Activity Simulation

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(based on work with Chandra Bhat and Ram Pendyala)

Leveraging Big Data for Future Mobility

Utilizing User Generated Content for Transport Modelling

Friday **15th December 2017 - Technical University of Munich**

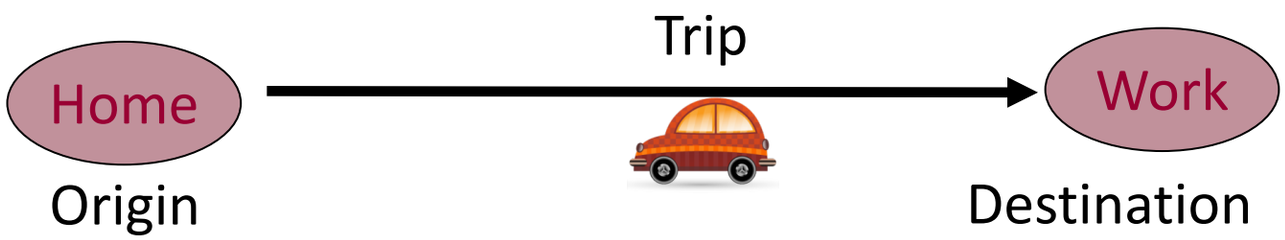
WHY ALL THIS?

To Design Policies
We Want to Understand Needs and Habits
of People
and
Develop Policy Simulation of Qatar

- **Travel** of people by different means
- **Activities** are the key to understanding and modeling people's travel behavior
- We are social animals and for this reason understanding human interaction is important
- This means define policies for different people and account for interactions
- Then create models that help us predict what will happen in the future under different policy scenarios
- Model need to be sensitive to changes in space, time, and attributes of transportation system

A Few Definitions

To Understand

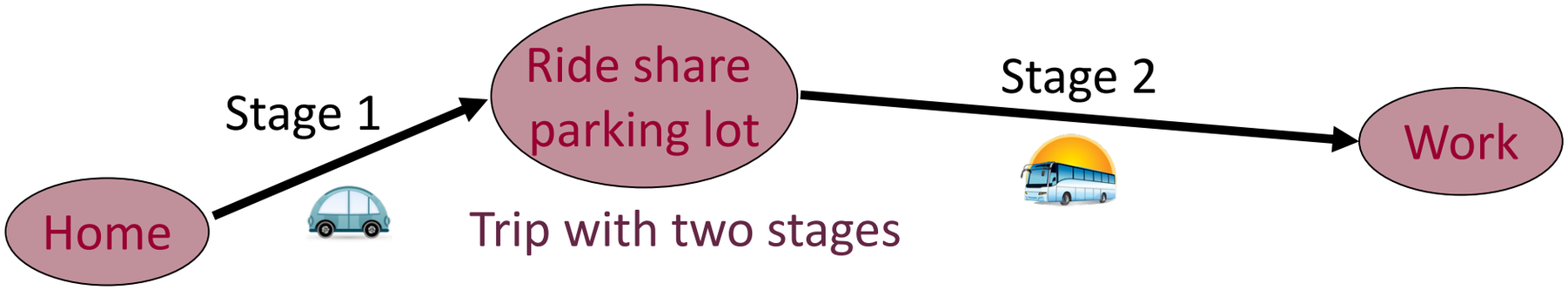


Activities

-In home stay (sleep, eat, personal care)

-Work

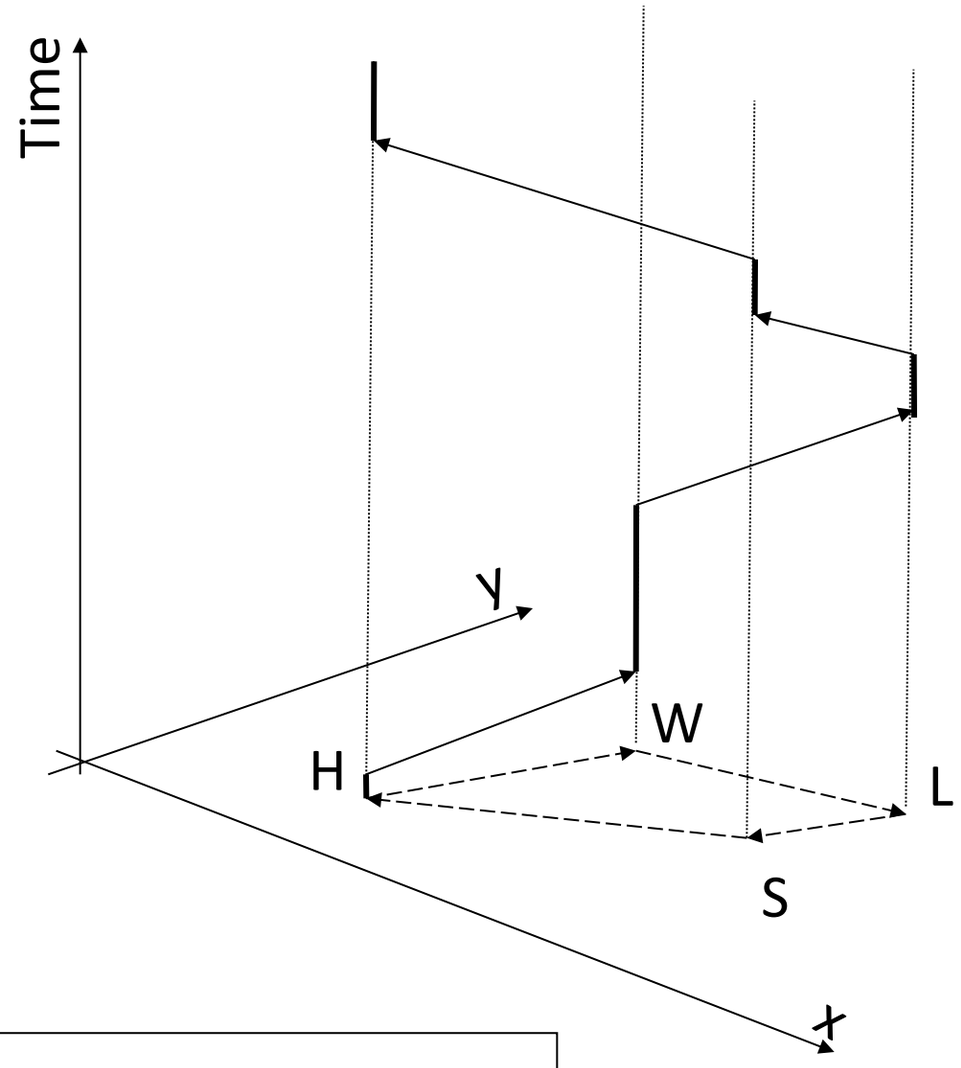
-Eat meal



-Means of travel is called mode of travel (drive alone, car sharing, taking a bus, cycling, walking)

Activities in Time and Space

The Activities

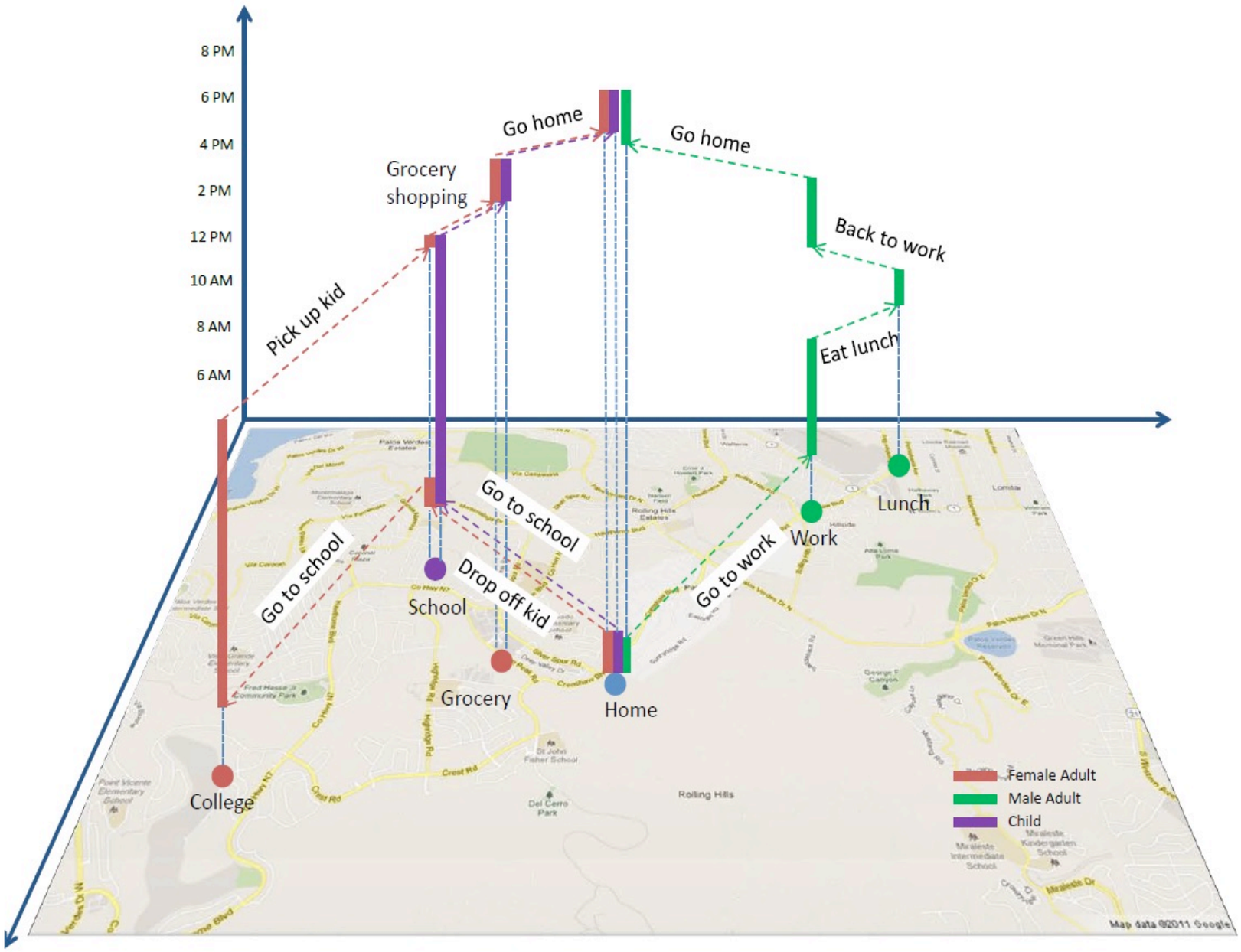


Activities:

