Visualizing commuting patterns using LODES data

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The average travel time to work in the United States is 29.4 minutes, according to the U.S. Census Bureau. Move around the map or enter your town or zip code to find commute times for your area.
The American Commute
A functional economic geography of the United States

About the map
This map shows all commuting links of 100 miles or less, between census tracts in the contiguous United States.

The shortest journeys are shown in yellow and the longest journeys in red. The map mirrors the underlying population distribution but it also highlights the functional economic geography of the nation, including several 'mega-regions'. There are just over four million lines in the dataset, and more than 130 million individual commutes.

Data Source: American Community Survey 2006-2010

Map created by Alasdair Rae
Census Transportation Planning Products

About CTPP

The CTPP is a set of special tabulations designed by transportation planners using large sample surveys conducted by the Census Bureau. From 1970 to 2000, the CTPP and its predecessor, Urban Transportation Planning Package (UTPP), used data from the decennial census long form. The decennial census long form has now been replaced with a continuous survey called the American Community Survey (ACS). Therefore, the CTPP now uses the ACS sample for the special tabulation.

The first CTPP using the ACS is the 2006-2008 CTPP, using 3 years of the ACS and is restricted to geographic units (counties and places) with population of 20,000 or more. The 2006-2010 CTPP, using 5 years of ACS, includes small geographic units such as census tracts and Transportation Analysis Zones (TAZs), is available on American Association of State Highway and Transportation Officials (AASHTO) website: https://ctpp.transportation.org/.

The CTPP tabulations are unique because they include three geographies:

- Part 1: Residence-based tabulations summarizing worker and household characteristics
- Part 2: Workplace-based tabulations summarizing worker characteristics
- Part 3: Worker flows between home and work, including travel mode

To learn more and access CTPP data products, visit the Data Products page.
LEHD Origin-Destination Employment Statistics (LODES)

• Part of the Longitudinal Employer-Household Dynamics data products from the U.S. Census Bureau

• Unemployment Insurance earnings data and Quarterly Census of Employment and Wages data from States are combined with administrative data, census data, and survey data

• Data limitations
  • Only includes data for employees covered by unemployment insurance. Does not include self-employed individuals
  • Workplace location reported by the employer may not be the physical location to which the employee commutes (e.g. telecommuters)
  • There are known issues with employers underreporting multiple worksite locations
  • Design Comparison of LODES and ACS Commuting Data Products: https://ideas.repec.org/p/cen/wpaper/14-38.html

• Three groups of data files are available for most states from 2002-2015
  • Origin-Destination (OD) data
  • Residence Area Characteristic (RAC) data
  • Workplace Area Characteristic (WAC) data

• The current version of LODES was enumerated by 2010 census blocks

• https://lehd.ces.census.gov/data/#lodes
OD file structure

• **[ST]_od_[PART]_[TYPE]_[YEAR].csv.gz**
  • **[ST]** = lowercase, 2-letter postal code for a chosen state
  • **[PART]** = Part of the state file, can have a value of either “main” or “aux”. Complimentary parts of the state file, the main part includes jobs with both workplace and residence in the state and the aux part includes jobs with the workplace in the state and the residence outside of the state.
  • **[TYPE]** = Job Type, can have a value of “JT00” for All Jobs, “JT01” for Primary Jobs, “JT02” for All Private Jobs, “JT03” for Private Primary Jobs, “JT04” for All Federal Jobs, or “JT05” for Federal Primary Jobs.
  • **[YEAR]** = Year of job data. Can have the value of 2002-2015 for most states.
Mapping Oregon commutes

- Commuters within Oregon
  - or_od_main_JT00_2015.csv.gz

- Residents of other states that commute to Oregon
  - or_od_aux_JT00_2015.csv.gz

- Oregon residents that commute to other states
  - ca_od_aux_JT00_2015.csv.gz
  - id_od_aux_JT00_2015.csv.gz
  - nv_od_aux_JT00_2015.csv.gz
  - wa_od_aux_JT00_2015.csv.gz
### Record-level structure

<table>
<thead>
<tr>
<th>State code</th>
<th>County code</th>
<th>Tract code</th>
<th>Block code</th>
<th>Total number of jobs</th>
<th>Number of jobs by age range</th>
<th>Number of jobs by earnings range</th>
<th>Number of jobs by industry sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
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<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: The table above represents a record-level structure with columns for State code, County code, Tract code, Block code, Total number of jobs, Number of jobs by age range, Number of jobs by earnings range, and Number of jobs by industry sector.
Transform data using statistical software

• Append files together
• Drop records without a home or work location in the main state
• Drop records of residents from non-neighboring states that work in the main state. We are not considering these to be daily commuters.
• Aggregate the work and home census block codes into census tract geo-ids. Ensure that the job variable counts are aggregated accordingly.
• Join lat/long values from tract centroids to the LODES data
• Generate a Well Known Text (WKT) LineString field that QGIS or Mapbox will use to create each commuting line

<table>
<thead>
<tr>
<th>w_lat</th>
<th>w_long</th>
<th>h_lat</th>
<th>h_long</th>
<th>geom</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.04066</td>
<td>-87.64438</td>
<td>36.98796</td>
<td>-89.16366</td>
<td>LINESTRING (-87.644256 38.040660, -89.163660 36.987960)</td>
</tr>
<tr>
<td>38.35257</td>
<td>-87.9812</td>
<td>36.99796</td>
<td>-89.16366</td>
<td>LINESTRING (-87.981200 38.352564, -89.163660 36.987960)</td>
</tr>
</tbody>
</table>
Determining frequency of map lines

- Mapping each individual commute (Indiana=3,061,054) is too many lines for the map to render quickly or for the viewer to interpret
- Experiment with setting a minimum threshold or adjusting the aggregation so each line represents a certain number of commuters
  - 5, 10, 20, 50, etc.
  - For Indiana, 20 commuters per line yields a good result (about 70,000 lines)
  - For Oregon, excluding all lines with less than 5 commuters renders well
Importing data to QGIS

- Add the csv file as a delimited text layer
Symbolizing the lines in QGIS

- Change the line width to 0.1 and darken the background
- Change the line color and add feature transparency
Add a glow effect

Adjust the feature blending mode

Addition mode

Screen mode
Adjust the line color to show non-Indiana residents
Setup a free Mapbox account to create a webmap.
Import the commuting data to Mapbox

- Create a new vector tileset in Mapbox studio by importing the csv output from the statistical software
- Within Mapbox studio, add the tileset to a default or custom style to create a map
Create the line glow effect in Mapbox

- Create a new style using the standard dark style
- Add the tileset layer to the map
- Drag the commuting layer sit under the label layers
- Style the color, opacity, and width of the lines using data driven properties based on the S000 variable (total number of jobs with the same origin and destination tract)
- Publish the map
- Adjust html file to customize map elements
Oregon Commuting Patterns

Each line represents 5 or more commuters with the same home and work census tracts.

Oregonian commuters

5 - 1000+

Residents of other states commuting to Oregon

5 - 1000+

Source: City of Eugene, using 2015 LEHD Origin-Destination Employment Statistics (LODES) data.
Create a more intense line glow effect in Mapbox

• Style the color using the data driven property on the jobs variable as before
• Set the blur for the tileset to be 0 px
• Set the width for the tileset to be 0.5 px
• Duplicate the tileset layer and adjust the properties for the bottom layer:
  • Make the colors for each step darker
  • Set the width of the layer to be one or two pixels wider
  • Set the blur of the layer to 0.5 px
• Adjust the opacity of both layers until you achieve the desired glow effect