New Tools for Understanding Cancer Patterns

National Cancer Advisory Board

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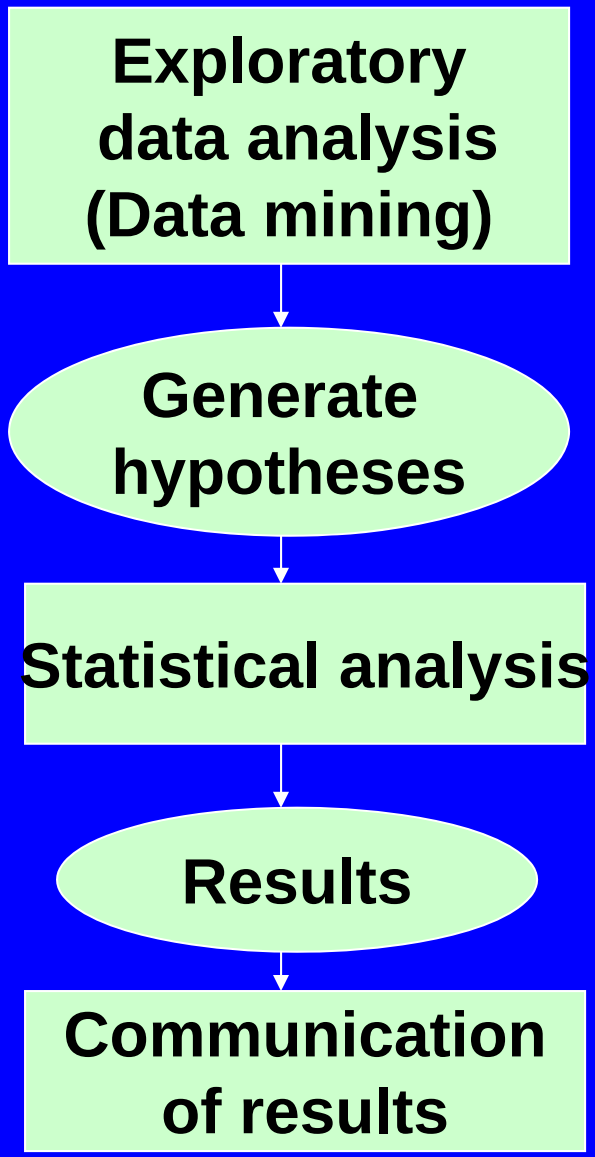
A Framework for Analysis



Goals of Cancer Data Exploration

- Identifying broad geographic patterns
- Identifying clusters of unusually high rates (“hot spots”)
- Generating hypotheses about causes of these geographic patterns
- Illustrating relationships among risk factors

New visualization tools

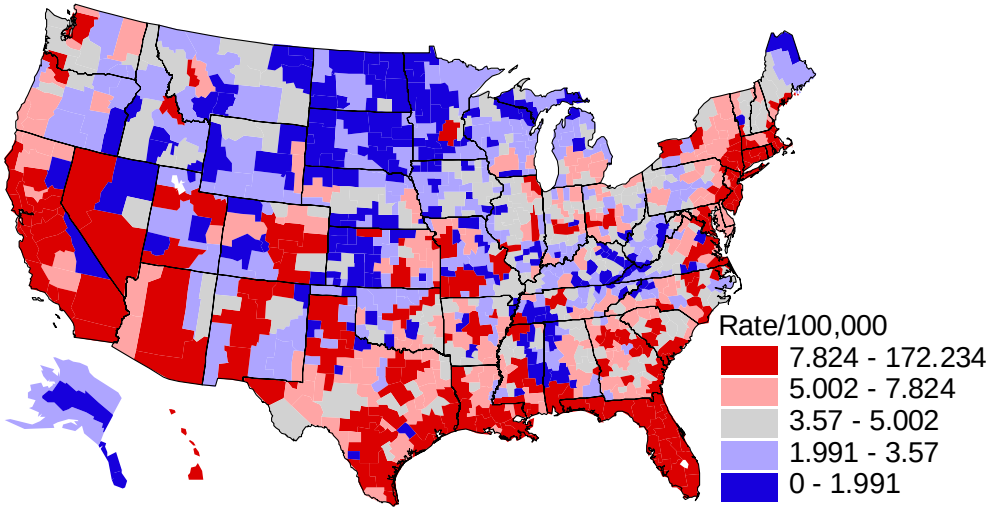
- Map smoothing methods
- Linked maps and graphs
- Maps conditioned on levels of risk factors
- Multivariate plots linked to maps
- Animation over time

Map smoothing methods

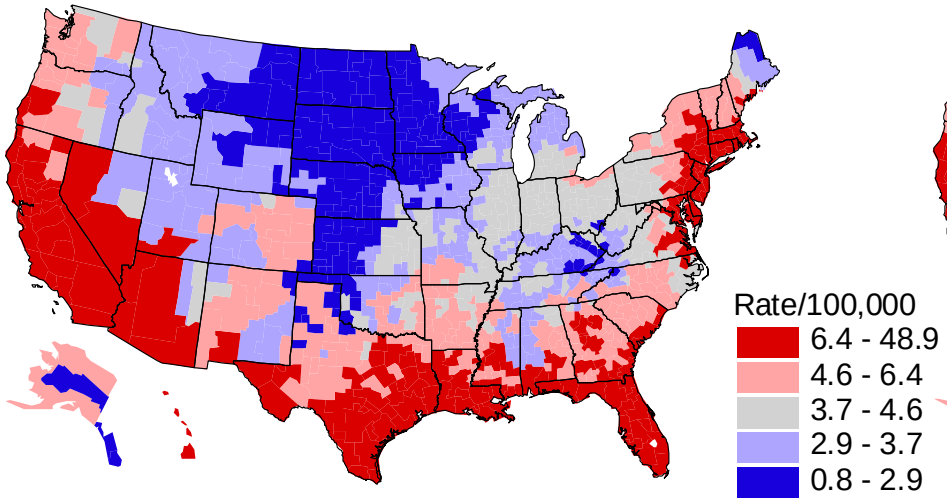
- Smoothing is a method of removing some of the variability in a quantitative map, e.g., of rates
- Maps of cancer rates for small areas, e.g., counties, can be difficult to interpret because of background “noise” (variability)
- Previous methods of smoothing, did not account for varying population size across the areas
- New methods now can incorporate weights so that very stable rates are smoothed less than rates that are more variable due to small populations

HIV mortality rates, 1988-92

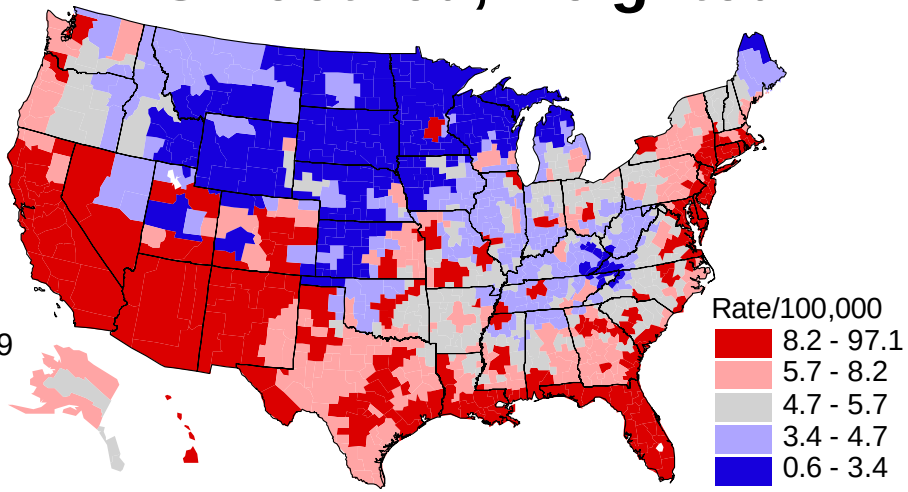
Original data:



Smoothed, unweighted



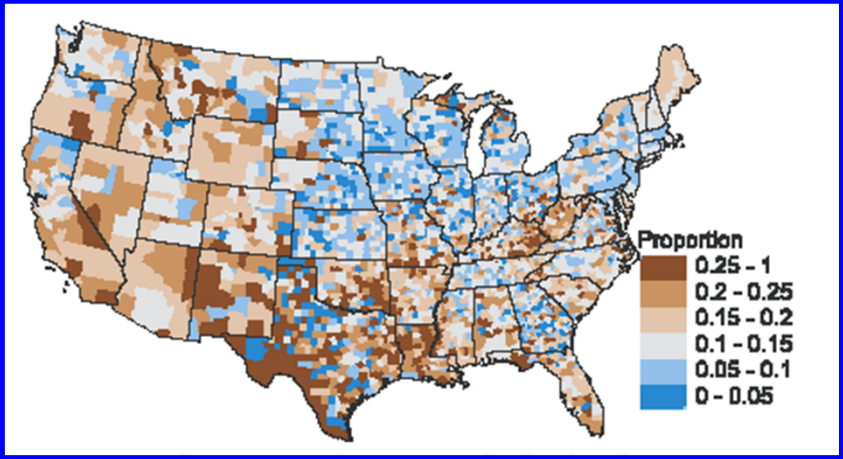
Smoothed, weighted



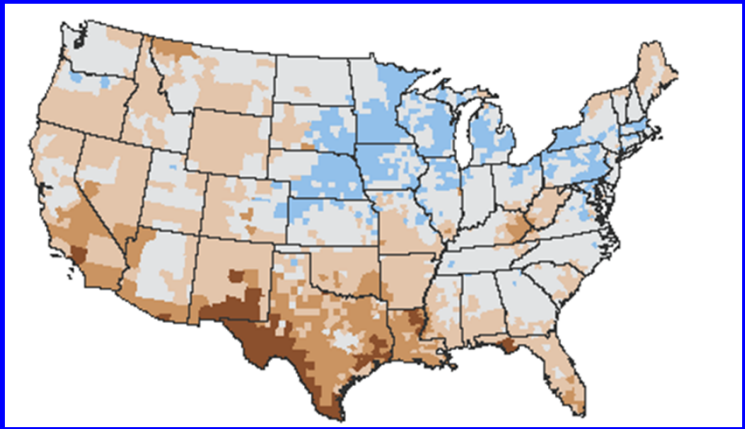
Source: Pickle et al., Atlas of United States Mortality, NCHS, 1996.

Proportion of residents without health care coverage, Behavioral Risk Factor Survey

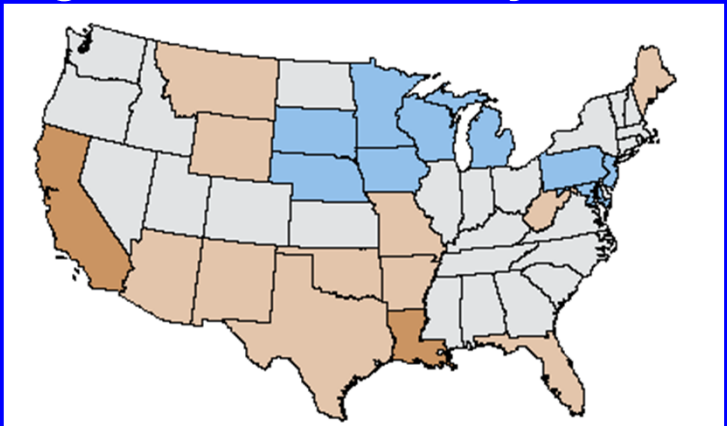
Original data, 1992-98, by county:



Smoothed county data

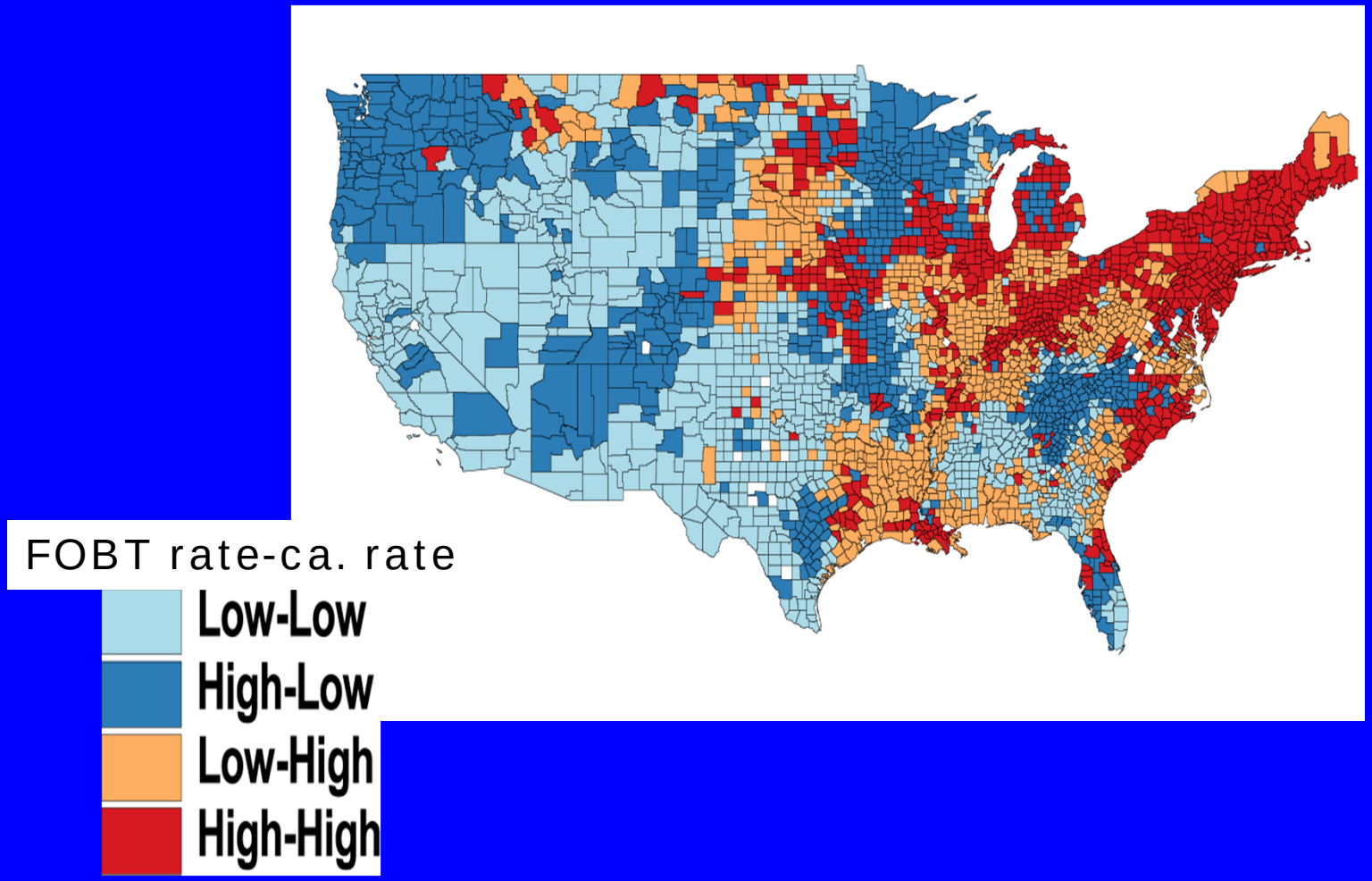


Original data, 1995, by state



Source: Pickle and Su, Am J Prev Med 2002, based on CDC BRFSS data for 1992-98

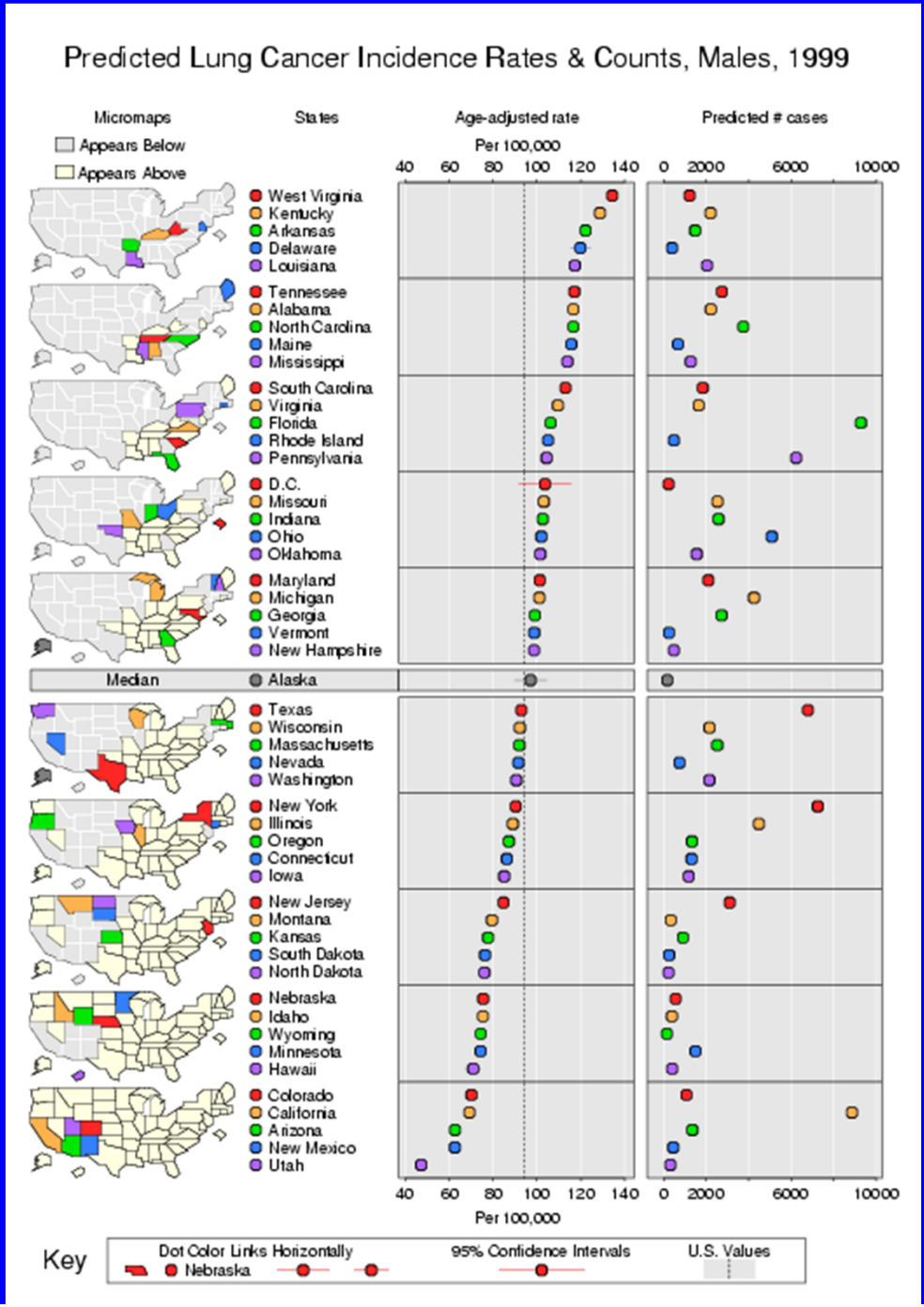
Colorectal Screening Behavior and Cancer Mortality Rates



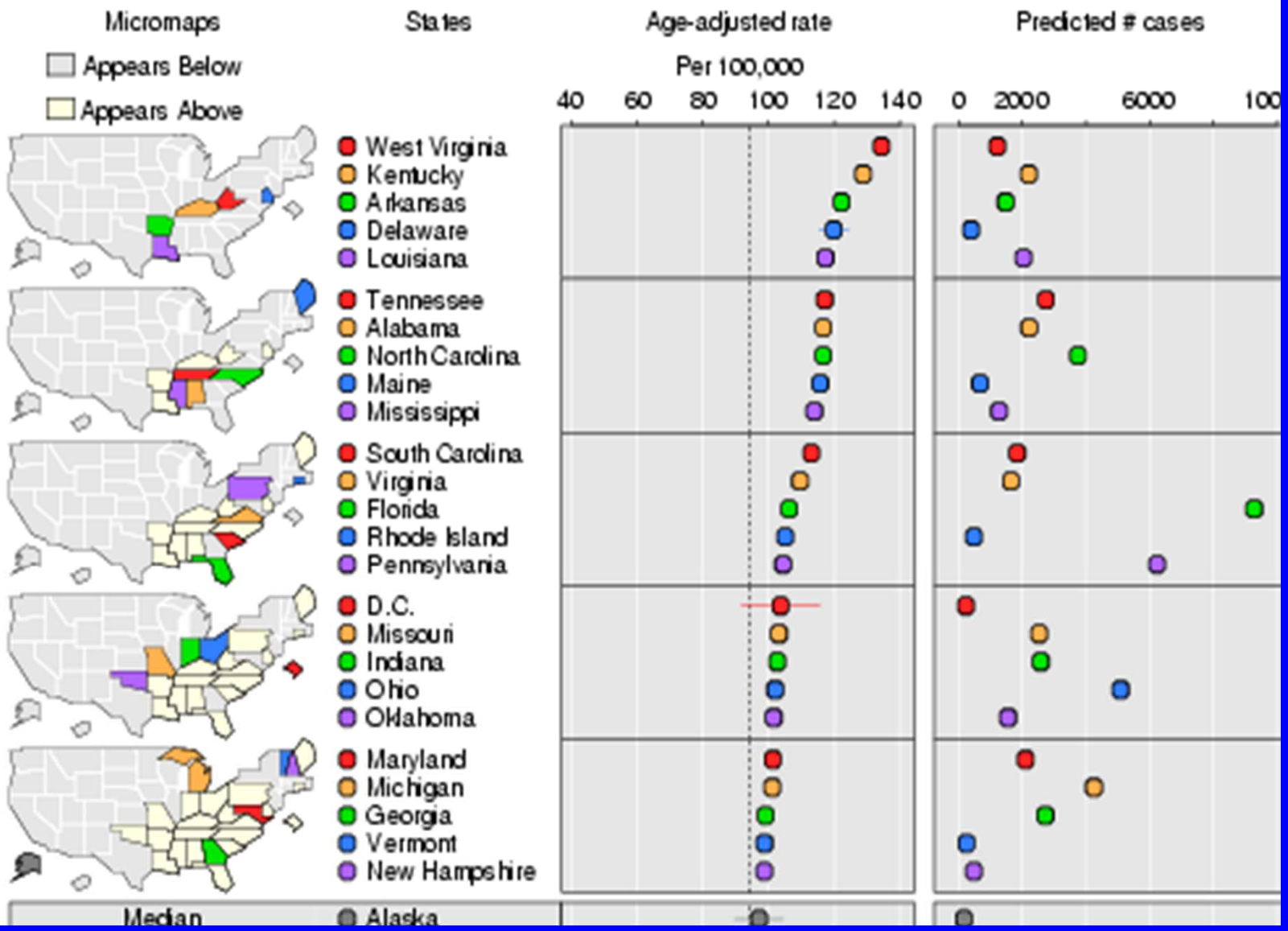
Can we judge geographic patterns and see statistical detail on the same graphic?

- "Linked micromap plot" links statistical graphs to maps, so patterns of both can be seen
- Can be static for publication or dynamic to allow user interaction over the web
- Any geographic units can be plotted – not restricted to states or counties
- Flexible types of statistical graphs

Linked Micromap Plot



Predicted Lung Cancer Incidence Rates & Counts, Males, 1999

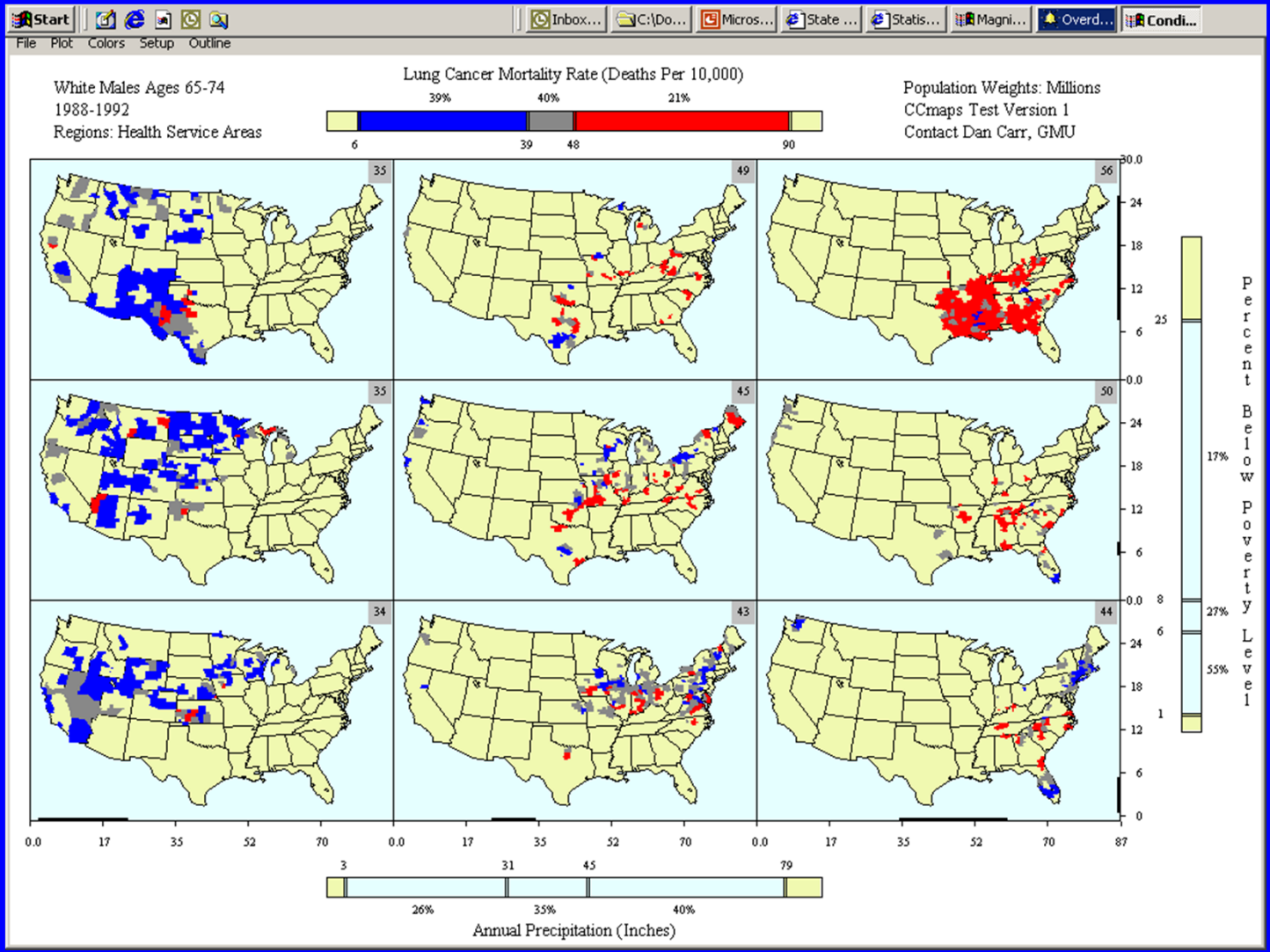


How can we explore the relationships between cancer rates and potential risk factors?