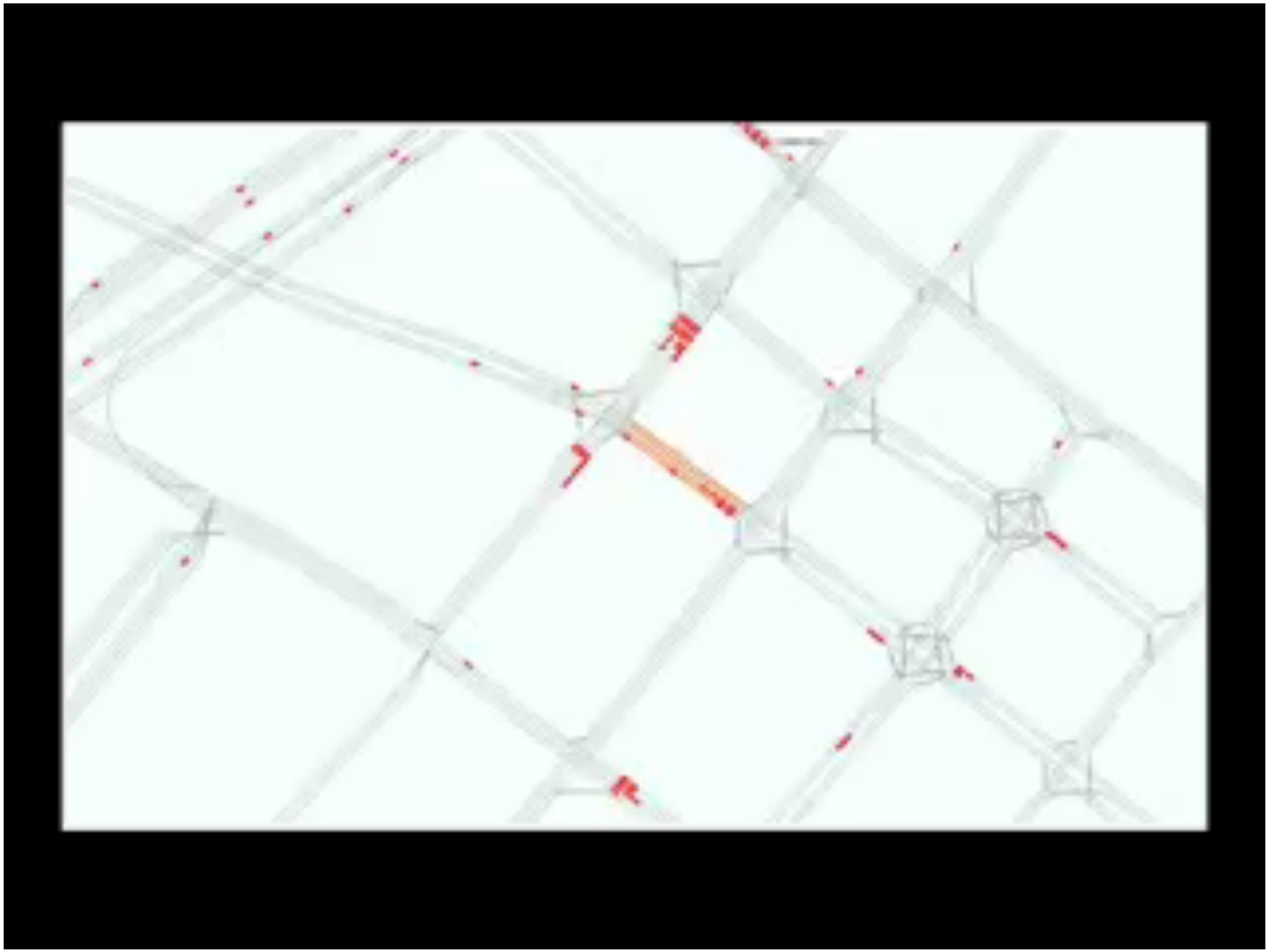
H … Home **W … Work** **L … Leisure** **S … Shopping**

