Byte-Sized Justice: Supporting School Desegregation Policymaking with Algorithmic Redistricting

Keywords: education, school choice, inequality, segregation, combinatorial optimization

Extended Abstract

Demographic segregation is a pervasive issue in school districts throughout the US, yet finding solutions is often difficult. Parents may express support for integration but oppose integration policies due in part to impacts on student travel time and school switching. One policy that particularly perpetuates segregation is districts' school "attendance boundaries" - policies that determine which school students attend based on their neighborhoods. We collaborate with a large school district serving over 50k students in the Southeastern US to explore algorithmic approaches to redrawing attendance boundaries, with preliminary explorations into how family school choice (i.e., attending schools beyond their boundary-assigned schools) might impact redistricting efforts. In particular, we explore the following questions: 1) what are the potential impacts of attendance boundary changes designed to foster more integrated schools on levels of segregation, travel times, and student school switching with and without factoring in choice patterns? And 2) what is the role of such simulations in supporting actual desegregation efforts on the ground?

Data and methods. We use the constraint programming redistricting algorithms presented in [2] as a starting point for our work. Unlike this prior work, we apply these models to precise student-level data shared by the collaborating school district. The anonymized data includes student demographic and school attendance information (namely, their boundary-assigned school and attended school, which can differ due to school choice). In consultation with this district, we explore two possible scenarios: 1) a scenario where school choice is eliminated and all students attend their boundary-assigned school, and 2) a scenario where students opting out of their boundary-assigned school remain assigned to the schools they selected, while those attending their boundary-assigned school are eligible to be reassigned. The objective function of our redistricting algorithm is to minimize White/non-White dissimilarity, a popular measure of segregation that indicates how closely school-level demographics reflect district-level proportions (a score of 0 indicates white students are evenly distributed across all schools; a score of 1 indicates perfect segregation of all white students into separate schools) [3]. Like [2], we set the following constraints on the boundaries produced by the algorithm: 1) contiguity, 2) maximum driving time increases of 50%, and 3) maximum school size increases of 15%. We expand the travel constraint to enable students to travel up to 5 minutes (driving) under a possible boundary change, regardless of percent increase over previous driving time. Focusing on elementary schools, we simulate boundaries under both scenarios.

Results. Approximately 1/3 of students in the district attend a school other than their boundary-assigned one, suggesting high levels of family choice—though choice rates are similar across demographic groups, as shown in Figure 1. The district's White/non-White dissimilarity index is 0.50, ranking it as the third most segregated district (in terms of elementary schools) out of the 71 districts in the same state with at least two thousand elementary school students. Prior to executing our algorithms, at the request of the district, we explore how segregation might change if there were no choice and all students attended their boundary-assigned schools. Under this hypothetical scenario, we observe a possible 8% decrease from 0.50 to 0.46, reflecting prior research highlighting how unbridled school choice—or choice without proper guardrails—can exacerbate segregation [5]. With this in mind, we execute Scenario 1 and observe a potential decrease in segregation of 22% (0.50 to 0.39 — a change that would shift the district from 3rd to 14th most segregated district in the state), while also observing a slight decrease in driving times for rezoned students compared to their original boundary assignment, similar to [2]. This change would require approximately 18% of students to switch schools (with switching generally balanced across demographic groups, except Native American students, who comprise a small total number of students in the district) and generally include students being rezoned to those ranked lower on popular school ratings website GreatSchools.org. Under Scenario 2, we observe a smaller decrease in dissimilarity of 12% (0.50 to 0.44 — a shift from 3rd to 6th most segregated district in the state). The smaller decrease is to be expected, given that this scenario replicates existing school choice (which slightly exacerbates segregation). Scenario 2 illustrates similar decreases in average travel times for rezoned students, and marginal decreases in average school ratings attended by students. Figures 2-6 summarizes these results.

Discussion. We conduct a preliminary validation of these findings through consultation and feedback from the district. An important limitation they highlight, which we will seek to mitigate in upcoming work, is that our models fail to anticipate family choice dynamics in response to boundary changes (or families leaving the district altogether—a perennial roadblock in education desegregation policymaking [4]). Expanding upon discrete choice models used in similar research practitioner partnerships [1] with our rezoning algorithms offers an exciting direction for future work. Beyond this limitation, the district expressed that the algorithmically-generated boundaries illustrate the potentially large relative impact localized boundary changes might make to foster more integrated schools, even in the face of family choice. As they are at the early stages of efforts to explore and potentially redraw more integrative boundaries, they see these modeling exercises as an important first step in building an evidence base for how possible boundary changes could affect school demographics *before* starting conversations with families and other district leaders. Indeed, an open question is if the transparency of the models themselves—especially if community stakeholders are invited to explore alternative values for the objective function and constraints—might help foster more support for their use in desegregation policymaking. We believe this preliminary work demonstrates how computational social scientists might partner with community-based organizations and policymakers to explore potential policies that support systems-level change.

