

CS448B :: 28 Sep 2009

# Visualization Re-Design



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## Last Time: Data and Image Models

## The Big Picture

task

data

physical type  
int, float, etc.  
abstract type  
nominal, ordinal, etc.

domain

metadata  
semantics  
conceptual model

processing  
algorithms

mapping  
visual encoding  
visual metaphor

image  
visual channel  
perception

## Taxonomy

1D (sets and sequences)

Temporal

2D (maps)

3D (shapes)

nD (relational)

Trees (hierarchies)

Networks (graphs)

Are there others?

The eyes have it: A task by data type taxonomy for information visualization [Shneiderman 96]

## Nominal, Ordinal and Quantitative

N - Nominal (labels)

- Operations: =, ≠

O - Ordered (rank-ordered, sorted)

- Operations: =, ≠, <, >

Q - Interval (location of zero arbitrary)

- Operations: =, ≠, <, >, -
- Can measure distances or spans

Q - Ratio (zero fixed)

- Operations: =, ≠, <, >, -, ÷
- Can measure ratios or proportions

S. S. Stevens, On the theory of scales of measurements, 1946

## Visual Encoding Variables

Position

Size

Value

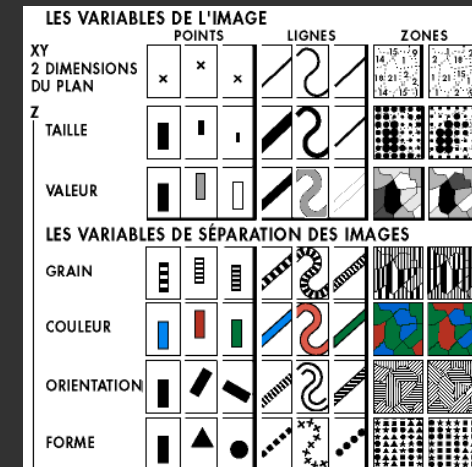
Texture

Color

Orientation

Shape

Others?



## Design Criteria (Mackinlay)

**Expressiveness** (supports *congruence*)

A set of facts is expressible in a visual language if the sentences (i.e. the visualizations) in the language express *all* the facts in the set of data, and *only* the facts in the data.

**Effectiveness** (supports *apprehension*)

A visualization is more effective than another visualization if the information conveyed by one visualization is more readily perceived than the information in the other visualization.

## Mackinlay's Ranking

Quantitative	Ordinal	Nominal
Position	Position	Position
Length	Density	Hue
Angle	Saturation	Texture
Slope	Hue	Connection
Area	Texture	Containment
Volume	Connection	Density
Density	Containment	Saturation
Saturation	Length	Shape
Hue	Angle	Length
Texture	Slope	Angle
Connection	Area	Slope
Containment	Volume	Area
Shape	Shape	Volume

Conjectured *effectiveness* of the encoding

## Visualization Re-Design Assignment 1 Review

## Design Considerations

**Title, labels, legend, captions!**

**Expressiveness and Effectiveness**

- Avoid unexpressive marks (lines? bars? gradients?)
- Use perceptually effective encodings
- Don't distract: faint gridlines, pastel highlights/fills
- The "elimination diet" approach – start minimal

**Support comparison and pattern perception**

- Between elements, to a reference line, or to totals

## Design Considerations

**Group / sort** data by meaningful dimensions

**Transform data** (e.g., log, invert, average)

**Reduce cognitive overhead**

- Reduce memory and calculation burden
- Minimize visual search (e.g., legend lookups)

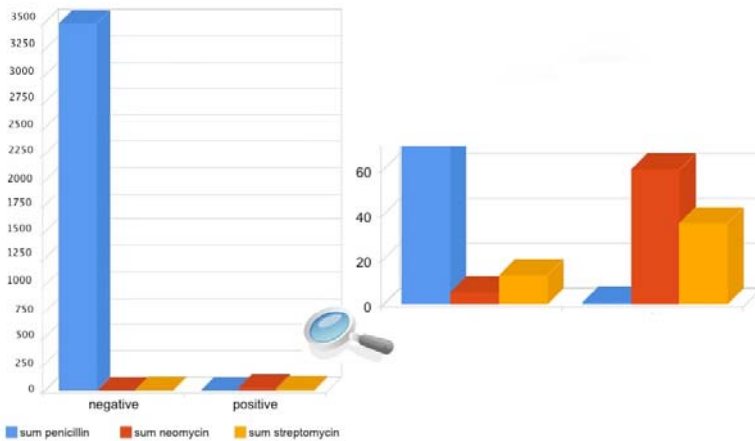
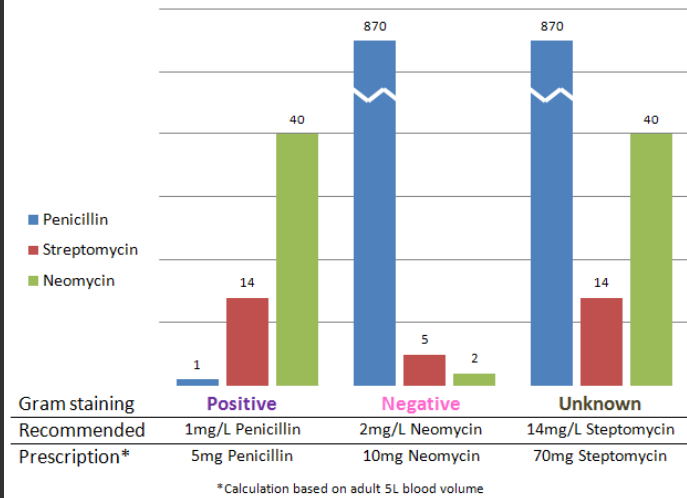
Be consistent! **Visual inferences** should consistently support **data inferences**