- Cancer rate maps conditioned on risk factors or confounding variables (e.g., income)
- “Conditioned choropleth (area shaded) maps” decompose a single color-coded map into strata according to 1 or 2 other factors
- Slider bars let the user choose how to stratify

Demo of conditioned maps

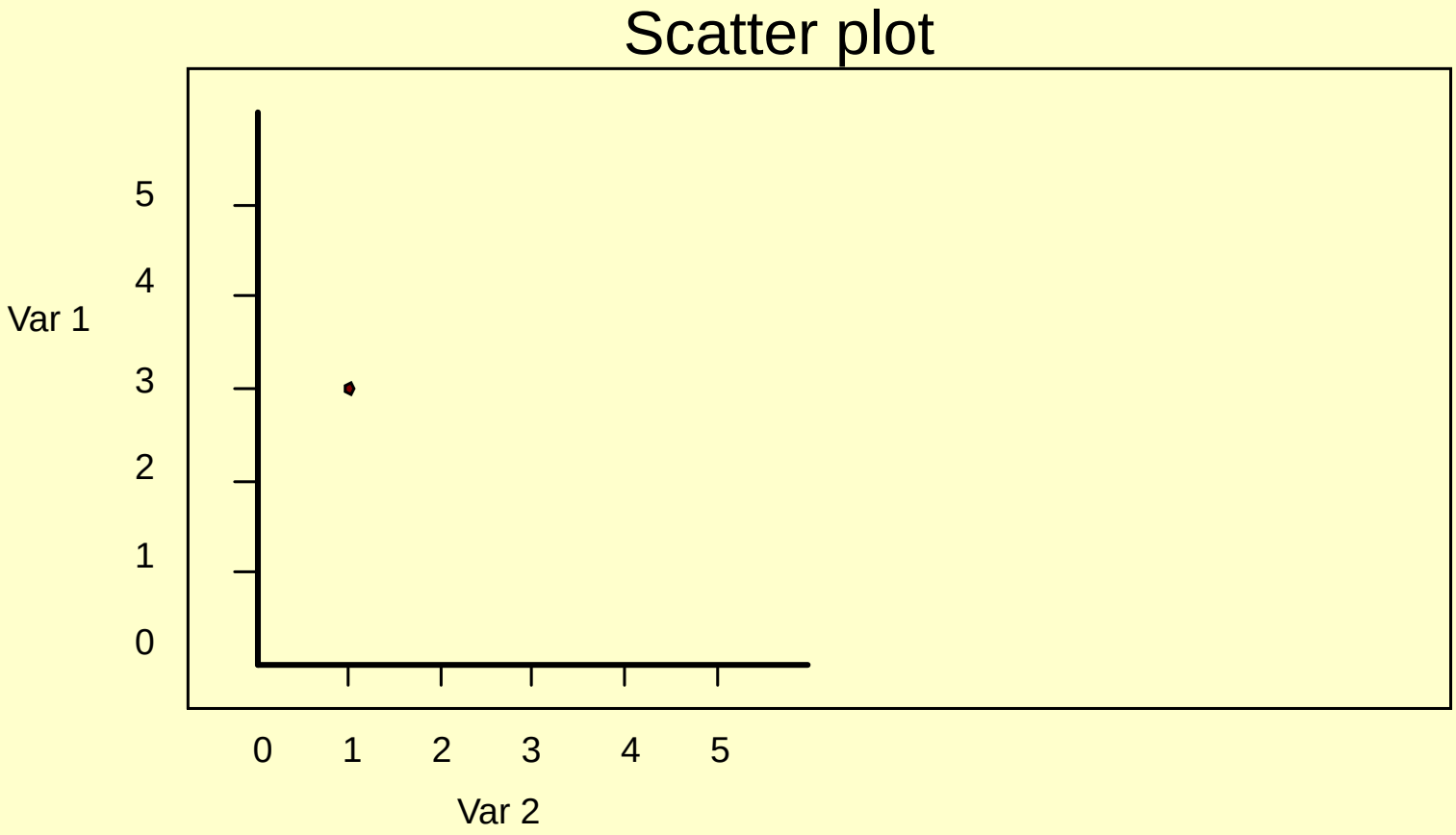
Let users control classifications (high, medium, low) with sliders

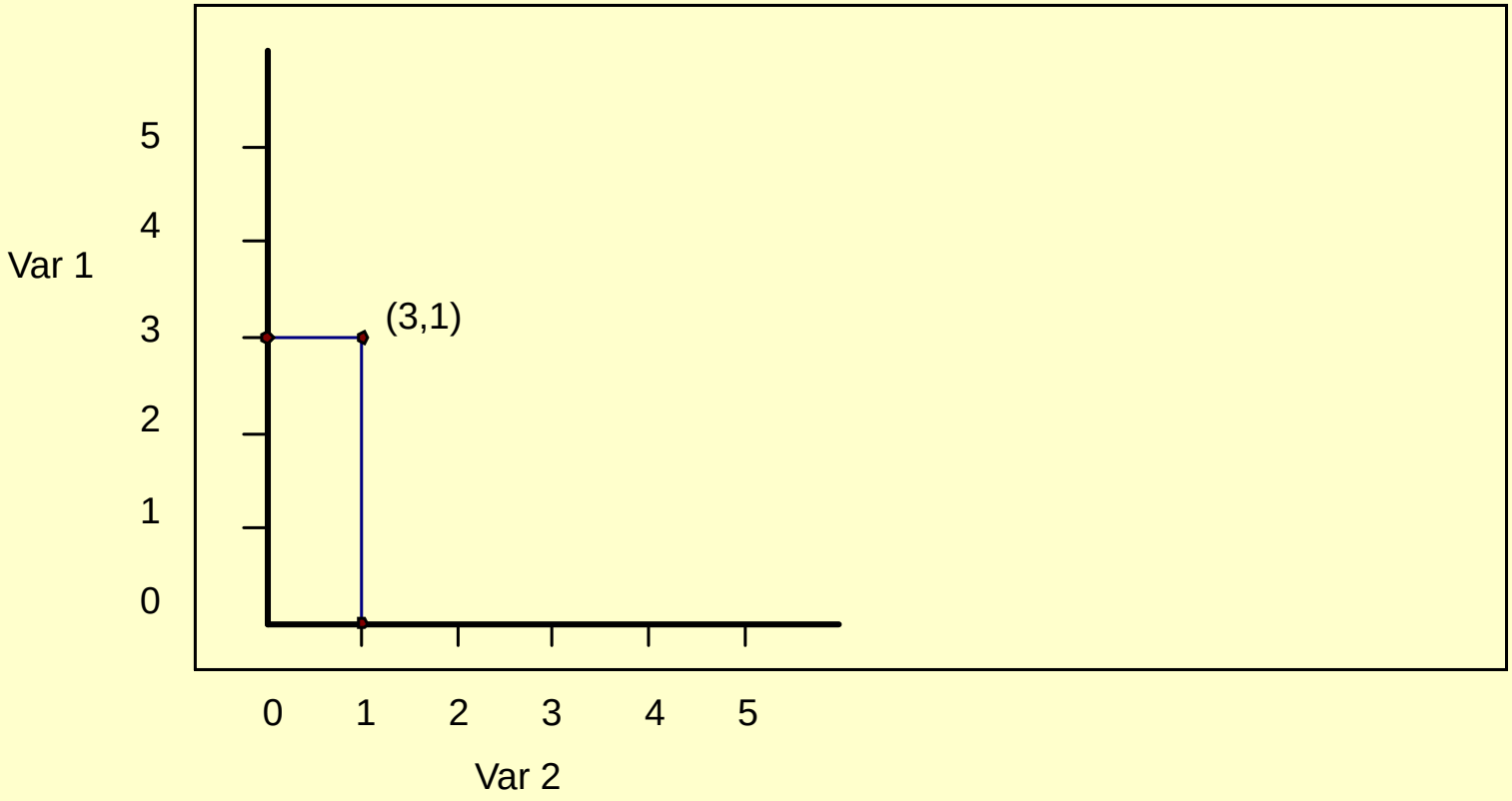


Is there a similar tool for more complex multivariate relationships among factors?

- Parallel coordinate plot linked to a map
- “Linking and brushing”: User can color-code data on plot, see where these places are on map, or vice versa
- Can examine virtually an unlimited # of factors, unlike many other types of plots
- Can add complex statistical tools behind the scenes to guide the user to interesting patterns

What is a parallel coordinate plot?

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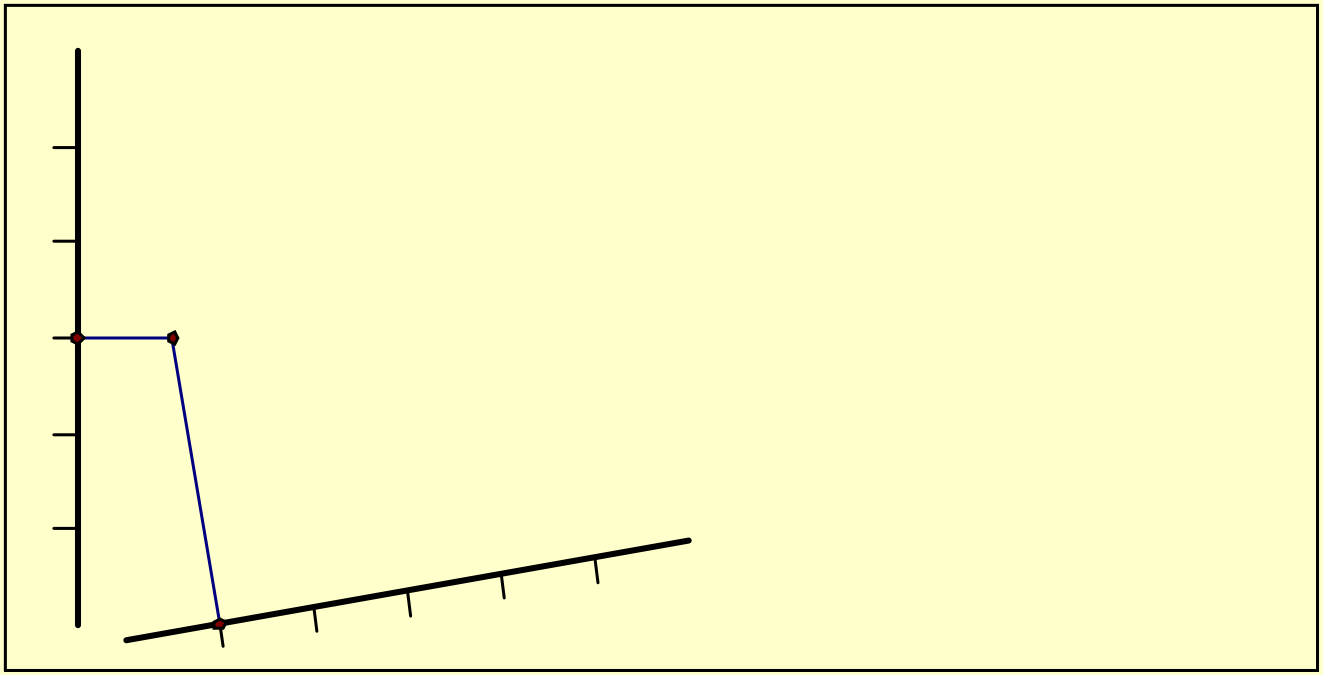

