Mapping Internet Access in Multnomah County

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Introduction

Suppose my client is the Multnomah County Library (MCL). Following the approval pf Measure 26-211 by voters in 2020, the county is funding renovation of 8 of the 19 libraries and creating a new flagship library at 7905 SE Holgate to serve East Portland.

As our daily lives have become increasingly digital, access to adequate information technology has become a necessity. The COVID-19 pandemic accelerated this shift, where video conferencing became the norm for so many of us to go to school, the doctor, and work.

However, not everyone has access to the internet at home in 2023. Our libraries provide access to information technology to everyone at no cost. The Multnomah County Library has asked that I provide a report addressing the following questions:

- Where in the county are there the most people without broadband internet access at home?
- Are the libraries' locations convenient for those who need access to information technology?

I used the 2021 American Community Survey to answer who how many people not have have access to the internet at home, where they live, and created visualization to present my findings to the Library Advisory Board.

My Findings

- Over 20,000 people in Multnomah County do not have access to broadband internet at home.
- The largest concentrations of people without internet at home are in Downtown (15.6%) and Old Town Portland (17.5%), followed by the Piedmont Neighborhood (8%).
- With the Central and Holgate Libraries closed for construction through 2023, there is currently a gap in service in providing Downtown and East Portland with access to information technology.
- MCL plans to open a pop-up technology resource center at 510 SE Washington, however no opening date has been announced.

Deliverables

- Static Map of Multnomah County
- Interactive Map of Multnomah County

Code

Loading packages:

```r
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ----------------------- tidyverse 2.0.0 --
## v dplyr     1.1.1     v readr     2.1.4
## v forcats   1.0.0     v stringr   1.5.0
## v ggplot2   3.4.1     v tibble    3.2.1
## v lubridate 1.9.2     v tidyr     1.3.0
## v purrr     1.0.1
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
```

```r
library(maps)
```

```
## 
## Attaching package: 'maps'
## 
## The following object is masked from 'package:purrr':
## 
##     map
```

```r
library(sf)
```

```
## Linking to GEOS 3.10.2, GDAL 3.4.2, PROJ 8.2.1; sf_use_s2() is TRUE
```

```r
library(tigris)
```

```
## To enable caching of data, set 'options(tigris_use_cache = TRUE)'
## in your R script or .Rprofile.
```

```r
library(tidycensus)
library(tmap)
library(leaflet)
library(htmltools)
library(htmlwidgets)
```

Authenticating US Census API key:

```r
options(tigris_use_cache = TRUE)
#getting access to census day with my API key
census_api_key(census_key, install = TRUE, overwrite = TRUE)
```

```
## Your original .Renviron will be backed up and stored in your R HOME directory if needed.
```

```
## Your API key has been stored in your .Renviron and can be accessed by Sys.getenv("CENSUS_API_KEY").
## To use now, restart R or run 'readRenviron("~/.Renviron")'
```

```
## [1] "a8150f07baa78cbba0671478efbfa37d0d2f9aa4"
```

