Overview: Visualizing Healthcare Data – A Literature Survey

Julia Zhu

Background

- Vast quantities of digital healthcare data are generated
  - Clinical trials, patient information, research findings, etc.

- Complexity in processing information increases
  - Leads to information overload

- Healthcare industry beginning to use visualization tools to visualize data

Overview

- My paper aims to:
  - Identify past studies that have used visualization idioms for health data, with an emphasis on multivariate data
  - Discuss how the idioms were used in these studies
  - Their advantages and disadvantages

- Health data visualization is still a fairly new subject

- 23 papers were found
  - Majority were design studies
  - Spanned from 2007 – 2016
  - Mostly published after 2013

Visualizing Multivariate Health Data

- Multivariate data = data involving 3 or more variables

- Visualization idioms:
  - Radar plot
  - Tree map
  - Bubble chart

Radar Plots

- Used in clinical studies to show changes over time
- Structure:
  - Circular graph with centrally-projecting rays
  - Each spoke represents a different variable
  - Ray lengths represent the values of the variables
- Saary's 2007 study examined how radar plots could be used to visualize patient satisfaction with their interaction with the health care system
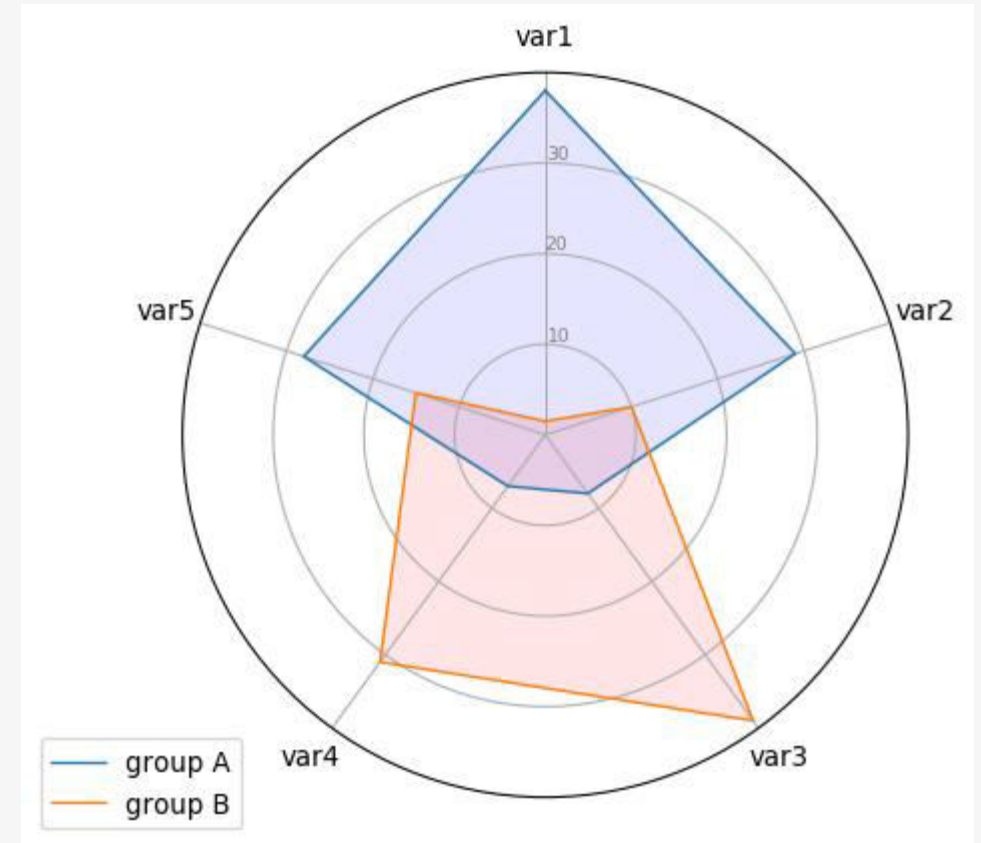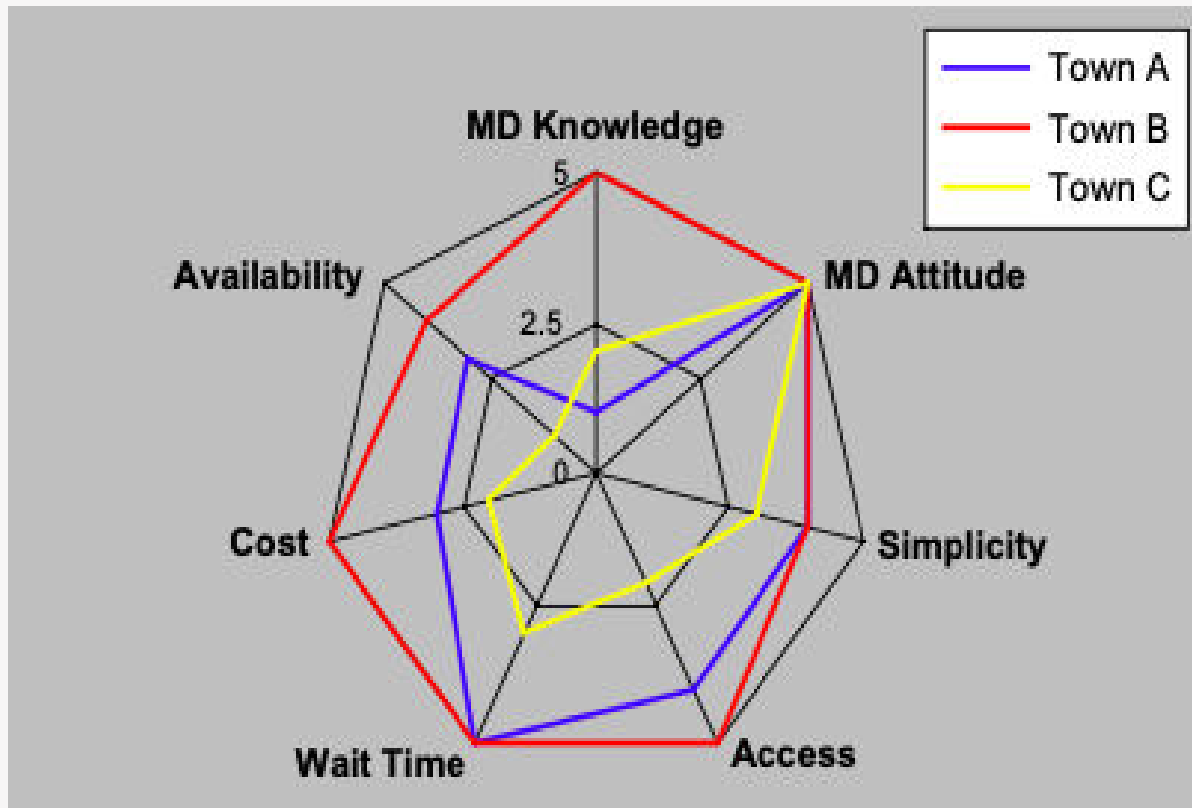

Figure 1. Example image of a radar plot.

Saary's Radar Plot

Figure 2. Radar plot comparing 3 groups on 7 variables.
Saary, Joan. "Radar Plots: a Useful Way for Presenting Multivariate Health Care Data." *Journal of Clinical Epidemiology*, vol. 60, Apr. 2007, pp. 311–317.

