Minneapolis Walkability Analysis by Census Tracts

A Case Study for Making Beautiful Web Maps with ArcGIS Arcade

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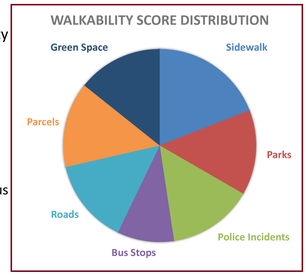
RESEARCH OBJECTIVES

The aim of this study is to learn how to implement Arcade, which is an expression language of ArcGIS, to ArcGIS Online and ArcGIS Pro, and discover its limitations. As a test case, the walkability of Minneapolis by Census Tract is studied.

- Determine Census Tract areas in Minneapolis that are suitable for leisure walking by calculating a *walkability score*
- Discover Arcade functions to make the analysis faster and easier
- Perform statistical analysis of the walkability score against median income per census tract to see if they are correlated

METHODS

A quantitative measure is defined to assign a "Walkability Score" to each feature using data from 7 different datasets:



· **Census Tract Shapefile**

Clipped by Minneapolis neighborhoods

Data source: Census Bureau

· **Police Incidents 2017 (Score 0 to 15)**

Number of crime points by Census tract, normalized by Census Tract area

Data source: Minneapolis Open Data

· **Road (Score 0 to 15)**

Length of State, Interstate and US Highways, County Highways, and Local Streets; normalized by total road length. Roads Weighted as:

State, Interstate and US Highways: 0

County Highways: 0.8

Local Streets: 1

Data source: MN Geospatial Commons/Minnesota Department of Transportation (MnDOT)

· **Green Space (0 to 15)**

Green space classification from 2015 NAIP Imagery. Green space area normalized by Census Tract's land area.

Data Source: National Agriculture Imagery Program (NAIP) - 2015 (Data were taken from FNRM 5262—Remote Sensing & Geospatial Analysis class project by McGraw, Birol, Sjostrom)

· **Sidewalk (Score 0 to 20)**

Sidewalk length divided by 2 and normalized by total street length within the census tracts.

Data Source: Minneapolis Open Data (PW Planimetric Lines)

· **Parcel (Score 0 to 15)**

Area of residential, commercial, apartment, and townhouse parcels divided by the total parcel area including the industrial parcels as well, per census tracts. (Other parcel types such as golf courses are not included.)

Data Source: Hennepin County Open Data (County Parcels)

· **Regional Parks (Score 0 to 15)**

Regional Park areas within Census Tracts, normalized by total Census Tract areas.

Data Source: MN Geospatial Commons/Metropolitan Council

· **Bus Stops (Score 0 to 10)**

Number of Bus stops by Census tract, normalized with Census Tract area.

Data Source: MN Geospatial Commons/Metropolitan Council - Metro Transit

Additional Data:

· **Median Household Income per Census Tracts**

American Community Survey (ACS) 2017 - 5 year estimates

· **School Locations**

Minneapolis Geospatial Commons/Minnesota Department of Education

· **Minneapolis Neighborhoods, 2019 Police Incidents (Service Link), Minneapolis Police Precincts (Service Link)**