## Design Rubric

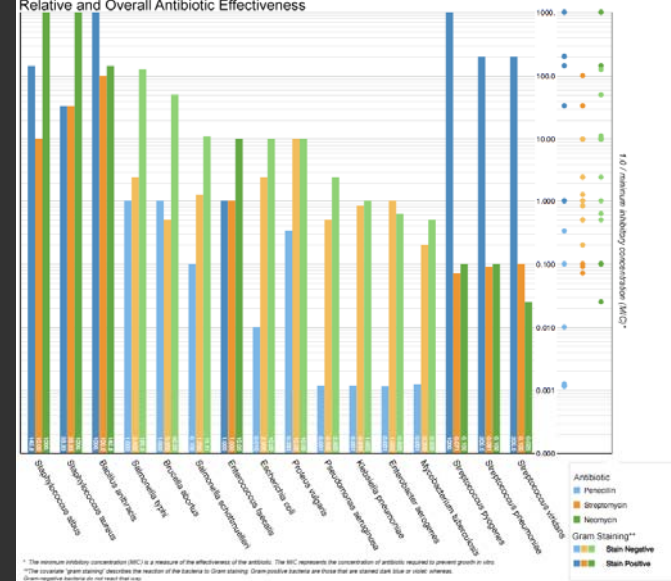
- Expressiveness (or *congruence*)
  - Prioritizes important information
  - Avoids false inferences
  - Consistent visual mappings
- Effectiveness (or *apprehension*)
  - Facilitates accurate decoding
  - Minimizes cognitive overhead
- Grouping / Sorting
- Data Transformation
- Non-Data Elements
  - Descriptive: Title, Label
  - Reference: Gridlines, Legend

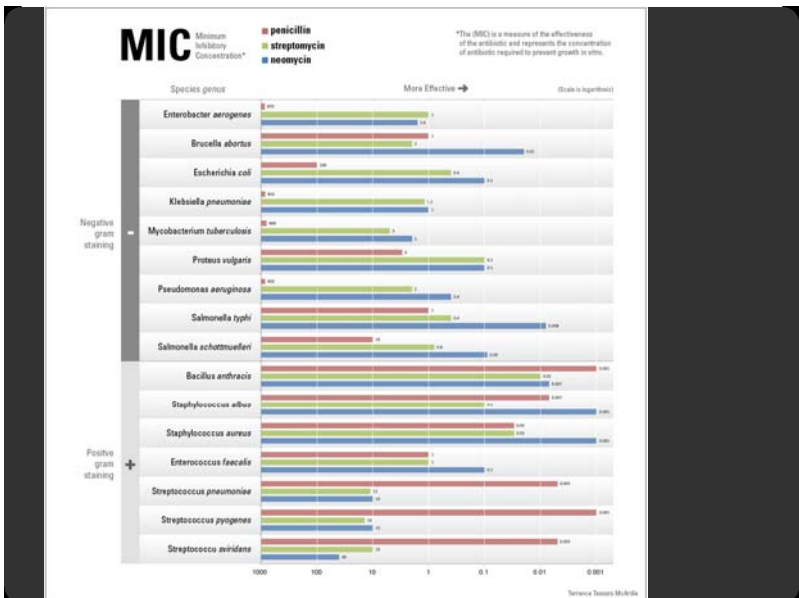
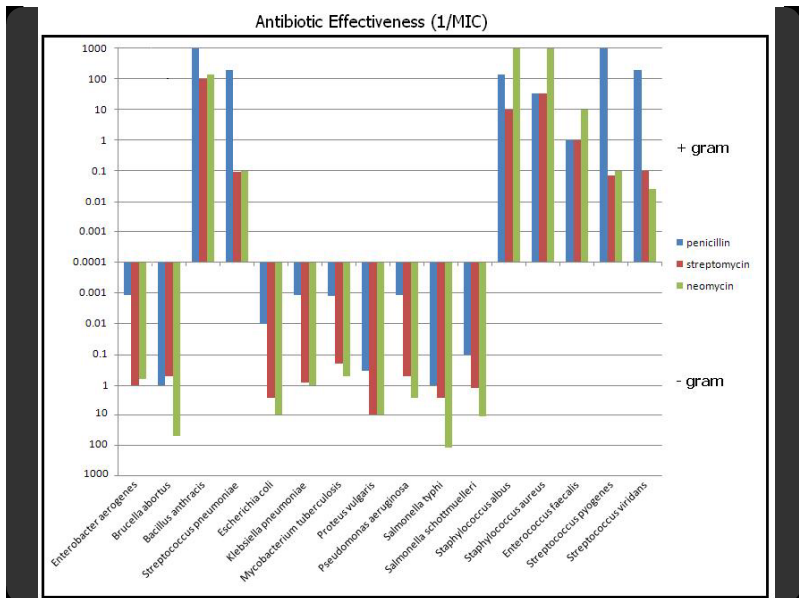
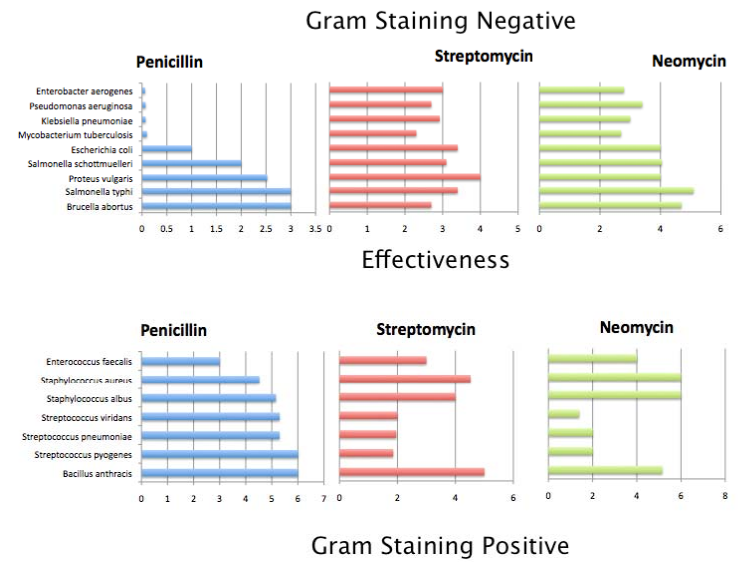
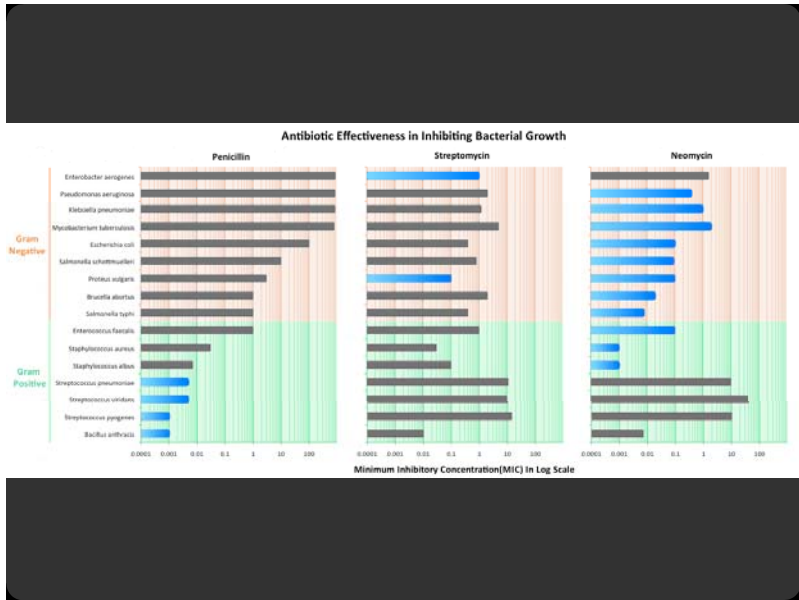
# Bar Charts