- Scale from dissatisfied (1) to totally satisfied (5)
- Total satisfaction is represented by the perimeter (outermost ring).
- The radar plot shows that patients from Town B are generally more satisfied than that other two

Treemaps

- Used to visualize genome data or health data statistics
- Structure:
  - A window subdivided into multiple parts
  - Each part represents unique data
  - Area of rectangle proportional to a specified dimension of the data
- Hugine *et al.'s* 2014 study researched how surgeons' surgery performances in comparison to their counterparts could be visualized with treemaps
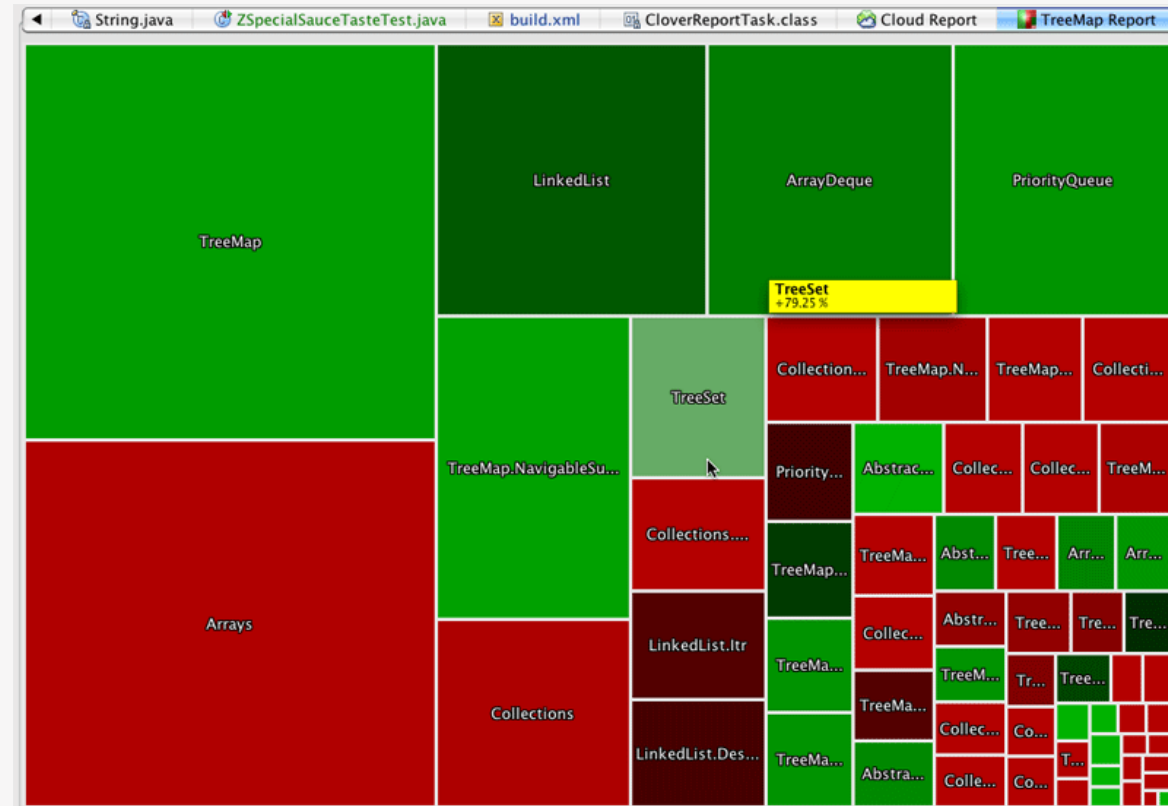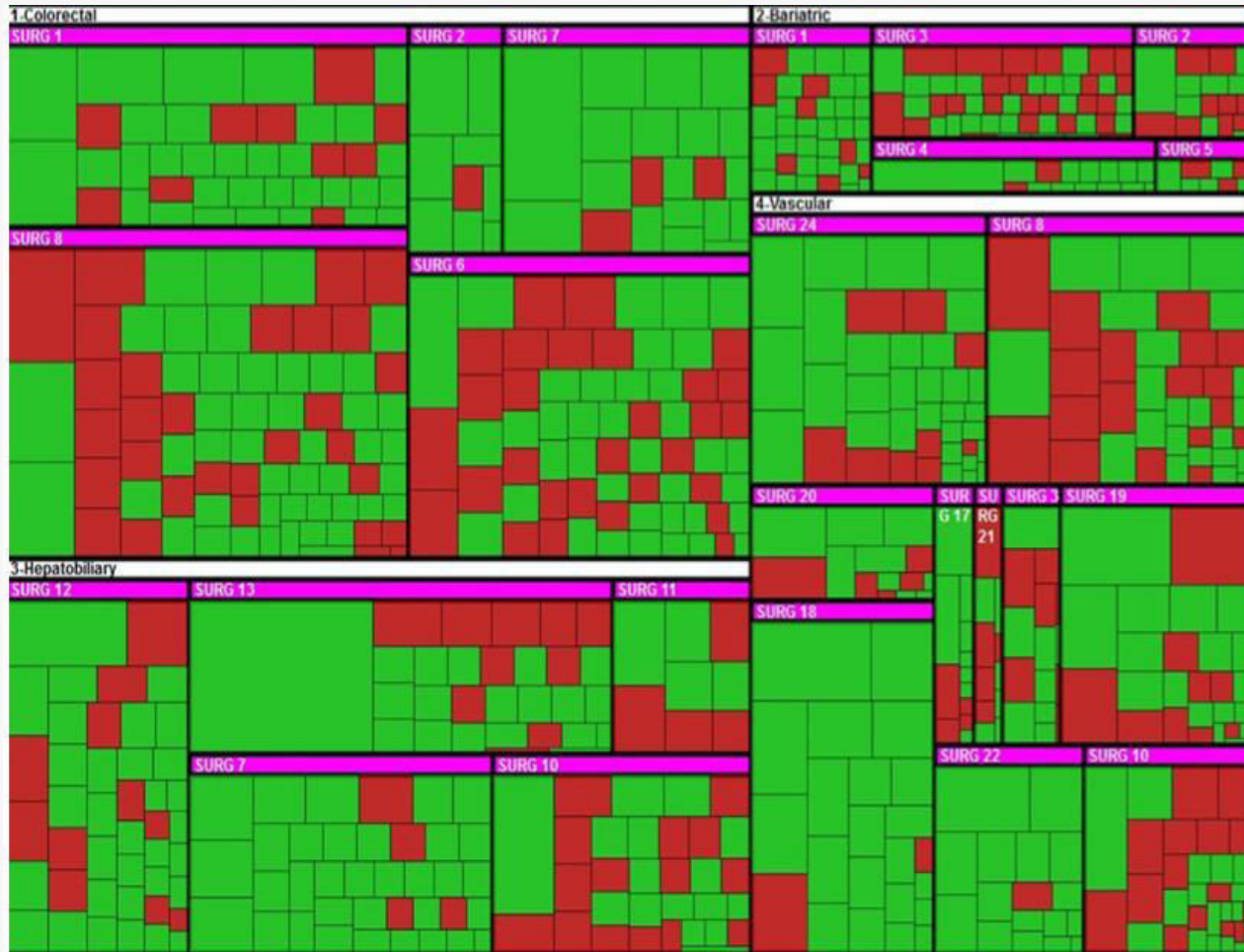

