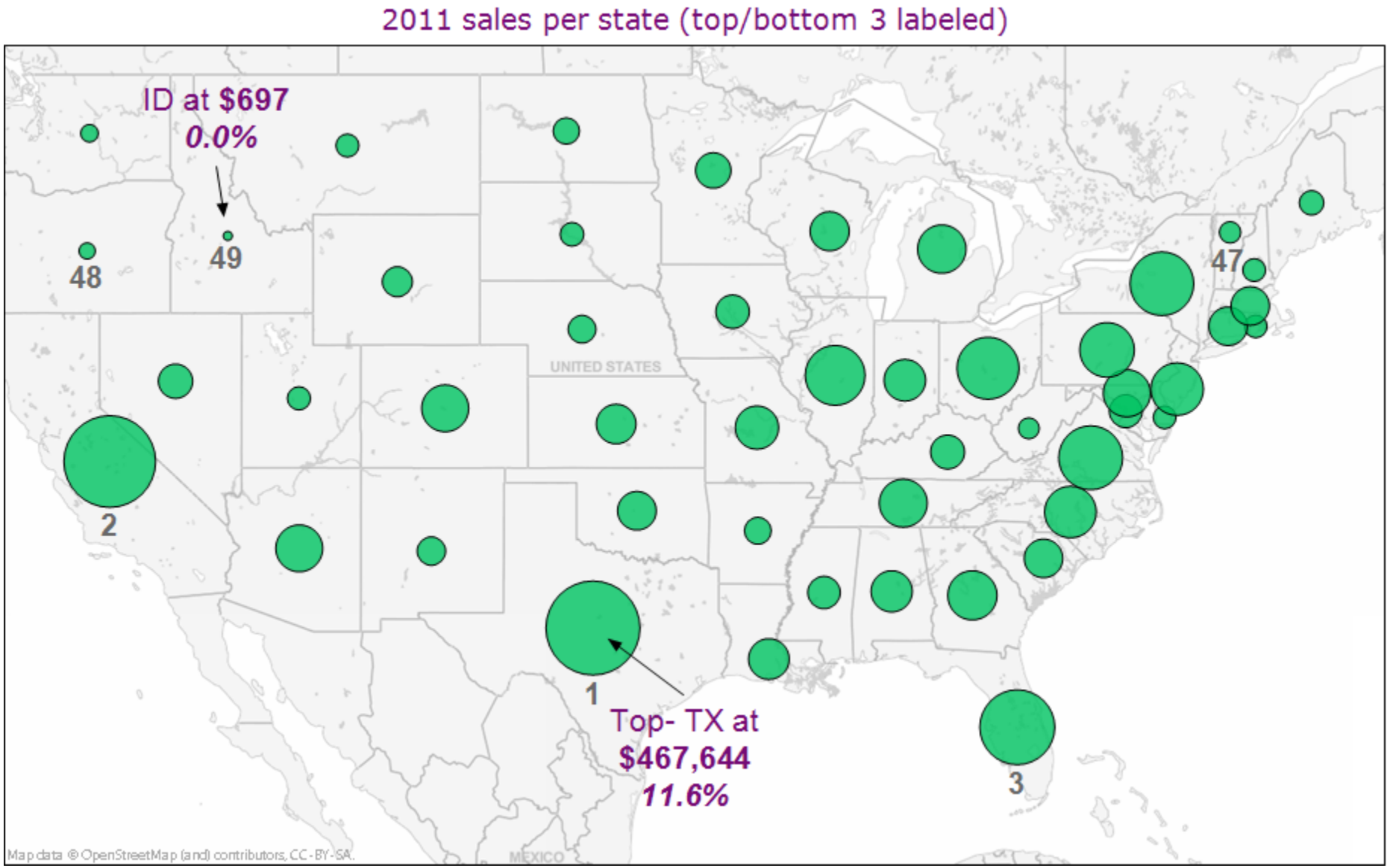
+The emphasis is on **potential**

Average sale per capita for top states

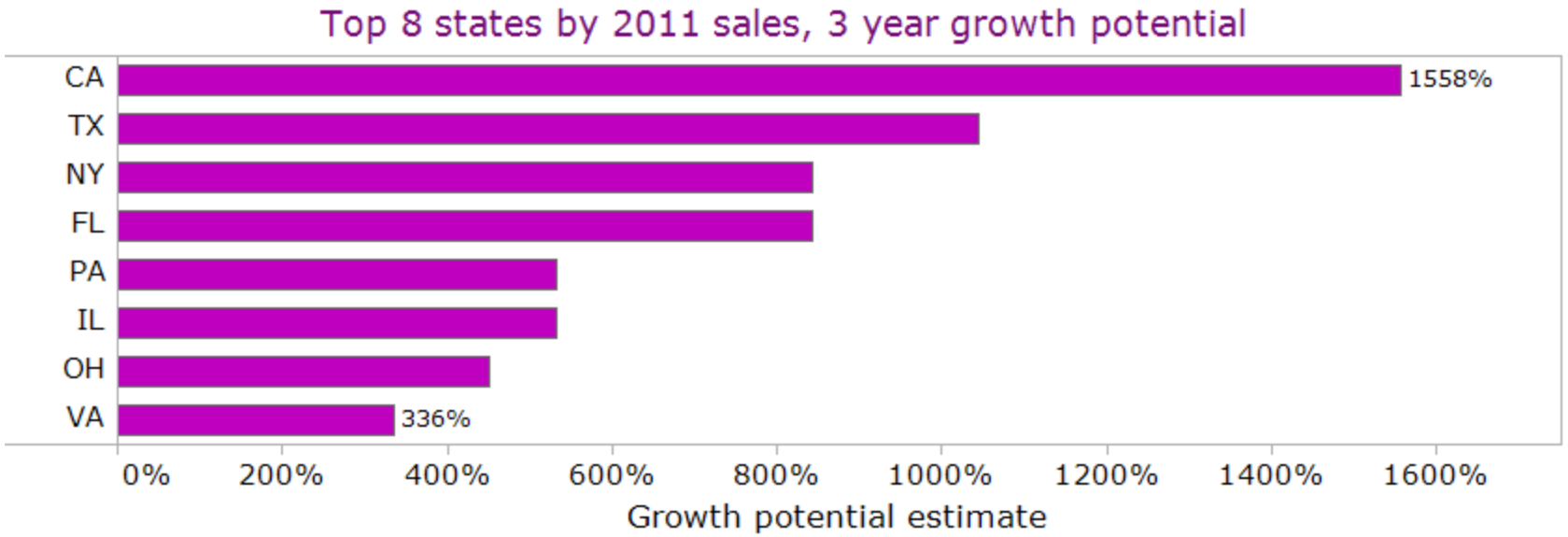
multiplied by

Current population of top sales states

Sales per State/Capita x Capita



Highest growth potential in top 8



+ If we were to pick just one state, California has the greatest potential

+ The next tier is Texas, New York & Florida