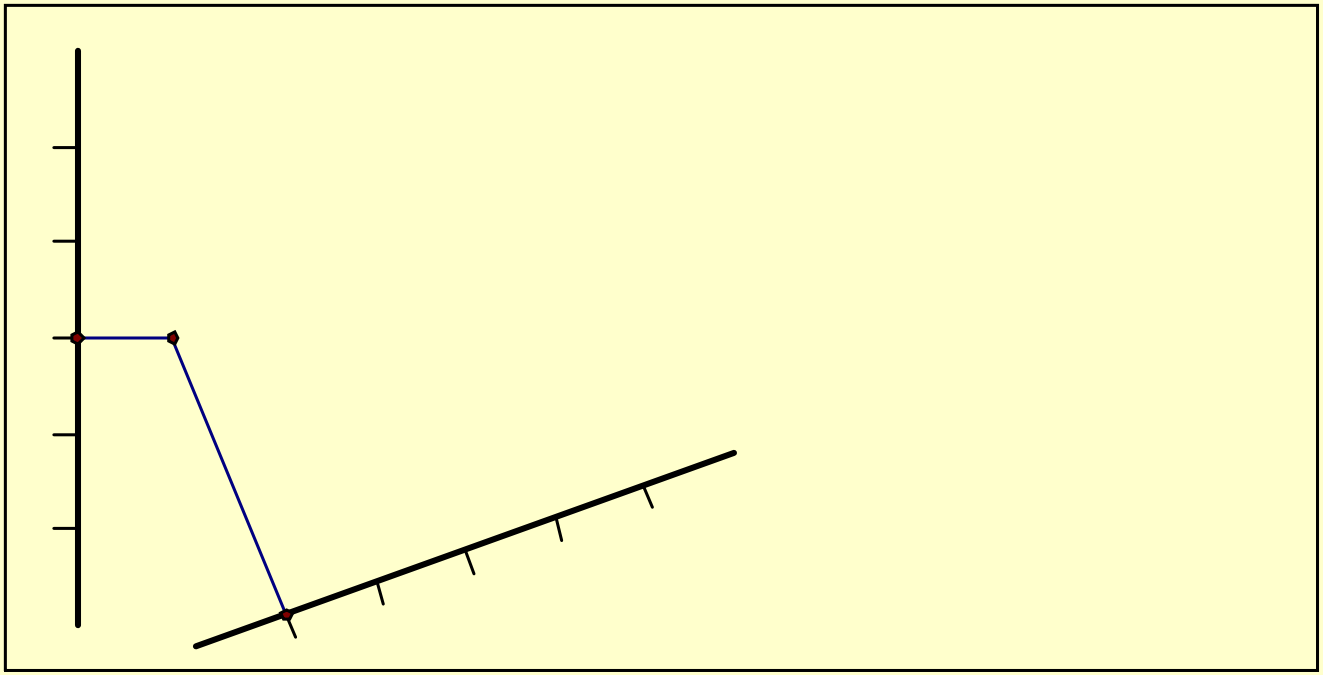

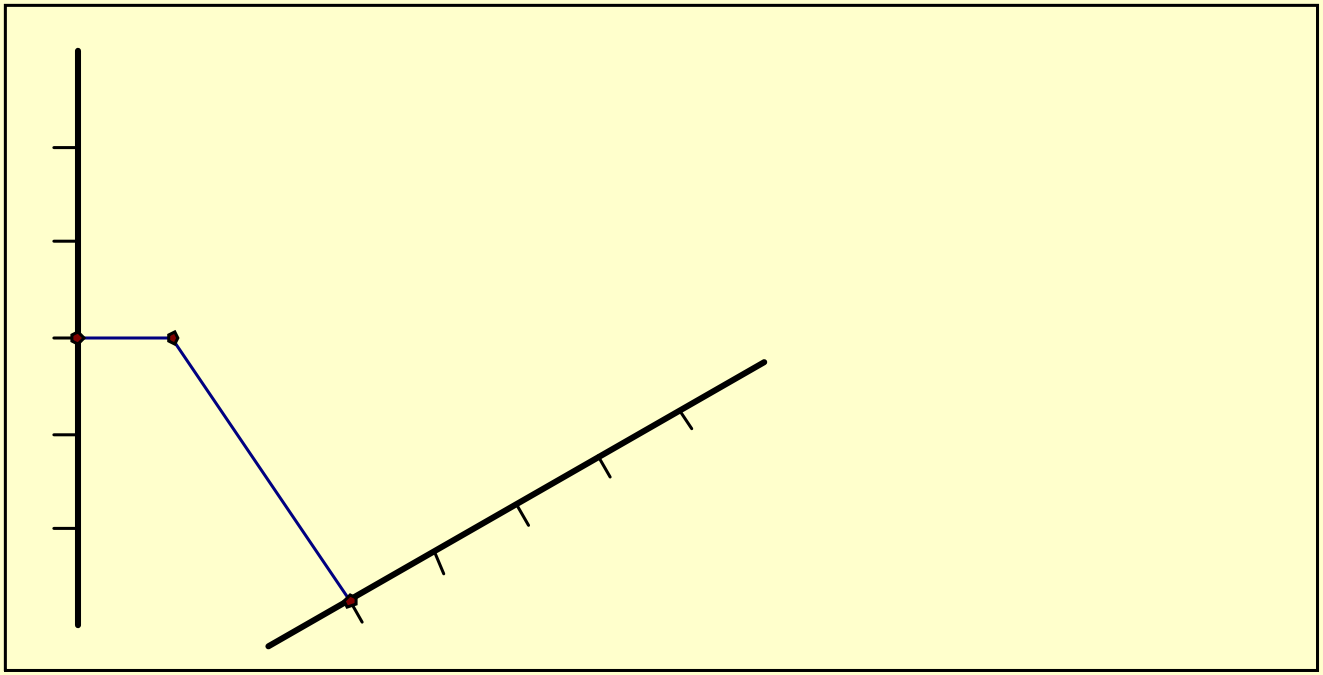

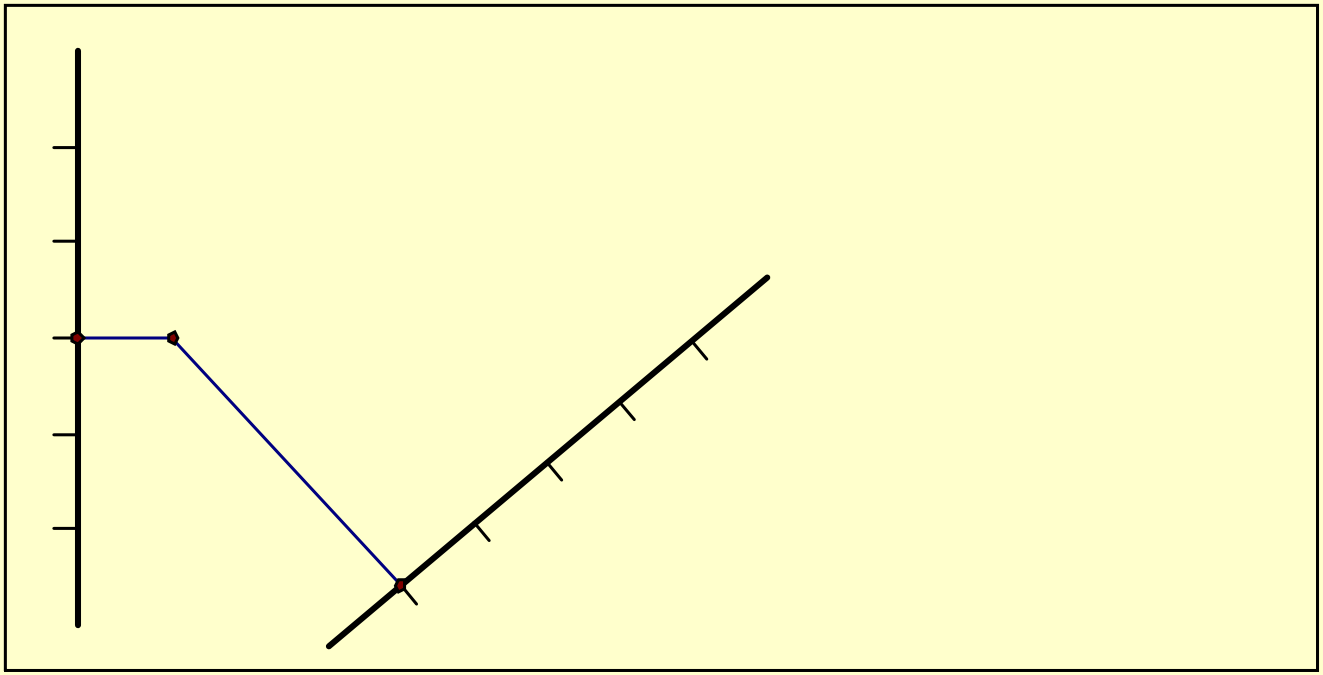

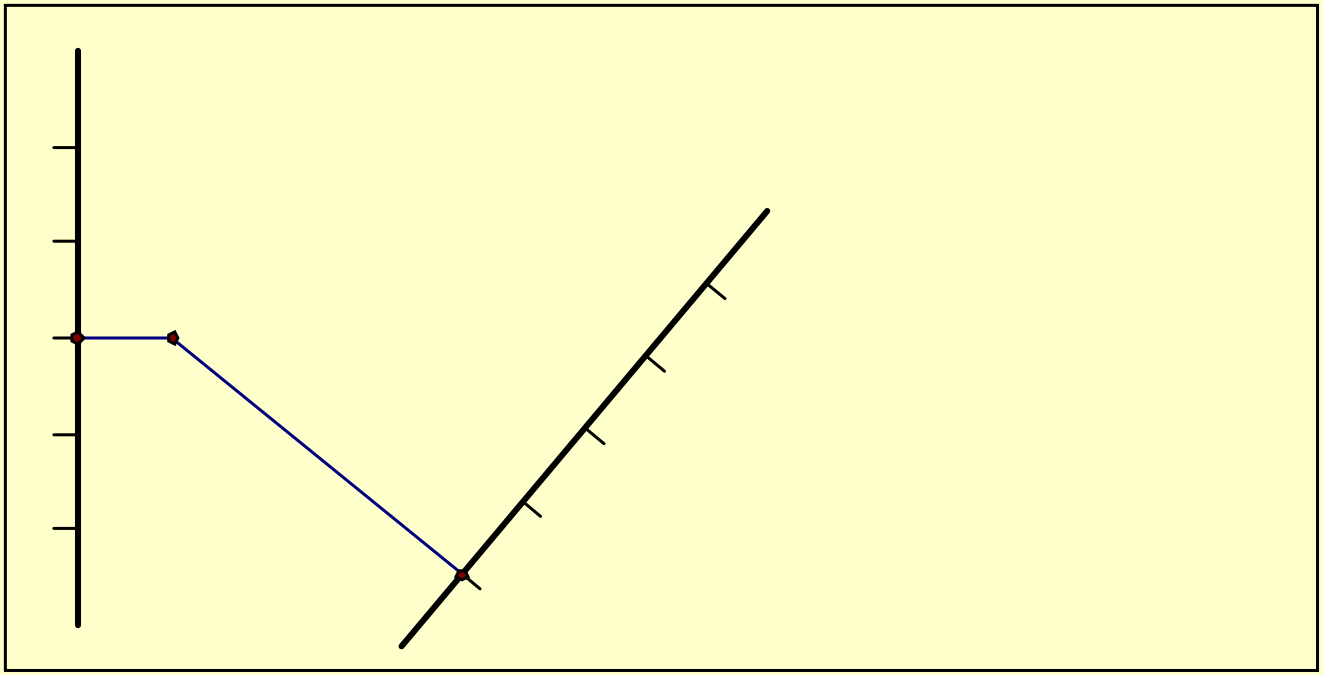

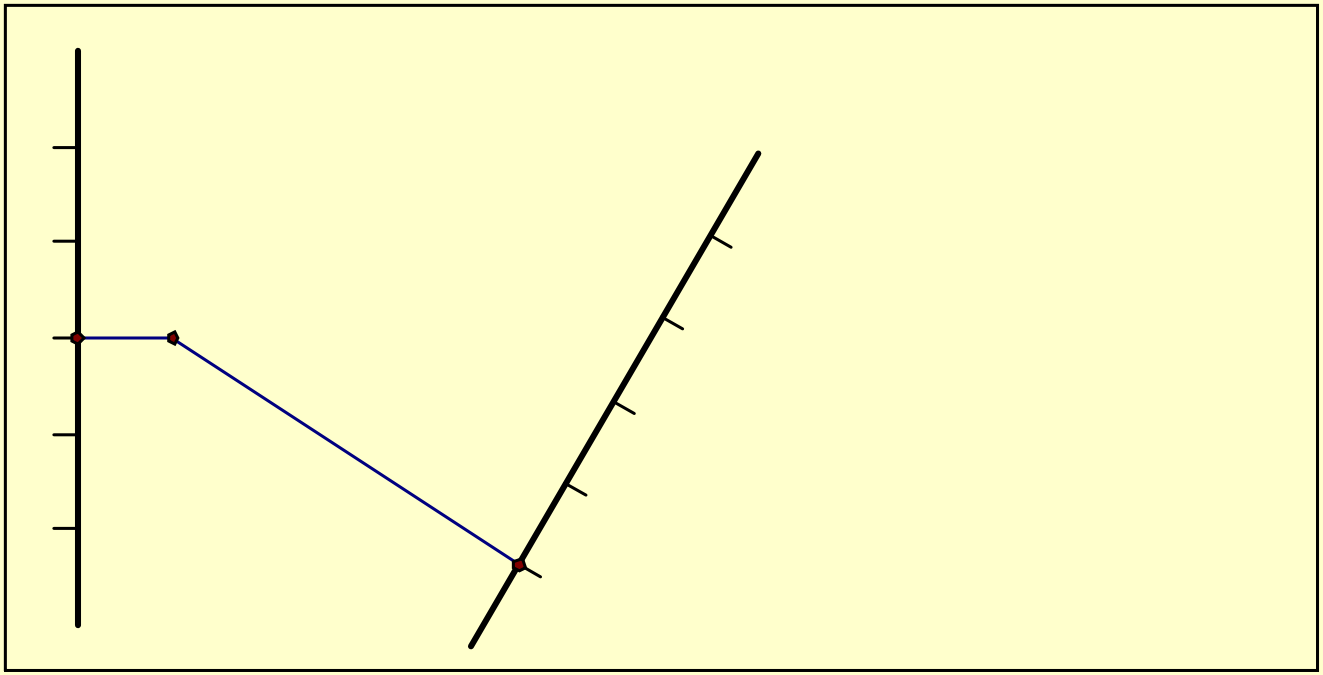

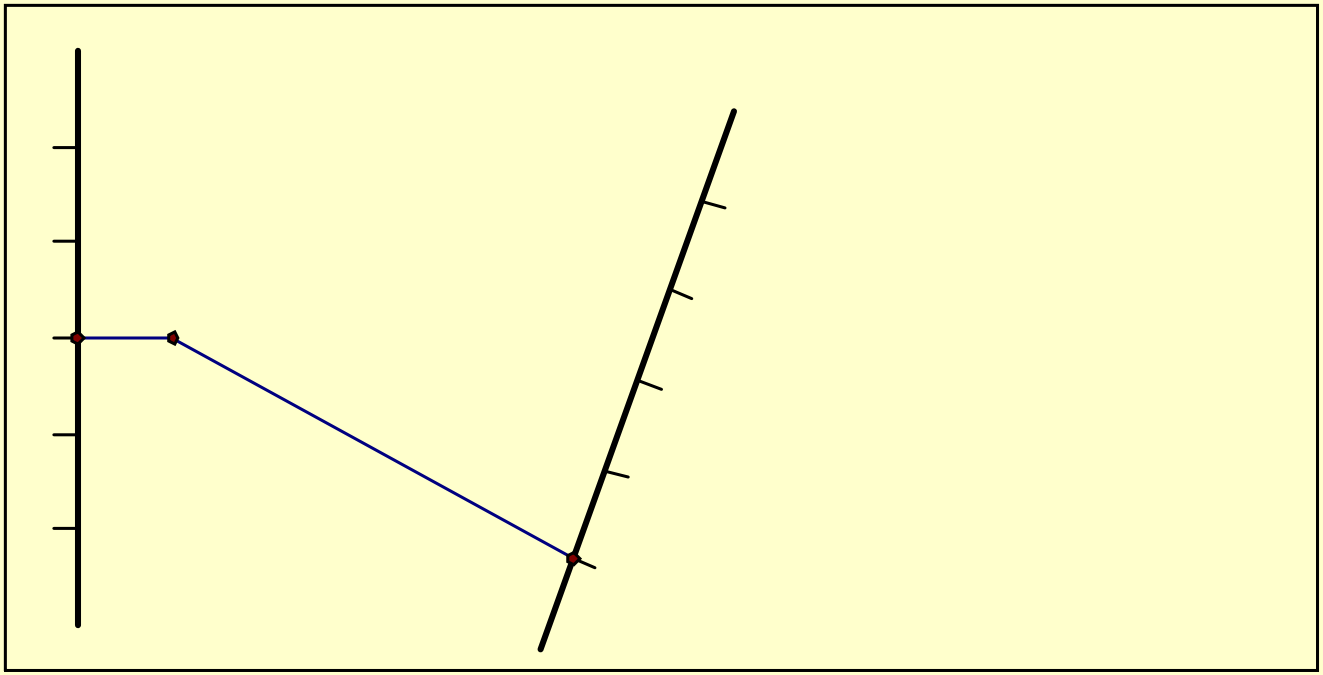