Activities in Time and Space

The Activities

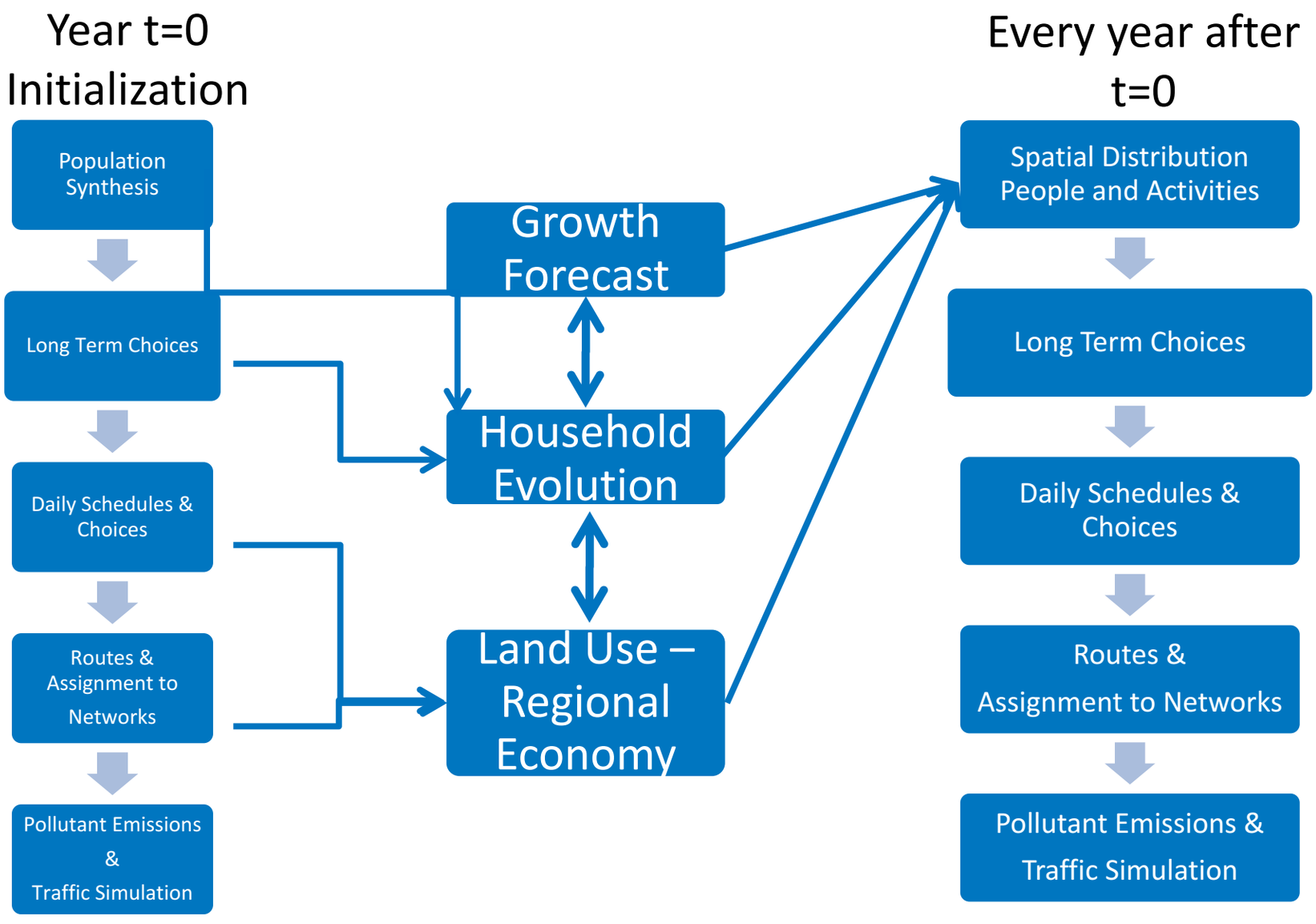


Eventually we want this for different policy scenarios

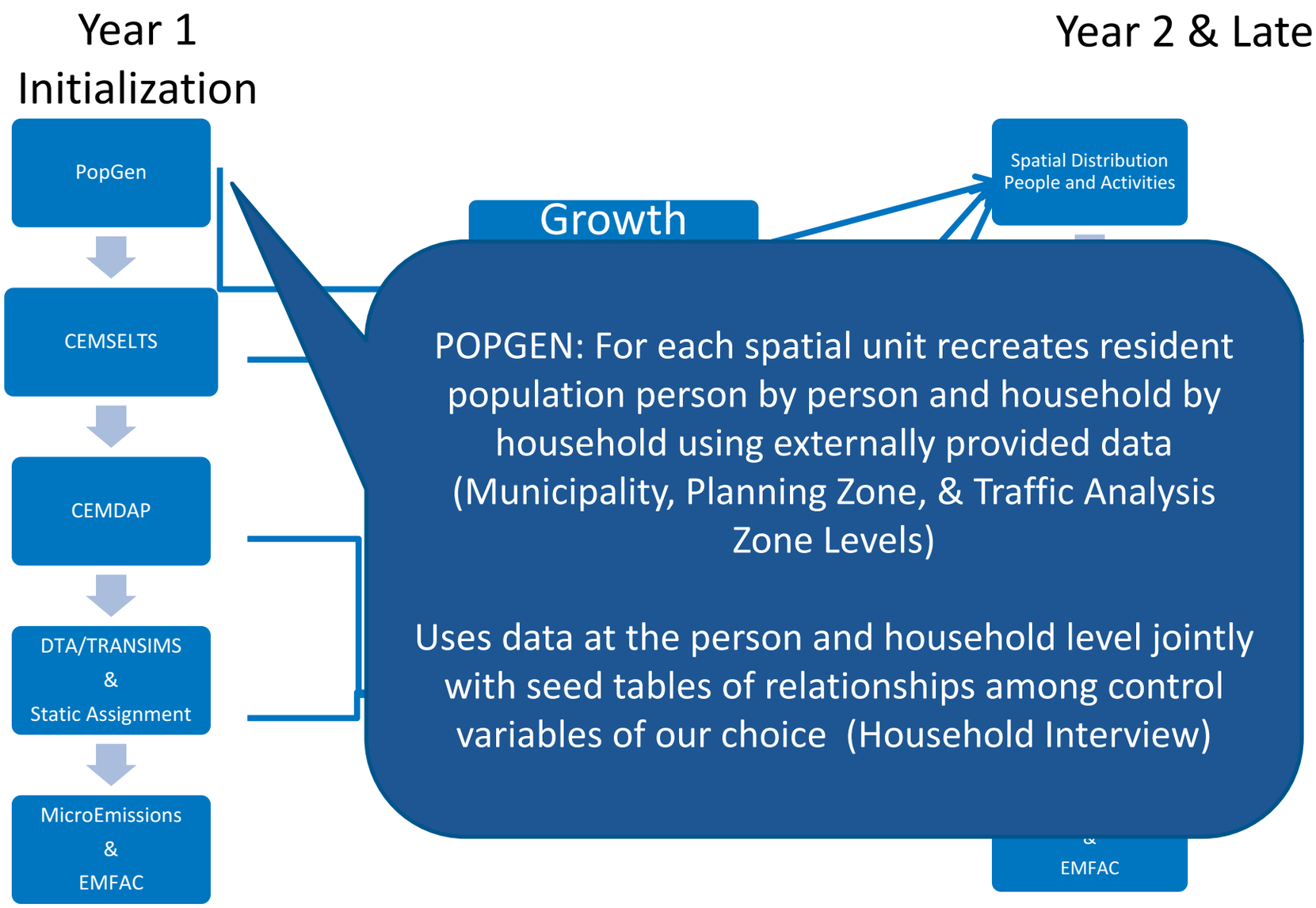


Sequence of QSTM-ABM Models

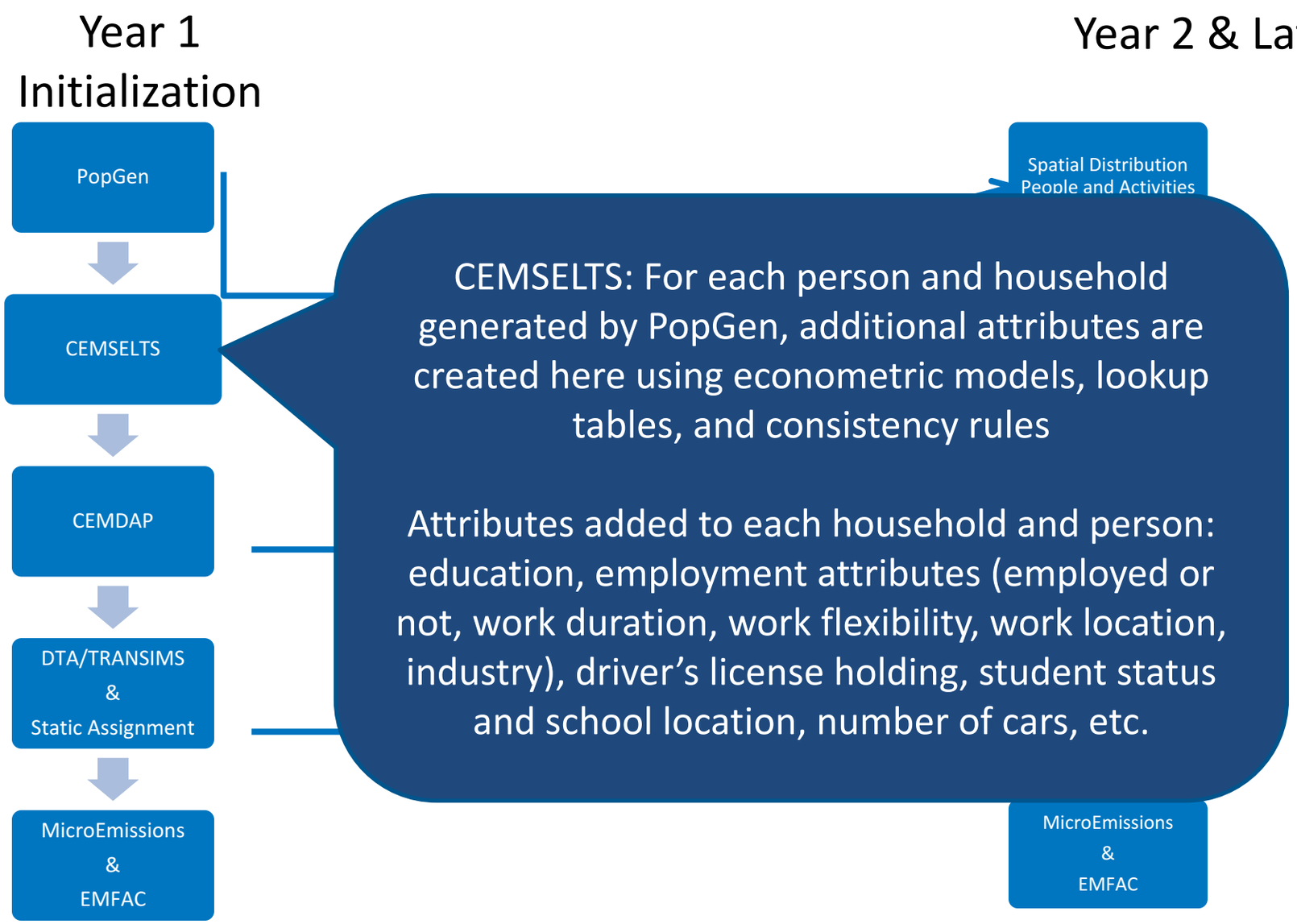
Framework



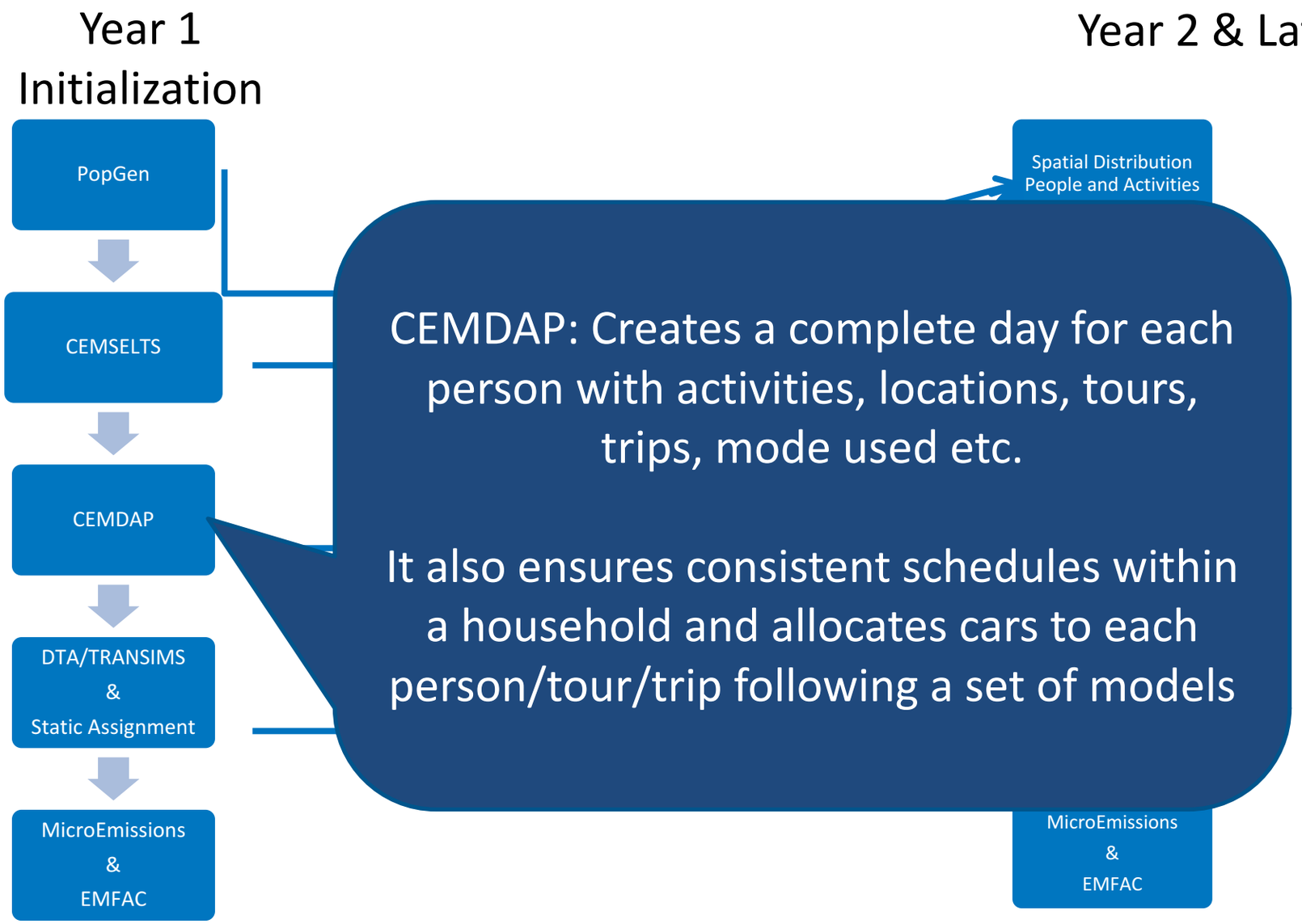
Sequence of QSTM-ABM Models



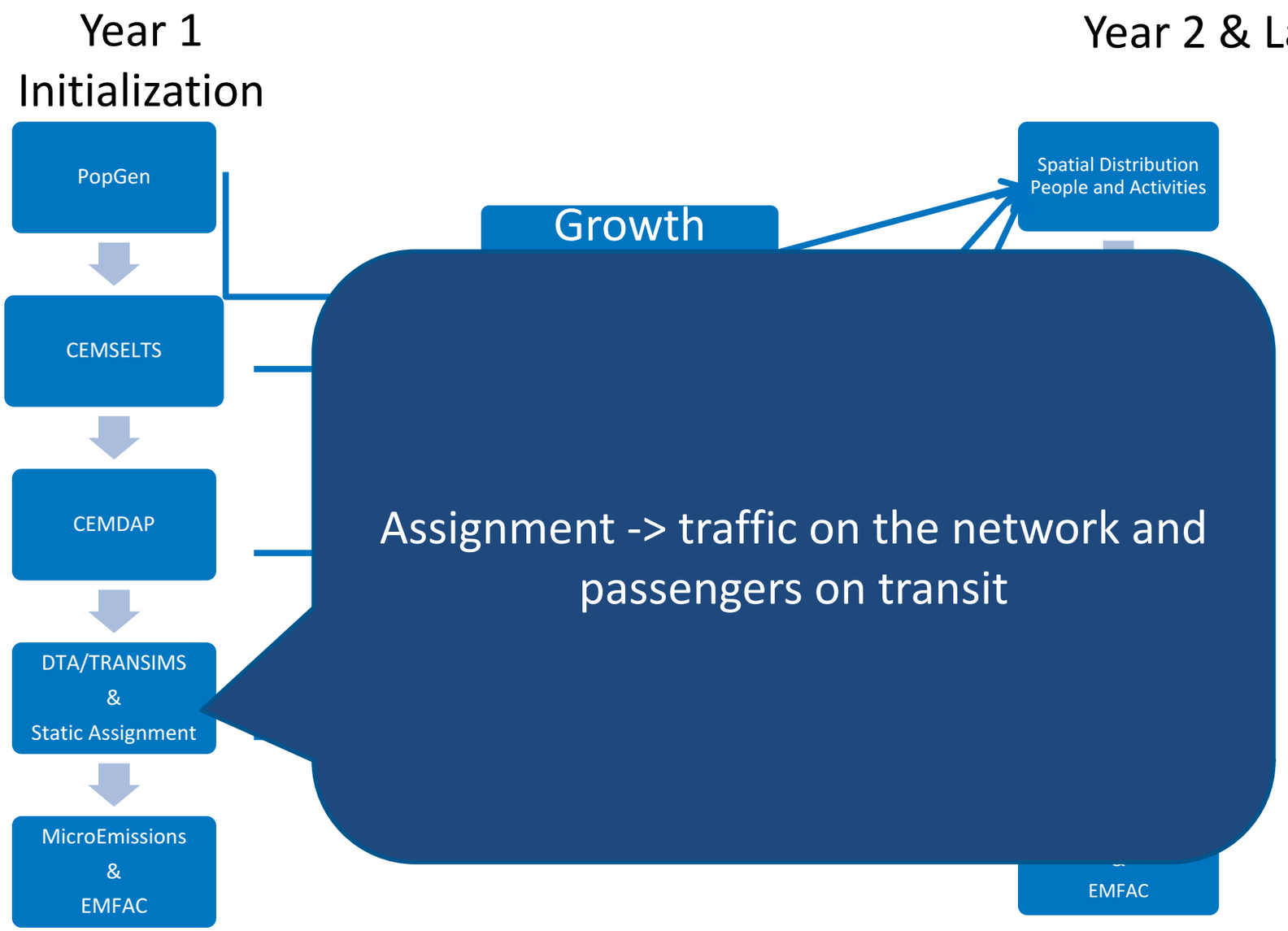
Sequence of QSTM-ABM Models



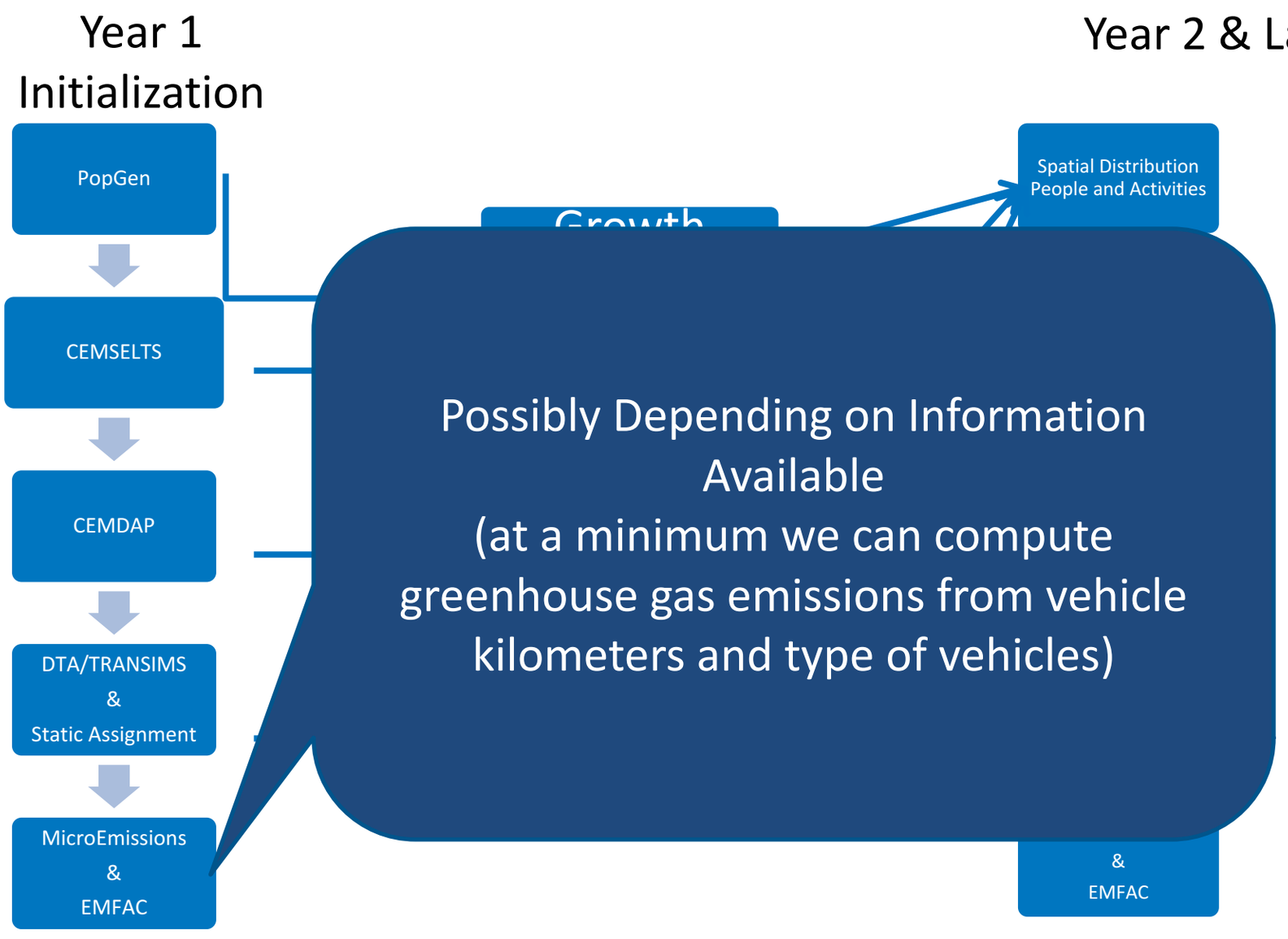
Sequence of QSTM-ABM Models



Sequence of QSTM-ABM Models