Figure 3. Example image of a treemap.

Hugine *et. al*'s Treemap

Figure 4. Treemap of surgeries performed by surgeons, and the surgery outcomes for each patient.

Hugine, Akilah, et al. "Visualizing Surgical Quality Data with Treemaps." *Journal of Surgical Research*, Mar. 2014, pp. 74–83.

- Surgeon ID on the upper left corner of each block
- Size of the rectangles represents the length of stay, in days, for each patient
- Color of each rectangle represents the outcome for each patient
  - Red = deceased
  - Green = alive

8

Bubble Charts

- Used to compare the relationships between data objects in 3 numeric-data dimensions
- Structure:
  - Data points represented as bubbles
  - Data represented on x axis, y axis, by bubble size and/or bubble color
- Al-Hajj *et al.*'s 2013 study used a bubble chart to visualize data and to spot trends on hospitalization from injury
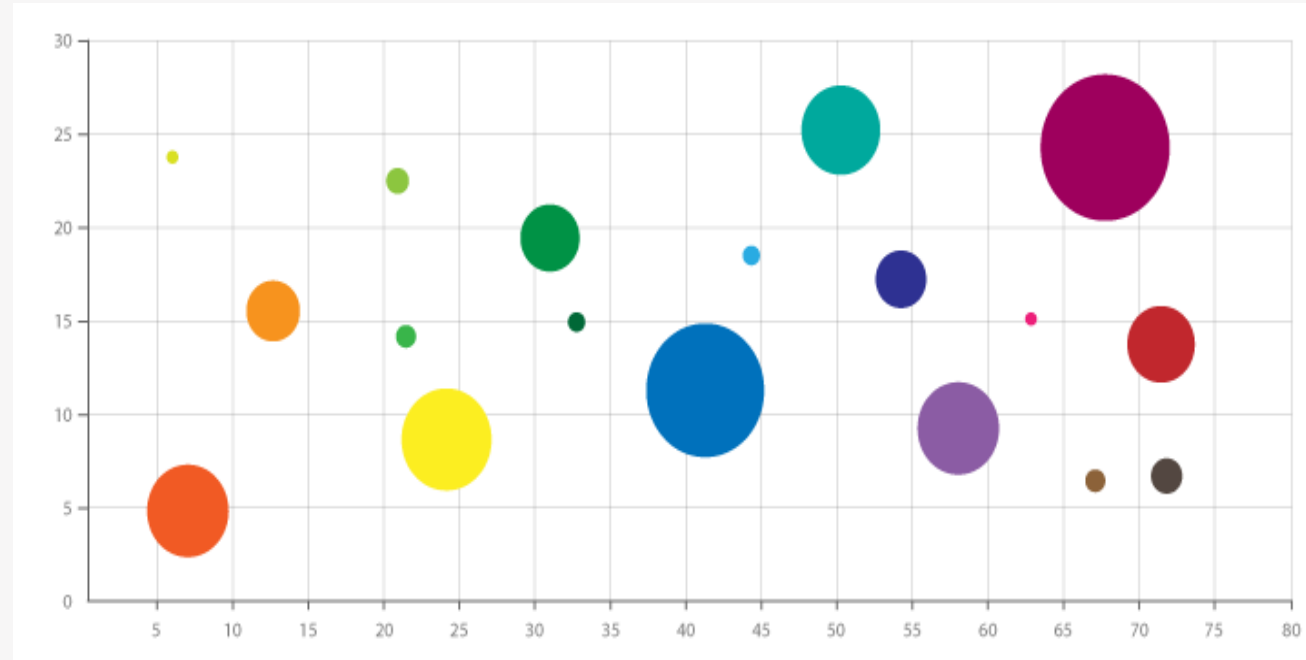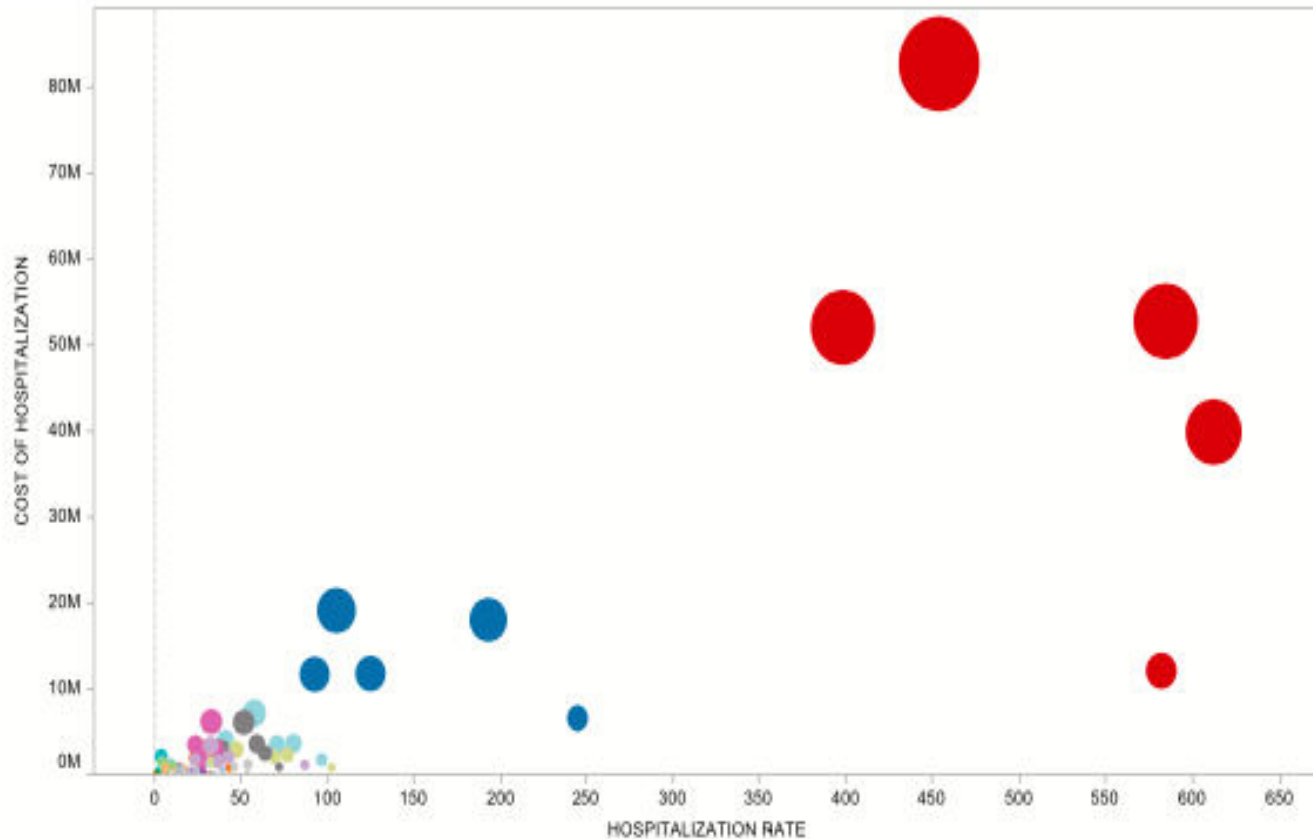