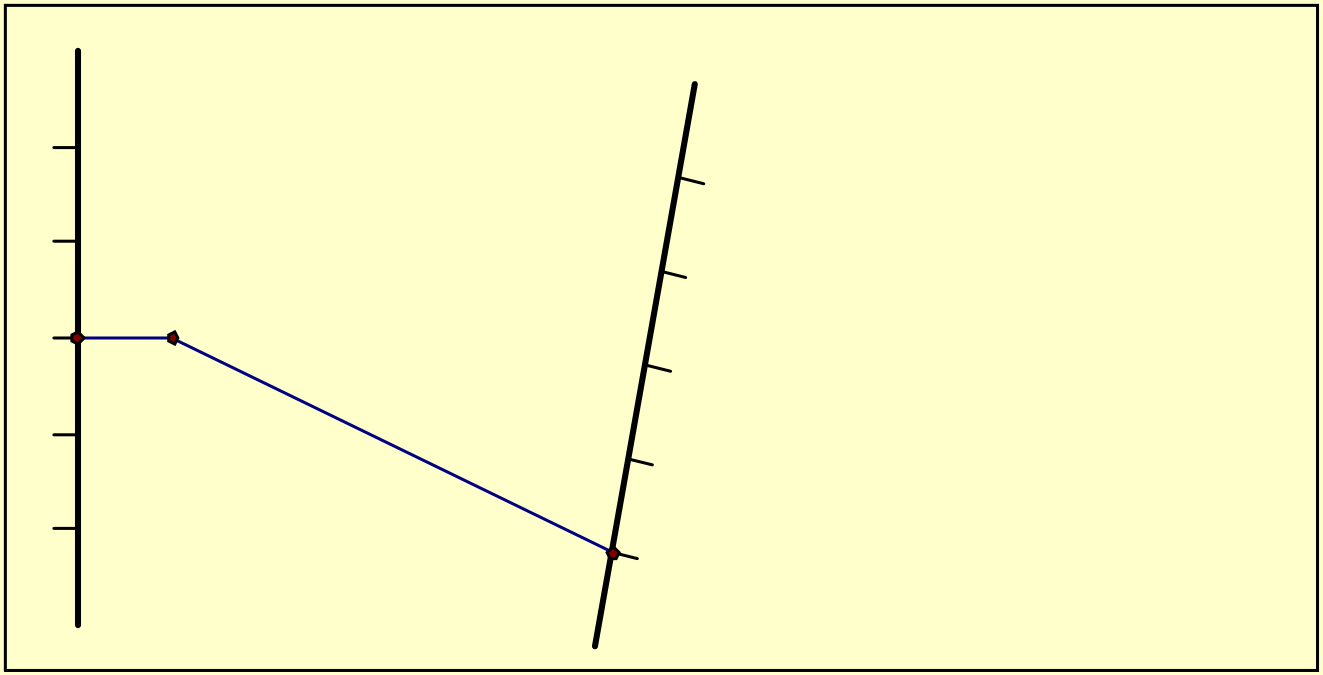

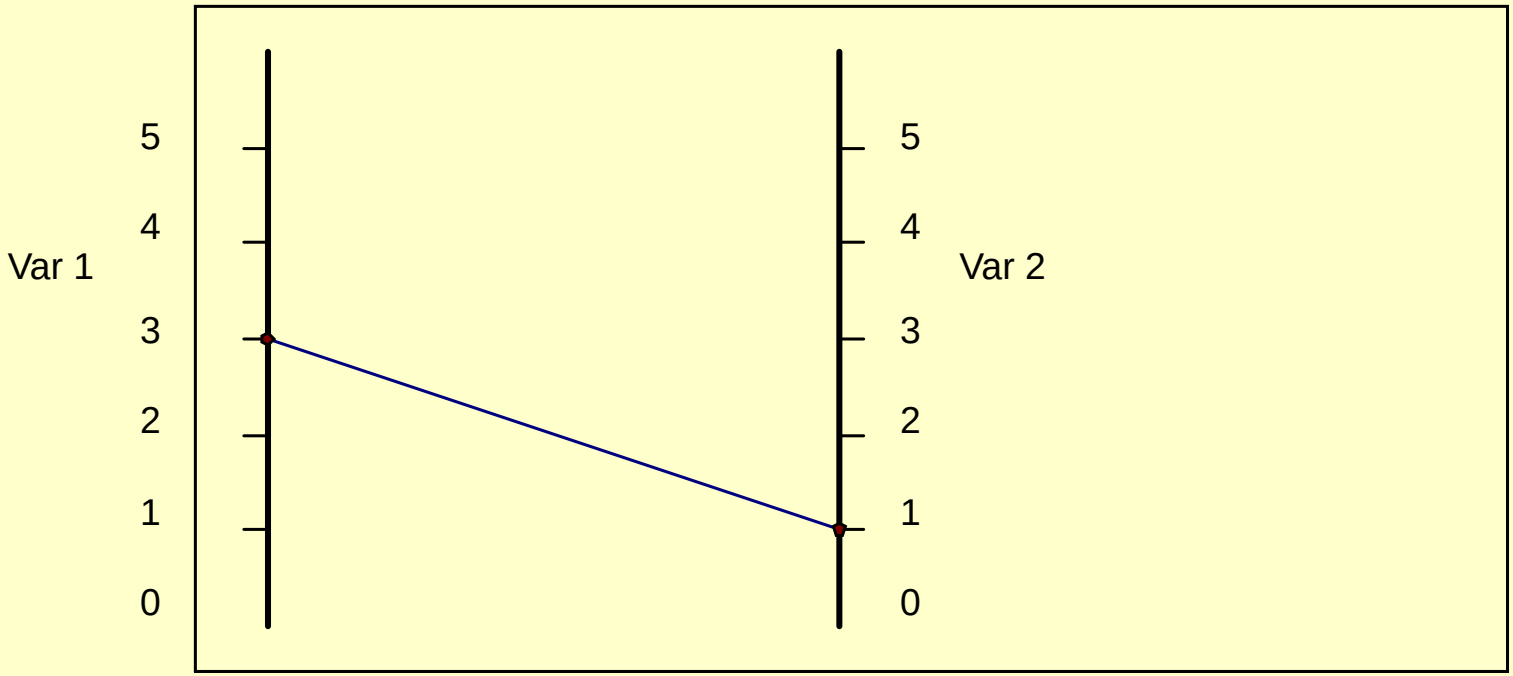
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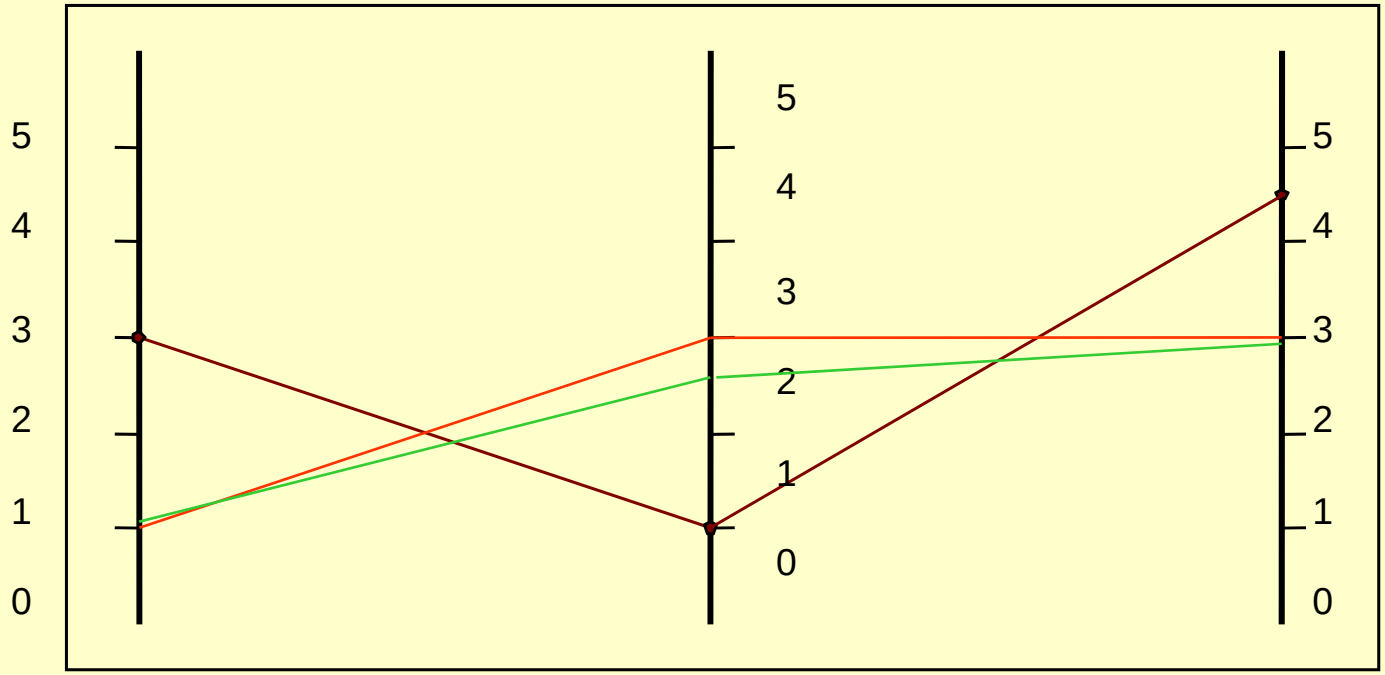
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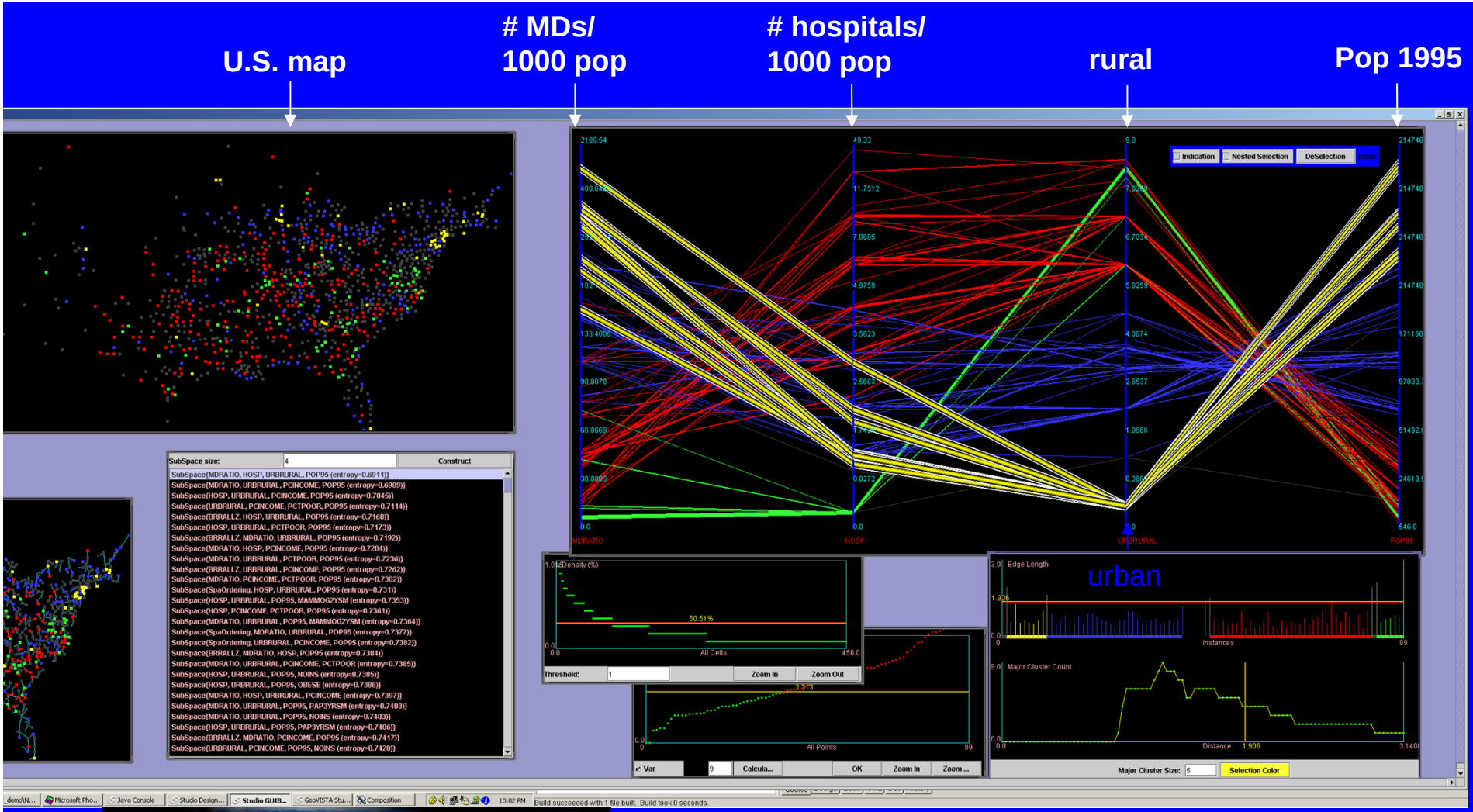