References

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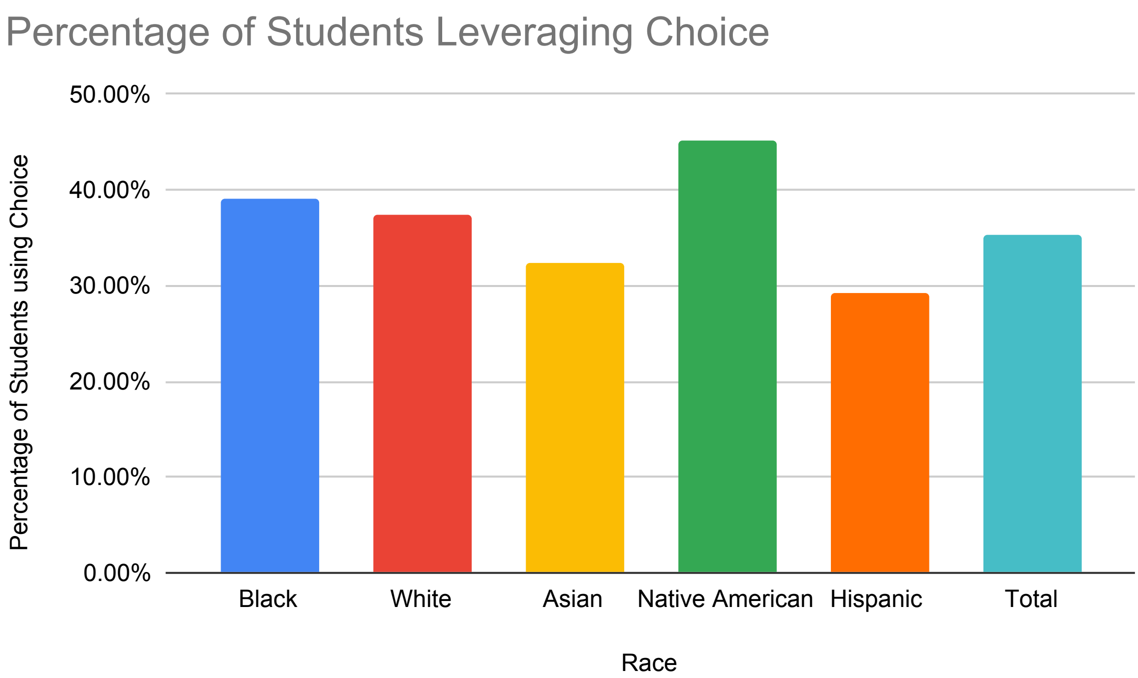

Figure 1: Rates of choice are mostly evenly distributed across races. Interestingly, the groups with the highest rates of leveraging choice are Black and Native American families, inconsistent with other districts, where White and Asian families may leverage choice the most. A possible explanation could be that because Black and Native American families are zoned to the lowest performing schools, they tend to leverage choice to go to higher performing schools.

