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Assignment 3: Washington State Algorithmic Redistricting

1. **What did you use for data sources? Do you have any concerns about these sources?**

The population and demographic data used in this assignment correspond to the data from the most recent census (2020), retrieved directly from the US Census Bureau database [1]. General concerns regarding the reliability of the US census data exist, as there have been complaints regarding the collection of census data. The census has the potential to either misrepresent or underrepresent the proportion of minorities in the population. The census is still the most reliable account for this information, and variations in census counts are considered statistically insignificant. African Americans, Latin Americans, and other minority groups were likely misrepresented in the latest census. [2]

2. **How did you define the objective function? To what extent were you able to accommodate both racial balance and population objectives?**

The objective function was defined to ensure that the number of districts for the state of Washington adhered to the actual assigned number of representatives, 10. We chose to assign representatives on a 1:1 basis, meaning each district has one representative, as assigning multiple representatives to a particular district based on population would have granted the district with King County significant power to mitigate the equality constraints. Regarding the racial balance and population objectives, it was difficult to accommodate the guidelines set out in the assignment prompt due to the state demographics. Washington has a highly variable population

at the county level, ranging from a minimum population of 2,258 (Garfield County) and a maximum of 2,225,064 (King County). King county represents nearly 30% of the entire state population. To ensure that the population of each district was reasonable, the state population was divided by the number of districts, and then the difference between the populations of the districts was minimized through the Linear Program.

The racial demographics are also skewed significantly towards the White demographic, which makes up nearly 75% of the state population; additionally, no county has a non-White population that exceeds 41% of the county population, contributing to significant difficulties in encouraging racial equality for state representation at the district level. Flexibility was then incorporated into the constraints imposed on the model, and an optimal solution was generated to ensure that racial equality was accounted for and that the district populations were as even as possible. However, the range of flexibility had to be fairly broad to generate an optimal solution that respected the other constraints imposed in the model. Without further granularity, perhaps down to the census tract level, it will be difficult to overcome the skew in the racial demographics in Washington state.

3. **How did you formulate the set covering and county adjacency constraints?**

The county adjacency constraints use the county_adjacency.txt file from the Census Bureau. County adjacency data is adapted into an adjacency matrix that displays whether counties were adjacent. A number one [1] indicates that two counties are adjacent, and a number zero [0] indicates that two counties are not adjacent. The matrix was used to create the constraints for the adjacency section of the linear program code. The set covering constraints was developed by comparing a map of Washington State overlaid with the state's counties. Further set covering constraints were added for population centers and geographic distances between

counties along with limiting certain counties that could be in a district together based on geographic distance.

4. **What is the optimal redistricting solution for your state?**

The optimal redistricting solution for Washington State is displayed in Table 1 below. Table 1 outlines each district's county groupings along with associated white and non-white population information.

TABLE 1. Optimal Redistricting Solution - Assigned Districts with respective Counties

Assigned District	County ID	County Name	Total Pop.	White Pop.	Non White Pop.	White %	Non White %
1	[13, 22, 33]	[GRAYS HARBOR, MASON, THURSTON]	423,793	343,998	79,795	0.811712	0.188288
2	[3, 8, 30]	[CHELAN, DOUGLAS, SNOHOMISH]	930,745	679,973	250,772	0.730569	0.269431
3	[16, 18]	[KING, KITTITAS]	2,272,161	1,423,675	848,486	0.626573	0.373427
4	[14, 17, 28]	[ISLAND, KITSAP, SKAGIT]	480,574	388,663	91,911	0.808747	0.191253
5	[5, 29]	[CLARK, SKAMANIA]	493,856	411,498	82,358	0.833235	0.166765
6	[2, 19, 38]	[BENTON, KLICKITAT, YAKIMA]	473,419	362,187	111,232	0.765045	0.234955
7	[7, 20, 24, 26, 34]	[COWLITZ, LEWIS, PACIFIC, PIERCE, WAHKIAKUM]	1,106,130	823,925	282,205	0.744872	0.255128

8	[9, 23, 25, 31, 32]	[FERRY, OKANOGAN, PEND OREILLE, SPOKANE, STEVENS]	621,946	534,567	87,379	0.859507	0.140493
9	[0, 1, 6, 10, 11, 12, 21, 35, 37]	[ADAMS, ASOTIN, COLUMBIA, FRANKLIN, GARFIELD, GRANT, LINCOLN, WALLA WALLA, WHITMAN]	360,043	260,979	99,064	0.724855	0.275145
10	[4, 15, 27, 36]	[CLALLAM, JEFFERSON, SAN JUAN, WHATCOM]	349,798	294,416	55,382	0.841674	0.158326

5. **Draw color-coded maps for your algorithmic/optimal redistricting and for the actual redistricting being proposed or implemented in your selected state. Which map would you recommend for your selected state? Can either of these plans be described as "fair and equitable"? To what extent are these plans consistent with the principle that citizens should have equal representation in voting (one person, one vote)?**

The map of Washington state, with the proposed redistricting of counties that were generated by the optimization model, is included as an image below. Additionally, the map was generated in an interactive fashion using plotly express, meaning the map in the included Html file can hover over for additional information, and the view can also be altered to the viewer's preferences; by running the jupyter notebook file or python file creates an interactive map that

displays selected details about each county that is hovered over, as well as the ability to zoom in or out and for ease of viewing. The included .html output file Static plots utilizing the ggplot library was also generated and will appear when the code is run.

And we would recommend an algorithmic/optimal redistricting map as it would propose racial balance (percentage white vs non-white race) as possible across all congressional districts, although Washington does not have any ideal proportion where every congressional district has approximately the same population that may lead to unfair or inequality in decision rights. As the district's population is skewed with the smallest one of 360,043 and the largest one with 2,272,161, each person would not have an equal representation in voting as their impact will vary depending upon district size.