Revisiting two charts of the Statistical Atlas 1874

Heike Hofmann*,[a], Ryan Goluch[b]

[a] *Department of Statistics and Statistical Laboratory, Iowa State University, Ames, IA 50011-1121*

[b] *Department, Iowa State University, Ames, IA 50011-1121*

Abstract

This is the abstract.

It consists of two paragraphs.

Introduction

Three times in the past, the US Census Bureau published a Statistical Atlas to map the state of the Union based on data collected in the 9th, 10th, and 11th US census (in 1870, 1880, and 1890). Each of these atlases represents a masterpiece in science and technology. Here, we want to focus on the ninth Census, supervised by Francis A. Walker. At this time, the United States had a population of about 38.5 million people. The Atlas represents a graphical compendium of the census information prepared in more than 100 lithographic plates. Most of these plates are overlaid maps, but some consist of more abstract and, at that time, novel visualizations. Of particular interest are plates #31 and #32. Both of these plates have a very similar studture: they show what are now known as mosaic plots or Marimekko charts in small multiples, one for each state.

XXX What we are planning on doing here

1. *Discuss the charts:*
2. *Recreate the charts:* that involves to get the data, check that it is the right data and re-create the charts (to the degree that modern charts will allow us to do that). In order to be able to check the data for correctness, we have to digitize the information provided in the chart (by measuring the relevant geometric objects).
3. *Re-display the data:* some of the visualization choices made in the original charts are cognitively questionable. Re-displaying the data also allows us to introduce a spatial component.

Gender Ratio in Agriculture, Trade, Service, Manufacturing, and Schools

Figure 1 shows a miniature of the chart published as plate #32 in the Statistical Atlas of 1874 (Walker 1874) produced from data collected in the 9th US Census. The chart is set-up in form of small multiples (Tufte 1991), also known as lattice or trellis plots (Becker, Cleveland, and Shyu 1996), one for each state and an enlarged plot as with an overview of the nation-wide aggregates. States are represented by squares of the same size, representing "the total population over 10 years of age", as detailed in the zoom-in in Figure 2, which shows the description at the top of the plate.

With the help of the description and the legend of Figures 2 and 3, we can interpret the details of each of the squares at the example of Figure 4. This figure shows an overview of type of occupation by gender across the US in 1870. It is essentially a mosaic (Hartigan and Kleiner 1981) or Marimekko plot [citation?] of type of occupation (horizontal) and gender (vertical), but with a twist: the grey band around each one of the states' squares is proportional to the number of population "unaccounted" for, i.e. the difference between the total population over

*Corresponding Author

Email addresses: hofmann@mail.iastate.edu (Heike Hofmann), rgoluch@mail.iastate.edu (Ryan Goluch)

the age of ten and the population gainfully employed in one of the five categories or attending school. The choice to show this part of the population by a band around is somewhat unfortunate, as it breaks the overall metaphor of the mosaicplot and thereby prevents any direct comparisons across charts except for area comparisons, which are cognitively harder and more error prone than comparisons of lengths (Cleveland and McGill 1984). It also masks the size of the population that is thus *unaccounted* for by visually cutting it into a quarter of the size it actually is. The percentage of unaccounted individuals is at about 30% nation-wide higher than any of the other groups. It is also made up of about 97% women and girls.

The Data

Data retrieved from Minnesota Population Center (2016) - from table NT13 on "Employed Population by Occupation by Age by Sex". XXX The numbers in this table are state-level aggregates of population numbers by gender and occupation. XX Adding sample? Because state-level aggregates of the number of total population above the age of ten is not available, we are making use of the 1% microsample of the ninth census provided by the Integrated Public Use Microdata Series (IPUMS-USA) provided through the Minnesota Population Center (Ruggles et al. 2015). This allows us to find state-wide estimates for the size of the male and female population above ten for each state. Based on these estimates we derive the size of the population not "gainfully employed" or attending school. Figure 10 shows that the numbers combined from NT13 and the microsample closely match the information on plate #32. For all occupation levels and school attendance the numbers are *very* close. For population not accounted for, the numbers are estimated from the 1% ipums microsample. this inflates the variability in these numbers, but the relationship to the visual measurements is still very strong.

Maps

The R package `USAboundaries` (Mullen 2016) provides historical US state borders. This is used to map the US in 1870 in Figure 8.

References

Becker, Richard A., William S. Cleveland, and Ming-Jen Shyu. 1996. "The Visual Design and Control of Trellis Display." *Journal of Computational and Graphical Statistics* 5 (2): 123–55.

Cleveland, William S., and Robert McGill. 1984. "Graphical Perception: Theory, Experimentation and Application to the Development of Graphical Methods." *Journal of the American Statistical Association* 79 (387): 531–54.

Hartigan, J. A., and B. Kleiner. 1981. "Mosaics for Contingency Tables." In *Computer Science and Statistics: Proceedings of the 13th Symposium on the Interface*, 268–73. Fairfax Station, VA: Interface Foundation of North America, Inc.

Minnesota Population Center. 2016. *National Historical Geographic Information.* doi:10.18128/D050.V11.0.

Mullen, Lincoln. 2016. *USAboundaries: Historical and Contemporary Boundaries of the United States of America.* https://CRAN.R-project.org/package=USAboundaries.