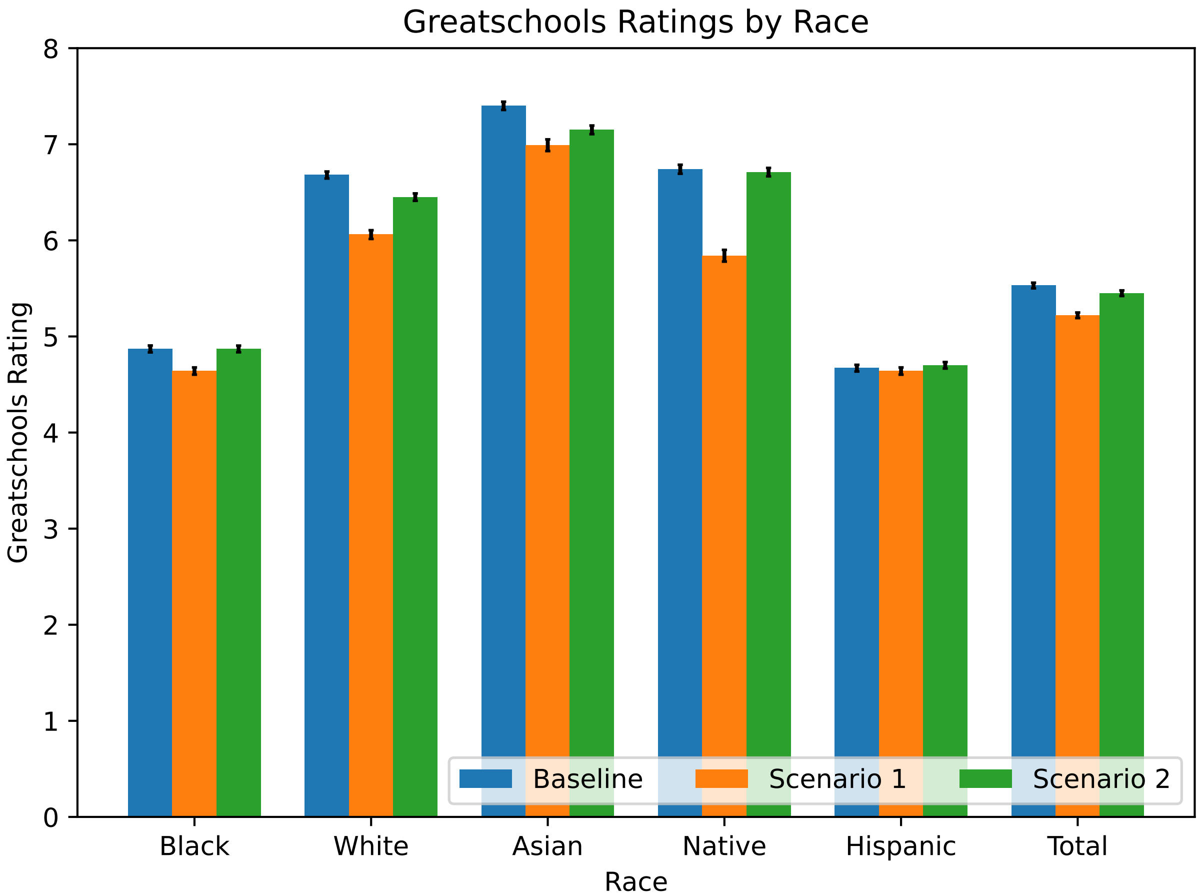

Figure 2: Consistent with national trends, Black and Hispanic students tend to attend lower-rated schools than White and Asian students. Surprisingly, Native American Students attend better schools than would be expected based on national trends. This could be due their high rates of school choice, but an important caveat is that this group occupies a small share of the total student population (0.2%). Error bars depict 95% confidence intervals.