Minimum guaranteed effective dose for antibiotics in MIC/mgL<sup>-1</sup> on an unknown infection (lower is better)

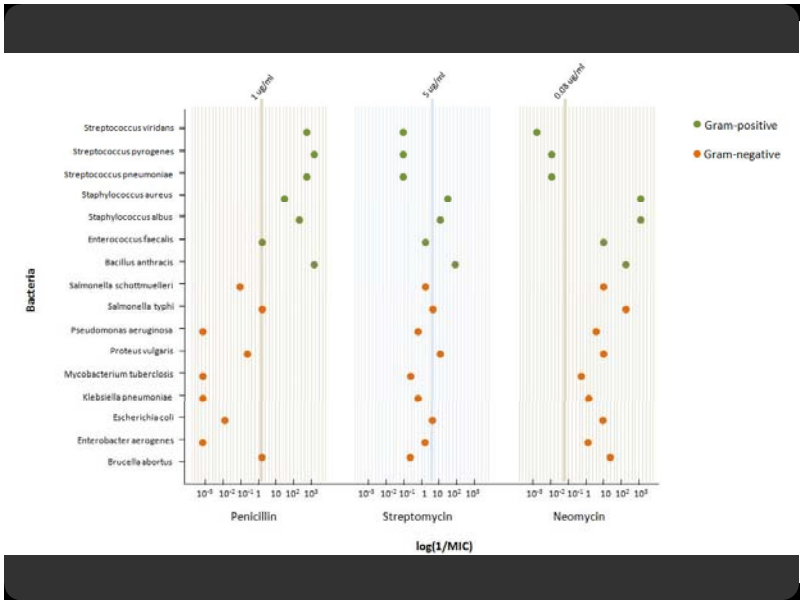


Relative and Overall Antibiotic Effectiveness

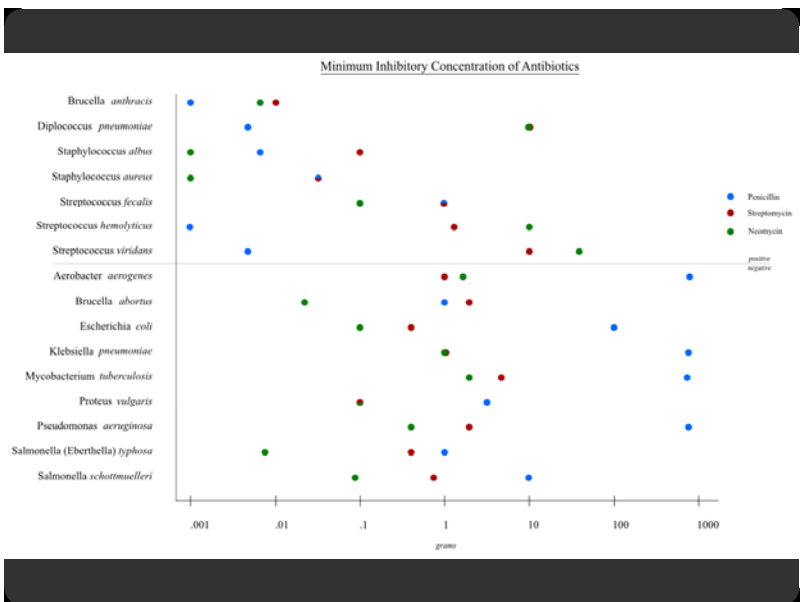
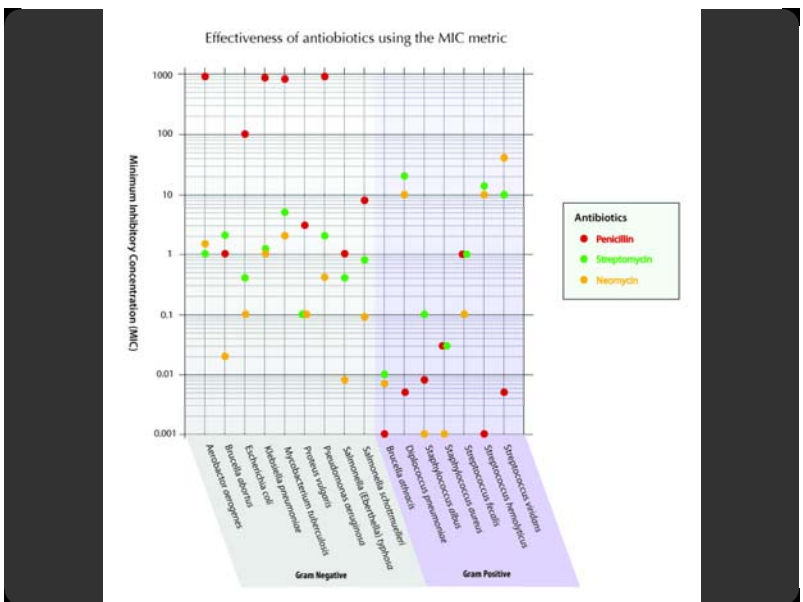
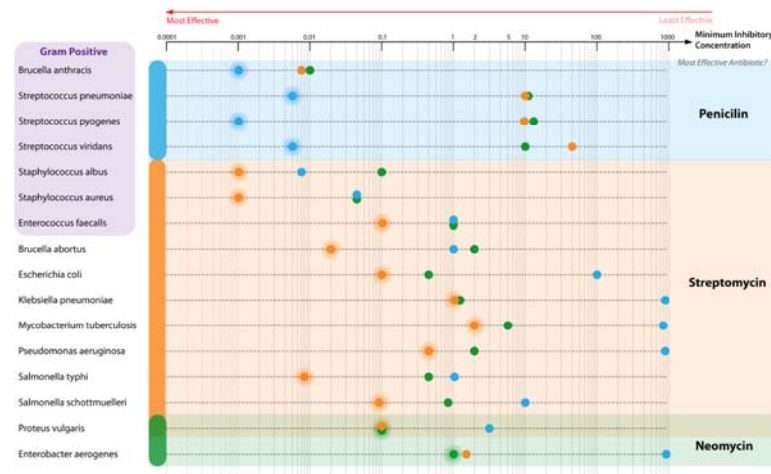