Loading the American Community Survey data from the Census bureau:

```r
#grabbing variables from 2021 ACS 1-year estimates (data collected Jan 1 2021 - Dec 31 2021)
acs_vars_2021 = load_variables(year = 2021, dataset = "acs1")

#searching for variables with internet
acs_vars_2021 %>% filter(grepl("internet", concept, ignore.case = T)) #| grepl("computer", concept, ign
```

```
## # A tibble: 203 x 3
##    name       label                                                 concept
##    <chr>      <chr>                                                 <chr
##  1 B28002_001 Estimate!!Total:                                      PRESEN~
##  2 B28002_002 Estimate!!Total:!!With an Internet subscription       PRESEN~
##  3 B28002_003 Estimate!!Total:!!With an Internet subscription!!Dial-up ~ PRESEN~
##  4 B28002_004 Estimate!!Total:!!With an Internet subscription!!Broadban~ PRESEN~
##  5 B28002_005 Estimate!!Total:!!With an Internet subscription!!Cellular~ PRESEN~
##  6 B28002_006 Estimate!!Total:!!With an Internet subscription!!Cellular~ PRESEN~
##  7 B28002_007 Estimate!!Total:!!With an Internet subscription!!Broadban~ PRESEN~
##  8 B28002_008 Estimate!!Total:!!With an Internet subscription!!Broadban~ PRESEN~
##  9 B28002_009 Estimate!!Total:!!With an Internet subscription!!Satellit~ PRESEN~
## 10 B28002_010 Estimate!!Total:!!With an Internet subscription!!Satellit~ PRESEN~
## # i 193 more rows
```

```r
#looks like I will need to take into account the population per tract in order to calculate percent of
acs_vars_2021 %>% filter(grepl("population", concept, ignore.case = T))
```

```
## # A tibble: 15,494 x 3
##    name        label                                      concept
##    <chr>       <chr>                                      <chr>
##  1 B01003_001  Estimate!!Total                            TOTAL ~
##  2 B05006PR_001 Estimate!!Total:                          PLACE ~
##  3 B05006PR_002 Estimate!!Total:!!Europe:                 PLACE ~
##  4 B05006PR_003 Estimate!!Total:!!Europe:!!Northern Europe PLACE ~
##  5 B05006PR_004 Estimate!!Total:!!Europe:!!Western Europe PLACE ~
##  6 B05006PR_005 Estimate!!Total:!!Europe:!!Southern Europe: PLACE ~
##  7 B05006PR_006 Estimate!!Total:!!Europe:!!Southern Europe:!!Spain PLACE ~
##  8 B05006PR_007 Estimate!!Total:!!Europe:!!Southern Europe:!!Other Sout~ PLACE ~
##  9 B05006PR_008 Estimate!!Total:!!Europe:!!Eastern Europe PLACE ~
## 10 B05006PR_009 Estimate!!Total:!!Europe:!!Europe, n.e.c. PLACE ~
## # i 15,484 more rows
```

Potenial variables to use:

B01003_001 total population B28002_013 no internet access B28002_004 with broadband of any type B28003_006 no computer B28003_004 has computer with broadband internet B01003_001 total population

```r
this.year = 2021

#downloading census tract shapefile of multnomah county
or_tracts = tracts(state = 'OR', county = 'Multnomah', cb = TRUE, year = this.year)

pop_and_no_internet = get_acs(geography = "tract", year=this.year,
               state = "OR", county = "Multnomah",
               variables = c(total_pop = "B01003_001",
                             no_internet = "B28002_013")) %>%
                    mutate(AFFGEOID=paste0("1400000US", GEOID)) #creating AFFGEOID id from GEOID in ord
```

