

# Visualization of Origin-Destination Commuter Flow Using CTPP Data and ArcGIS

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2015 ESRI User Conference | July 23, 2015 | San Diego, CA

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# Contents

- **What is SCAG?**
- **Objectives**
- **Methodology**
- **Results**
- **Conclusions**
- **Future Studies**

# What is SCAG?

SCAG  
Region

San Francisco

Los Angeles

San Diego

Phoenix

Dallas

San Antonio

Houston

Chicago

Philadelphia

New York



**6** counties and **191** cities

**15** sub-regions

**18.4** million people (2012)

**38,000** square miles

**16th** largest economy in the world (GRP: **\$924** Billion in 2013)

Nation's largest Metropolitan Planning Organization (MPO)

# Objectives

- Identify work destinations for each jurisdiction in the SCAG region at the Census Tract level
  - 191 cities and 6 counties
- Visualize the spatial patterns of the major work destinations for each jurisdiction
  - To understand where residents of each jurisdiction are employed
- Provide informational data resources to local jurisdictions for planning purposes
  - E.g. 2013 Local Profiles: Planning data reports

# Census Transportation Planning Package (CTPP)

- The CTPP is a set of special tabulations designed by transportation planners using large sample surveys conducted by the Census Bureau.
- Utilize continuous survey called American Community Survey (ACS)
- Three components of CTPP:
  - 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
- CTPP supports a wide variety of transportation planning tasks

# CTPP Program

data5.ctpp.transportation.org/ctpp/Browse/BrowseTables.aspx

File View Tools Help

Data set: 2006-2010 (5-year) Selected Geography: RESIDENCE (new set) WORKPLACE (new set)

CTPP Tables

- CTPP 5-Year Data Set (2006 to 2010)
  - Part 1: Residence
    - Residence: All Population
    - Residence: Workers 16 years and over
    - Residence: Workers 16 years and over who did not work at home
    - Residence: Workers in Households
    - Residence: Households
    - Residence: Housing Units
  - Part 2: Workplace
    - Workplace: Workers 16 Years and Over
    - Workplace: Workers 16 years and over who did not work at home
    - Workplace: Workers 16 years and over in households
  - Part 3: Flows
    - Flows: Workers 16 Years and Over
      - Flows: Workers 16 Years and Over - Set A (from microdata)
        - A302100 - Total Workers (1) (Workers 16 years and over)
        - A302105 - Means of transportation (18) (Workers 16 years and over)
      - Flows: Workers 16 Years and Over - Set B (from disclosure proofed microdata)
        - B302101 - Age of Worker (8) (Workers 16 years and over)
        - B302102 - Industry (8) (Workers 16 years and over)
        - B302104 - Time leaving home (17) (Workers 16 years and over)
        - B302105 - Minority status (3) (Workers 16 years and over)
        - B302106 - Travel time (12) (Workers 16 years and over)
        - B302200 - Age of Worker (6) by Means of transportation (7) (Large geos only) (Workers 16 years and over)
        - B30220C - Age of Worker (6) by Means of transportation (4) (Workers 16 years and over)
        - B302201 - Time leaving home (5) by Means of transportation (7) (Workers 16 years and over)
        - B302201C - Time leaving home (5) by Means of transportation (4) (Workers 16 years and over)
        - B302202 - Travel time (12) by Means of transportation (7) (Large geos only) (Workers 16 years and over)
        - B302202C - Travel time (12) by Means of transportation (4) (Workers 16 years and over)
        - B304100 - Poverty status (4) (Workers 16 years and over for whom poverty status is determined)
        - B305101 - Industry (8) (Large geos only) (Workers 16 years and over who are not self-employed)
        - B307200 - Aggregate Vehicles used (1) by Time leaving home (5) (Workers 16 years and over who used car, truck or van)
        - B307201 - Workers per car, truck, or van (1) by Time leaving home (5) (Large geos only) (Workers 16 years and over who used car, truck or van)
        - B309200 - Aggregate Carpools (1) by Time leaving home (5) (Workers 16 years and over who carpooled)
        - B309201 - Workers per carpool (1) by Time leaving home (5) (Workers 16 years and over who carpooled)
      - Flows: Workers 16 years and over who did not work at home
      - Flows: Workers 16 years and over in households

data5.ctpp.transportation.org/ctpp/Dim/InsideGeoSelection.aspx?GeoType=WORKPLACE&AuxiliaryLevel=C22

File Help

Census Transportation Planning Products Welcome (sign in to)

Data set: 2006-2010 (5-year) Selected Geography: RESIDENCE (new set) WORKPLACE (new set)

WORKPLACE

Bulk selection Selection list\* Selection map Totals Percentages Custom groups Custom calculations