Ruggles, Steven, Katie Genadek, Ronald Goeken, Josiah Grover, and Matthew Sobek. 2015. *Integrated Public Use Microdata Series: Version 6.0.* Minneapolis: University of Minnesota. doi:10.18128/D010.V6.0.

Tufte, Edward. 1991. *The Visual Display of Quantitative Information.* 2nd ed. USA: Graphics Press.

Walker, Francis Amasa. 1874. "Statistical Atlas of the United States Based on the Results of the Ninth Census 1870 with Contributions from Many Eminent Men of Science and Several Departments of the Government." digitized version provided through Library of Congress, https://www.loc.gov/item/05019329/.

List of Figures

1 Plate #32 from the Statistical Atlas of 1874: Gender ratio of population over the age of 10 in different types of occupation. . . . 4

2 Zoom-in to the description section of plate #32 . . . 5

3 Zoom-in to the legend section of plate #32 . . . 6

4 Zoom-in to the overview of the US wide distribution of genders across occupations. . . . 7

5 Recreation of the mosaicplot based on gainfully employed population over ten. . . . 8

6 Recreation of mosaics of gainful occupation by states. . . . 9

7 Mosaics of gainful occupation by territories. . . . 10

8 Map of States in the US in 1870 . . . 11

9 Density plots: each dot represents (according to its size) the number of people employed in each occupation or going to school. For women in particular, strong geographic patterns emerge. . . . 12

10 Set of scatterplots showing a comparison of estimates of occupation percentages based on the Census Data (y) and Chart measurements (x). . . . 13

11 Mosaicplot of the gender ratio in different occupations of the population ten years of age and above. 14

12 Mosaics of gainful occupation by territories including population not employed. . . . 15

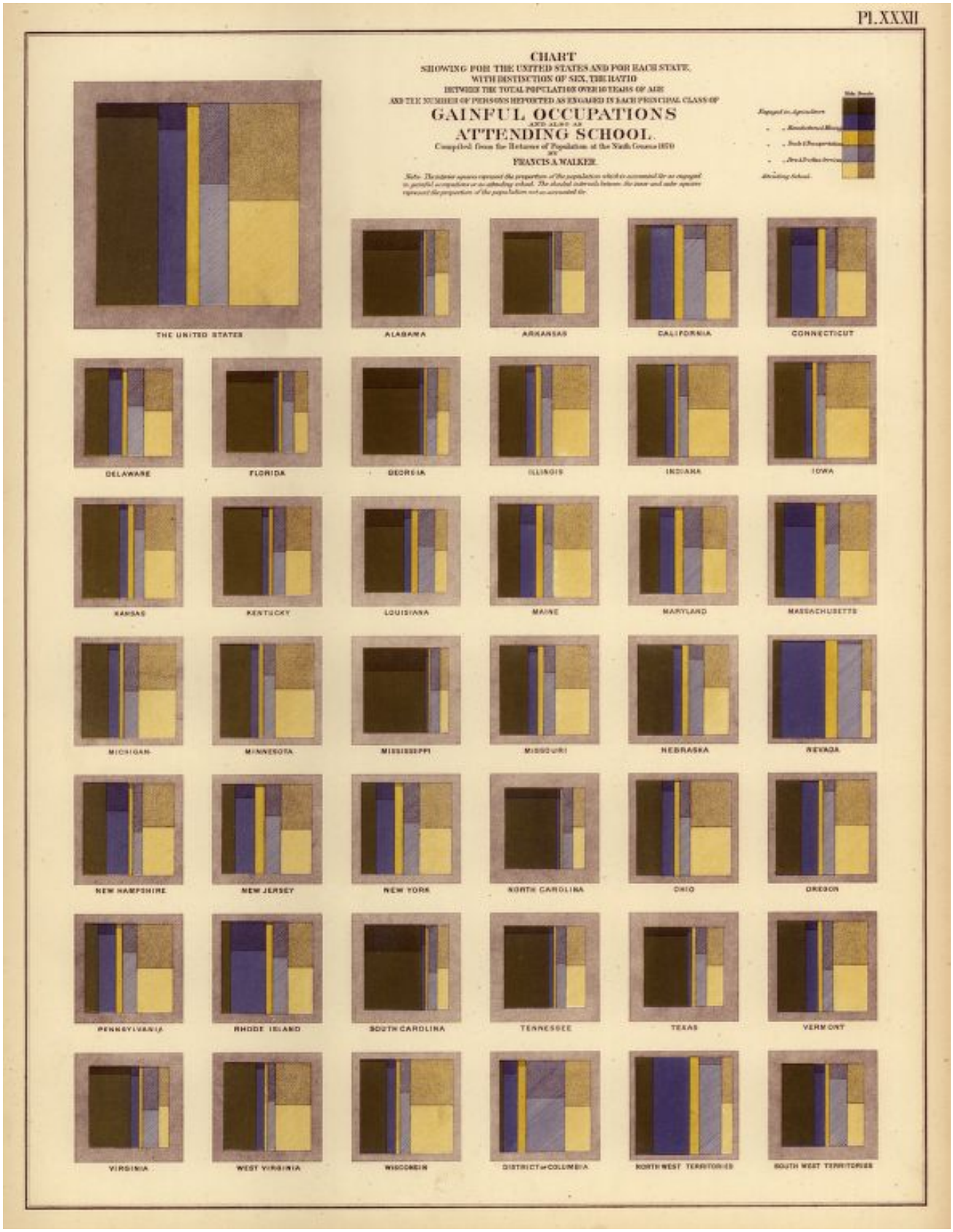


Figure 1: Plate #32 from the Statistical Atlas of 1874: Gender ratio of population over the age of 10 in different types of occupation.