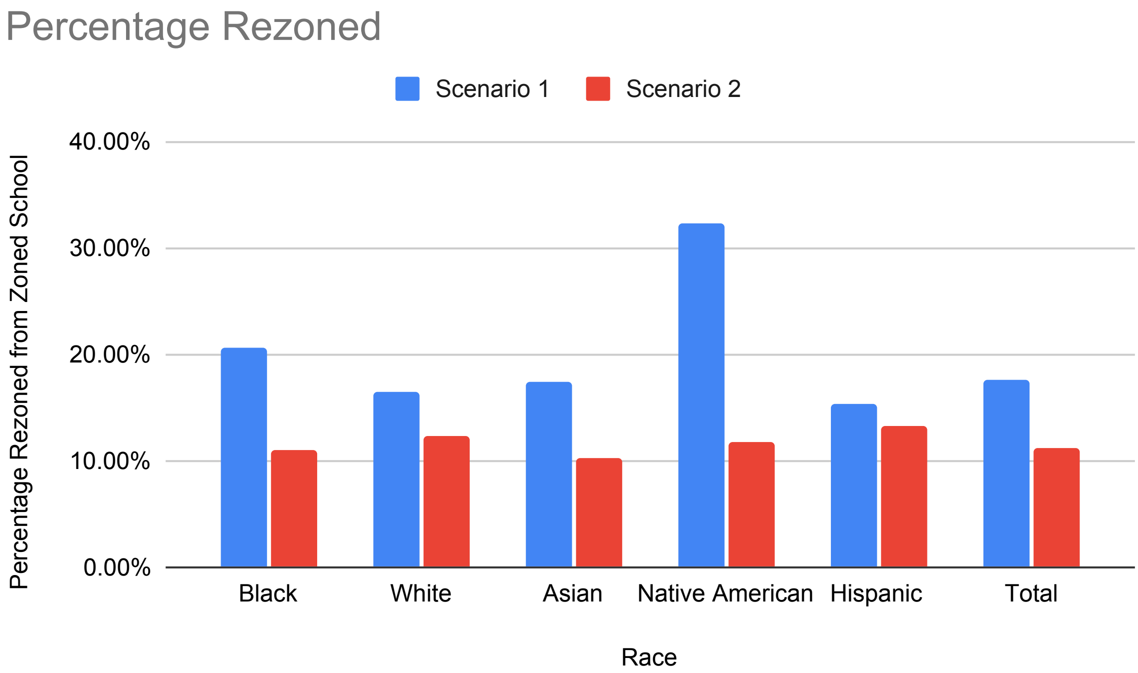

Figure 3: As expected, the percentage rezoned from their zoned school is significantly higher for Scenario 1 than Scenario 2. School switching is generally balanced across racial/ethnic groups in both scenarios, with the exception of Native American students in Scenario 1.

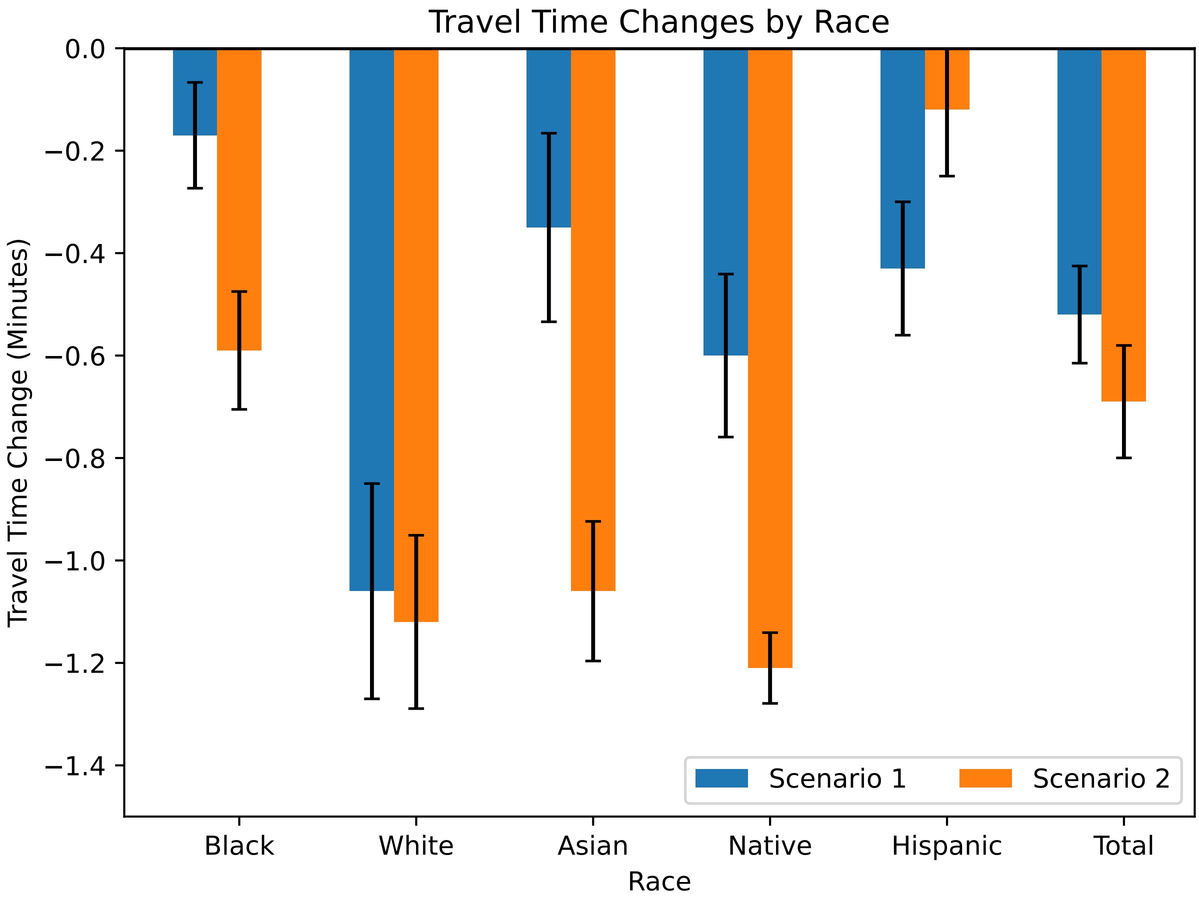

Figure 4: Both scenarios estimate slight decreases in average travel times across rezoned students from different groups (compared to a setting where those students attend their boundary-assigned school), with relatively similar decreases by race except for smaller average decreases for Black students under Scenario 1 and Hispanic students under Scenario 2. Error bars depict 95% confidence intervals.