LEVEL: POW STATE-COUNTY-TRACT AVAILABLE FLOWS

2346 POW State-County-Tract(s) highlighted + Add all highlighted POW State-County-Tract(s) to selection

Map Scale: 1:80,000

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# DATA Description

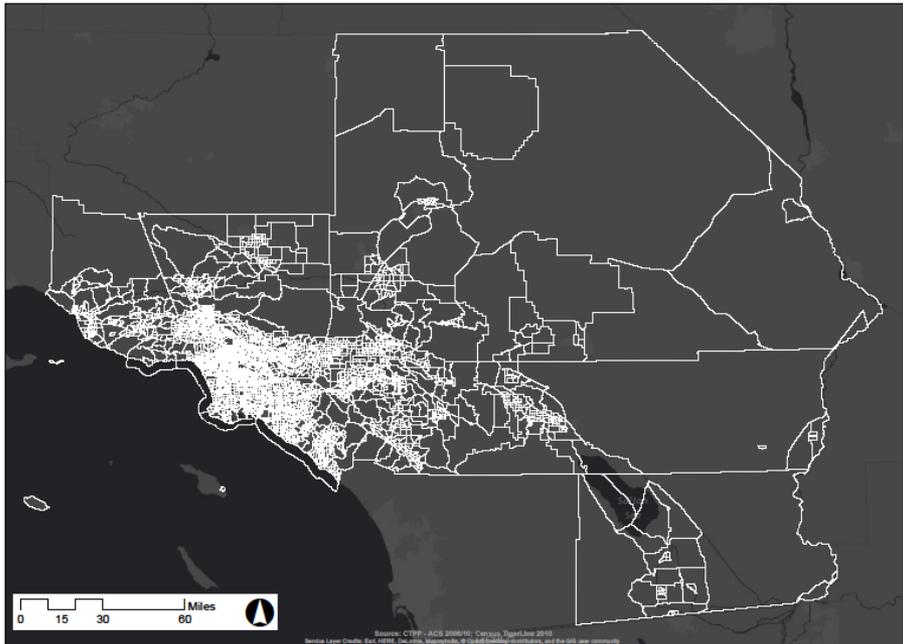
- Census 2010 shapefile:
  - Tiger/Line shapefile
  - Place and Tract
- CTPP 2006-2010 Census Tract Flows
  - Download the database file (.accdb)
    - Total of 4,156,426 records (151 MB)

# Census 2010 Shapefiles

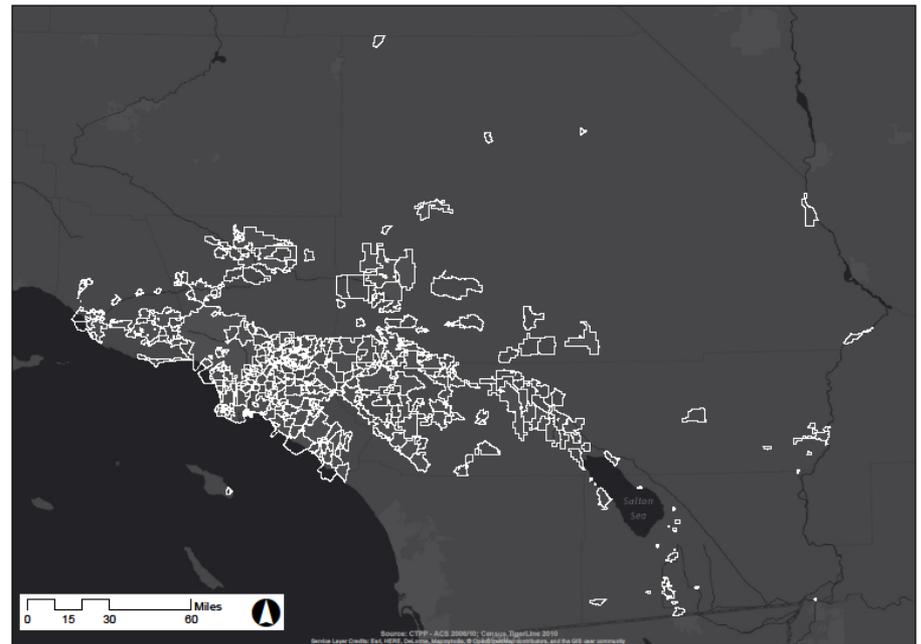
Census 2010

- Place & Tract

Map of SCAG Region (Tract Level)



Map of SCAG Region (Place Level)