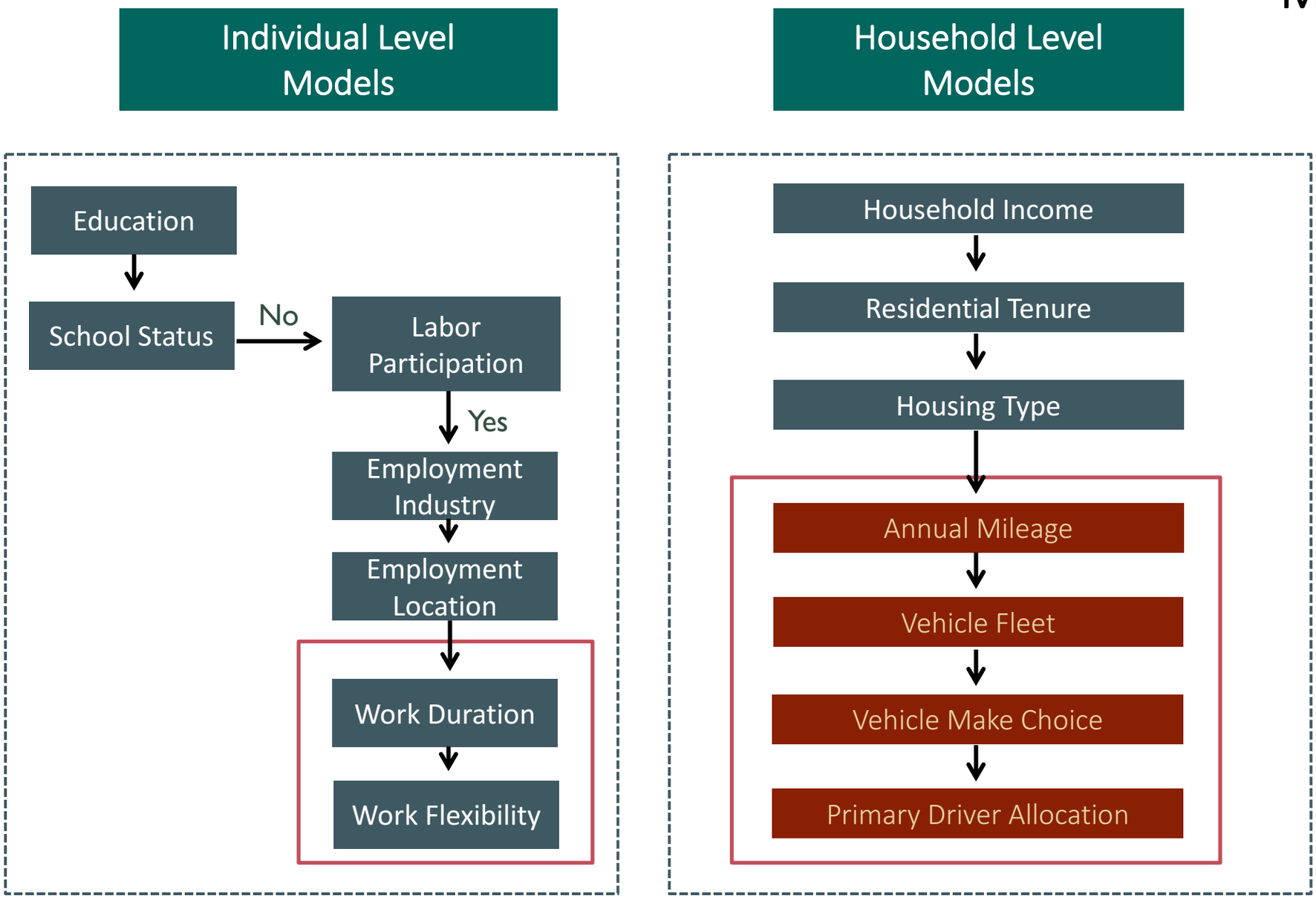


Sequence of QSTM-ABM Models



CEMSELTS

Models (Base Year)



Synthetic Schedule Simulation

Representing Activity-travel Patterns

Recognizing Fixities

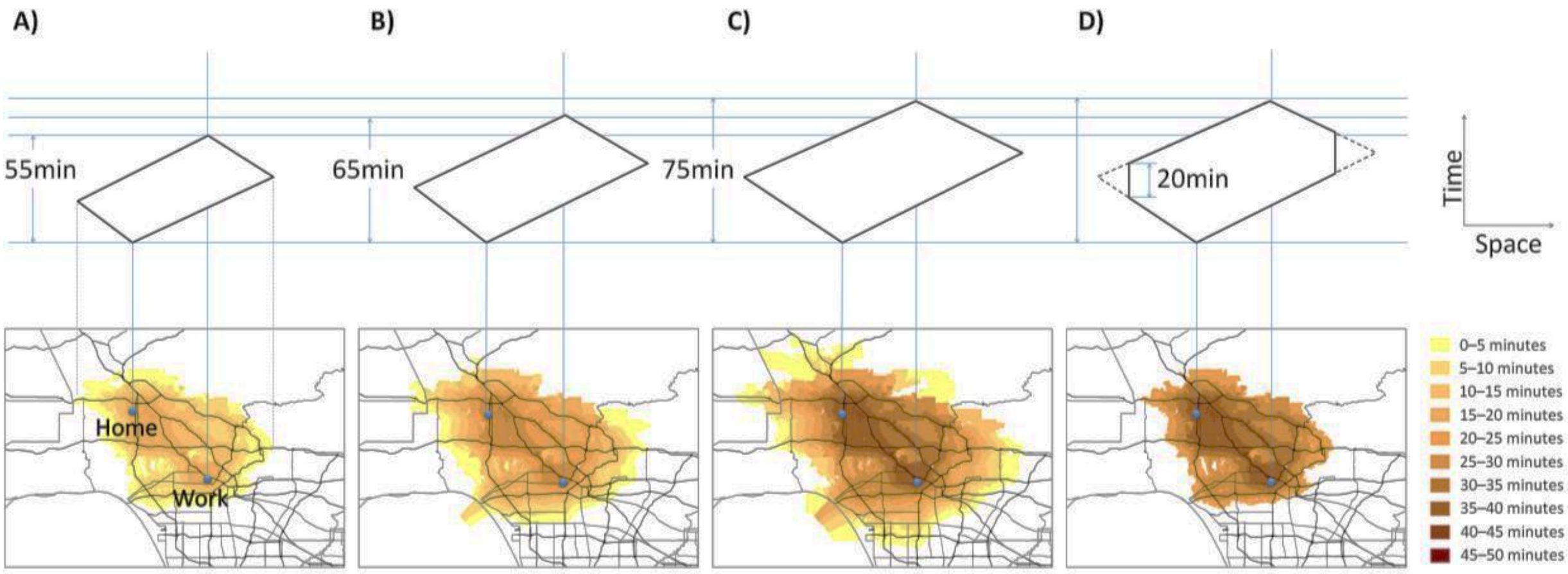
Non-Workers

- No obvious activity with spatial and temporal fixities
- Person more flexible in scheduling his/her activities

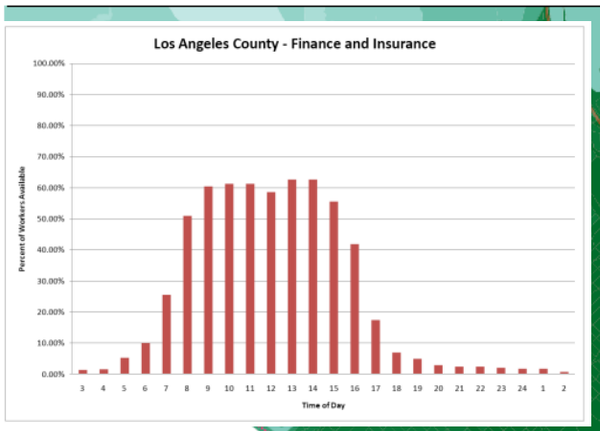
Workers

- The “work” activity has spatial and temporal fixities
- Person schedules his/her activities around the work activity