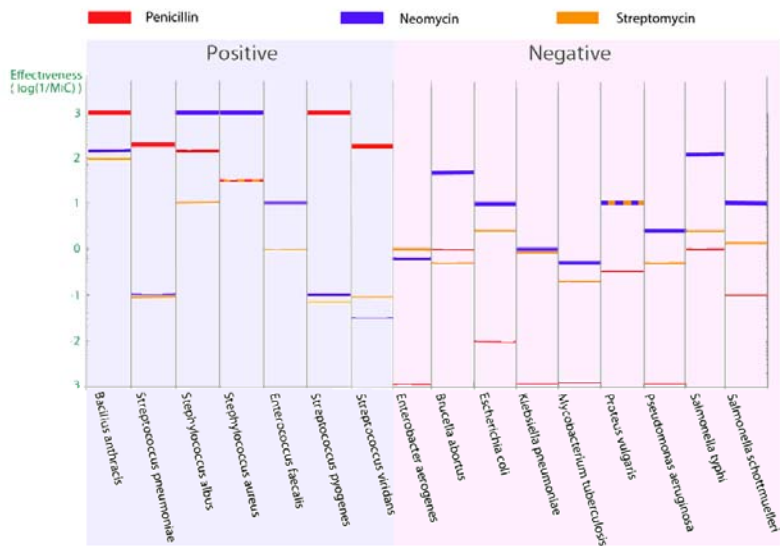




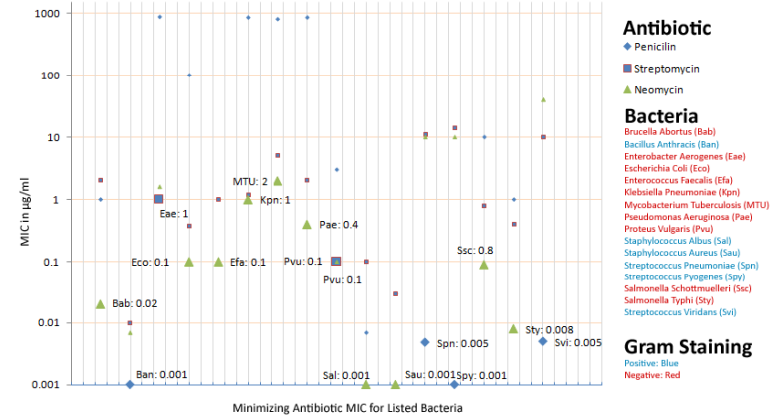


**Effectiveness of Antibiotics on 16 Different Bacteria Species**

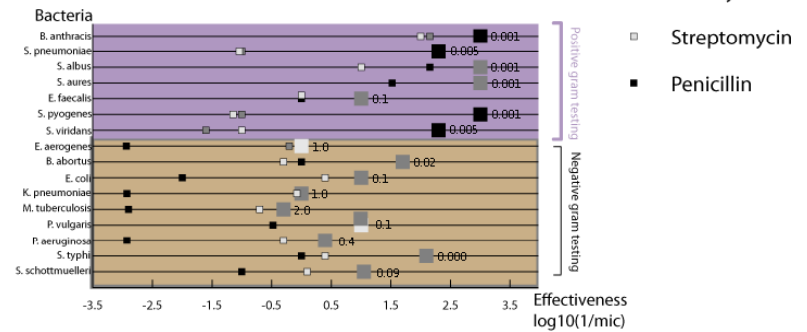
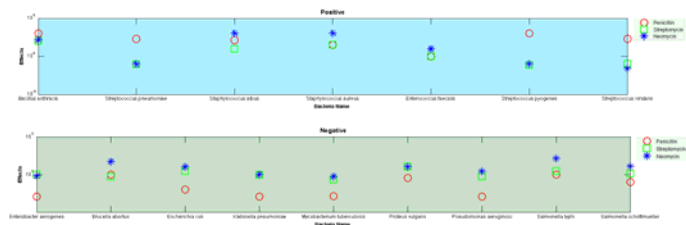