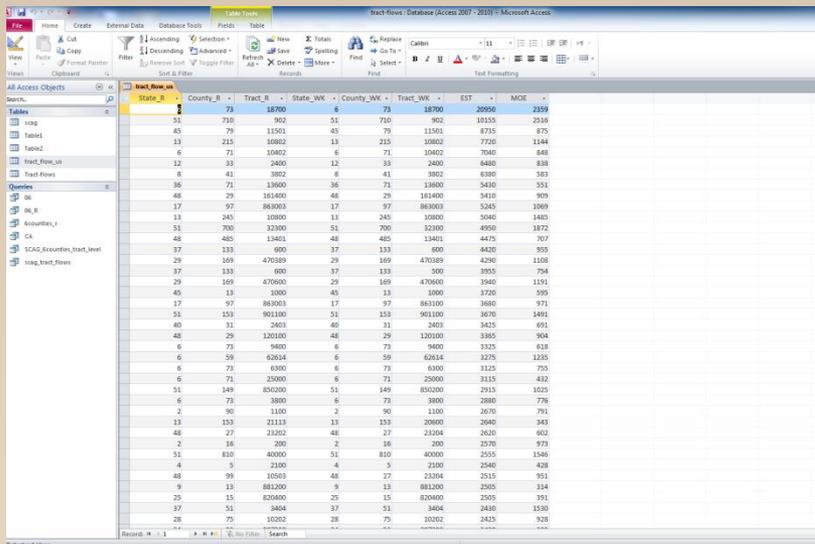


# Methodology for Identifying Work Destination

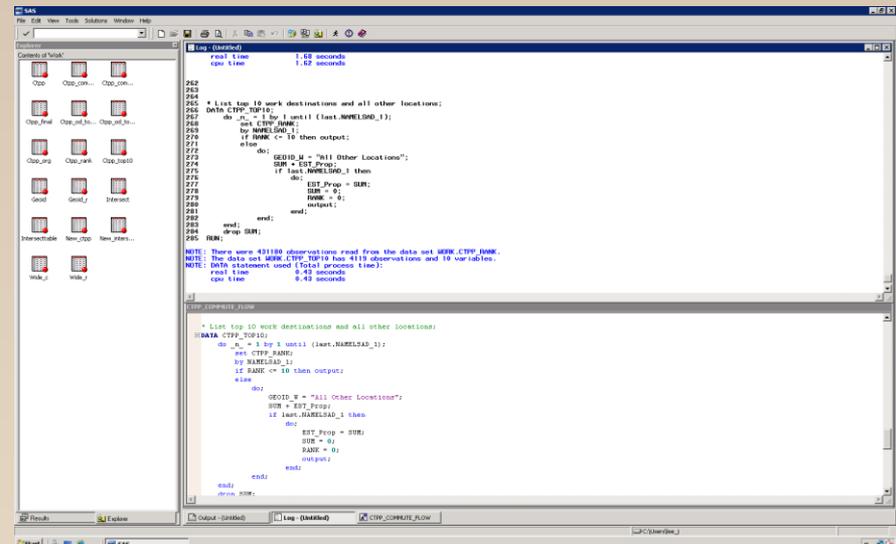
- Census tract to census tract flows from the new CTPP 2006-2010, using **CTPP 2006 – 2010 Census Tract Flows Query**
- Statistical Analysis System (SAS) program with CTPP raw datasets
  - To select census tract-to-tract commuter data within SCAG's region
  - To generate top 10 working destinations at the Census Tract level for each jurisdiction in SCAG region

# Combination of SAS and CTPP Datasets

- CTPP – ACS 2006/10
  - Origin-Destination (OD)
    - Residence Area & Workplace Area
  - Total worker counts
- Enumerated by 2010 Census Tracts



State	County	Tract	EST	MCE
78	18700	6	78	20960
35	726	902	51	720
45	79	11501	45	79
13	215	10882	13	215
6	73	10882	6	71
12	33	2490	12	33
8	41	3802	8	41
36	73	13600	36	71
48	29	181400	48	29
17	97	883003	17	97
13	243	10900	13	243
51	700	32300	51	700
48	485	13401	48	485
37	133	600	37	133
29	169	470389	29	169
37	133	600	37	133
51	153	981100	51	153
40	31	2403	40	31
48	29	120100	48	29
6	73	9400	6	73
6	59	62614	6	59
6	73	6300	6	73
6	73	2000	6	71
51	149	850200	51	149
6	73	3800	6	73
2	96	1180	2	96
13	153	21113	13	153
48	27	23202	48	27
2	16	200	2	16
51	810	40000	51	810
4	5	2100	4	5
48	99	10503	48	27
9	13	881200	9	13
25	15	820400	25	15
37	51	3404	37	51
28	75	10202	28	75



```
log (Default)
real time 1.68 seconds
cpu time 1.62 seconds
262
263
264 * List top 10 work destinations and all other locations:
265 DATA CTPP_TOP10;
266   do _i_ = 1 by 1 until (last.NMRESLAD_1);
267     by NMRESLAD_1;
268     if NEST <= 10 then output;
269     else
270       do;
271         GROUP_E = "All Other Locations";
272         SUM = EST_Prog;
273         if last.NMRESLAD_1 then
274           EST_Prog = SUM;
275           SUM = 0;
276           NEST = 0;
277           output;
278         end;
279       end;
280     end;
281   end;
282   drop SUM;
283 RUN;
```

```
NOTE: There were 4119 observations read from the data set WORK.CTPP_FLOW.
NOTE: The data set WORK.CTPP_TOP10 has 4119 observations and 10 variables.
NOTE: Data statement used 1024 processor time:
      real time 0.42 seconds
      cpu time 0.40 seconds
```