Available Time and Accessibility

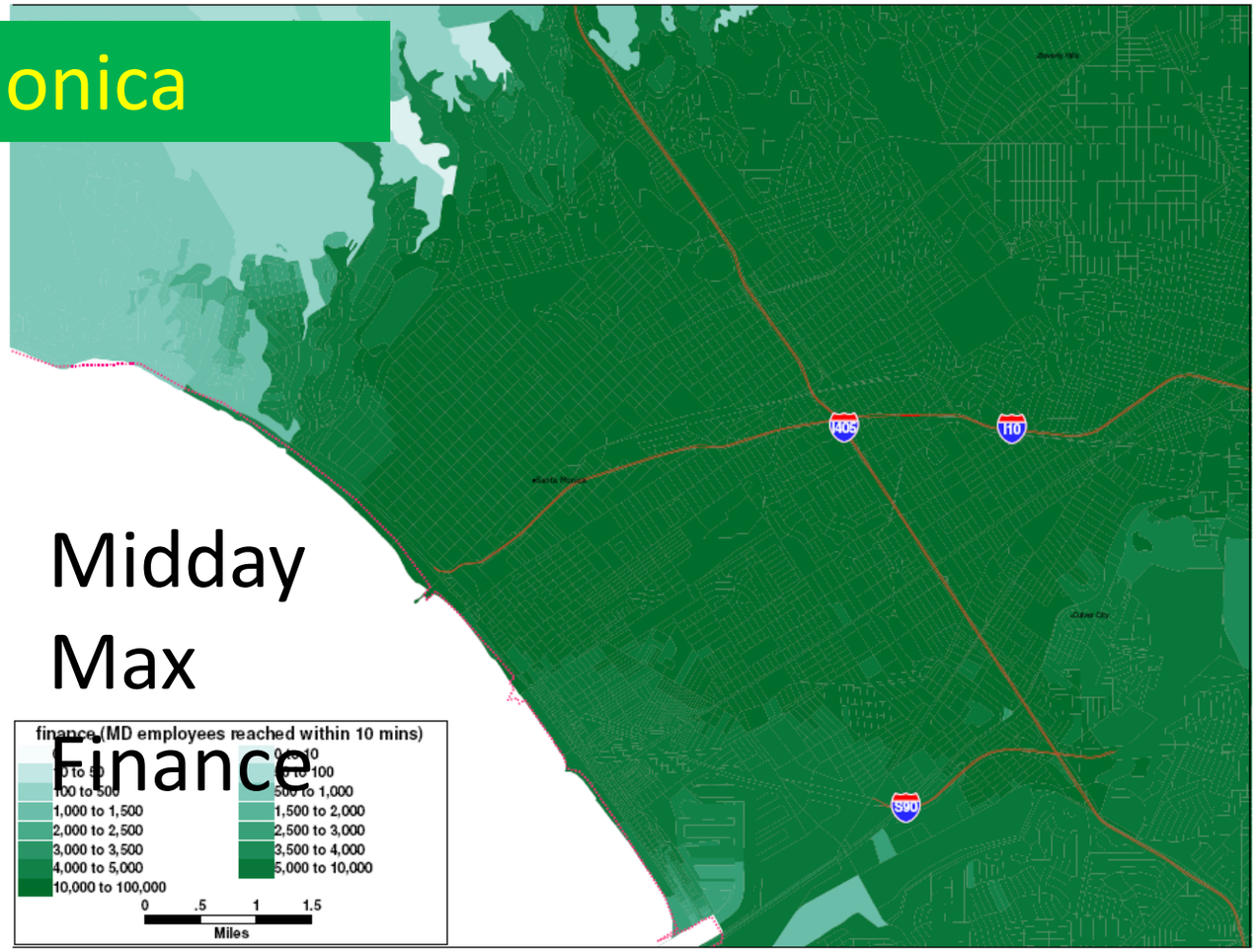


Santa Monica

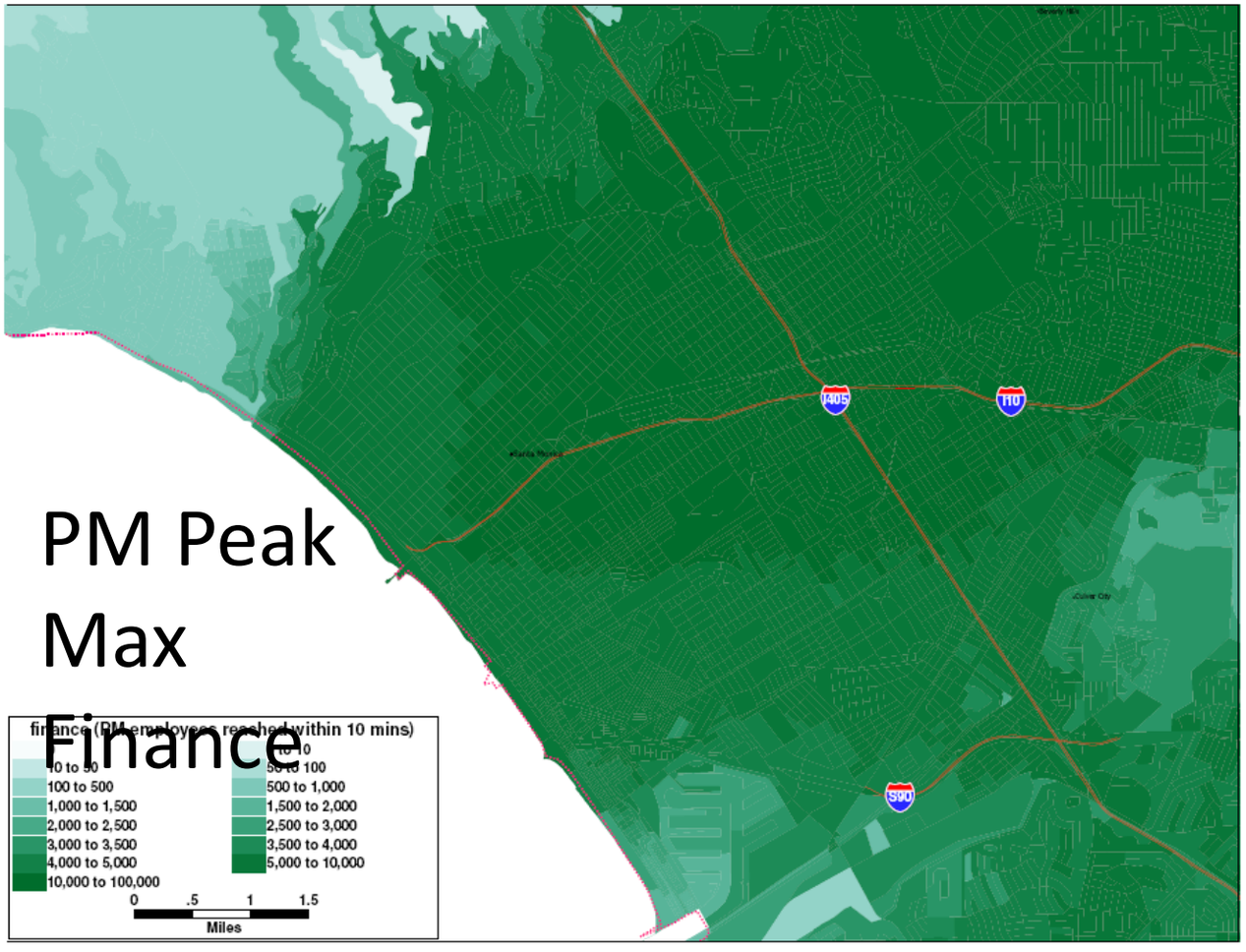


AM Peak Max Finance

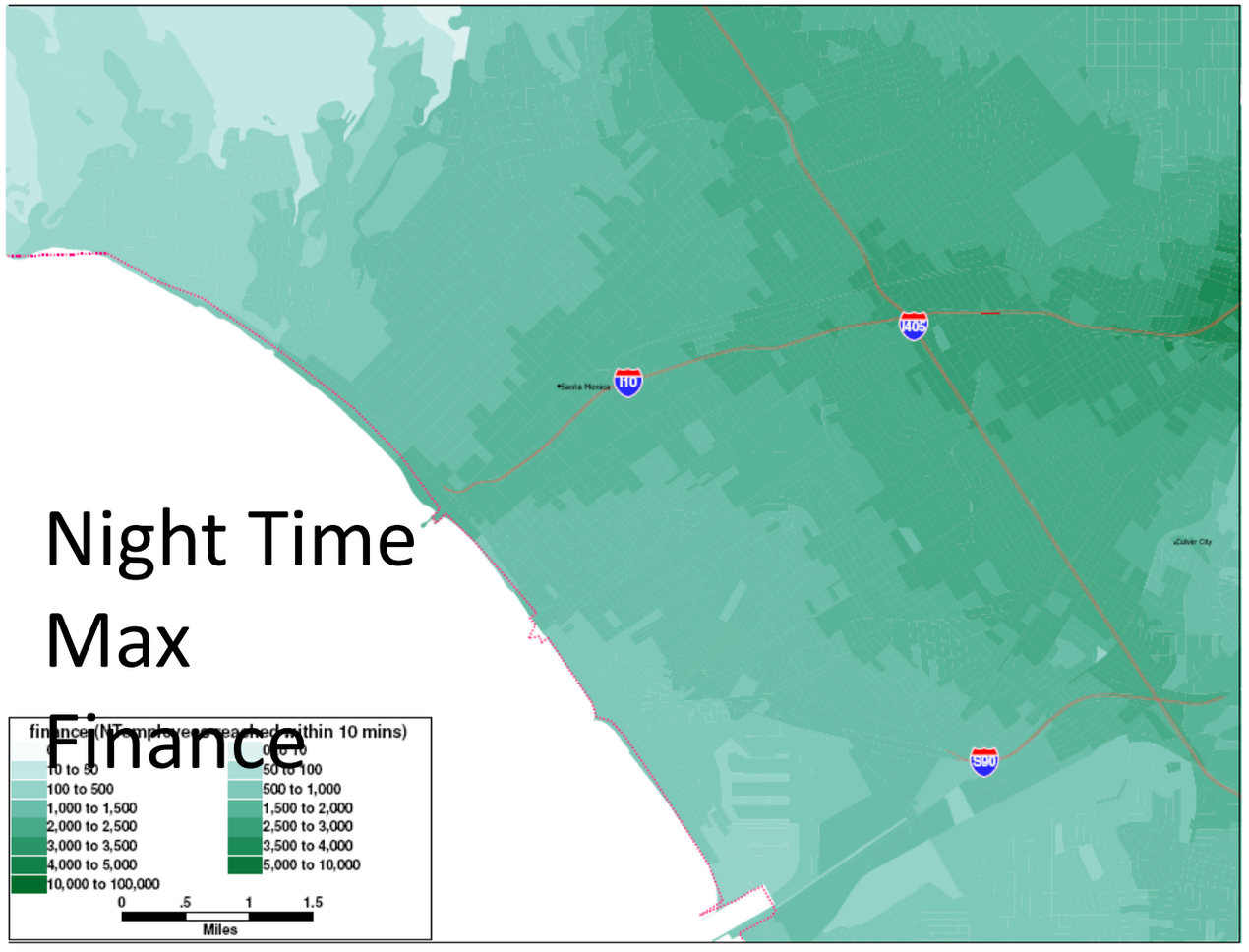
Midday Max Finance



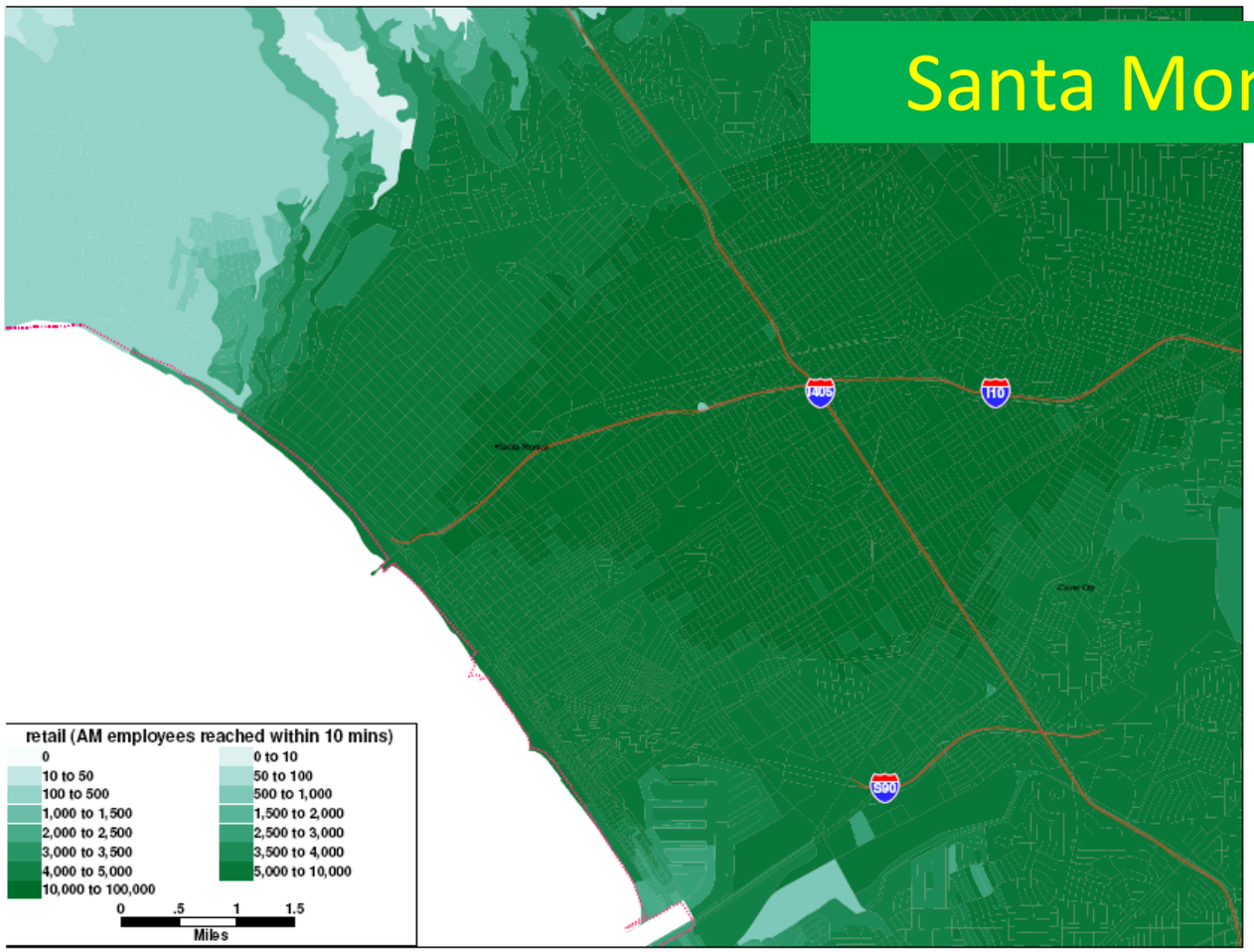