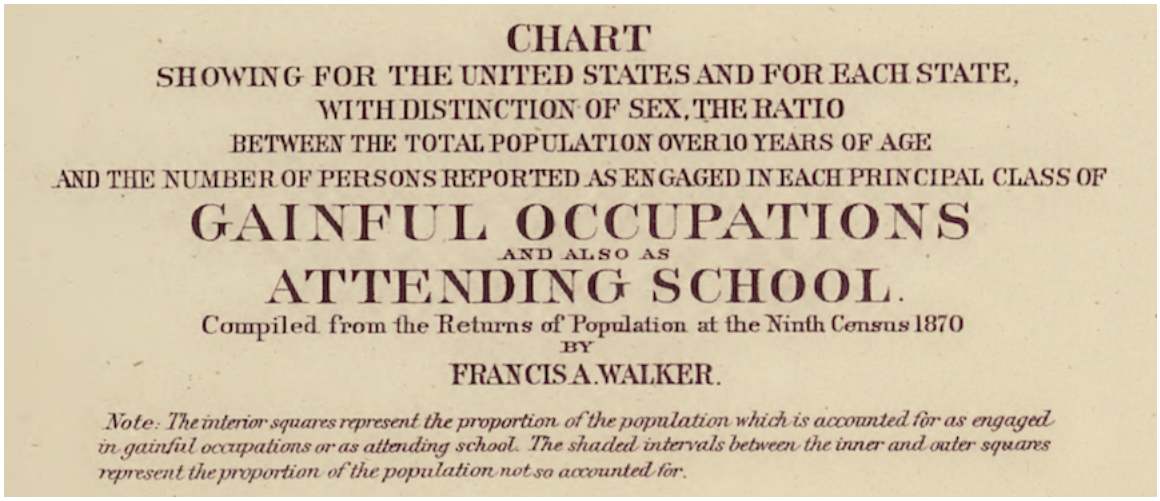


Figure 2: Zoom-in to the description section of plate #32

Figure 3: Zoom-in to the legend section of plate #32

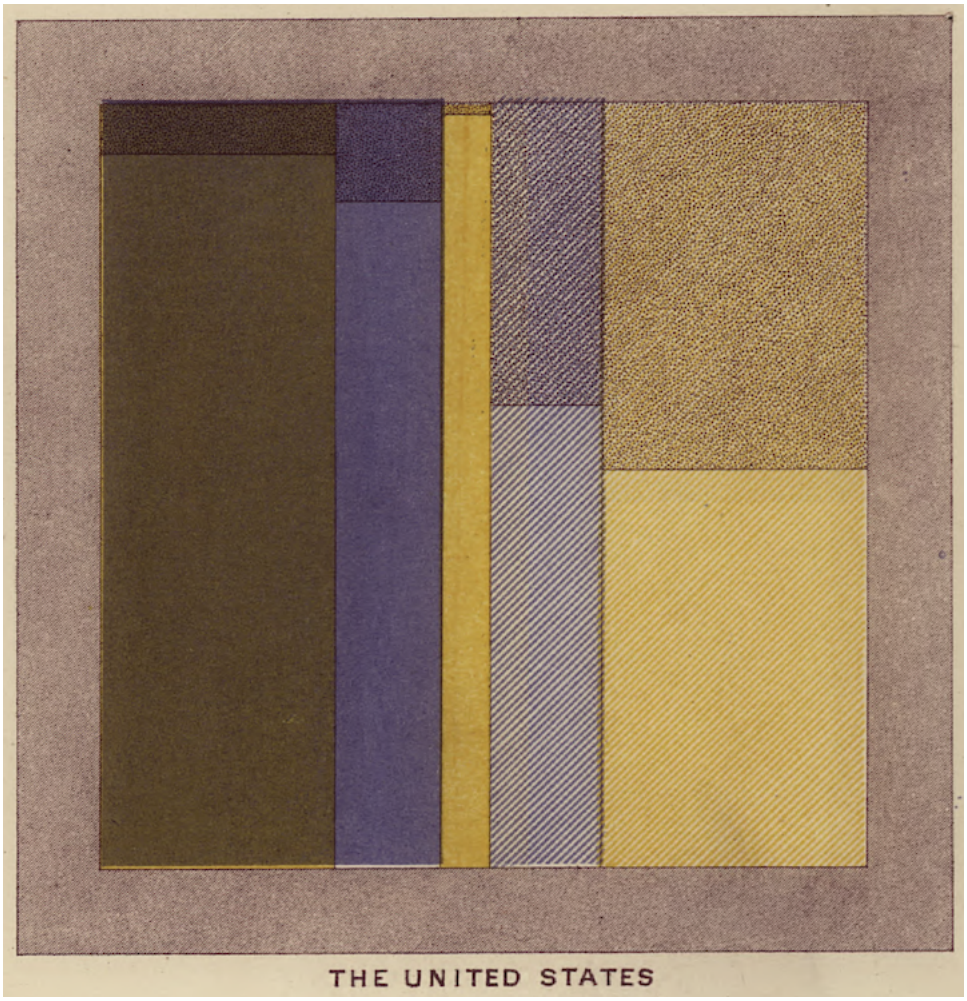


Figure 4: Zoom-in to the overview of the US wide distribution of genders across occupations.