# CTPP Variable

- CTPP raw dataset description

Pos	Variable	Type	Explanation
1	State_R	Number	FIPS code for residence state
2	County_R	Number	FIPS code for residence county
3	Tract_R	Number	FIPS code for residence tract
4	StateFP_W	Number	FIPS code for workplace state
5	CountyFP_W	Number	FIPS code for workplace county
6	TractFP_W	Number	FIPS code for workplace tract
7	EST	Number	Estimate of commuter
8	MOE	Number	Its associated margins of error

# SAS Script Steps

1. Import the CTPP main OD file and import correspondence table
2. Select SCAG's region from the OD file
3. Merge CTPP OD file with the correspondence table
4. Estimate new commuter (EST\_NEW) number by Area Weighted Interpolation

$$EST\_New = tract\_acre / Total\ Acre \times EST$$

\*tract\_acre: split tract after intersecting place and tract shapefile to create the correspondence table

\*Total Acre: original tract acre

\*EST: number of commuter

5. Rank EST\_New
6. Determine top 10 OD

# Top 10 OD Table

SAS - [VIEWTABLE: EXPO\_ctpp\_od\_top10\_withoutcdp]

File Edit View Tools Data Solutions Window Help

Contents of P:\JISu\LESRI\_Presentation\Transportation\Script

	NAMESAD_1	GEOID_W	EST	GEOID_R	PLACEFP10	Total_Acre	Tract_Acre	Proportion	EST_Prop	Rank for Variable EST_Prop
1	Adelanto city	06071009117	235.00000	06071009116	00296	5006.91431832000	4611.46838910000	0.92102003268	216.43970768	1
2	Adelanto city	06071009904	230.00000	06071009114	00296	3409.53217565000	2918.36331965000	0.85594244879	196.86676322	2
3	Adelanto city	06071009116	160.00000	06071009116	00296	5006.91431832000	4611.46838910000	0.92102003268	147.36320523	3
4	Adelanto city	06071009114	160.00000	06071009114	00296	3409.53217565000	2918.36331965000	0.85594244879	136.95079181	4
5	Adelanto city	06071002110	135.00000	06071009112	00296	1208.03314242000	1208.03314242000	1.00000000000	135	5
6	Adelanto city	06071009117	125.00000	06071009112	00296	1208.03314242000	1208.03314242000	1.00000000000	125	6
7	Adelanto city	06071009116	105.00000	06071009112	00296	1208.03314242000	1208.03314242000	1.00000000000	105	7
8	Adelanto city	06071009308	105.00000	06071009112	00296	1208.03314242000	1208.03314242000	1.00000000000	105	7
9	Adelanto city	06071010026	115.00000	06071009114	00296	3409.53217565000	2918.36331965000	0.85594244879	98.433381611	9
10	Adelanto city	06071009913	110.00000	06071009114	00296	3409.53217565000	2918.36331965000	0.85594244879	94.153669367	10
11	Adelanto city	All Other Locations	4.00000	06071011700	00296	104006.73647200000	12.94415263680	0.00012445494	5915.0896473	0
12	Agoura Hills city	06037800332	475.00000	06037800332	00394	1187.40663997000	1187.40663997000	1.00000000000	475	1
13	Agoura Hills city	06037800324	390.00000	06037800324	00394	896.12635182400	696.48733744200	0.78599100005	306.53649002	2
14	Agoura Hills city	06037800327	295.00000	06037800327	00394	1399.86660022000	1399.86660010000	0.99999999991	254.999999998	3
15	Agoura Hills city	06037800326	250.00000	06037800332	00394	1187.40663997000	1187.40663997000	1.00000000000	250	4
16	Agoura Hills city	06037800329	150.00000	06037800327	00394	1399.86660022000	1399.86660010000	0.99999999991	149.999999999	5
17	Agoura Hills city	06037800329	135.00000	06037800332	00394	1187.40663997000	1187.40663997000	1.00000000000	135	6
18	Agoura Hills city	06037800204	165.00000	06037800324	00394	896.12635182400	696.48733744200	0.78599100005	129.68951501	7
19	Agoura Hills city	06037800329	145.00000	06037800324	00394	896.12635182400	696.48733744200	0.78599100005	113.96869501	8