PM Peak Max Finance

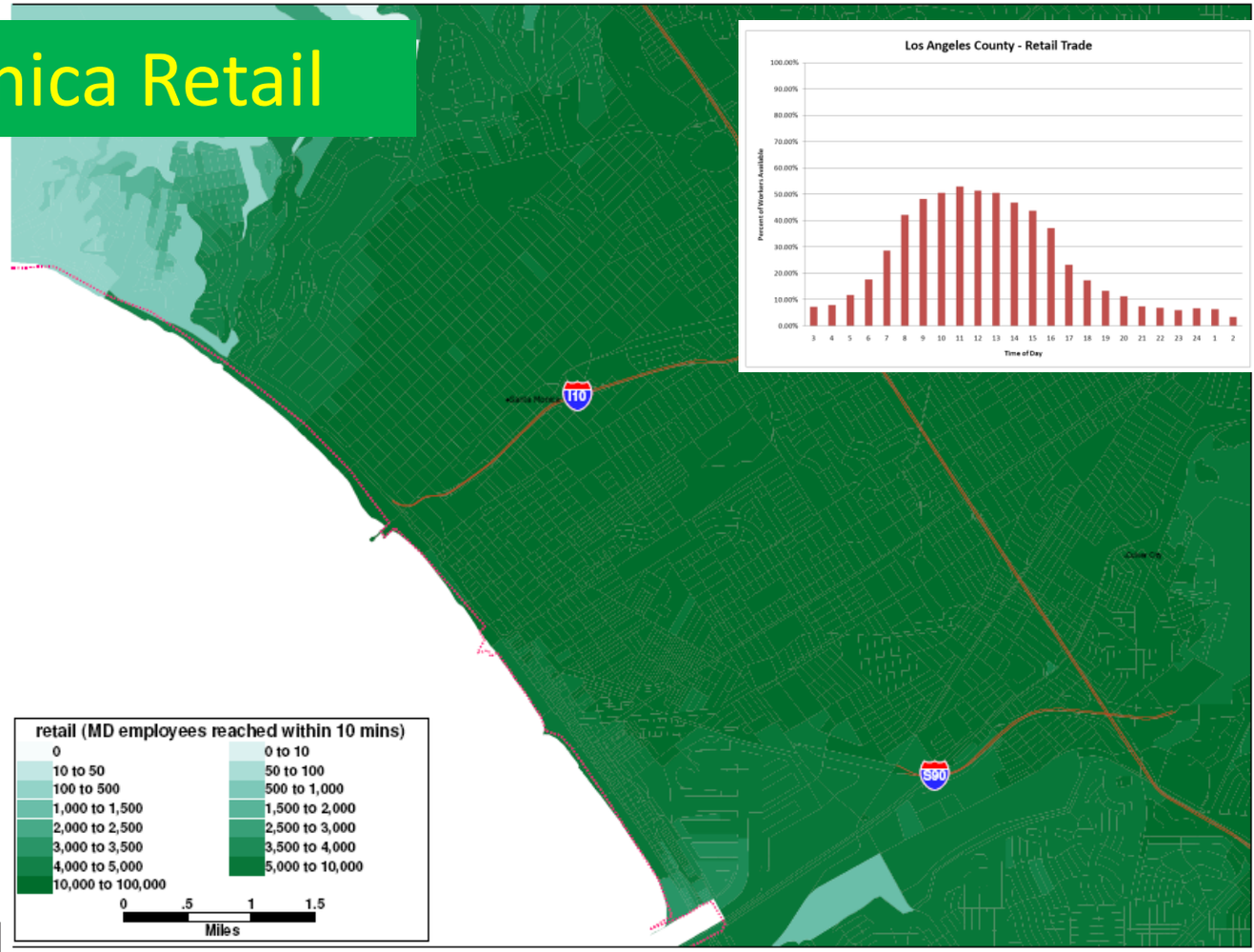


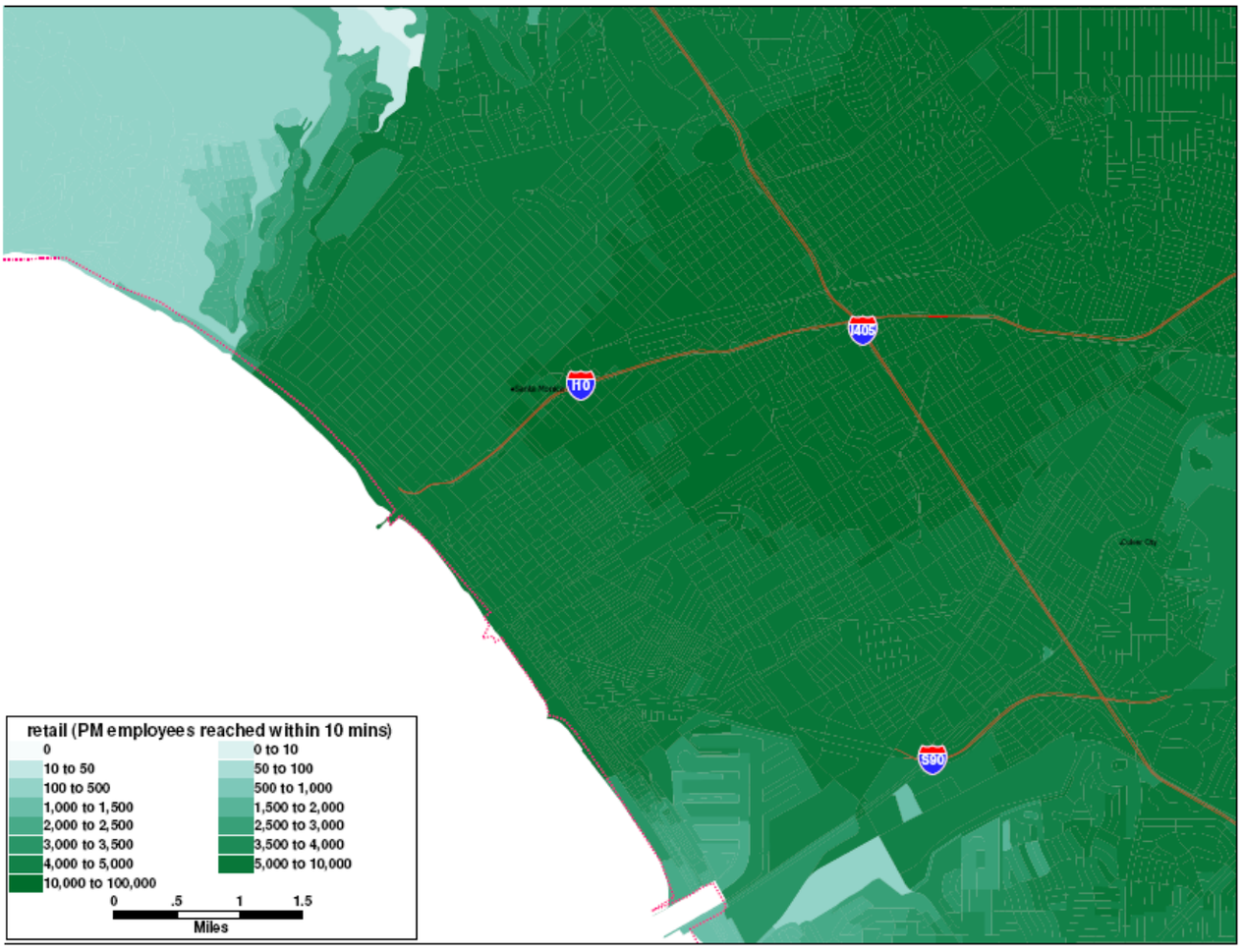
Night Time Max Finance

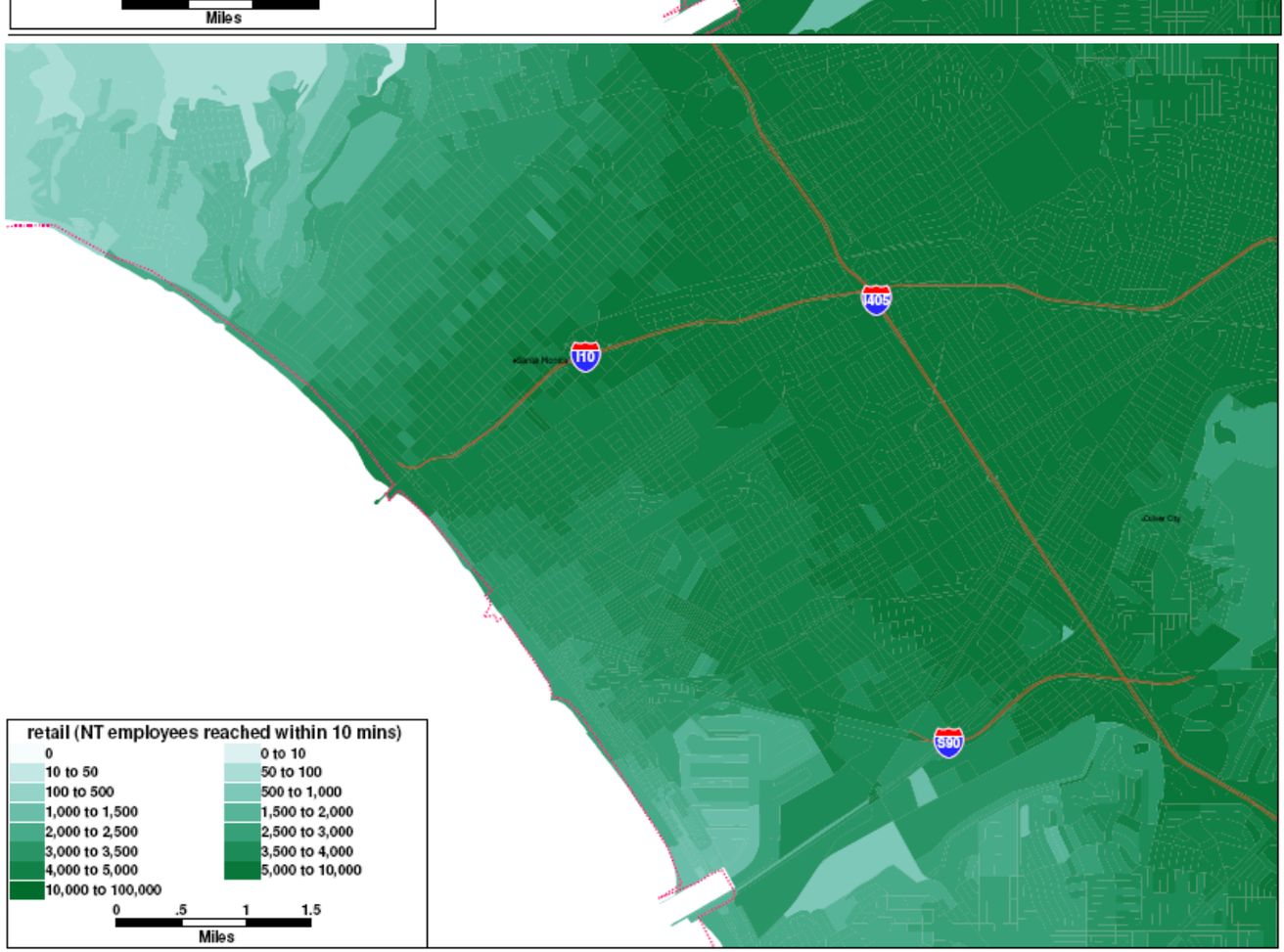


Santa Monica Retail





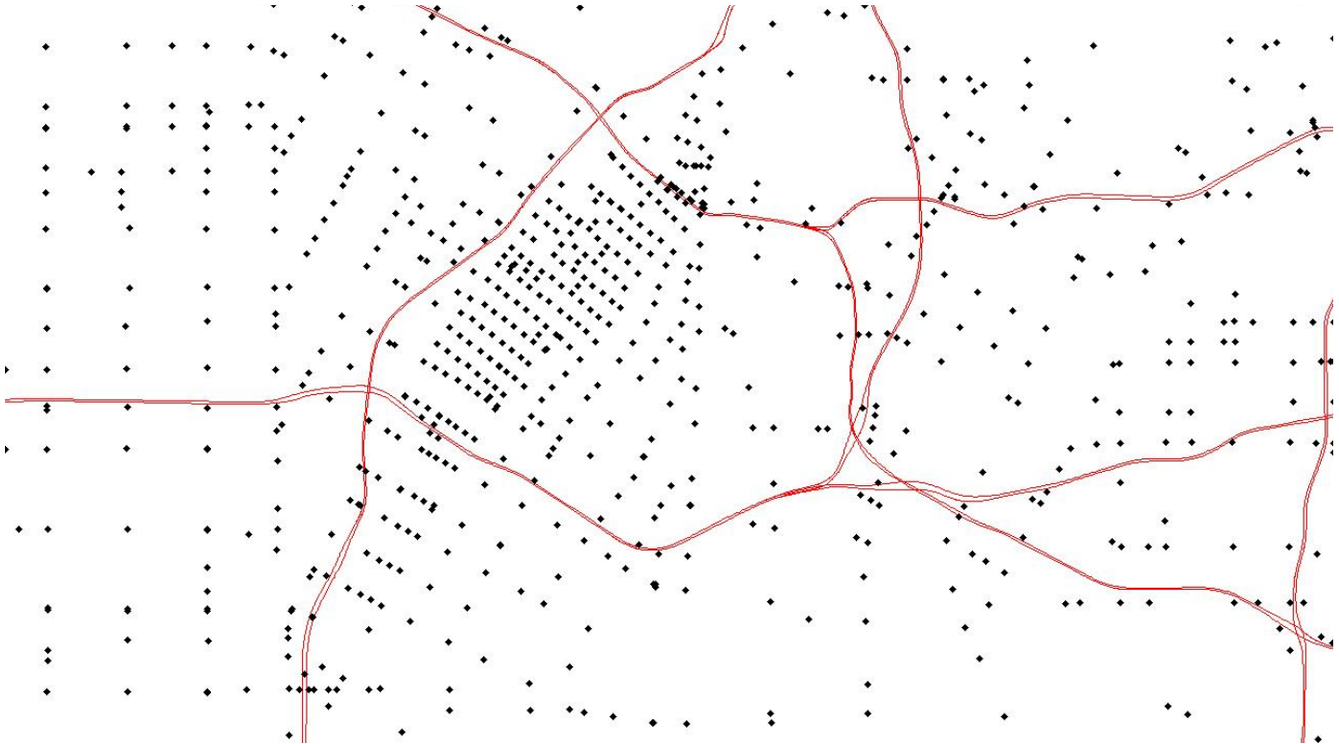