Combining statistical clustering algorithms with new visualization tools



GeoVISTA Center

Alan MacEachren, Diansheng Guo, Penn State University

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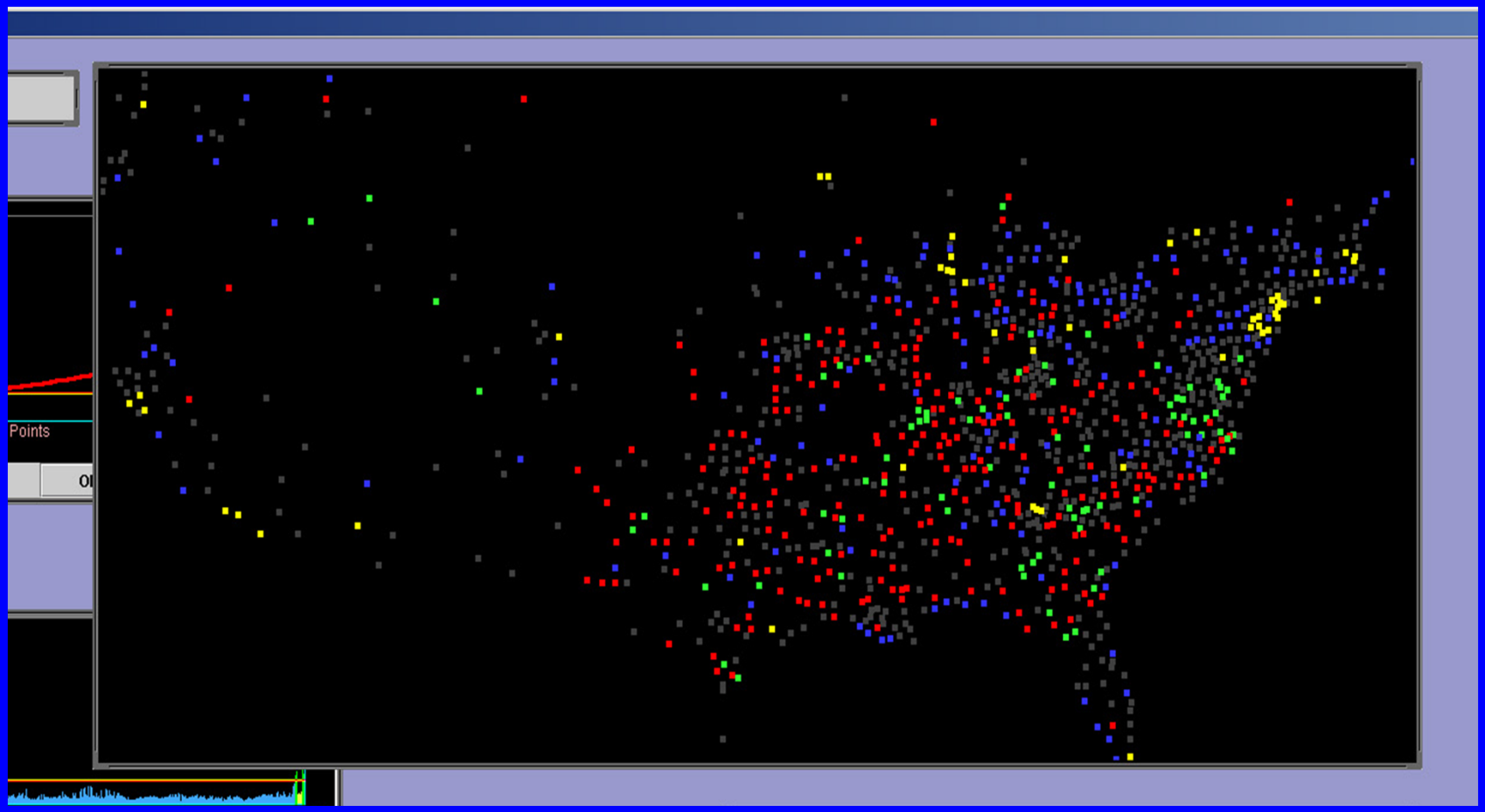
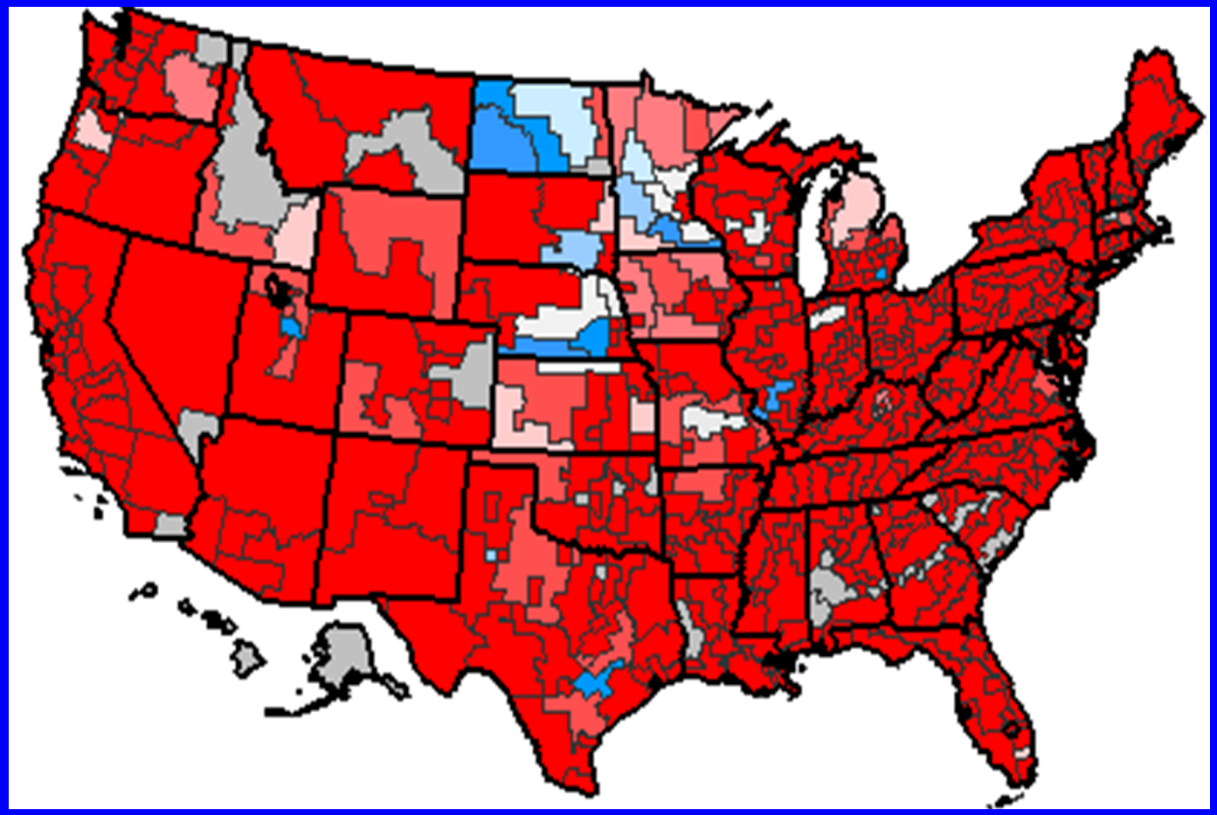