20	Agoura Hills city	06111006100	110.00000	06037800327	00394	1399.86660022000	1399.86660010000	0.99999999991	109.999999999	9
21	Agoura Hills city	06037137502	100.00000	06037800332	00394	1187.40663997000	1187.40663997000	1.00000000000	100	10
22	Agoura Hills city	All Other Locations	4.00000	06037800328	00394	2421.23799305000	4.79562933731	0.00198065178	7471.872938	0
23	Alhambra city	06037480302	395.00000	06037480302	00884	259.43642561500	259.43642561600	1.00000000000	355	1
24	Alhambra city	06037480304	190.00000	06037480304	00884	107.83884920300	107.83884920300	1.00000000000	190	2
25	Alhambra city	06037481603	170.00000	06037481603	00884	161.94157520700	161.94157520700	1.00000000000	170	3
26	Alhambra city	06037481604	170.00000	06037481604	00884	153.86764040600	153.86764040600	1.00000000000	170	3
27	Alhambra city	06037480804	165.00000	06037480804	00884	204.42896865700	204.42896865800	1.00000000000	165	5
28	Alhambra city	06037461902	160.00000	06037480400	00884	317.49706360700	317.49706360800	1.00000000000	160	6
29	Alhambra city	06037480901	155.00000	06037480901	00884	234.97410282600	234.97410282600	1.00000000000	155	7
30	Alhambra city	06037480803	120.00000	06037480803	00884	269.60252735000	269.60252735000	1.00000000000	120	8
31	Alhambra city	06037481001	120.00000	06037481001	00884	259.23433448400	259.23433448400	1.00000000000	120	8
32	Alhambra city	06037480802	110.00000	06037480804	00884	204.42896865700	204.42896865800	1.00000000000	110	10
33	Alhambra city	All Other Locations	4.00000	06037480500	00884	522.81033577500	1.42323375280	0.00027227547	37319.769845	0
34	Aliso Viejo city	06059062634	615.00000	06059062634	00947	754.18448862100	743.86033005300	0.98631036067	606.58087181	1
35	Aliso Viejo city	06059062637	390.00000	06059062637	00947	396.97326363200	396.97326363200	1.00000000000	390	2
36	Aliso Viejo city	06059062639	365.00000	06059062639	00947	431.11912792500	431.11912792500	1.00000000000	365	3
37	Aliso Viejo city	06059062610	330.00000	06059062639	00947	431.11912792500	431.11912792500	1.00000000000	330	4
38	Aliso Viejo city	06059062635	305.00000	06059062635	00947	286.14832666400	278.62785948500	0.97371829056	296.98407862	5
39	Aliso Viejo city	06059062633	345.00000	06059062633	00947	1673.91506879000	1262.37854890000	0.75414731156	260.18082249	6
40	Aliso Viejo city	06059062640	225.00000	06059062640	00947	364.03362248300	360.01780822200	0.98968656221	222.5179265	7
41	Aliso Viejo city	06059062638	215.00000	06059062638	00947	324.66591943500	324.66591943500	1.00000000000	215	8
42	Aliso Viejo city	06059062636	205.00000	06059062636	00947	290.83316814900	285.21556555200	0.98068445001	201.04031225	9
43	Aliso Viejo city	06059062610	175.00000	06059062637	00947	396.97326363200	396.97326363200	1.00000000000	175	10
44	Aliso Viejo city	All Other Locations	4.00000	06059062632	00947	3677.95642463000	2.02113834605	0.00054952769	20423.549291	0
45	Anaheim city	06059021920	410.00000	06059021920	02000	1223.86642004000	1072.01872976000	0.87592788903	359.1304345	1
46	Anaheim city	06059011714	340.00000	06059087300	02000	402.20310612500	402.20310612600	1.00000000000	340	2
47	Anaheim city	06059021905	285.00000	06059021905	02000	874.12890569200	874.12890569300	1.00000000000	285	3
48	Anaheim city	06059087102	275.00000	06059087102	02000	360.39249262100	360.39249262000	1.00000000000	275	4
49	Anaheim city	06059021922	265.00000	06059021922	02000	516.82098925100	516.82098925100	1.00000000000	265	5

Results Explorer Output - (Untitled) Log - (Untitled) CTPP\_COMMUTE\_FLOW VIEWTABLE: EXPO\_ct...