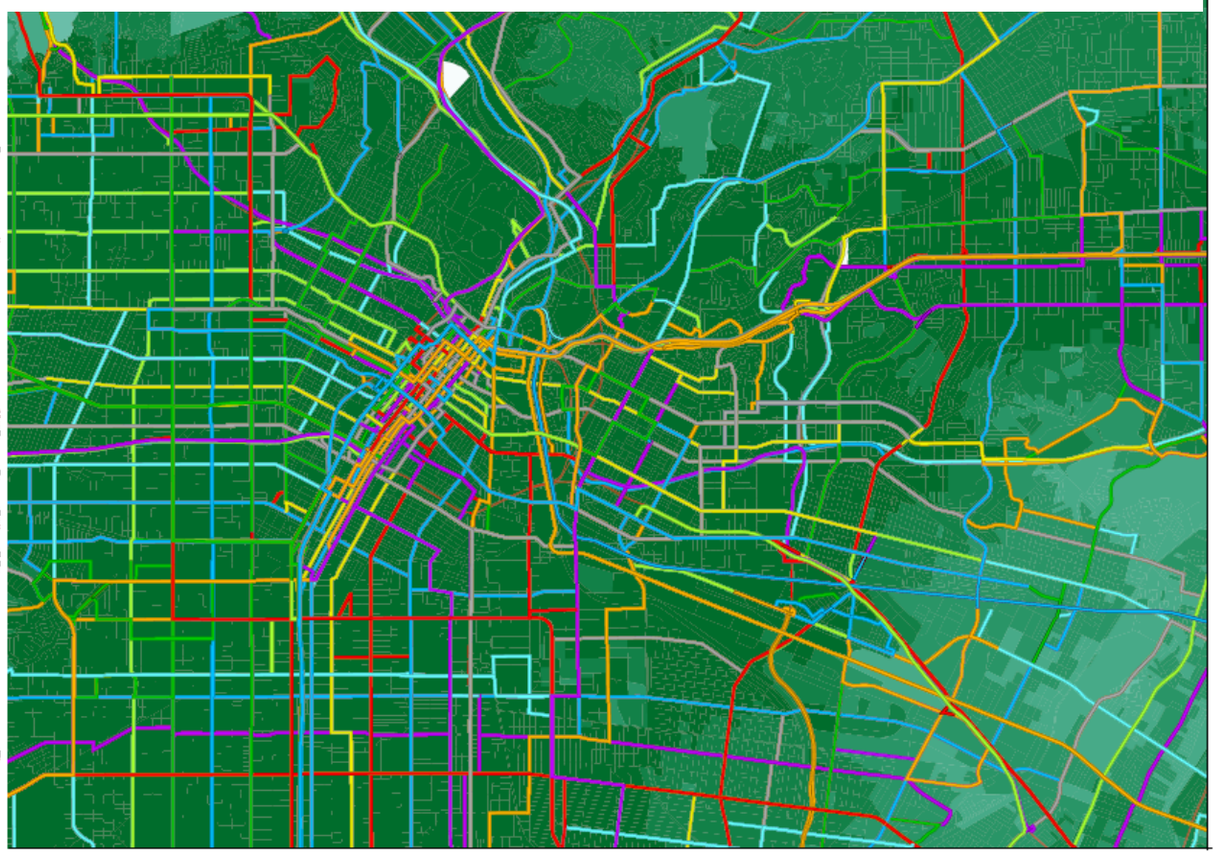
Transit Accessibility

- 60 meters / min walking speed
- 6 min penalty for switching transit lines
- Max time set at 3 hours
- Sparse distance matrix in output
  - Do not report if > 3 hours

