Optimizing School Districts to Reduce Segregation

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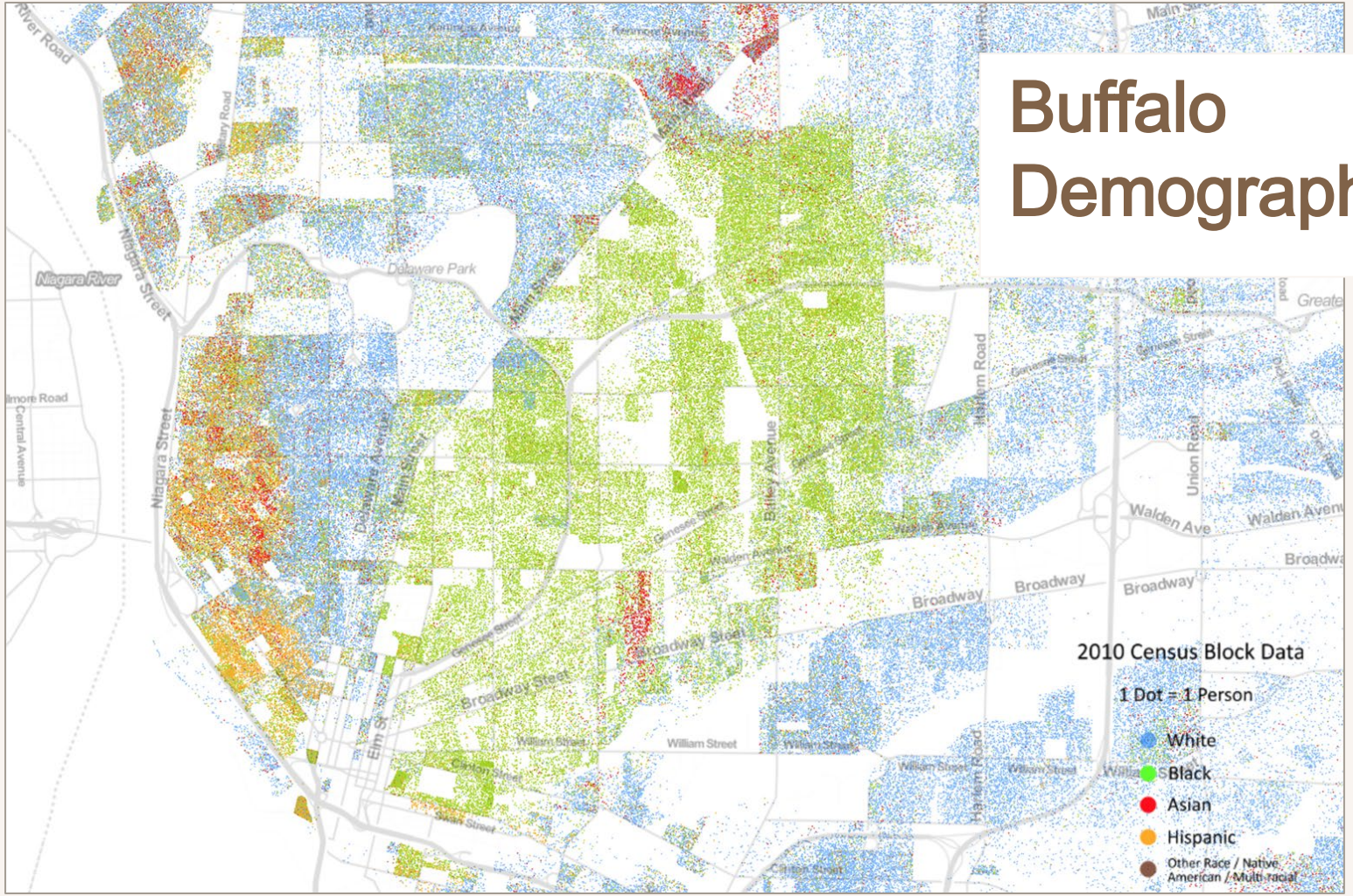
Buffalo Demographics



The Issue Of Segregation

- Historical policies separating racial groups
- Segregation persists due to economic disparities, prejudice/discrimination, barriers to upward mobility
- Racial inequalities are reproduced in schools
    - Most students attend their neighborhood school
    - Schools are primarily funded by property taxes