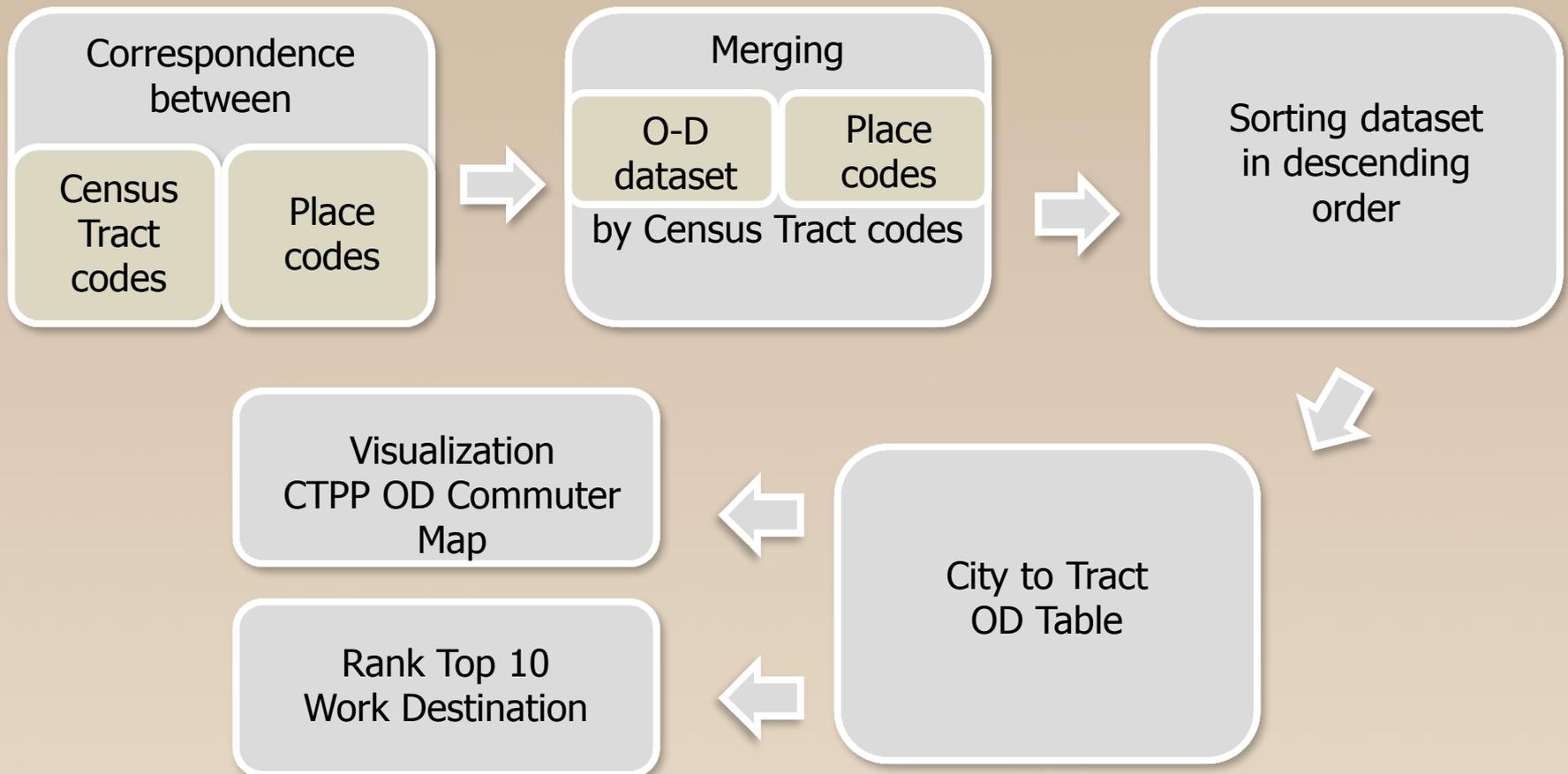
C:\Users\jee\_

# Advantage and Disadvantage

	<b>CTPP</b>	<b>Programming Scripts</b>
<b>Pros</b>	<ul style="list-style-type: none"><li>■ Easy-to-use interface and able to visualize data instantly</li><li>■ Easy to perform analyses at multiple levels of geography</li></ul>	<ul style="list-style-type: none"><li>■ Efficient to manipulate data for multiple areas at once</li><li>■ Improve efficiency of managing and processing big data</li></ul>
<b>Cons</b>	<ul style="list-style-type: none"><li>■ Inefficient to search/download for multiple locations</li></ul>	<ul style="list-style-type: none"><li>■ Requires programming skills</li><li>■ Requires GIS skills</li></ul>