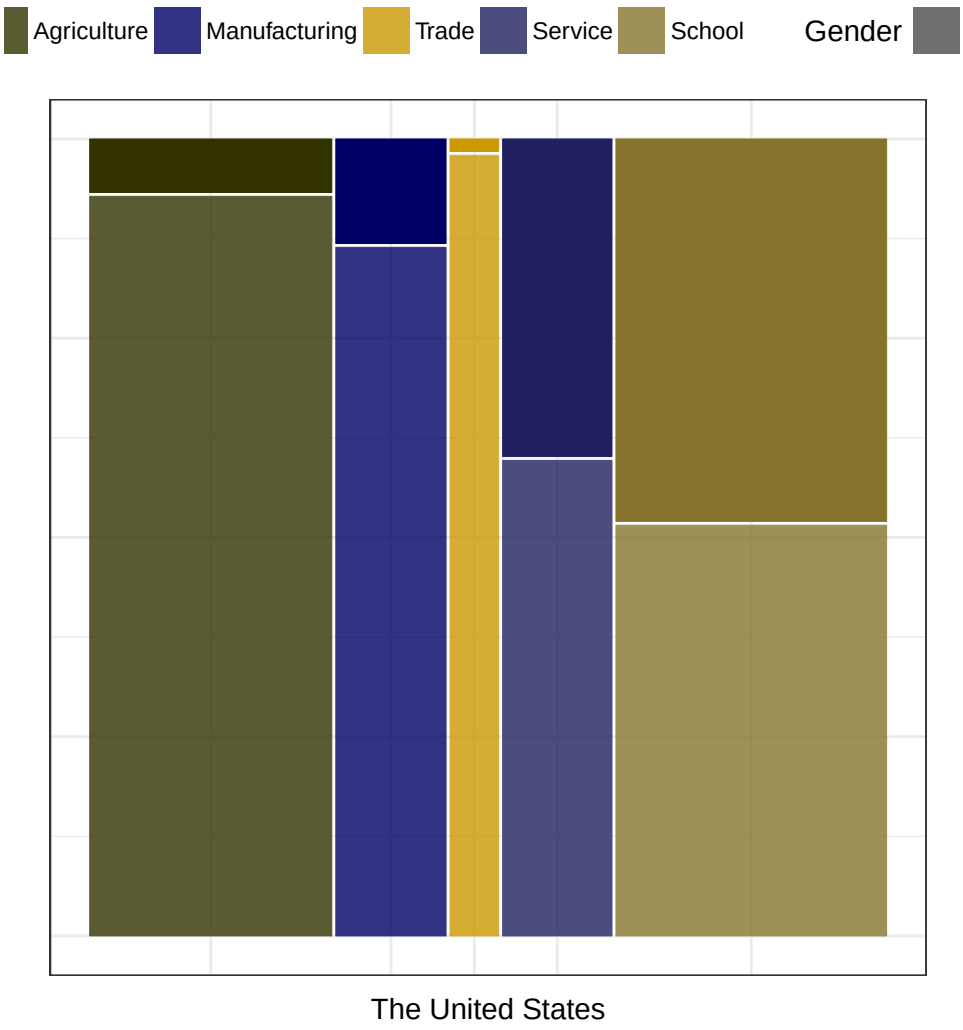


Figure 5: Recreation of the mosaicplot based on gainfully employed population over ten.

