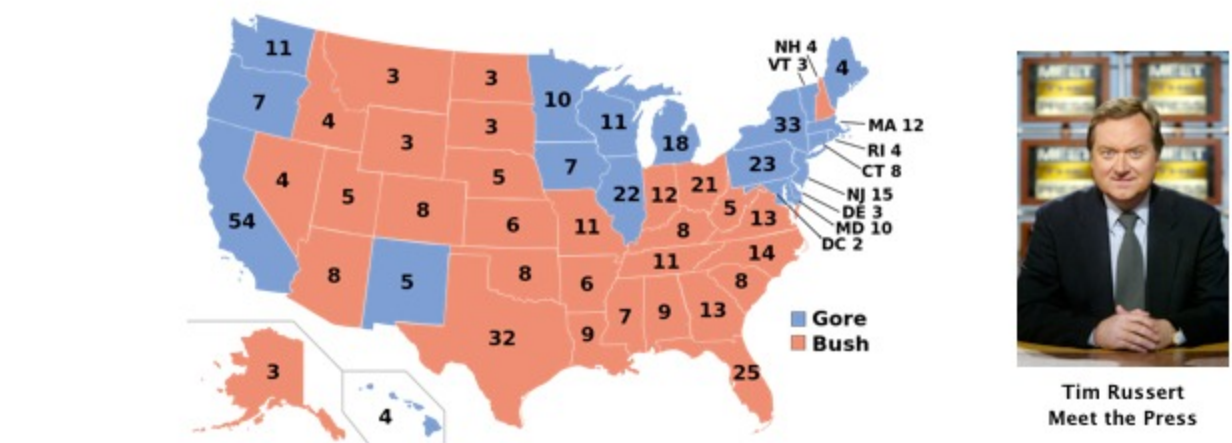


# Purple America

Write a program to visualize U.S. presidential election results.

**Historical context.** During coverage of the 2000 presidential election, Tim Russert coined the political terms *red states* and *blue states* to refer to states that predominantly vote for the Republican presidential candidate (red) or the Democratic presidential candidate (blue). The news media use red-state blue-state maps, such as the one below, to display election results.



**The problem.** On this assignment, you will create more refined (and less polarizing) *choropleth maps* by mashing up two sources of data: geographic boundary data and election return data.

**Geographic data.** We supply geographic data (sourced from the [U.S. Census](#)) that describes the boundary of each state and county in the United States.

- The first line consists of four real numbers, representing the bounding box of the region. The first two numbers are the minimum longitude and latitude values; the second two numbers are the maximum longitude and latitude values.
- The next line is an integer that specifies the number of subregions.
- There is one block for each subregion (with a blank line separates blocks):
  - The first line of a block is an integer  $N$  that specifies the number of points in the polygon describing the subregion.
  - The second line of a block is a string that is the name of the subregion.
  - The third line of a block is a string that is the name of the region.
  - The remaining  $N$  lines of the block describe the polygonal boundary, given as  $N$  pairs of real numbers, representing the longitude and latitude coordinates.

```
% more USA.txt
-124.731216 24.544102
-66.980385 49.384365
104

Alabama
USA
498
-88.200027 34.995548
-88.202919 35.007942
-87.984886 35.005848
...
-88.153519 34.921185
-88.176064 34.962433
-88.187088 34.974182

...

Wyoming
USA
68
-111.048203 44.474144
-111.054558 44.666336
-111.054420 45.001392
...
-111.043846 43.315800
-111.044724 43.501213
-111.046272 43.983456
```

```
% more NJ.txt
-75.560143 38.928589
-73.894402 41.357330
21

Atlantic
NJ
127
-74.877563 39.608414
-74.736694 39.729721
-74.676102 39.691162
...
-74.857353 39.420528
-74.856087 39.424465
-74.985443 39.514725

...

Warren
NJ
121
-75.120819 40.968208
-75.122986 40.970055
-75.131744 40.969185
...
-75.095901 40.924057
-75.112061 40.948017
-75.118141 40.952927
```

```
% more USA-county.txt
-124.731216 24.544102
-66.980385 49.384365
3206

Autauga
AL
118
-86.916969 32.664028
-86.816589 32.659988
-86.713409 32.661602
...
-86.916809 32.649662
-86.917458 32.653877
-86.921387 32.655415

...

Weston
WY
11
-105.078743 44.176205
-104.375000 44.181641
-104.054001 44.180401
...
-105.081238 43.592144
-105.078255 43.827049
-105.080872 43.826954
```

We note that the number of subregions in [USA.txt](#) is not 50 for two reasons: first, we do not include either Alaska or Hawaii; second, we include an entry for each polygonal subregion—some states (such as Michigan, Florida, and California) comprise several polygonal subregions.