# Identifying Major Work Destinations

## ■ O-D Analysis Steps



# Visualizing Major Work Destinations

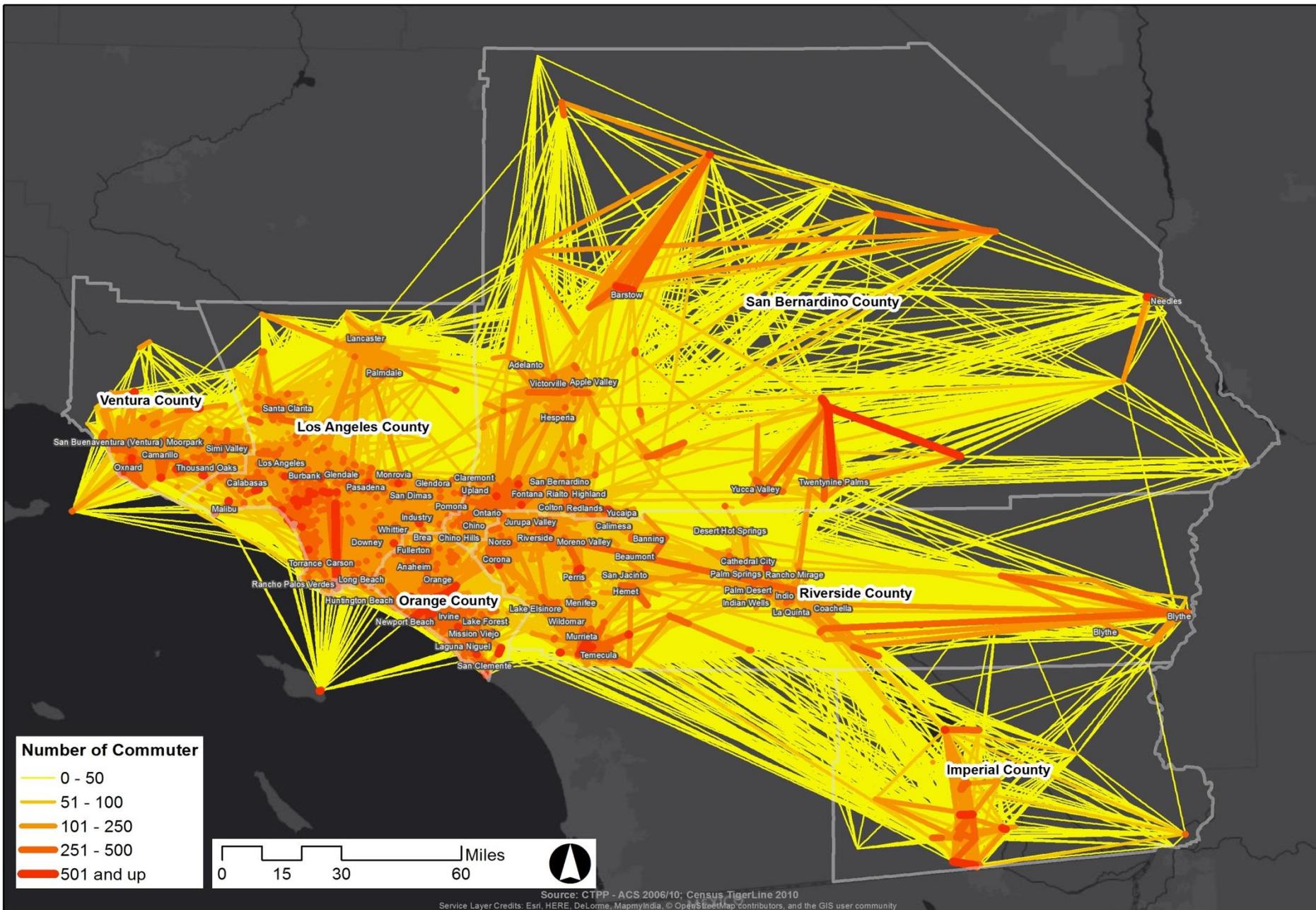
- Using ESRI ArcGIS application
  - *Data Driven Pages* – To create a multi-page map series from a single map document
- Using *Python* programming language
  - *Python* – Interpreted, object-oriented, high-level general-purpose programming language
  - Widely utilize in ArcGIS environment for automation process



# Python and ArcGIS

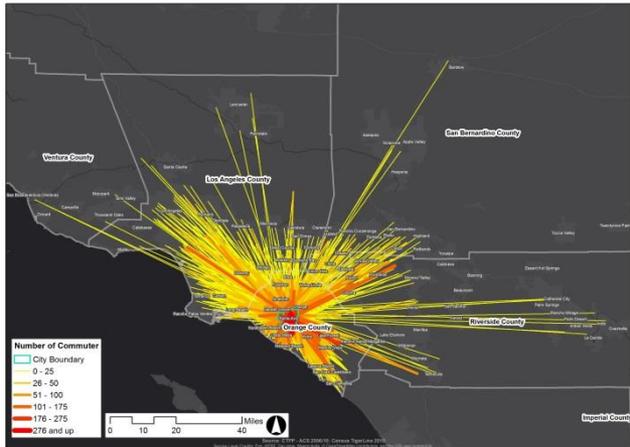
- Importing ArcPy sitepackage in Python to automatically create work destination maps at the Census Tract level
  - Data Driven Page, Definition Query, Spatial Analyst, and Exporting functions in ArcGIS
    - Loop function (for row in cursor:)
    - Search Cursor (arcpy.da.SearchCursor)
    - Data Driven Page (mxd.dataDrivenPages.currentPageID)
    - Definition Query (lyr.definitionQuery = sqlExp)
    - Exporting (arcpy.mapping.ExportToJPEG)