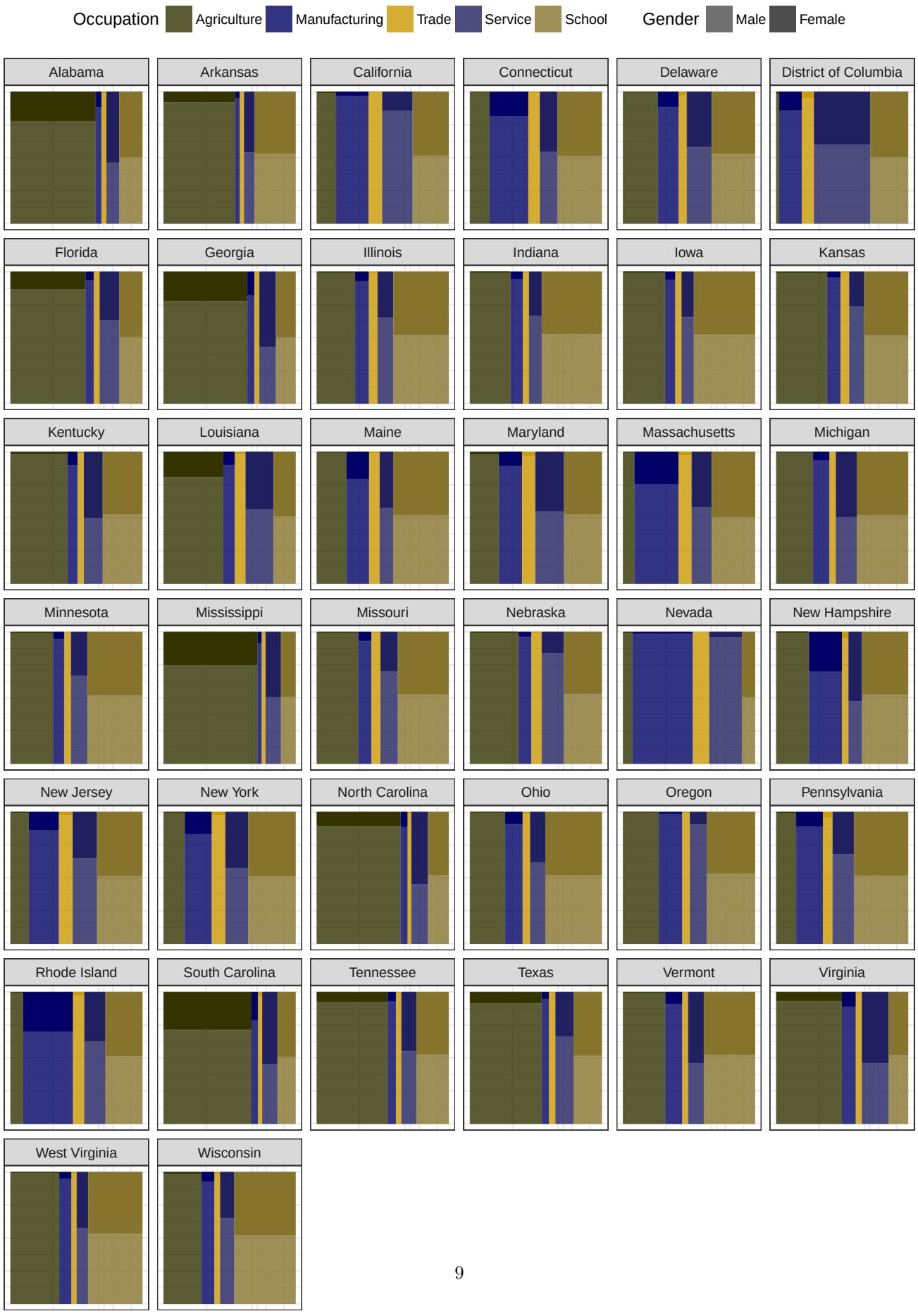


Figure 6: Recreation of mosaics of gainful occupation by states.

Figure 7: Mosaics of gainful occupation by territories.