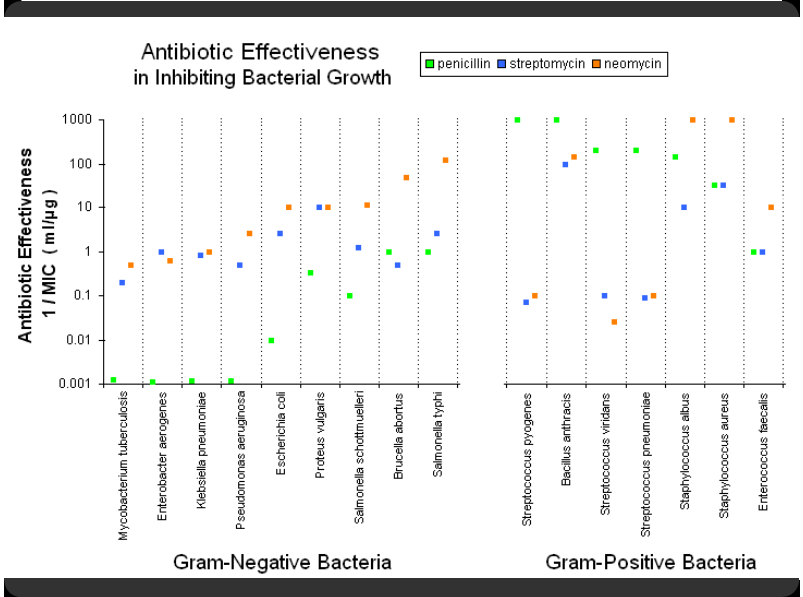
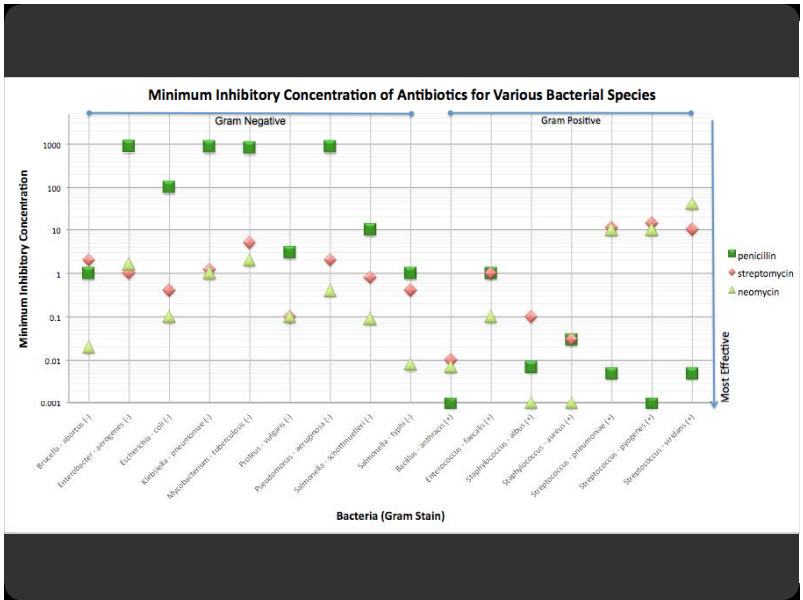
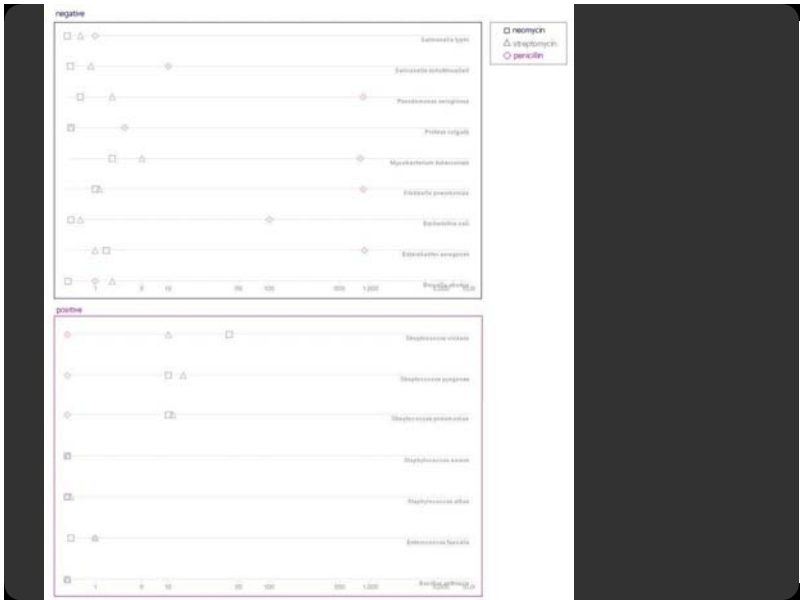