# Origin-Destination Commuter Flow Map of SCAG Region

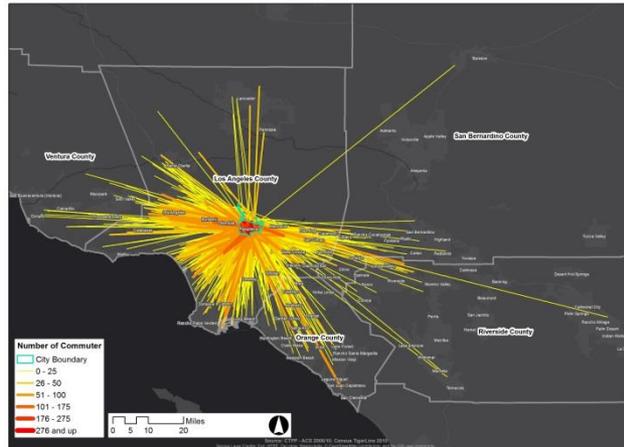


# O-D Commuter Flow Maps (Cont.)

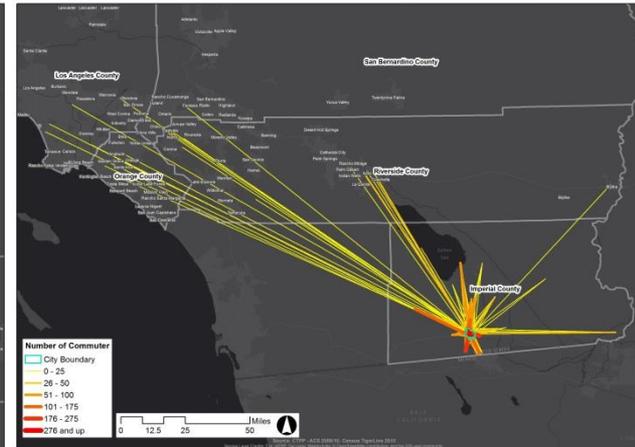
Origin-Destination Commuter Flow Map of Santa Ana city



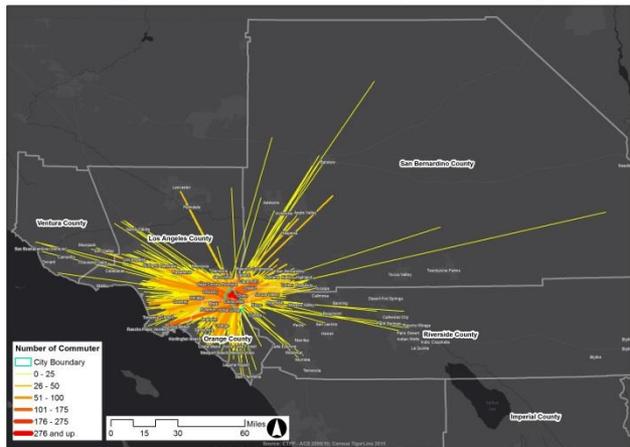
Origin-Destination Commuter Flow Map of Pasadena city



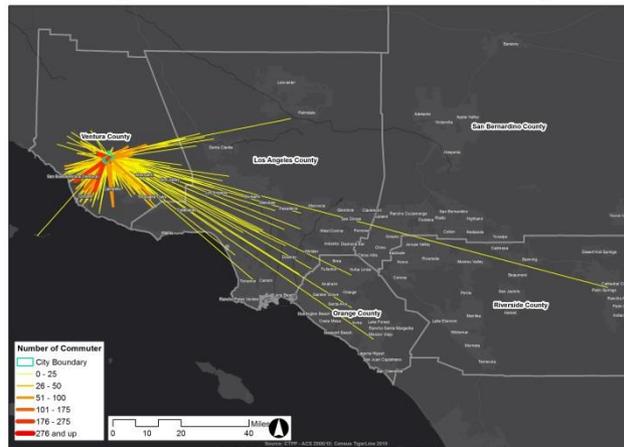
Origin-Destination Commuter Flow Map of El Centro city



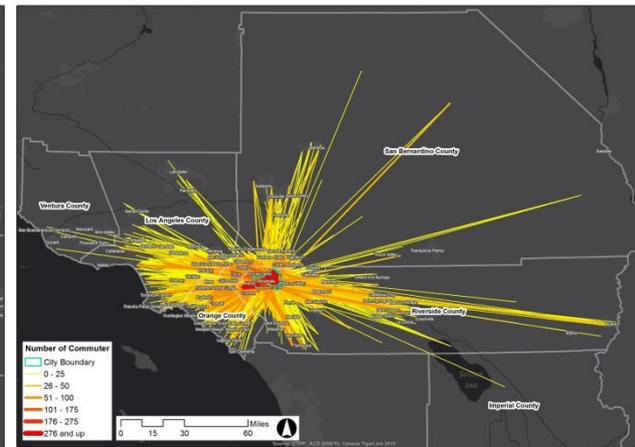
Origin-Destination Commuter Flow Map of Chino Hills city



Origin-Destination Commuter Flow Map of Santa Paula city



Origin-Destination Commuter Flow Map of Riverside city



# Conclusions

- Significantly efficient in processing O-D analysis with SAS for numerous jurisdictions
- Python and ArcGIS improve the processing time and accuracy of map production as a set of maps or individual map
- Creating OD commuting flow at the Census Tract level helps to understand the travel pattern better

# Future Studies

- Work destinations at different geographical level
- Relationship between demographic groups and estimated travel distance
- Include land use data
- Land use-weighted interpolation method to increase accuracy of the place of residence and work