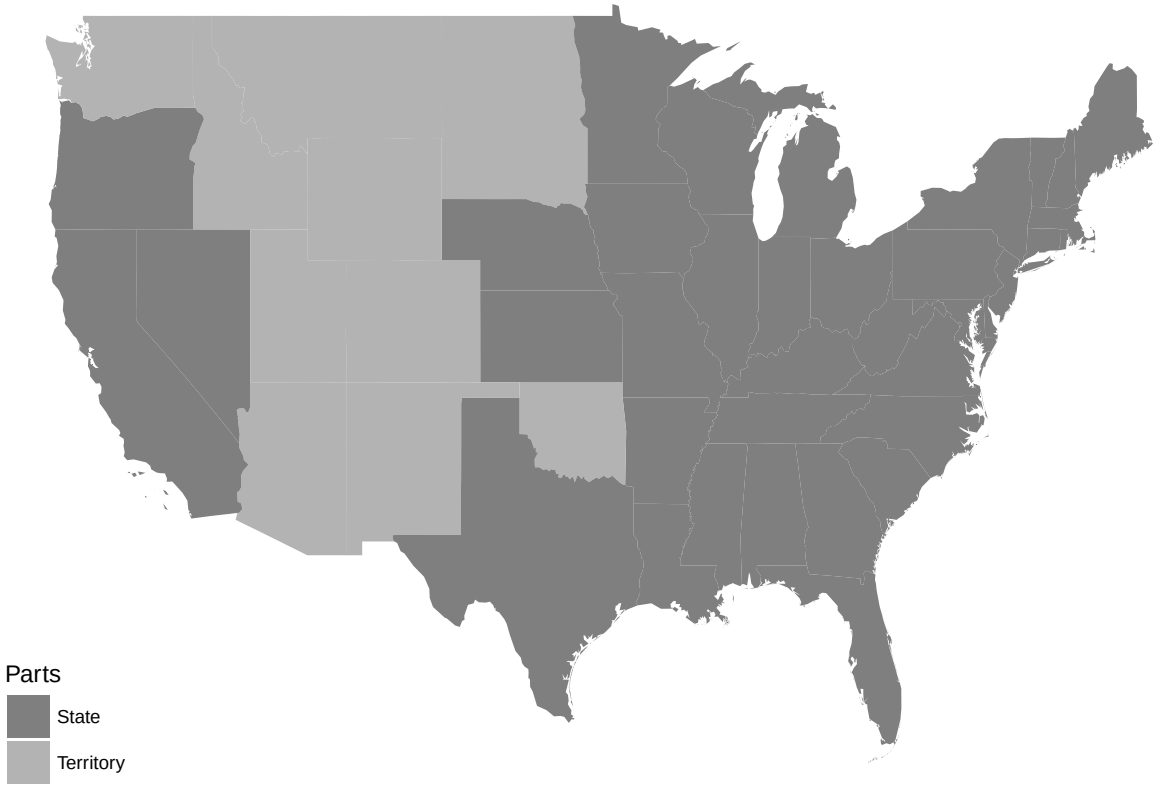


Figure 8: Map of States in the US in 1870

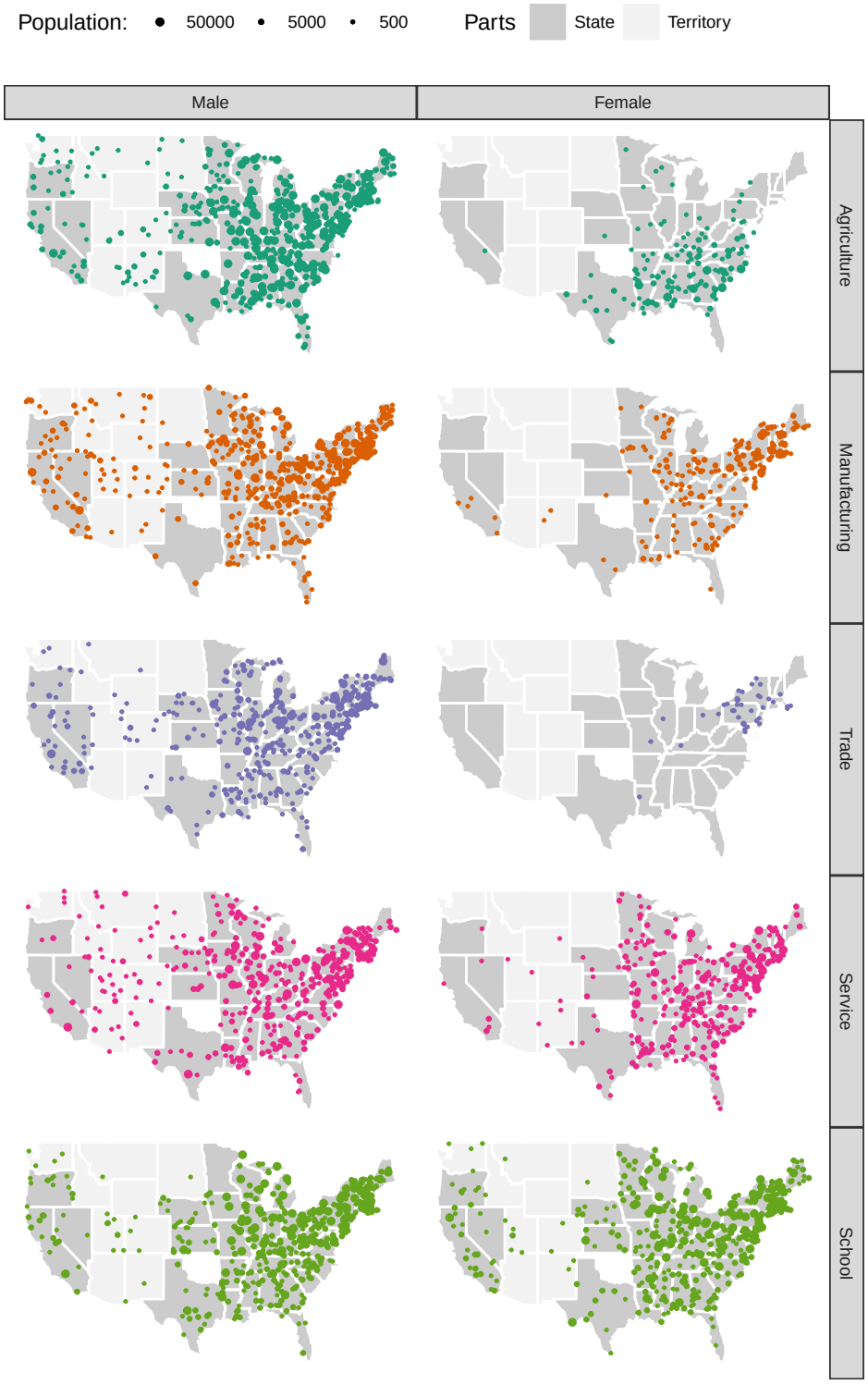


Figure 9: Density plots: each dot represents (according to its size) the number of people employed in each occupation or going to school. For women in particular, strong geographic patterns emerge.