### Minimum Inhibitory Concentration (MIC) for Selected Antibiotics against Common Bacteria

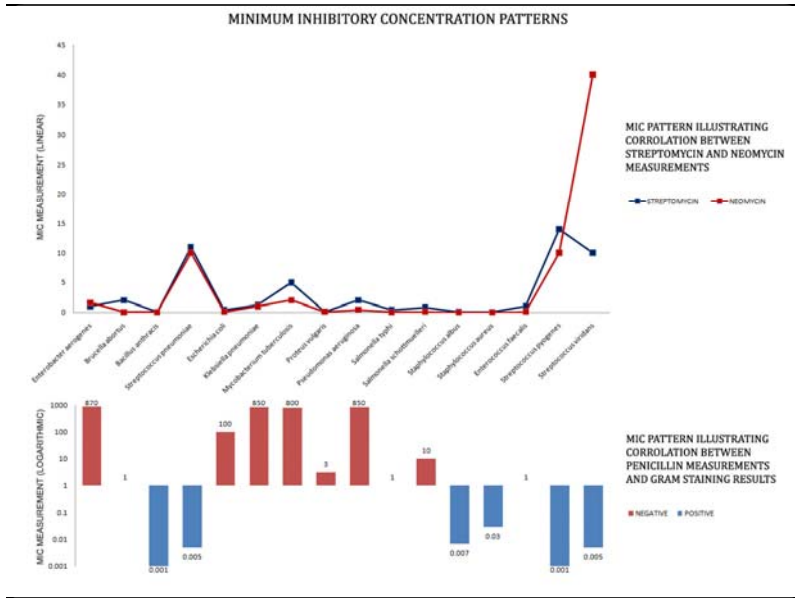


### Effectiveness of Antibiotics Against Bacteria

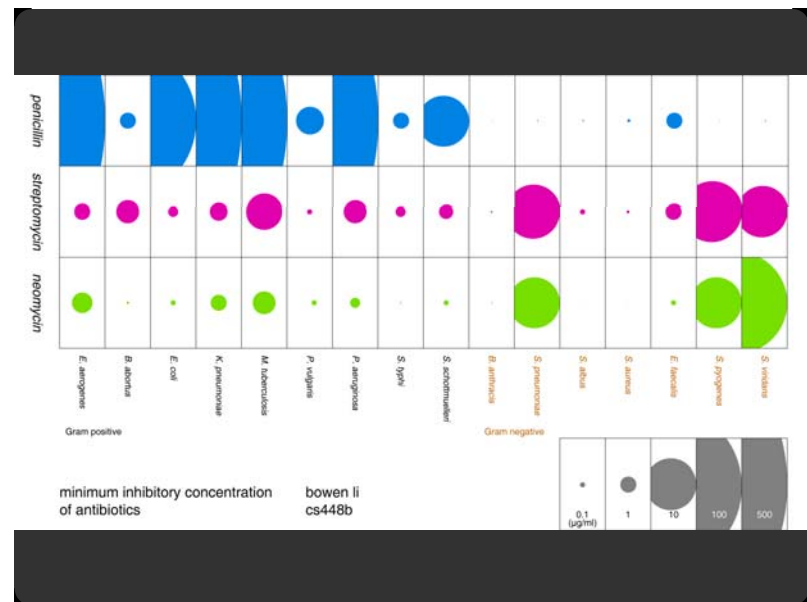
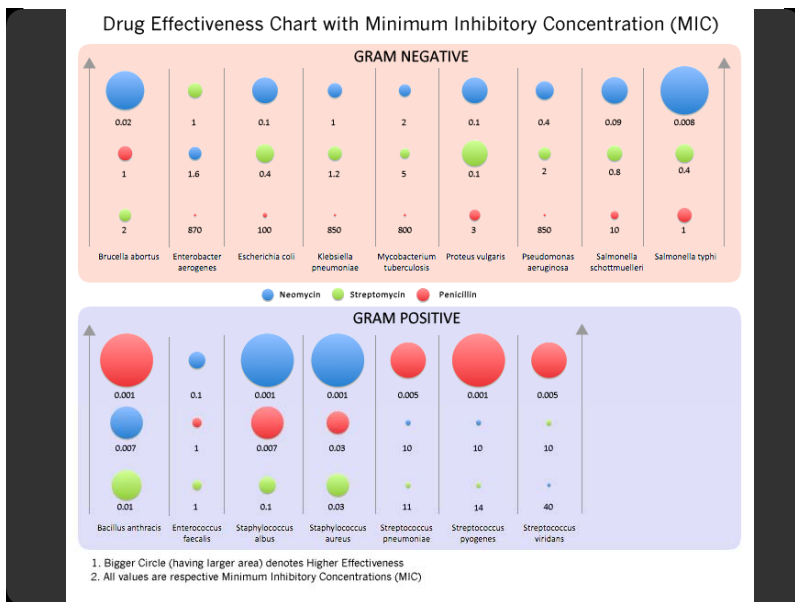




Line Charts



# Area Charts







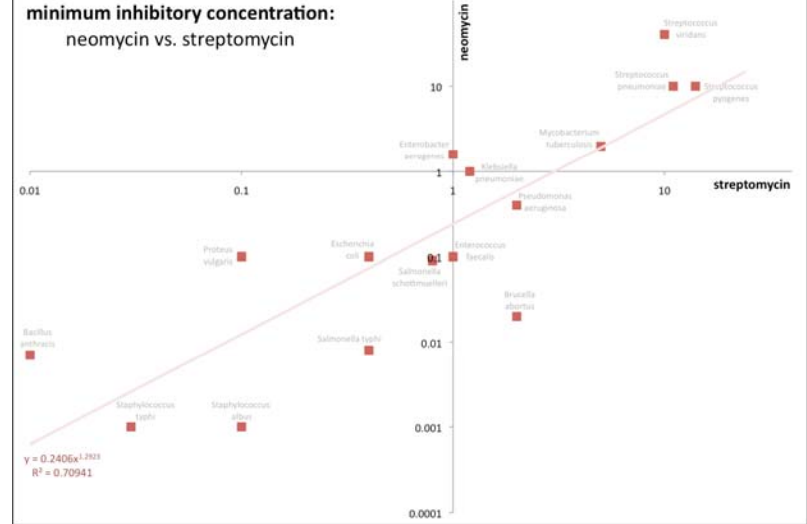
## Popular Antibiotics Compared

Effectiveness in stopping...	Penicillin (dosage)	Streptomycin	Neomycin
Bacillus anthracis	● (0.001)	● (0.01)	● (0.007)
Brucella abortus	● (1)	● (2)	● (0.02)
Enterobacter aerogenes	● (870)	● (1)	● (1.6)
Enterococcus faecalis	● (1)	● (1)	● (0.1)
Escherichia coli	○ (100)	● (0.4)	● (0.1)
Klebsiella pneumoniae	● (850)	● (1.2)	● (1)
Mycobacterium tuberculosis	● (800)	● (5)	● (2)
Proteus vulgaris	● (3)	● (0.1)	● (0.1)
Pseudomonas aeruginosa	● (850)	● (2)	● (0.4)
Salmonella schottmuelleri	○ (10)	● (0.8)	● (0.09)
Salmonella typhi	○ (1)	● (0.4)	● (0.008)
Staphylococcus albus	● (0.007)	● (0.1)	● (0.001)
Staphylococcus aureus	● (0.03)	● (0.03)	● (0.001)
Streptococcus pneumoniae	● (0.005)	○ (11)	○ (10)
Streptococcus pyogenes	● (0.001)	○ (14)	○ (10)
Streptococcus viridans	● (0.005)	○ (10)	● (40)