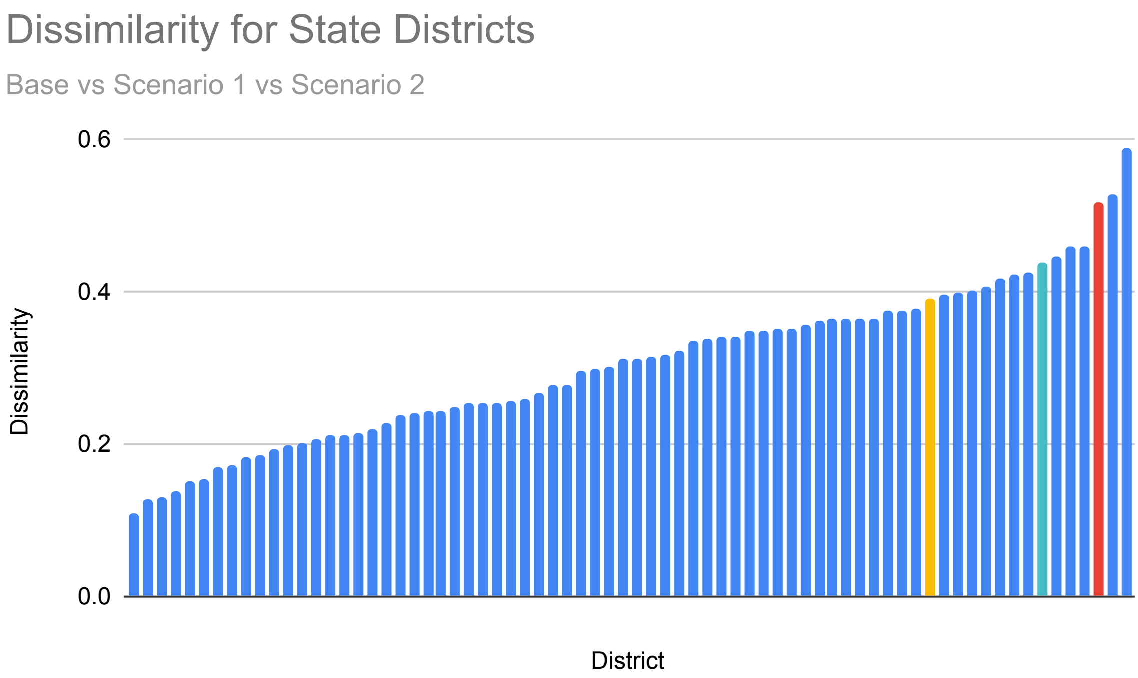

Figure 5: This distribution demonstrates the change in the district's relative segregation ranking with respect to other districts in its state who serve at least two thousand elementary school students. The red bar indicates the district's current standing; the teal bar represents the district's estimated dissimilarity under Scenario 2; and the yellow bar represents the district's estimated dissimilarity under Scenario 1.

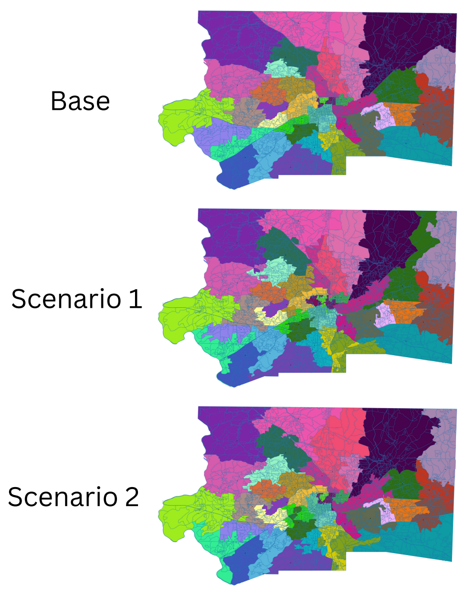

Figure 6: Boundary maps under status quo, Scenario 1, and Scenario 2.