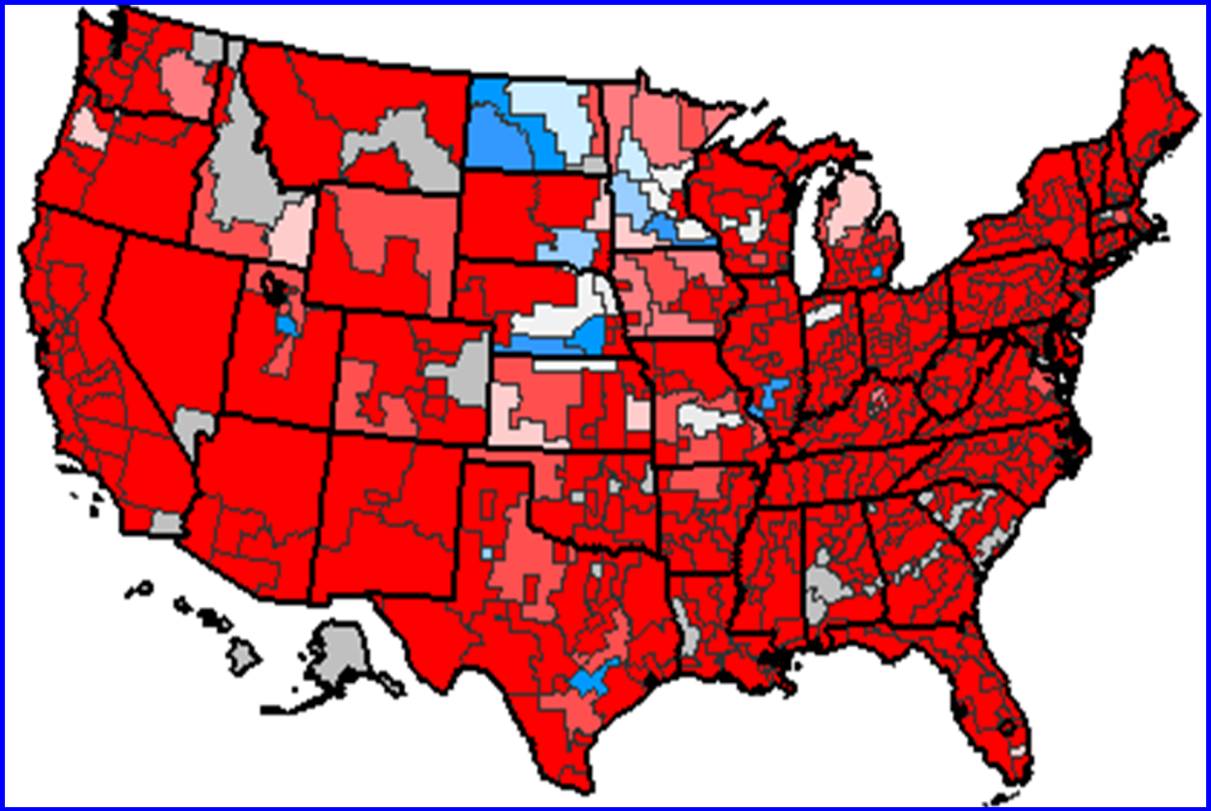
Alan MacEachren, Diansheng Guo, Penn State University

Cervix uteri cancer mortality rates, white females, 1950-94
Time trends by State Economic Area
(dark red=highest rates, dark blue=lowest, gray=sparse data)