Figure 5. Example image of a bubble chart.

Al-Hajj *et al.*'s Bubble Chart

Figure 6. Bubble chart visualization of hospitalization data showing hospitalization rates and hospitalization costs per injury cause.

Al-Hajj, Samar, et al. "Visual Analytics for Public Health: Supporting Knowledge Construction and Decision-Making." Jan. 2013, doi:10.1109/HICSS.2013.599.

- Y axis: cost of hospitalization
- X axis: hospitalization rate
- Bubble size: injury cost
- Bubble color: type of injury

10

Multidimensional Health Data & Geospatial Regions

- Population healthcare data are usually tightly paired with geospatial regions

- Visualization idioms:
  - Spiral theme plot
  - Ring Map

Spiral Theme Plot

- Used to visualize many years of patient data

- Structure:
  - A spiral pattern composed of stacked categories (themes)
  - Themes are along a spiral curve - the time axis
  - Each data point plotted within themes

- Bloomquist *et al.* 2016 visualized seasonal flu patterns of patients over 4 years with a spiral theme plot

Figure 7. Example image of a spiral theme plot.

Bloomquist *et al.'s* Spiral Theme Plot

Disease: FLU
Gender: M
Race: W
Age: 88
Date: 2006-02-07

- 1 dot = 1 patient
- Dot radius = patient's age
- Dot color = patient's race
- Dot shape = patient's gender
- Time = spiral base curve
- The theme's width at a particular angle = total occurrence of flu at that time

Figure 8. Spiral theme plot displaying seasonal pattern of flu over four years.