**Election return data.** We supply election return data (sourced from [Dave Leip's Atlas of U.S. Presidential Elections](#)) that describes the results for each presidential election, by state and county. Each row consists of four fields, separated by commas: the name of a subregion, the number of votes for the Republican candidate, the number of votes for the Democratic candidate, and the number of votes for the Independent (or third party) candidate.

```
% more USA2012.txt
Alabama,1255925,795696,22717,
Alaska,164676,122640,13179,
Arizona,1233654,1025232,47673,
Arkansas,647744,394409,27315,
California,4839958,7854285,360745,
...
Virginia,1822522,1971820,60147,
Washington,1290670,1755396,99892,
West Virginia,417655,238269,14743,
Wisconsin,1407966,1620985,39483,
Wyoming,170962,69286,8813,
```

```
% more NJ2012.txt
Atlantic,46522,65600,1222,
Bergen,169070,212754,4166,
Burlington,87401,126377,2561,
Camden,69476,153682,2791,
Cape May,25781,21657,655,
...
Salem,14334,14719,570,
Somerset,66603,74592,1985,
Sussex,40625,26104,1465,
Union,68314,139752,2022,
Warren,25744,18745,926,
```

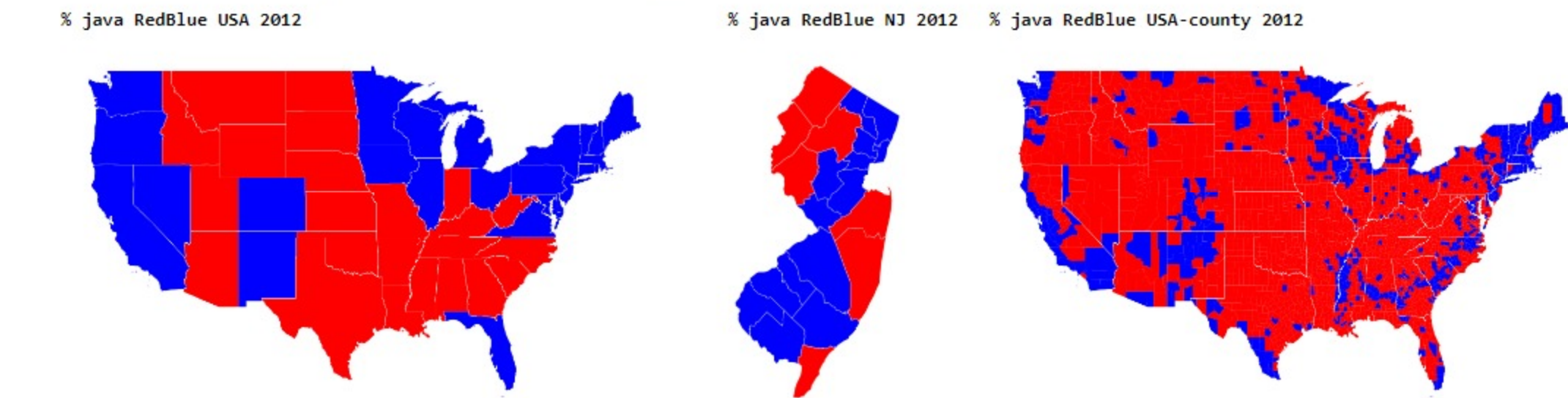
You can download all of the geometric and election return data files collectively as [purple-america-data.zip](#).

**Part 1.** Write a program `White.java` that takes the name of a region as the command-line argument and produces an outline map, as in the examples below:



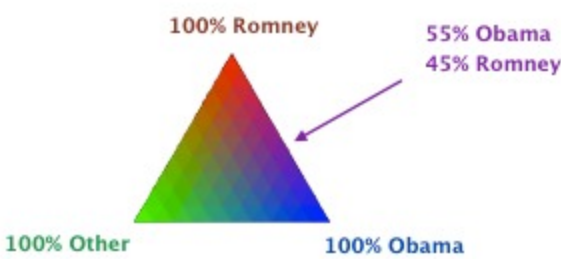
For simplicity, draw the point with longitude  $x$  and latitude  $y$  at location  $(x, y)$  in the plane. Use the bounding box of the region to determine the part of the plane to display in the drawing window and rescale the coordinates accordingly.