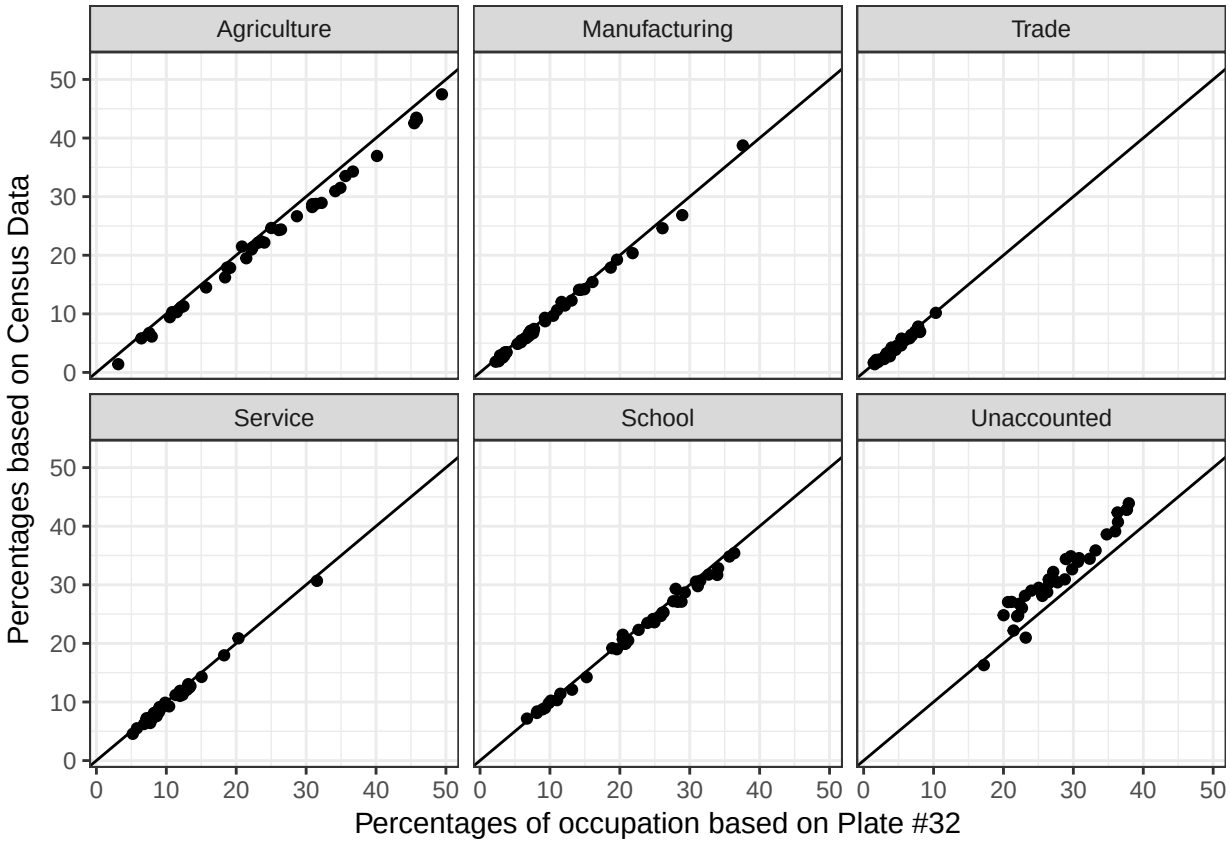


Figure 10: Set of scatterplots showing a comparison of estimates of occupation percentages based on the Census Data (y) and Chart measurements (x).