Wealthy Neighborhood

Higher Property Taxes

More Funding For Schools

Low Income Neighborhood

Lower Property Taxes

Less Funding For Schools

School Redistricting

- Similar to political redistricting
- Redrawing district boundaries to create balance
  - Districts have similar population
  - Districts have similar demographics
- Districts should be compact and contiguous
  - To prevent inequality (e.g. gerrymandering)

Using Optimization

- Redistricting can be modeled using optimization
- The goal is to redraw elementary school assignment zones to reduce black-white segregation
- Case studies of Buffalo and Chicago
    - Both are in the top 20 cities with the worst black-white segregation

The Model

I = set of block groups
J = set of schools

x_{ij} = 1 if block group i is assigned to school j
x_{ij} = 0 otherwise

y_j = dissimilarity of school j

z_i = 1 if block group i is reassigned
z_i = 0 otherwise

S_i = number of students in block group i
W_i = number of whites in block group i
N_i = number of non-whites in block group i
L_i = current school assignment

C_j = capacity of school j
FC_j^{low} = lower percent change in capacity
FC_j^{high} = upper percent change in capacity

D_{ij} = travel time from block group i to school j
T_j = maximum travel time

$$\min \sum_j y_j$$

$$\sum_j x_{ij} = 1, \quad \forall i \in I$$

$$\sum_i S_i x_{ij} \leq \left(1 + FC_j^{high}\right) C_j, \quad \forall j \in J$$

$$\sum_i S_i x_{ij} \geq \left(1 - FC_j^{low}\right) C_j, \quad \forall j \in J$$

$$\sum_i (N_i W - W_i N) x_{ij} \leq y_j, \quad \forall j \in J$$

$$\sum_i (W_i N - N_i W) x_{ij} \leq y_j, \quad \forall j \in J$$

$$D_{ij} x_{ij} \leq T_j, \quad \forall i \in I, \forall j \in J$$

$$z_i = 1 - x_{iL_i}, \quad \forall i \in I$$

$$\sum_i z_i \leq \theta$$

$$x_{ij} \in \{0,1\}, \quad \forall i \in I, \forall j \in J$$

Model Objective

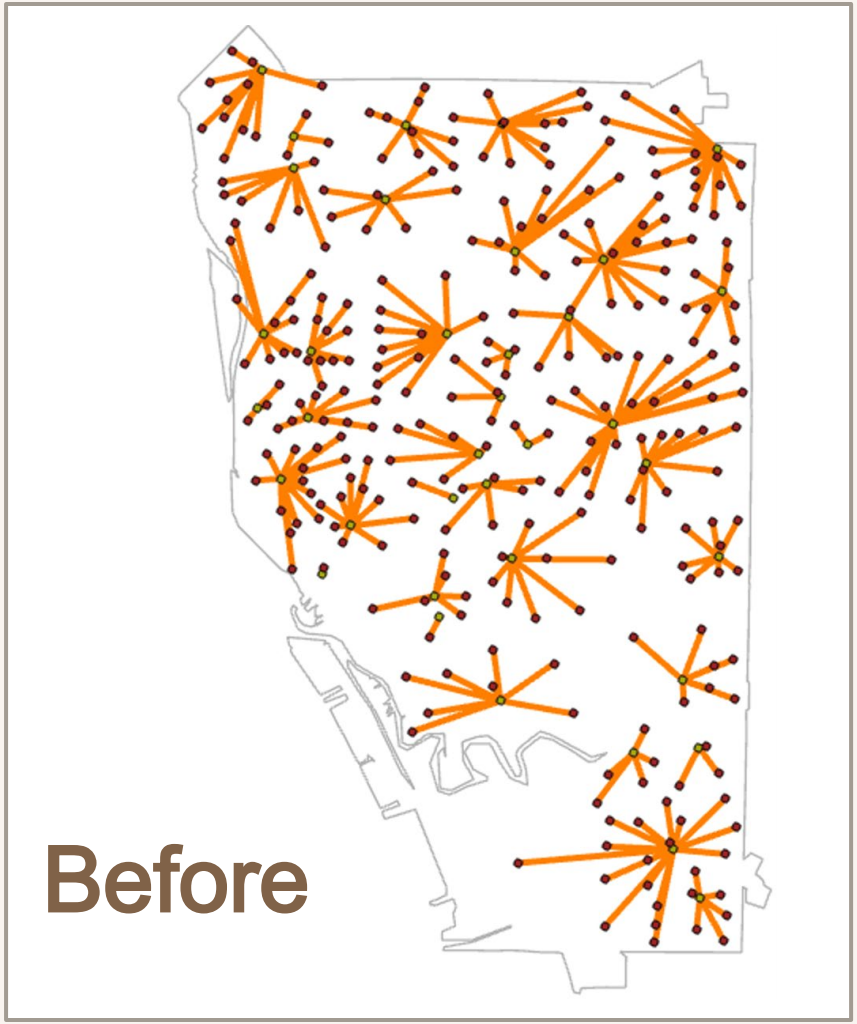
- Minimize the dissimilarity index
  - Most common measure of segregation
  - Degree to which a racial group is evenly distributed across schools
  - Scale from 0 (complete integration) to 100 (complete segregation)