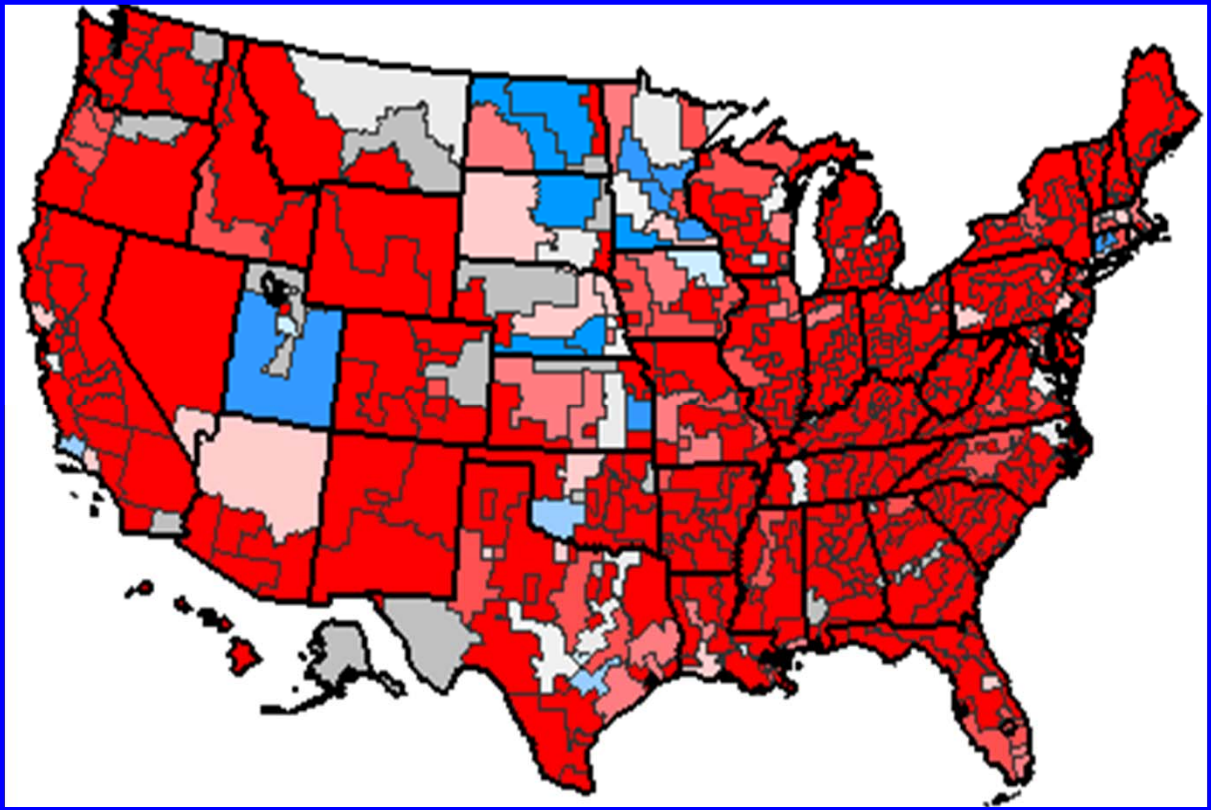
1950-54



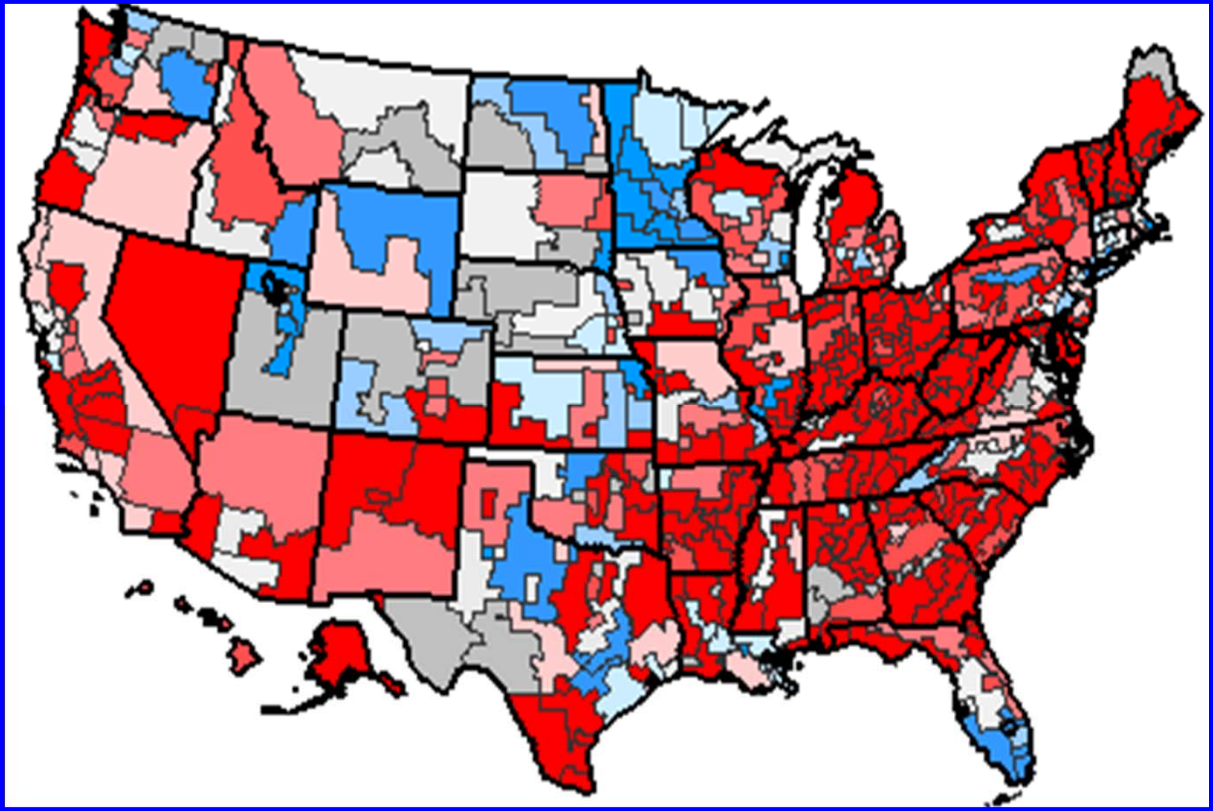
1955-59



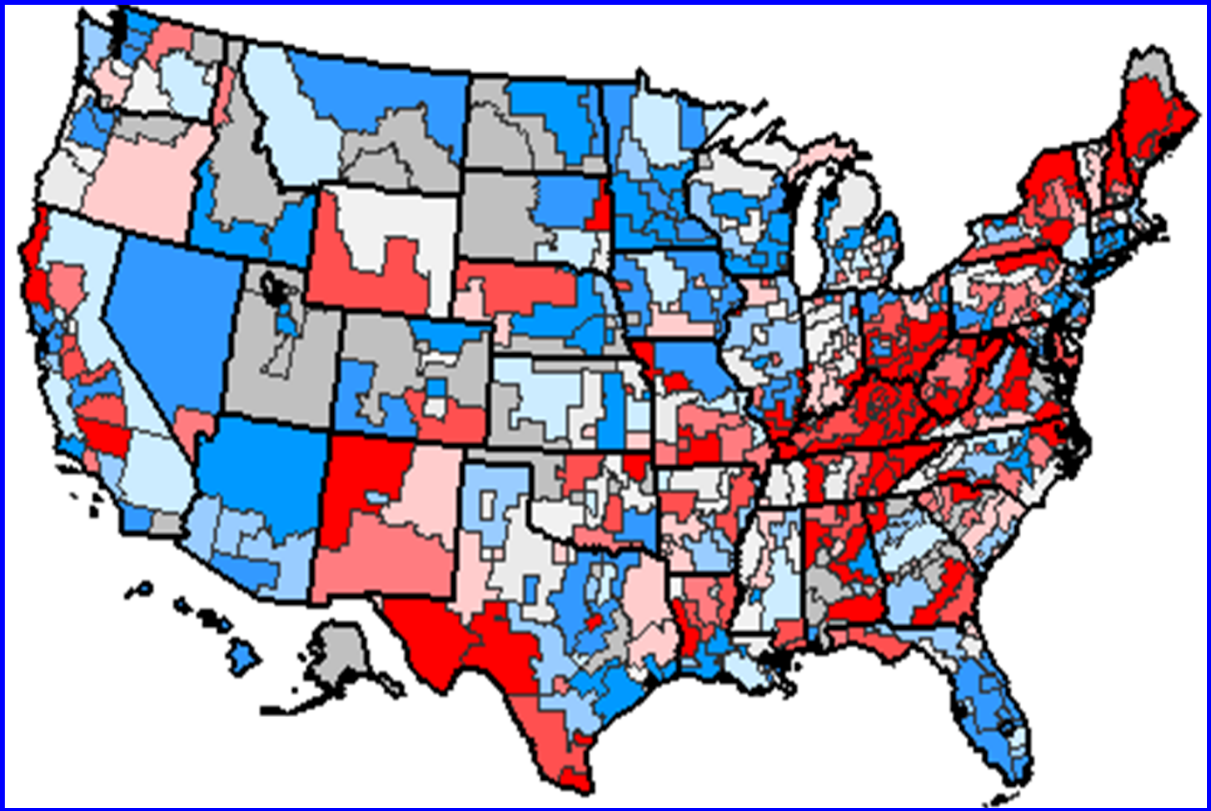
1960-64



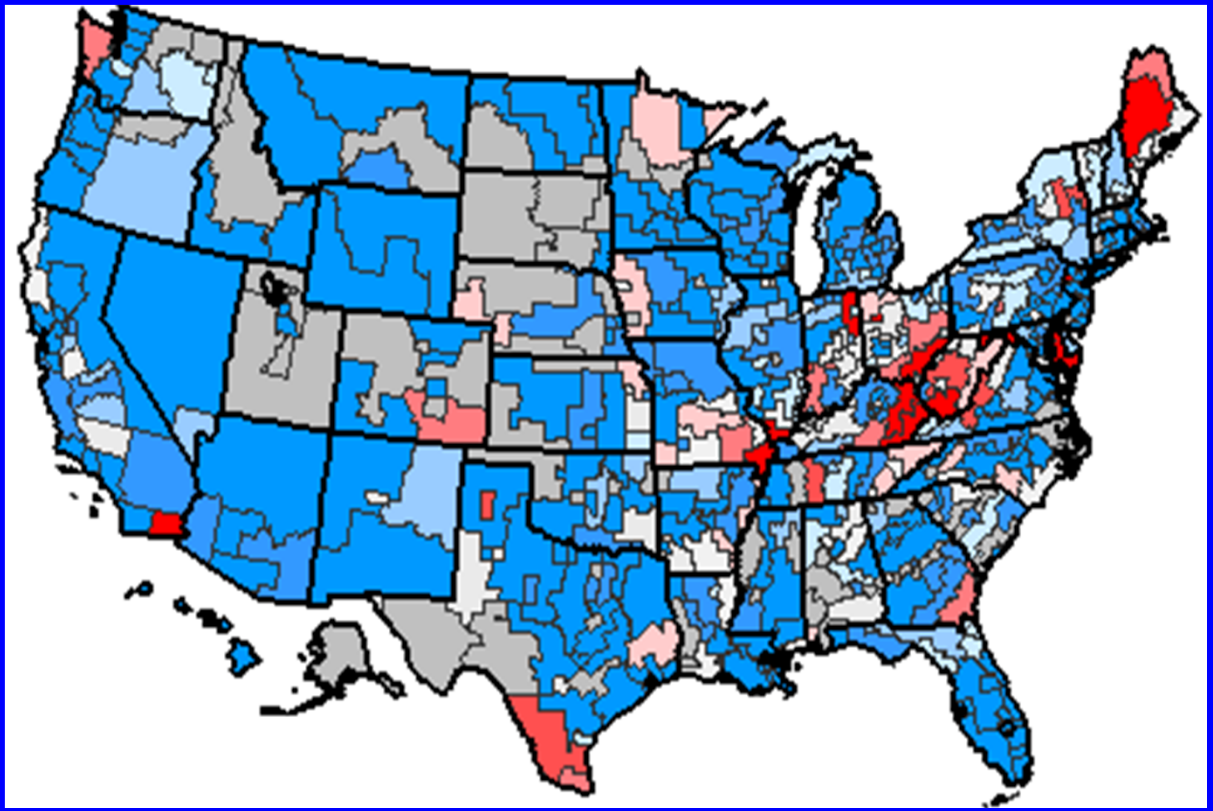
1965-69



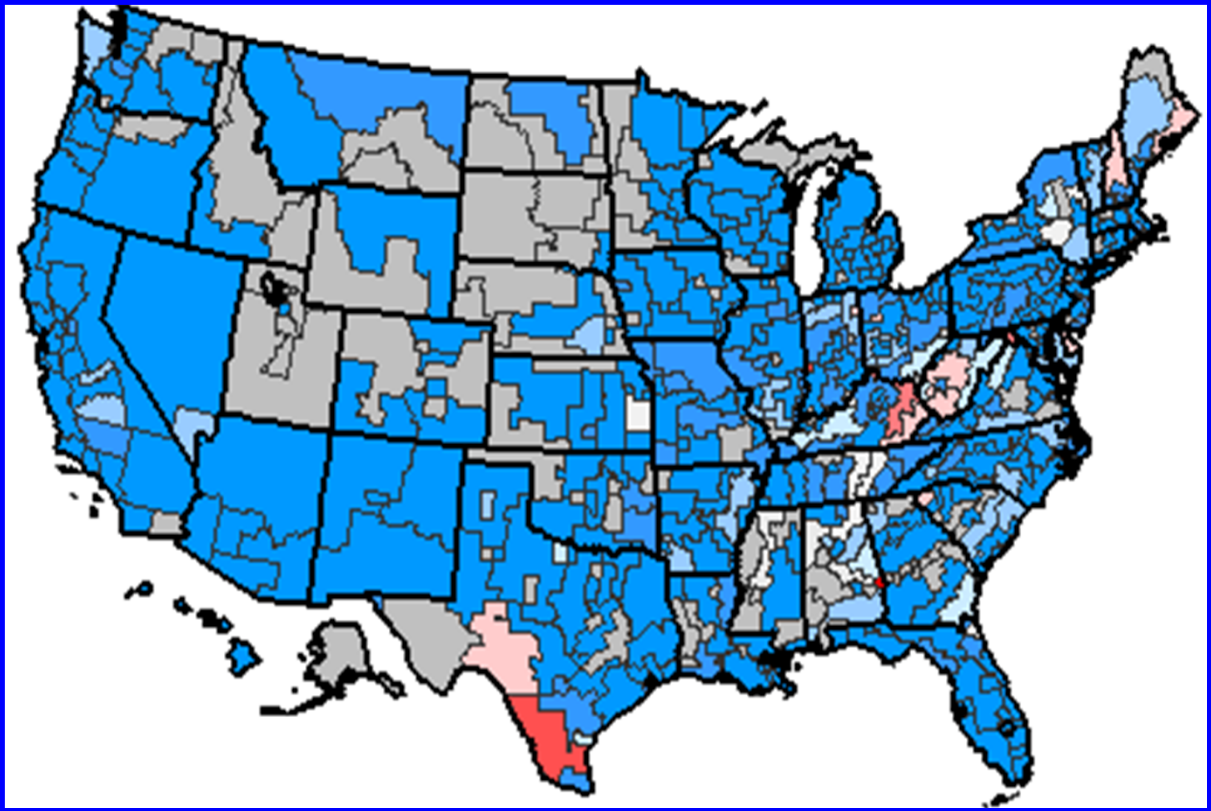
1970-74



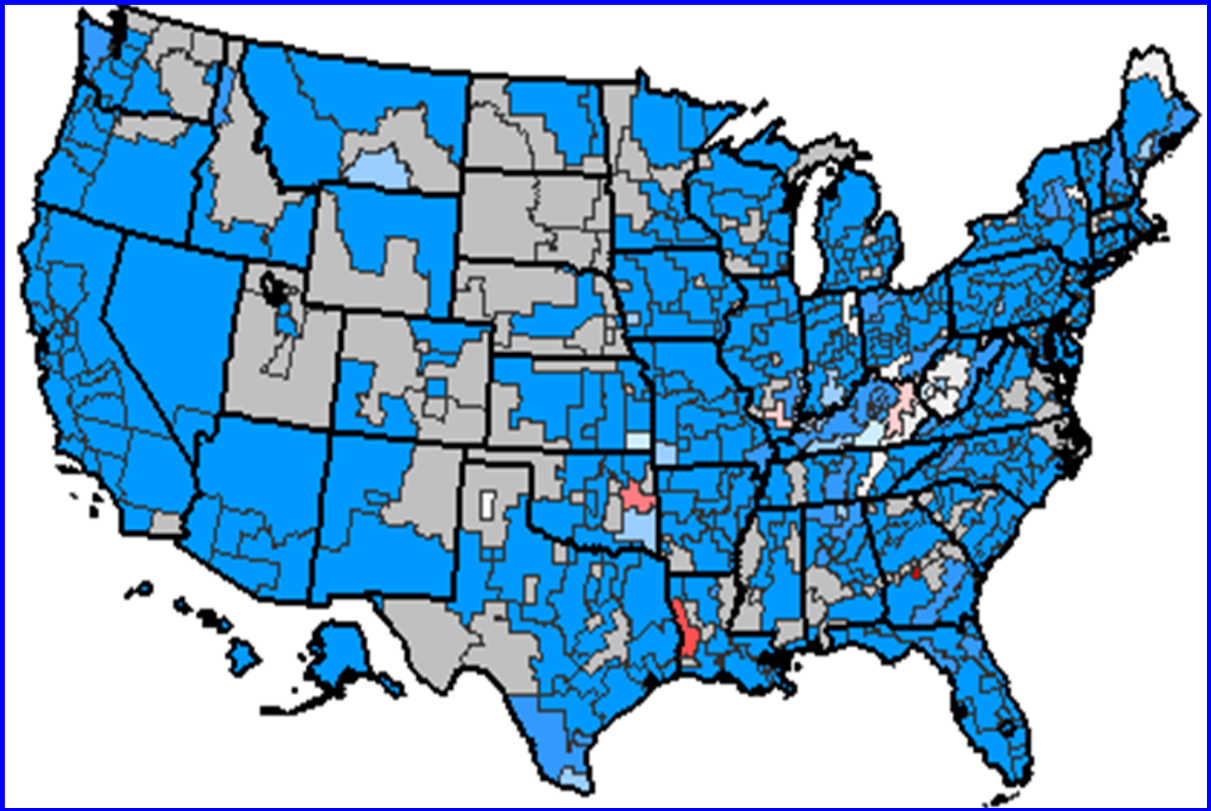
1975-79



1980-84



1985-89



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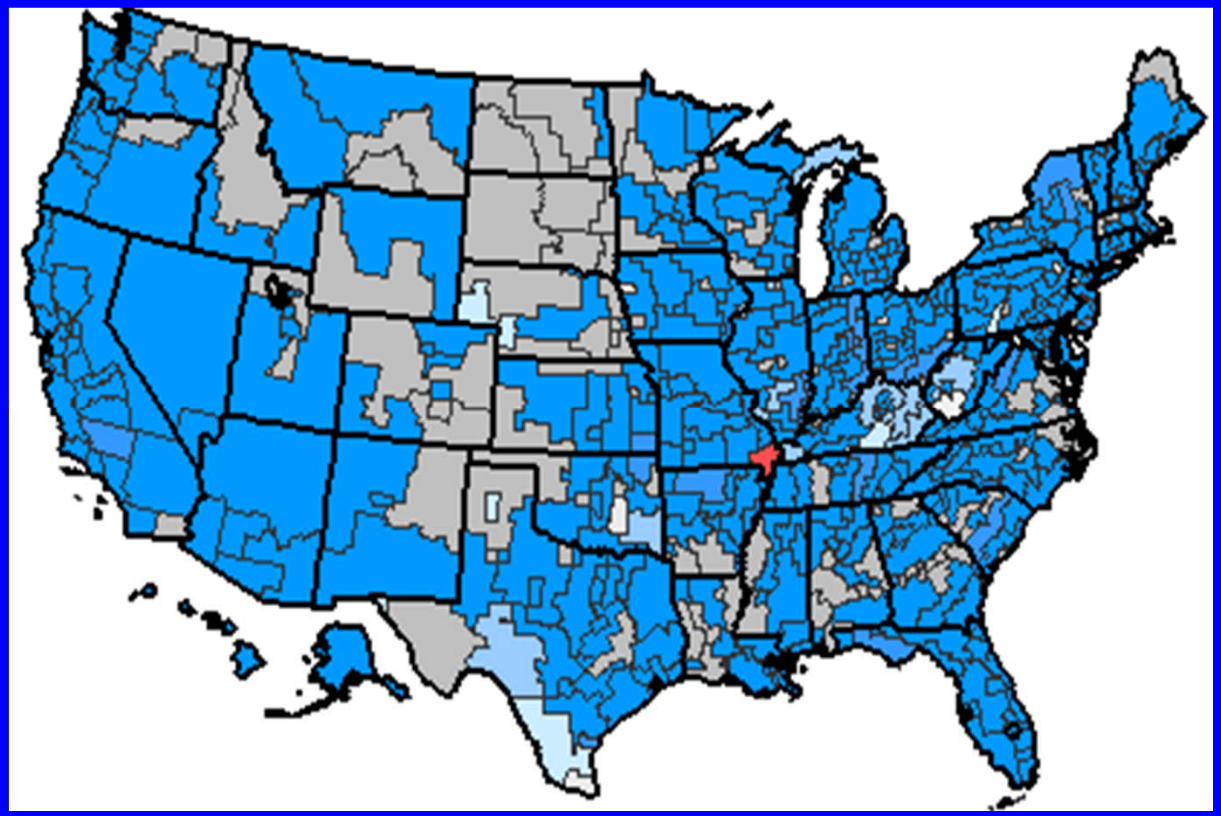
1990-94



Collaborators

- NCI is a partner in a Digital Government Initiative (NSF) grant to develop better visualization tools to "improve the way government serves the American people" (web site: diggov.org)

  Dan Carr, George Mason University

  Alan MacEachren, Penn State University

  David Scott, Rice University

- NCI geographic information systems grant

  Alan MacEachren, Penn State University

- NCI sabbatical

  Dan Carr, George Mason University