Source: Burtin's Data, 1951

## minimum inhibitory concentration: neomycin vs. streptomycin

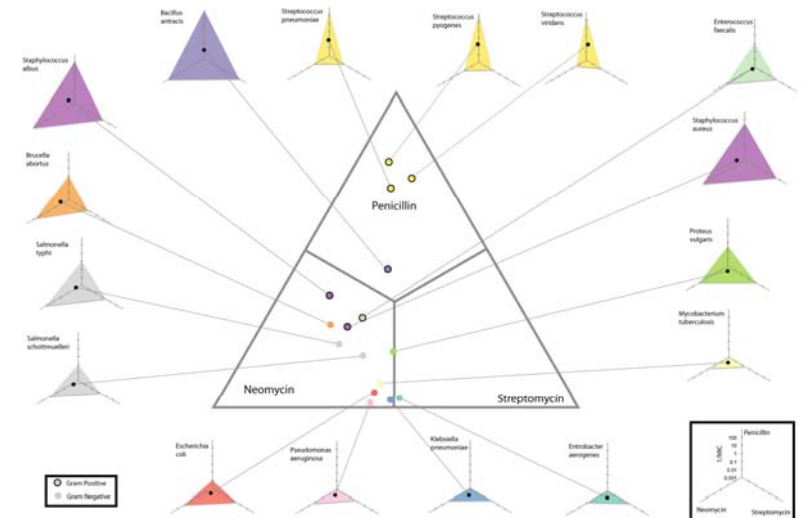


## three antibiotics

minimum inhibitory concentration (mic) required to prevent growth of various bacteria

	gram positive bacteria			gram negative bacteria		
	penicillin	streptomycin	neomycin	penicillin	streptomycin	neomycin
Bacillus anthracis	<b>0.001</b>	10.0 x	7.0 x	50.0 x	100.0 x	<b>0.02</b>
Brucella abortus	10.0 x	10.0 x	<b>0.1</b>	870.0 x	<b>1</b>	1.6 x
Enterococcus faecalis	10.0 x	10.0 x	<b>0.1</b>	1000.0 x	4.0 x	<b>0.1</b>
Staphylococcus albus	7.0 x	100.0 x	<b>0.001</b>	850.0 x	1.2 x	<b>1</b>
Staphylococcus aureus	30.0 x	30.0 x	<b>0.001</b>	400.0 x	2.5 x	<b>2</b>
Streptococcus pyogenes	<b>0.001</b>	14000.0 x	10000.0 x	30.0 x	<b>0.1</b>	<b>0.1</b>
Streptococcus pneumoniae	<b>0.005</b>	2200.0 x	2000.0 x	2125.0 x	5.0 x	<b>0.4</b>
Streptococcus viridans	<b>0.005</b>	2000.0 x	8000.0 x	111.1 x	8.9 x	<b>0.09</b>
				125.0 x	50.0 x	<b>0.008</b>

for each bacterium, mic for most potent antibiotic is highlighted in bold white text  
absolute mic value is marked for most potent antibiotic in each row; for others, relative concentration is indicated



Effectiveness of Three Antibiotics on Species of Bacteria

Effectiveness is taken to be 1/MIC. An effectiveness of 1 L/mg indicates that 1 mg of antibiotic will inhibit 1 liter of bacteria. The effectiveness of each antibiotic is plotted for each species along the perimeter. The center plot shows the centroid of each radial plot and serves as a summary of the relative effectiveness of each antibiotic. A species susceptible to Penicillin (100 L/mg) but resistant to Neomycin and Streptomycin would end up at the top of the triangle, whereas one equally susceptible to all three would end up in the center.

## Visualization Re-Design In-Class Exercise

## In-Class Design Exercise

**Task:** Analyze and Re-design visualization

- Identify data variables (N,O,Q) and encodings
- Critique the design: what works, what doesn't
- Sketch a re-design to improve communication
- Present result to the class

Break into groups (~5 people per group)

## Re-Design Presentation (5 min)

1. Describe the data and visualization (~1 min)
2. Present your critique
3. Briefly describe your re-design ideas

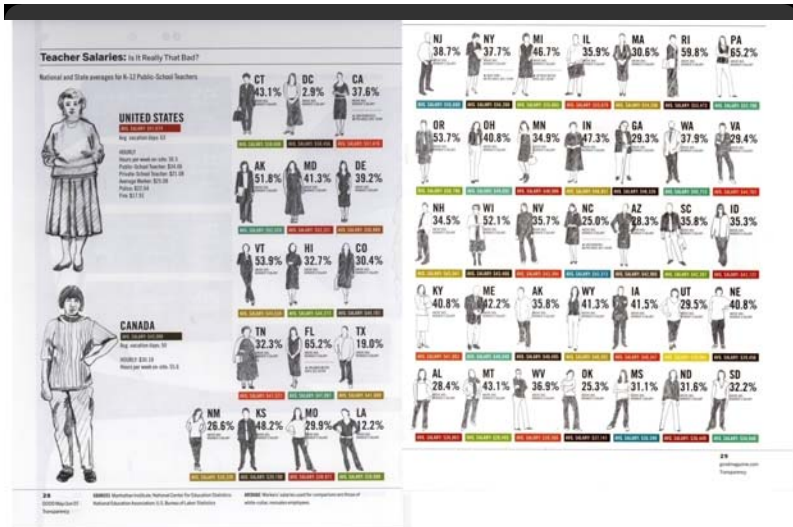
Each group member should speak

- Introduce yourself: name, department, etc

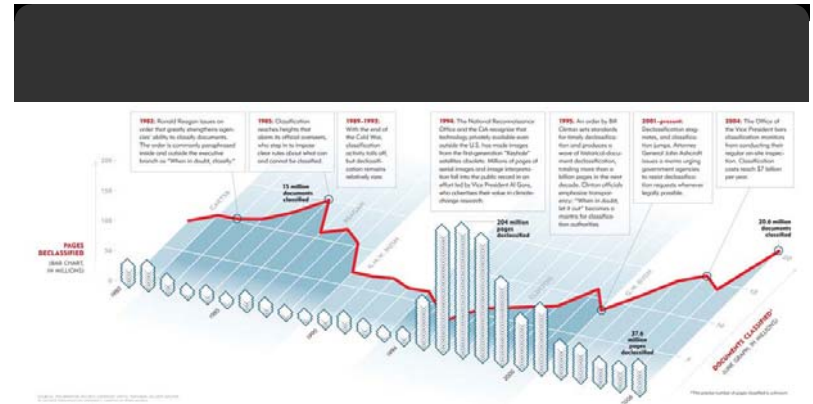
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Area	Texture	Containment
Volume	Connection	Density
Density	Containment	Saturation
Saturation	Length	Shape
Hue	Angle	Length
Texture	Slope	Angle
Connection	Area	Slope
Containment	Volume	Area
Shape	Shape	Volume

