Designing a Better Train System for Austin, Texas

Background

My hometown, Austin, has a rapidly growing problem: itself. Austin is one of the fastest growing cities in the country, and growing from a small college town to one of the largest cities in the country has brought the city more than its fair share of growing pains. One of the most irritating changes that has come with the population boom in Austin has been the inability of the city's transportation infrastructure to keep up with the higher volume of traffic being imposed on it. According to Forbes, Austin has the 8th worst traffic in America, and residents waste on average 30 hours a year stuck in traffic. In order to alleviate this problem, the city has approved several temporary, half-done solutions such as adding lanes to highways, a solution that some research suggests could make traffic even worse. One proven way to alleviate road congestion is through public transportation infrastructure. Though Austin completed a MetroRail in 2010, its ridership is currently only around 2,800 riders per day- compared to about 598,200 in Boston. I wanted to create a subway that would be an easy means of transportation into and throughout the city for residents and commuters. My main goals were serving a large, equally representation population of the city, and to alleviate as much traffic as possible.

Methods

In order to determine where to place subway lines in order to maximize ridership, I used a principal component analysis (PCA) to determine which variables, at the census tract level, were most indicative of public transportation ridership. In order to do this, I did a preliminary literature review and reached out to Allison Kaplan and Steve Roth, who both were involved with planning the Austin Metrorail, to identify census variables that generally indicate strong public transportation placement.

After narrowing my variables down to a shortlist of age, race, income, and population density, and acquiring and joining census data to the corresponding shapefiles, I ran a regression in Geoda to determine which variables were significantly effecting public transportation ridership averages. This process turned out to be slightly more difficult than anticipated, as I had to create more appropriate age brackets for the analysis, and convert racial population totals to percentages. Once I had the appropriate data, I was able to run the regression shown, and then the same regression in SPSS in order to receive standardized coefficients, allowing me to weight each variable proportionately to its impact on public transportation ridership. Once I had the correct weights for the census data, I used the model shown to combine them. I also included a core transit corridors map from the city of Austin, which I converted into a Euclidean distance raster and combined with the final output to account for areas of the city that were most in need of traffic reduction.

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SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set            :     trav_will_final
Dependent Variable  :    SE_T128_03  Number of Observations:     307
Mean dependent var  :      261.567  Number of Variables   :      11
S.D. dependent var  :      221.205  Degrees of Freedom    :     296

R-squared           :        0.542274  F-statistic           :      35.0674
Adjusted R-squared  :        0.526810  Prob(F-statistic)     :1.12104e-044
Sum squared residual:6.87595e+006  Log likelihood        :    -1973.18
Sigma-square        :       23229.6  Akaike info criterion :     3968.35
S.E. of regression  :       152.412  Schwarz criterion     :     4009.35
Sigma-square ML     :       22397.2
S.E of regression ML:       149.657

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    Variable     Coefficient       Std.Error     t-Statistic     Probability
------------------------------------------------------------------------------
    CONSTANT       -910.04         482.113       -1.887607       0.06006
       65_85       -100.8606       109.5699      -0.9205136      0.35806
       10_24       -113.3864       101.7613      -1.114239       0.26608
African_Am          1039.739        502.2497       2.070163       0.03930
    Hispanic        1247.981        483.4031       2.581657       0.01031
       White         773.8382       495.3429       1.562228       0.11930
       Asian         874.4651       527.0387       1.659204       0.09813
  SE_T057_00    0.001590812   0.0004632304       3.43417        0.00068
  SE_T093_00      0.1252657     0.009668721     12.95577        0.00000
  SE_T101_00  -0.0003688708   9.326424e-005      -3.955115       0.00010
  SE_T002_01    0.004873951     0.003228105       1.509849      0.13215
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REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER   193.990281
TEST ON NORMALITY OF ERRORS
TEST                 DF          VALUE              PROB
Jarque-Bera           2          772.2469           0.00000

DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                 DF          VALUE              PROB
Breusch-Pagan test   10          197.7520           0.00000
Koenker-Bassett test 10           43.6274           0.00000
================================ END OF REPORT =================================
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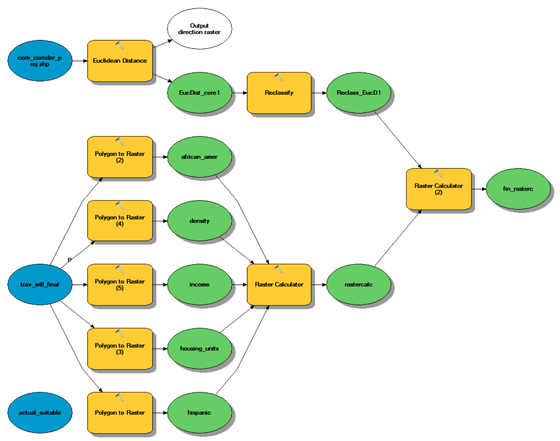
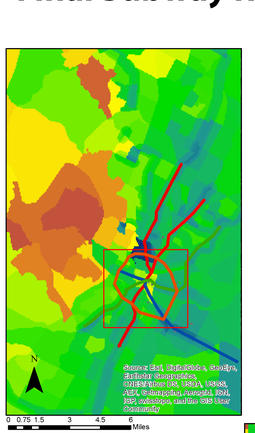
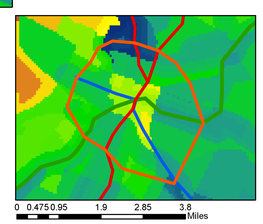


Results

Once I had my final public transit suitability raster, the rest of the analysis was qualitative. I used a land use inventory shapefile to try to identify places where a train stop could be placed most cheaply, where it was applicable, and the rest of the analysis was based on what made would provide the most logical flow of transportation through the city. For example, though the central business district area of Austin was designated as a low suitability area, I knew I needed to have multiple stops there, as that is the destination of many commuters. Furthermore, on the advice of Ms. Kaplan I attempted to connect each stop to a development, neighborhood, job center, or stadium. For example, I made sure to include stops at most of the University of Texas stadiums. I thought my final route selection didn't look very impressive on its own, so I created a stylized Austin subway map in Adobe Illustrator to more clearly indicate where stops were located.

Final Subway Route Design





Austin MetroRail

Limitations

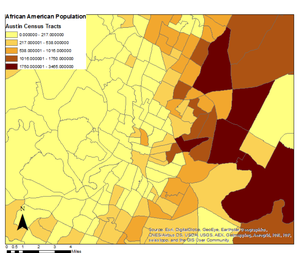
The main limitations of my final result in my opinion were the simplicity of the analysis. In order to fully address the limitations of the Austin MetroRail, I initially intended to incorporate a demographic analysis, ensuring that no Austin populations were being under or overserved by my final design. Though my suitability raster certainly addressed that to an extent, further analysis was limited by time constraints. Furthermore, my suitability raster was more effective in indicating areas of suitability, not specific stops. Lastly, though I am happy with my final result and believe it would be an effective, convenient improvement over the MetroRail, it is largely a fantasy. In my literature review I read extensively regarding the fiscal barriers to the construction of such an expansive train system at this point.

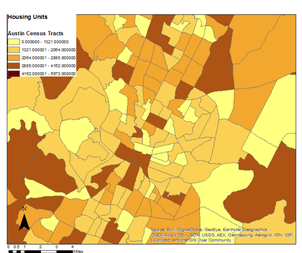
Cartographer: Emery Reifsnyder, GIS 102 Spring 2016

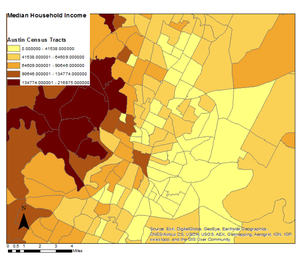
Project Date: May 2016

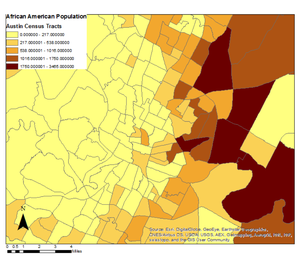
Data Sources: City of Austin, American Community Survey 2014

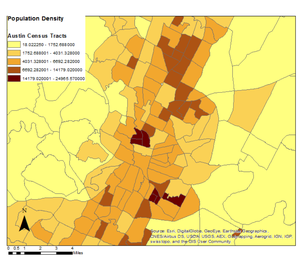
Projection Coordinate System: NAD_1983_StatePlane_Texas_Central_FIPS_4203_Feet

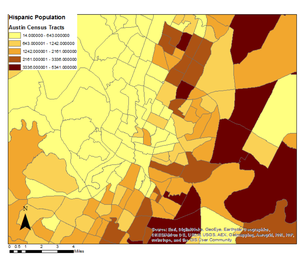












Tufts