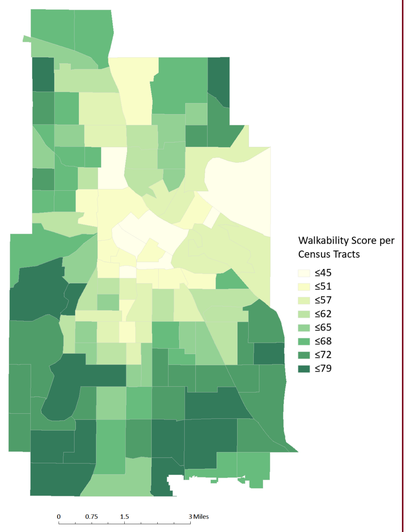
Minneapolis Open Data

Arcade - Walkability Score Calculation

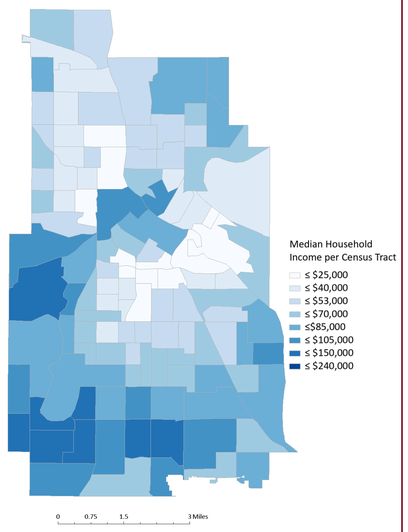
Arcade is used when calculating Walkability Score in ArcGIS Pro "Calculate Field" tool. The image below is an example of how Parcel Score is calculated. After calculating each score per Census Tracts, the sum of the scores are assigned to Score field. The very same codes are also used in Web Map pop-up windows to calculate Parcel Scores of individual Census Tracts On-The-Fly.

```
Score =
var comm = area(intersects(filter(FeatureSetByName($datastore, "MinneapolisParcels_Tracts"),
"PR_TYP_NM1 LIKE '%COMMER%' "), $feature), 'square-meters' )
var res = area(intersects(filter(FeatureSetByName($datastore, "MinneapolisParcels_Tracts"),
"PR_TYP_NM1 LIKE '%RESIDN' "), $feature))
var ind = area(intersects(filter(FeatureSetByName($datastore, "MinneapolisParcels_Tracts"),
"PR_TYP_NM1 LIKE '%INDUS%' "), $feature))
var apt = area(intersects(filter(FeatureSetByName($datastore, "MinneapolisParcels_Tracts"),
"PR_TYP_NM1 LIKE '%APT%'OR PR_TYP_NM1 LIKE '%TOWN%' "), $feature))
var totalParc = (res+ind+comm+apt)
var parcelScore = ((res+apt+comm)/(totalParc))*15
```

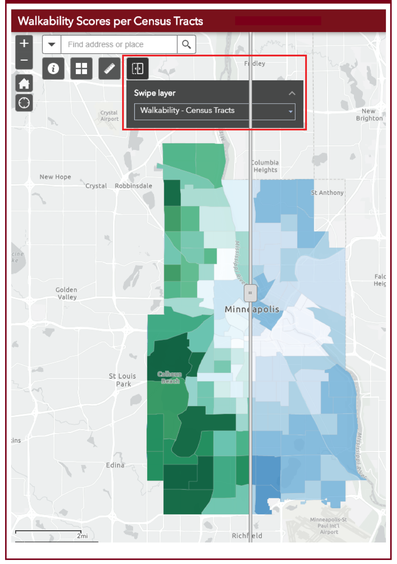
Walkability Score Results (Not Interactive)



Median Household Income (Not Interactive)