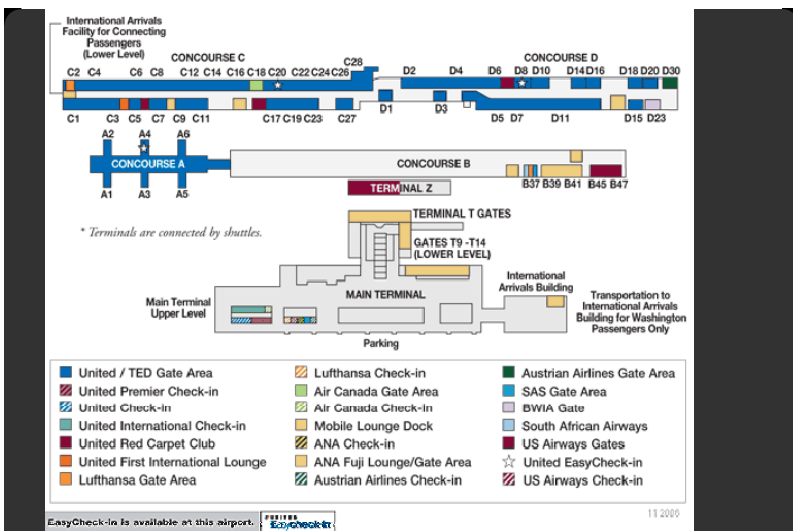
Conjectured *effectiveness* of the encoding



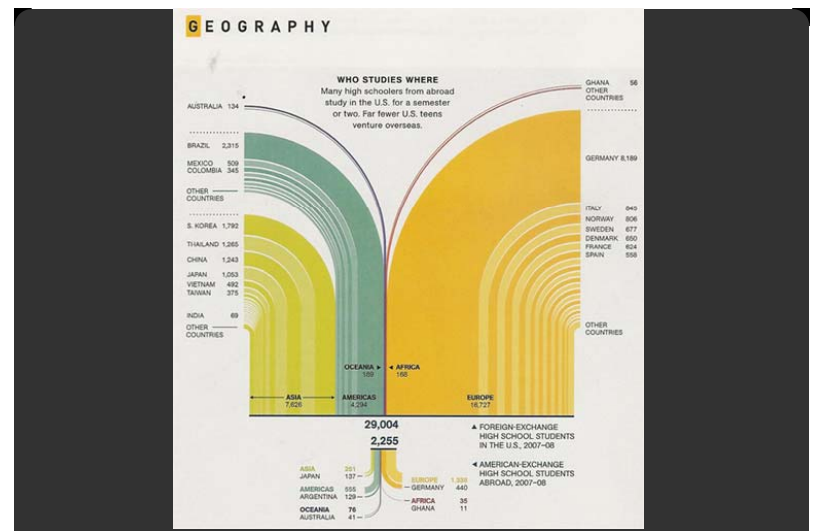
Source: Good Magazine



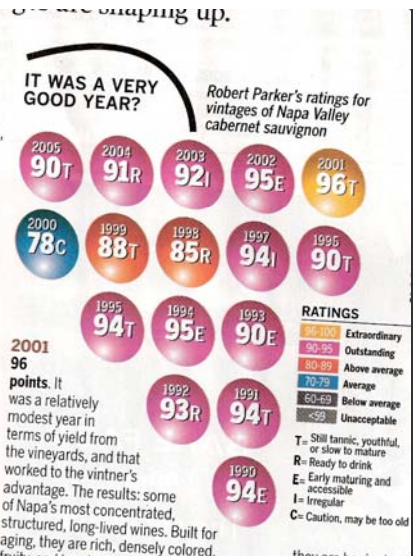
Source: The Atlantic 300 no. 2 (September 2007)  
Number of Classified U.S. Documents



Washington Dulles Airport Map  
Source: United Airlines Hemispheres



Source: National Geographic, September, 2008, p. 22.  
Silver, Mark. "High School Give-and-Take."



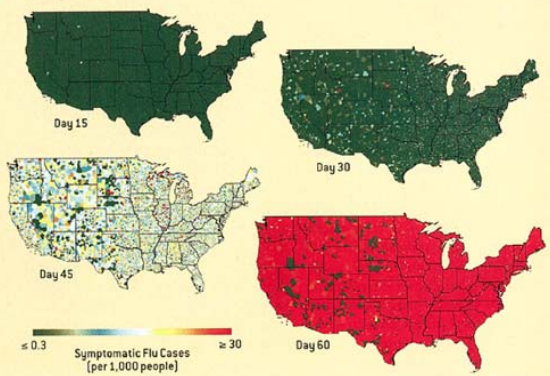
Source: Business Week, June 18, 2007



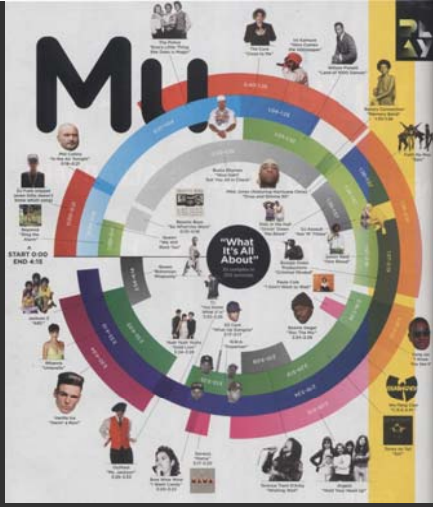
Source: India Today

### Pandemic Flu Hits the U.S.

A simulation created by researchers from Los Alamos National Laboratory and Emory University shows the first wave of a pandemic spreading rapidly with no vaccine or antiviral drugs employed to slow it down. Colors represent the number of symptomatic flu cases per 1,000 people (see scale). Starting with 40 infected people on the first day, nationwide cases peak around day 60, and the wave subsides after four months with 33 percent of the population having become sick. The scientists are also modeling potential interventions with drugs and vaccines to learn if travel restrictions, quarantines and other disruptive disease-control strategies could be avoided.



Preparing for a Pandemic  
Source: Scientific American, 293(5). November, 2005, p. 50



Source: Wired Magazine, September 2008 Edition  
Music: Super Cuts (page 92)