Bloomquist, Sam, et al. "Healthcare Data Visualization: Geospatial and Temporal Integration." *Imaging and Computer Graphics Theory and Applications*, vol. 2, Jan. 2016, pp. 214–221., doi:10.5220/0005714002120219.

Ring Maps

- Used to visualize multivariate spatial health data
- Illustrates individual datasets as separate rings of information
- Structure:
  - Concentric, segmented rings -- circular or elliptical
  - Rings surround a base map of a certain geographic region of interest
- Lopez-De Fede *et al.*'s 2011 study used a ring map to visualize county-level HIV/AIDS, and STD diagnostic data for South Carolina
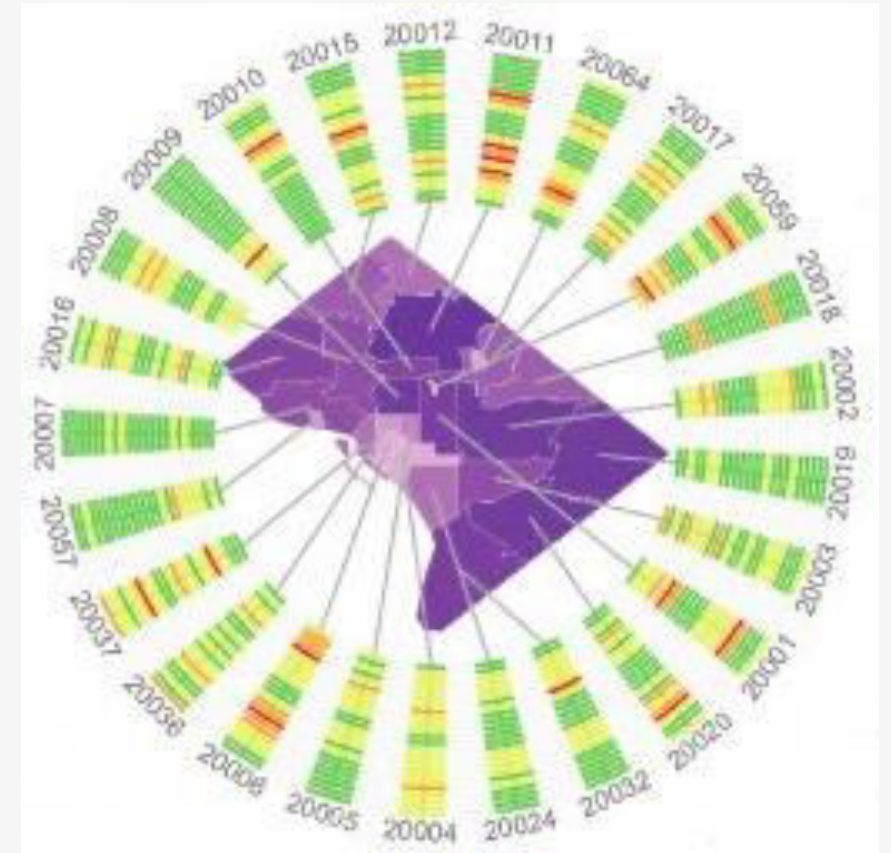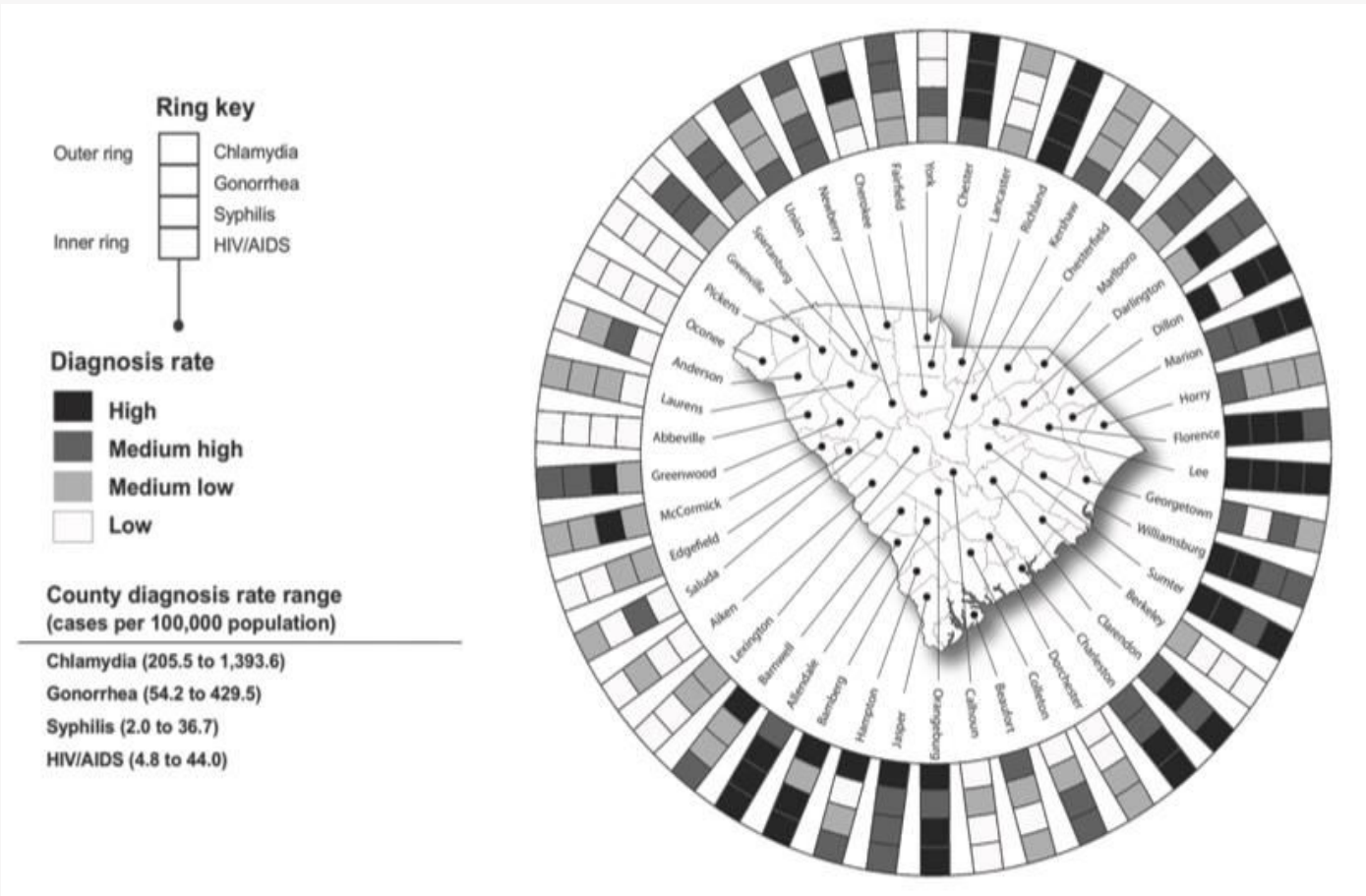

Figure 9. Example image of a ring map.

14

Lopez-De Fede *et al.*'s Ring Map

Figure 10. Ring map showing diagnosis rate of HIV/AIDS, syphilis, gonorrhea, and chlamydia in South Carolina counties.

- Ring map: central base map and ring display
- Central base map shows South Carolina's 46 counties
- 1 spoke = 1 county

- Ring display has 4 concentric rings
- 1 ring = a separate layer of data
- Ring shade = illness prevalence

Advantages & Disadvantages

- The strengthens and limitations for each type of idiom is different
- In general they can be categorized as:
- Advantages:
  - Effectively present the bigger picture in a single diagram
  - Display many variables without using 3D graphs
  - Can accommodate longer time studies
- Disadvantages:
  - Can exhibit high information density
  - Layout design can affect decision-making
  - May be difficult to interpret

Thank you!