**Part 2.** Write a program `RedBlue.java` that takes two command-line arguments (the name of the region and the year of the election) and produces a red-state blue-state map, as in the examples below:

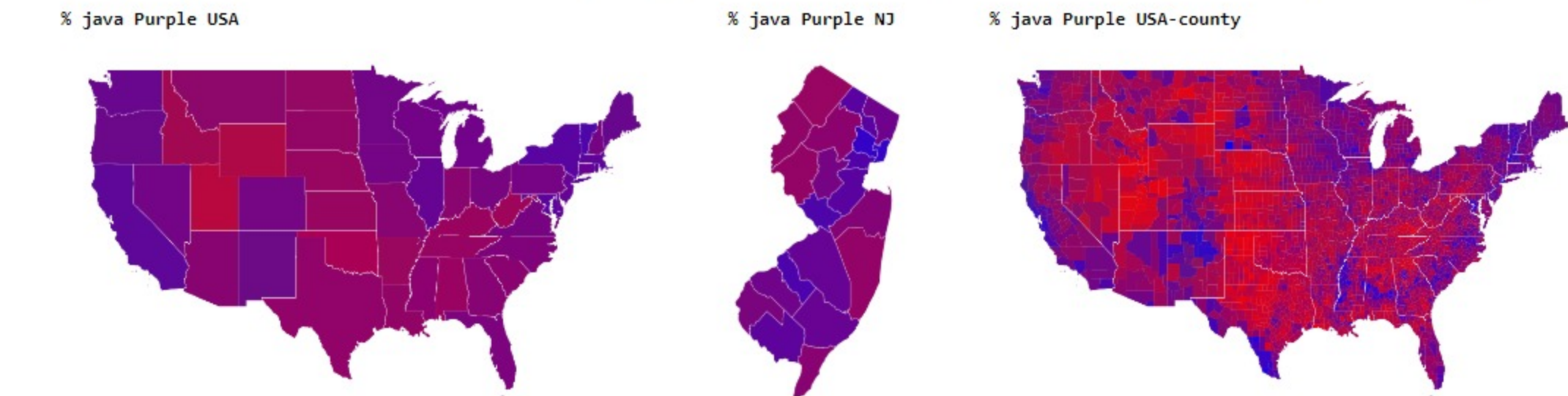


**Part 3.** A more refined visualization reveals that the United States is not as polarized by geography as suggested in the above visualizations. In 2000, Bob Vanderbei created a [Purple America](#) map, in which each region is colored in a shade of red, green, and blue, according to the proportion of votes received by each candidate. Specifically, if the Republican, Independent, and Democratic candidates receive  $a_1$ ,  $a_2$ , and  $a_3$  votes, respectively, then we draw the subregion using the following formula:

$$(R, G, B) = \left( \frac{a_1}{a_1 + a_2 + a_3}, \frac{a_2}{a_1 + a_2 + a_3}, \frac{a_3}{a_1 + a_2 + a_3} \right)$$



Write a program `Purple.java` that takes two command-line arguments (the name of the map and the year of the election) and produces a Purple-America map, as in the examples below:



**Extra credit.** There are limitless opportunities for creativity, enrichment, and inspiration.

- Write a program to screen scrape the election return data from [Dave Leip's Atlas of U.S. Presidential Elections](#). Pay careful attention to name clashes between Dave Leip's site and the U.S. Census (e.g., LaSalle vs. La Salle, Kings County vs. Brooklyn).
- Modify your program to include Hawaii and Alaska.
- Use a [map projection](#) (such as Mercator, azimuthal, Albers, or Gall-Peters) to transform longitude and latitude coordinates into points in the plane.
- Explore a different color palette (with 5-7 color categories) for coloring the subregions. Here is one [example](#).
- Write the state name in the appropriate place. For large states, draw it in the *centroid* of the polygon describing the state.
- Create an interactive GUI which displays the election returns for a county as the user hovers over it. You will probably need to add a method to your polygon data type to determine whether a point is inside the polygon.
- Visualize the *gradient* or change in votes from one election to the next.
- Visualize a different data set by county, e.g., poverty rate, access to Internet, and average price of health care. Or collect data for elections in another country.