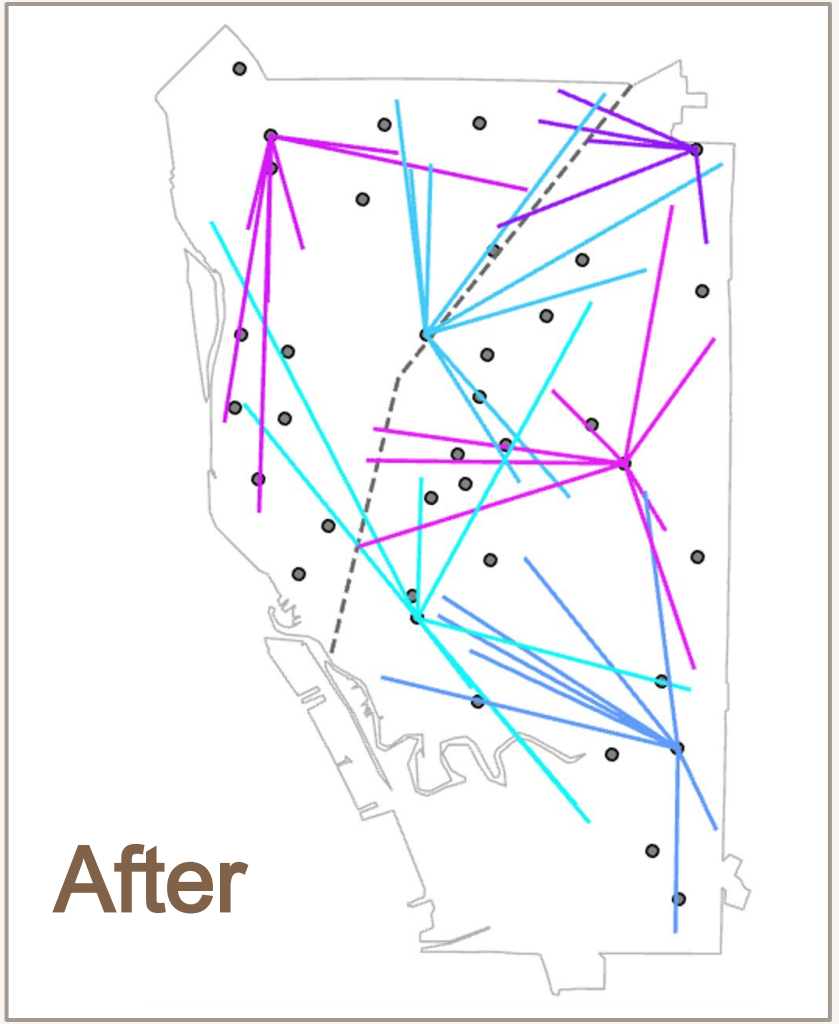
Model Constraints

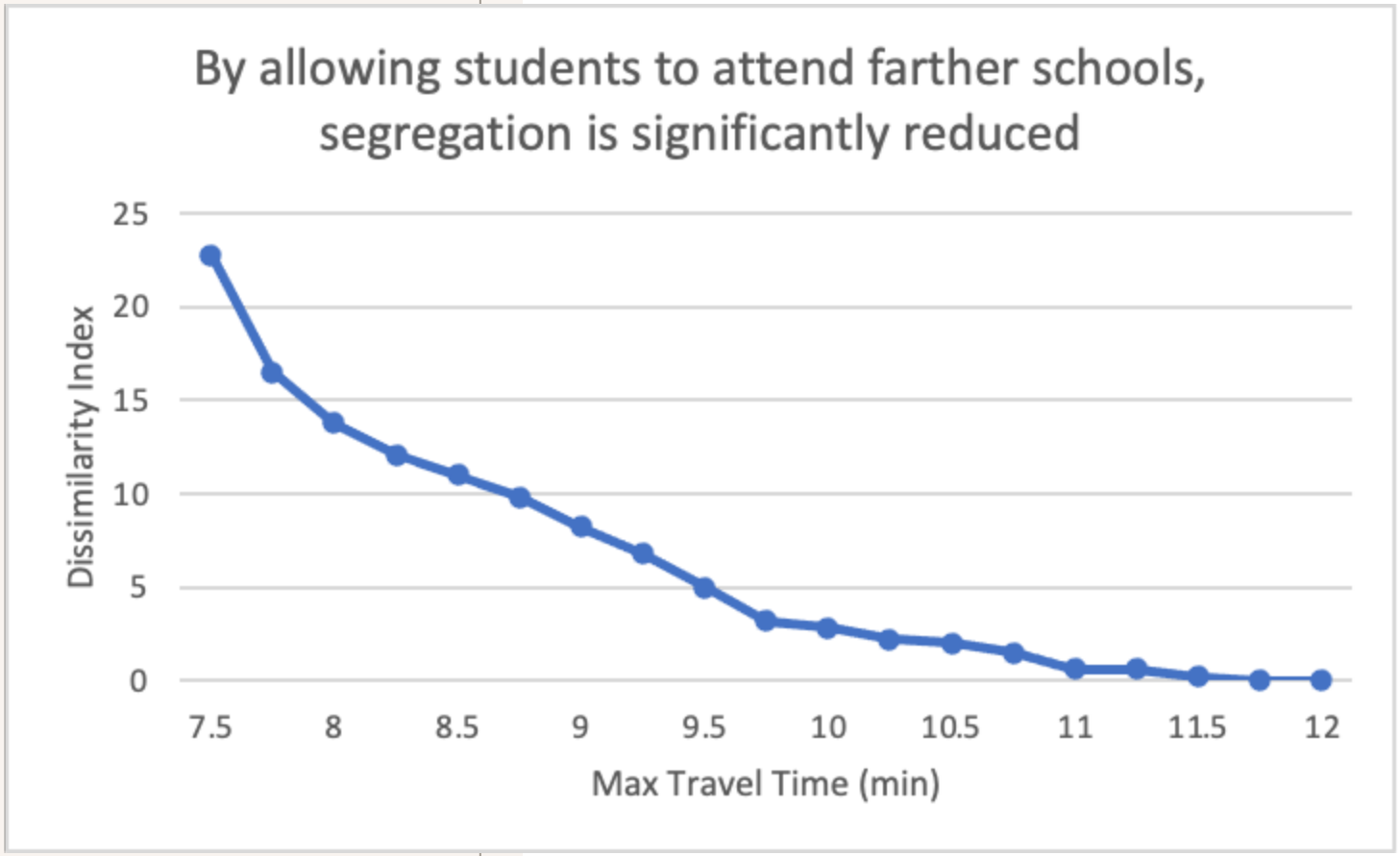
- Each block group is assigned to one school
- School capacity remains the same
- Maximum student travel time
- Keep block groups/neighborhoods together
- Limit the number of block groups reassigned

Analyzing The Model

- As schools become more integrated…
  - Student travel time increases
  - Transportation is more expensive
- There are tradeoffs. How do we quantify them?


Before


After


By allowing students to attend farther schools, segregation is significantly reduced
Dissimilarity Index
25
20
15
10
5
0
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
Max Travel Time (min)

Thanks!