Getting data from the 2017-2021 5-year ACS

```r
pop_no_int = as.data.frame(pop_and_no_internet)[,c(1,3:4)] %>%
    pivot_wider(names_from = variable, values_from = estimate) %>% #making the data frame tidy
      mutate(perc_no_int = round((no_internet/total_pop)*100,2), #creating variable that is percentage
             AFFGEOID=paste0("1400000US", GEOID))

#summary data
pop_no_int %>% drop_na() %>% summarize(sum_pop = sum(total_pop), sum_no_internet = sum(no_internet))
```

```
## # A tibble: 1 x 2
##    sum_pop sum_no_internet
##      <dbl>           <dbl>
## 1   810011           20800
```

```r
pop_no_int %>% arrange(desc(perc_no_int))
```

```
## # A tibble: 197 x 5
##       GEOID      total_pop no_internet perc_no_int AFFGEOID
##       <chr>          <dbl>       <dbl>       <dbl> <chr>
##  1 41051005103       2302         402       17.5   1400000US41051005103
##  2 41051010601       1530         240       15.7   1400000US41051010601
##  3 41051010602       1966         161        8.19  1400000US41051010602
##  4 41051003701       4360         355        8.14  1400000US41051003701
##  5 41051008203       5923         409        6.91  1400000US41051008203
##  6 41051010410       4430         296        6.68  1400000US41051010410
##  7 41051010001       6295         408        6.48  1400000US41051010001
##  8 41051002702       3600         229        6.36  1400000US41051002702
##  9 41051002402       3178         199        6.26  1400000US41051002402
## 10 41051005102       3013         182        6.04  1400000US41051005102
## # i 187 more rows
```

```r
# GEOIDs 41051005103 has estimated 17 % no internet at home, 41051010601 has almost 16%


#joining this ACS data with tract spatial data
pop_no_int_tracts = geo_join(or_tracts, pop_no_int, by_sp = "AFFGEOID", by_df = "AFFGEOID")
```

```
## Warning: We recommend using the dplyr::*_join() family of functions instead.
```

```
## Warning: 'group_by_()' was deprecated in dplyr 0.7.0.
## i Please use 'group_by()' instead.
## i See vignette('programming') for more help
## i The deprecated feature was likely used in the tigris package.
##   Please report the issue at <https://github.com/walkerke/tigris/issues>.
## This warning is displayed once every 8 hours.
## Call 'lifecycle::last_lifecycle_warnings()' to see where this warning was
## generated.
```

```r
#first visualization using
map2 = tm_shape(pop_no_int_tracts) +
  tm_fill("perc_no_int", style = "cont", palette = "Oranges", title = "") +
  tm_style("grey") +
  tm_legend(bg.color = "white", bg.alpha = 0.6, position = c("left", "bottom")) +
  tm_layout(title = "Percent of Households in Multnomah\nCounty without Broadband Internet",
            title.position = c("center", "top"),
            title.size = 1,
            fontfamily = "sans", fontface = "bold") +
  tm_credits("Top 5 Neighborhoods      ",size = .8, position = c("RIGHT", "BOTTOM")) +
  tm_credits("Old Town: 17.46 %\nSW Downtown: 15.69%\nSE Downtown: 8.19%\nPiedmont: 8.14%\nHazelwood 6.9
  tm_credits("Data source: American Community Survery 2021", size = .6, fontface = "italic", position =


pop_no_int_tracts = pop_no_int_tracts %>%
                    arrange(desc(perc_no_int)) %>%
                        mutate(name = case_when(TRACTCE == "005103" ~ "Old Town",
                                                TRACTCE == "010601" ~ "SW Downtown",
                                                TRACTCE == "010602" ~ "SE Downtown",
                                                TRACTCE == "003701" ~ "Piedmont",
                                                TRACTCE == "008203" ~ "Hazelwood"))
```

Creating an interactive graphic using leaflet:

```r
pal<-colorNumeric("Reds", domain=0:ceiling(max(pop_no_int_tracts$perc_no_int, na.rm=TRUE)))

popup<-paste("Tract: ", as.character(substring(pop_no_int_tracts$GEOID.x, 6, 11)), "<br>",
             "Percentage of Households without broadband internet: ", as.character(pop_no_int_tracts$pe

library(leafletCN)


multco_leaflet = leaflet()%>%
  addProviderTiles("CartoDB.Positron")%>%
  addPolygons(data=pop_no_int_tracts,
              fillColor= ~pal(pop_no_int_tracts$perc_no_int),
              fillOpacity = .5,
              weight =.5,
              smoothFactor = 0.2,
              popup = popup) %>%
  addMarkers(lat = 45.519702018355936, lng = -122.6831405693095, popup = "Multnomah County Central Libra
  addMarkers(lat = 45.582959138612935, lng = -122.68644127317535, popup = "Multnomah County Kenton Libra
  addMarkers(lat = 45.490583320668875, lng =  -122.582268235629, popup = "Multnomah Count Holgate LIbrar
  addControl(
    position = "bottomright",
```

```
    html = "<h4> Percent of Households without Access to the Internet in Multnomah County</h4>"
  )
```

```
## Warning: sf layer has inconsistent datum (+proj=longlat +datum=NAD83 +no_defs).
## Need '+proj=longlat +datum=WGS84'
```

```
#exporting interactive map as html:
#saveWidget(multco_leaflet, file ="multco_leaflet.html")
```