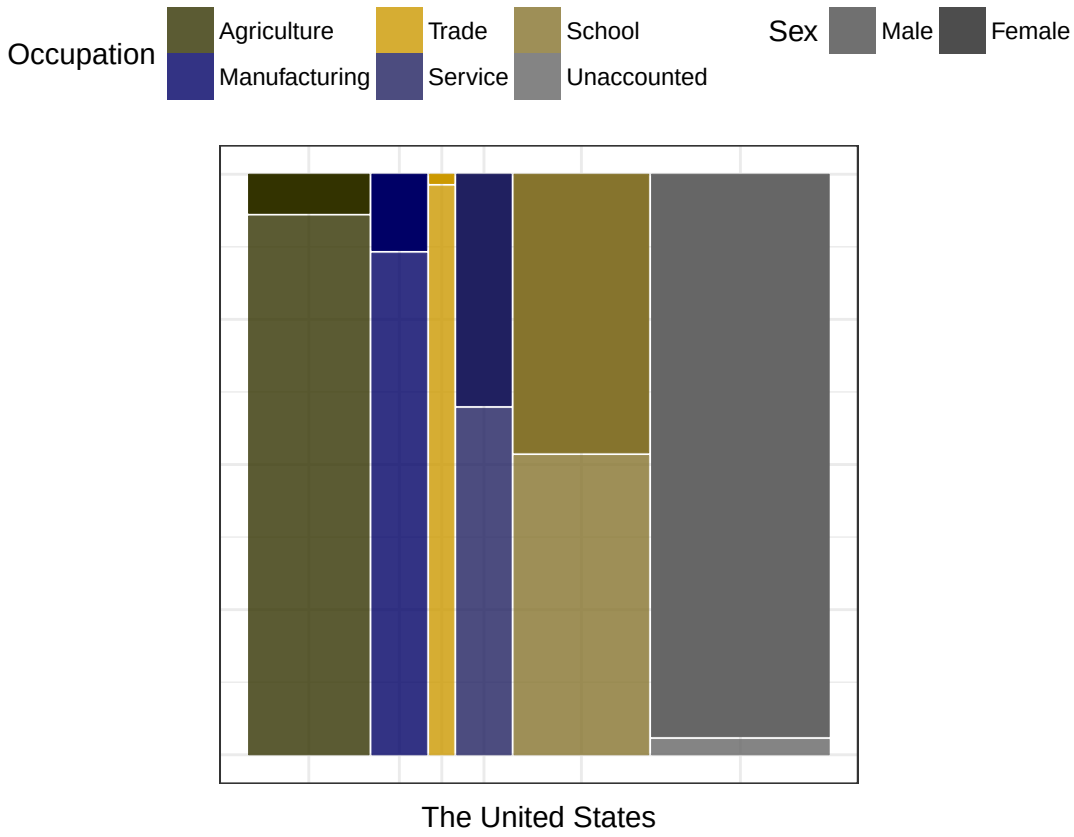
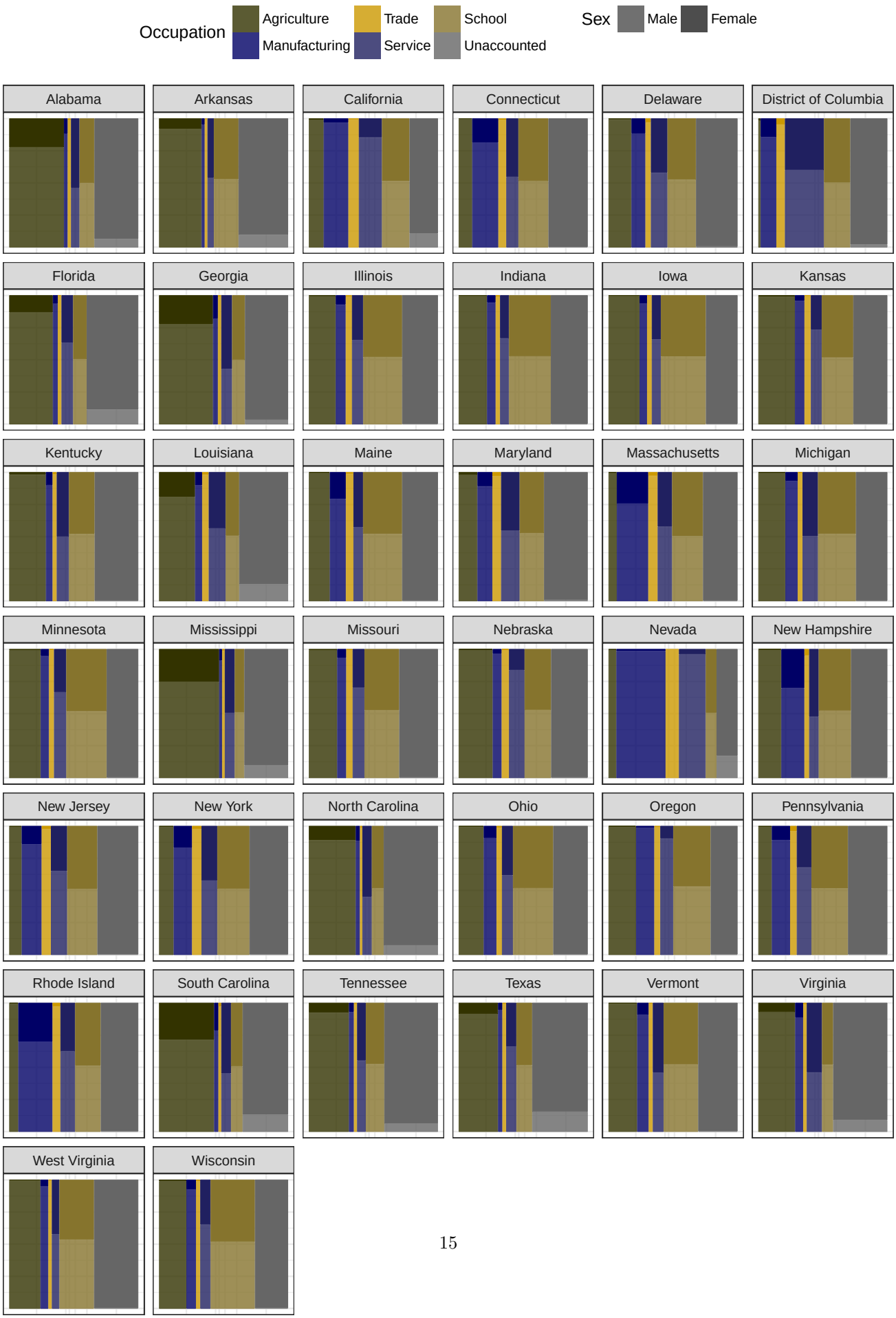


Figure 11: Mosaicplot of the gender ratio in different occupations of the population ten years of age and above.


Occupation
Agriculture
Manufacturing
Trade
Service
School
Unaccounted
Sex
Male
Female
Alabama
Arkansas
California
Connecticut
Delaware
District of Columbia
Florida
Georgia
Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
Missouri
Nebraska
Nevada
New Hampshire
New Jersey
New York
North Carolina
Ohio
Oregon
Pennsylvania
Rhode Island
South Carolina
Tennessee
Texas
Vermont
Virginia
West Virginia
Wisconsin