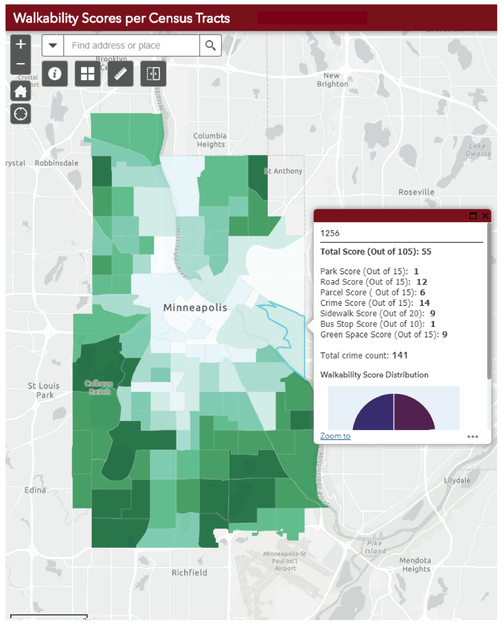


Walkability Score and Median Household Income - Web Map—Swipe Tool

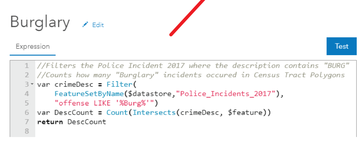


Per-Tract Walkability Score Against Median Household Income

Walkability Scores per Census Tracts



Web maps are more useful when displaying multiple analysis. It allows users to interact with the map. With Arcade, users can create dynamic pop-ups that derives information from different datasets without making any necessary changes on the data. In this example, various charts that display data from other layers can be seen.



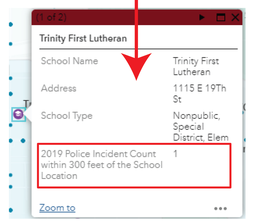
With **Arcade**, multiple variables/attributes are created within the "Walkability Scores per Census Tract" layer. The count information are derived from 2017 Police incident data which is in the map. Different types of charts can also be plotted within popups.

Arcade helps users to create dynamic pop-ups. In the example below, the School location data has an expression in its pop-up to calculate how many Police Incident locations (in 2019) are in 300 feet around the point. The 2019 Police Incident data is added to this map as a feature service, and when Minneapolis updates the data, the service layer will automatically update itself as well.

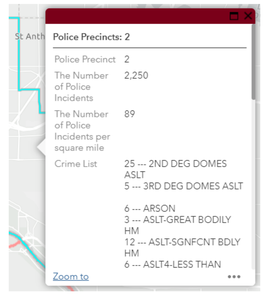
2019 Police Incident Count within 300 feet

Expression — Test

```
// creates 100 feet buffer around the school location point
// counts number of Police Incident 2019 points within each buffer
var buff = buffer($feature, 300, 'feet')
var crimeCount = count(
    intersects(FeatureSetByName($map,"Police_Incidents_2019"),buff))
return crimeCount
```



In the example below, both Police Precinct and Police Incidents 2019 are service layers. Number of incidents that are within the polygons of each class can also be shown as a list in the pop-ups. The data is shown on-the-fly, and it calculates the results every time when the pop-up is opened. When the source data is updated, the information will also be updated.



However, it is not possible to use feature sets when symbolizing layers and feature services. In order to symbolize the Police Precinct polygons for police incident count, we need to create a field, which is not possible with feature services.

DISCUSSIONS

· Minneapolis walkability scores are correlated with Median Household Income with high R^2 value. (Shown in scatter plot.)

· The datasets come from different years: Police incident data (2017), Green space classification (2015), sidewalk (various years, including 1991), Average income (ACS 2017 estimates). Using consistent data from the same year would improve the reliability of the results.

· The sidewalk data is not up to date, hence it is not completely reliable. When better data is publicly available, the same analysis can be re-run to gain more reliable results.

· Walking time (the length of available walking paths between two points) was not considered in this study.

· Since there is not a unique definition of "the walkability score", it is subjective. In this study we used only a few parameters. In an ideal study, sidewalk pavement quality, intersection density, various commercial type (such as restaurants, stores , etc.) land uses, and pollution index would have been also considered at the "sidewalk" level, rather than large areas like Census Tracts.

· Arcade's geometry functions are considerably slow when using feature sets in ArcGIS Online pop-ups.

· ArcGIS Pro is more useful when running codes with geometry functions of feature sets.

· Feature sets are useful when calculating fields, but each layer has to be in the same data source which makes things a bit complicated when working in different environments.

· Arcade is the most useful when using service layers that are being updated regularly, such as Police Incident 2019 and Police Precinct example.

· Arcade decreases the number of the steps for spatial analysis.

· Arcade enriches data visualization with custom pop-ups, symbology, and labelling.

· In order to perform these analysis with Arcade, and use functions such as feature set and geometry, users need the version of ArcGIS Server 10.7 or ArcGIS Pro 2.4.