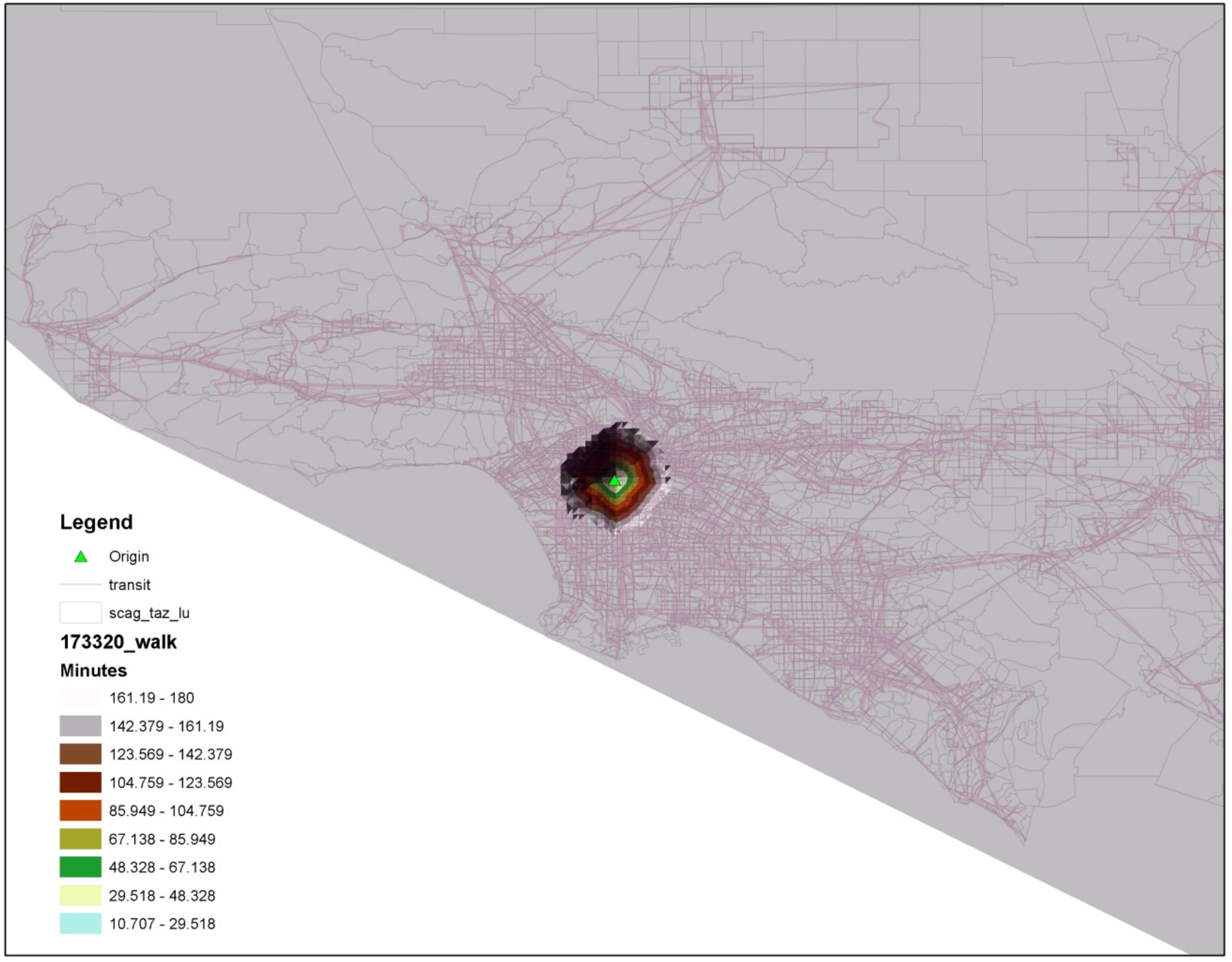
Access Points to Public Transportation



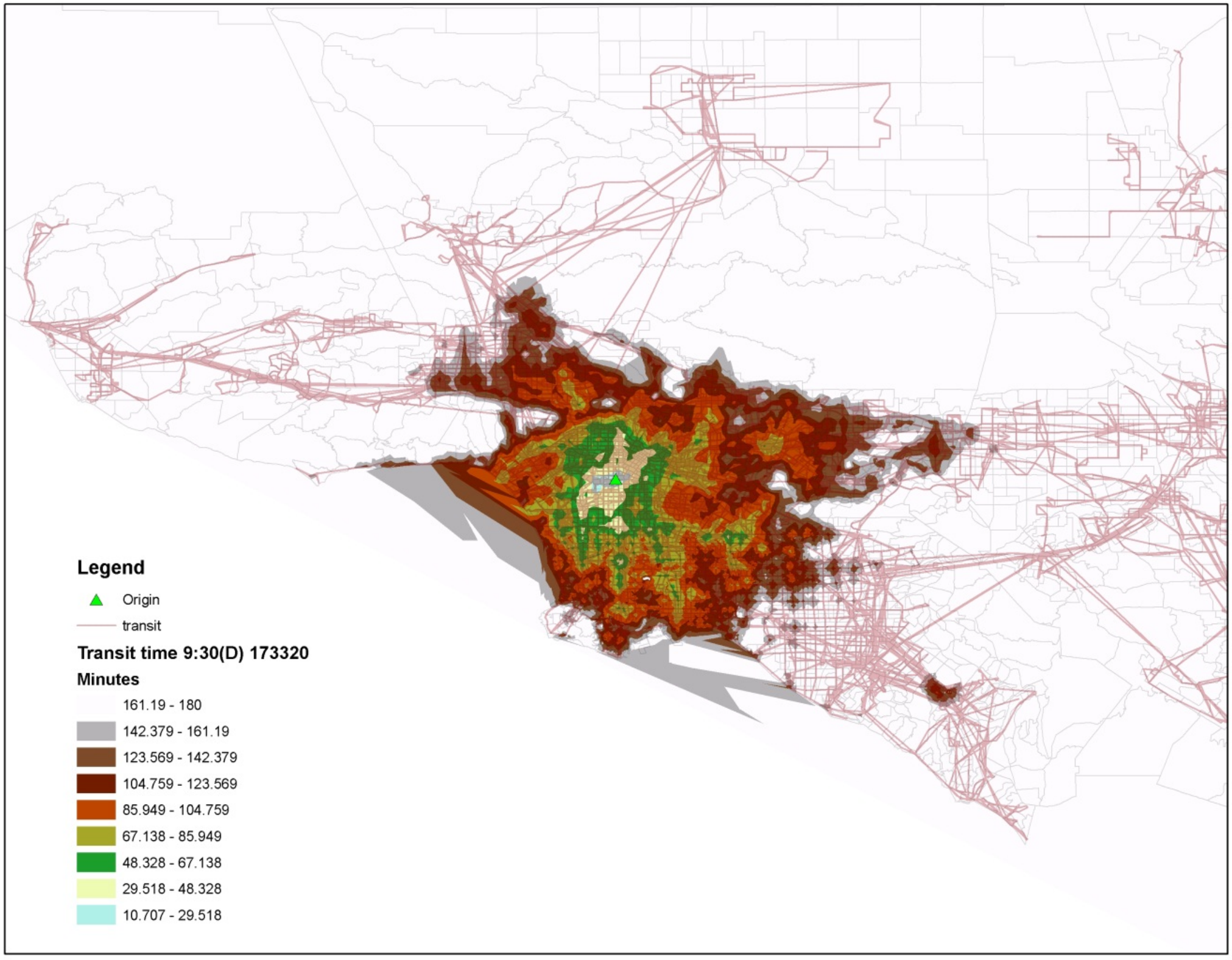
Routes of Public Transportation



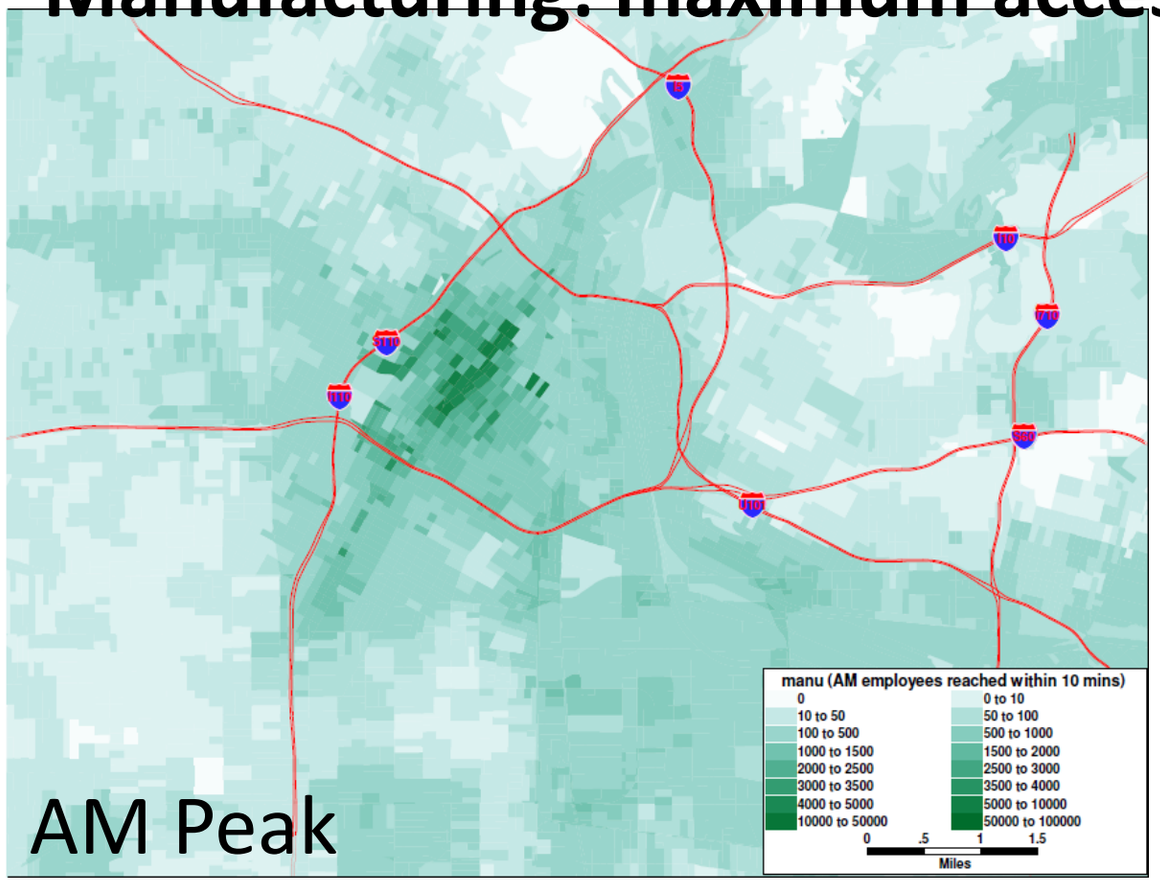
Walk Time Isochrones Example



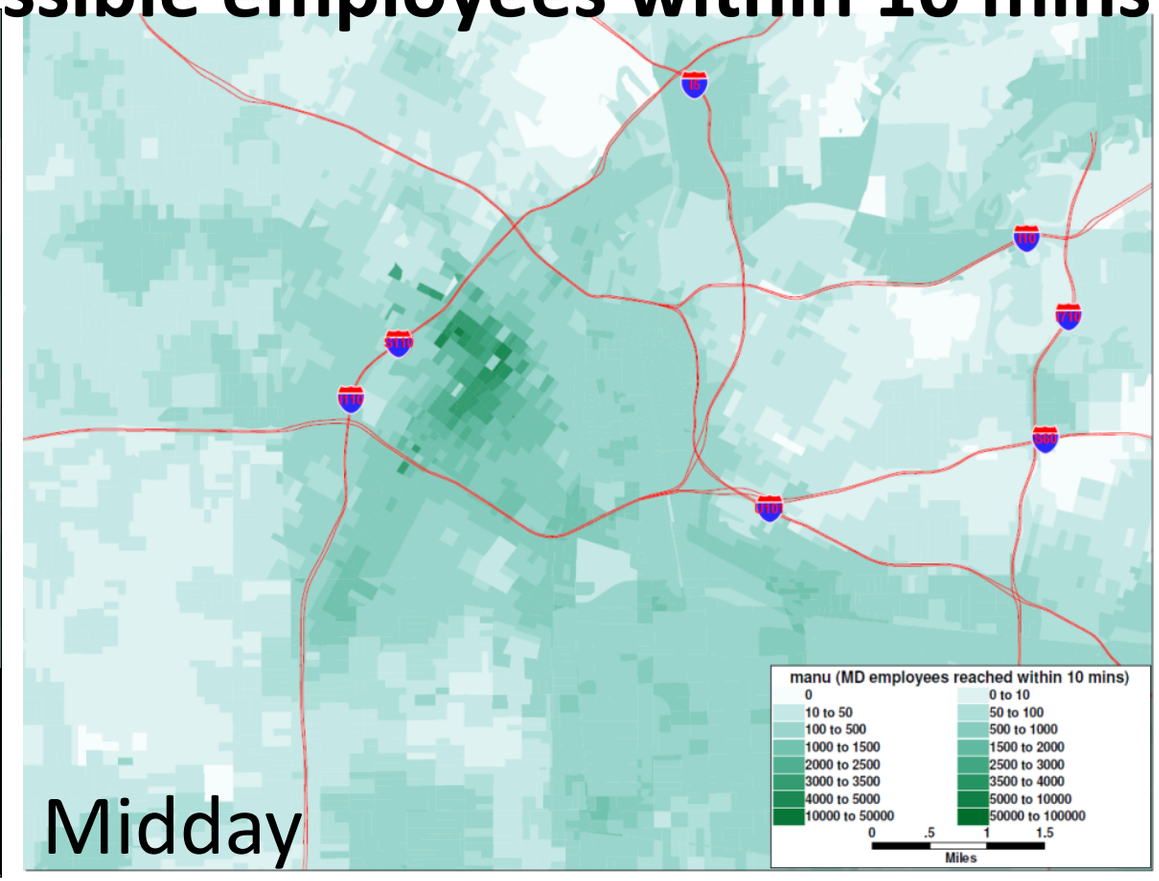
Transit Travel Time Isochrones Example



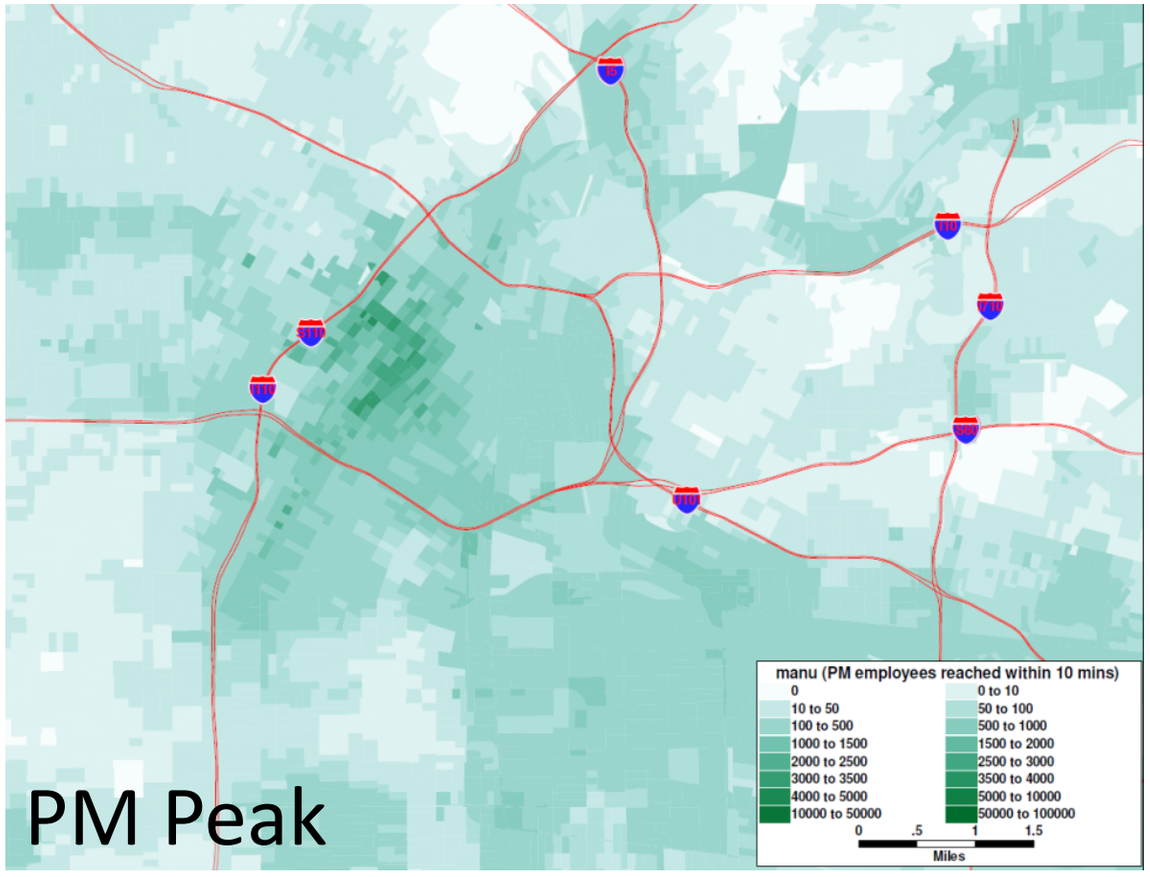
Manufacturing: maximum accessible employees within 10 mins



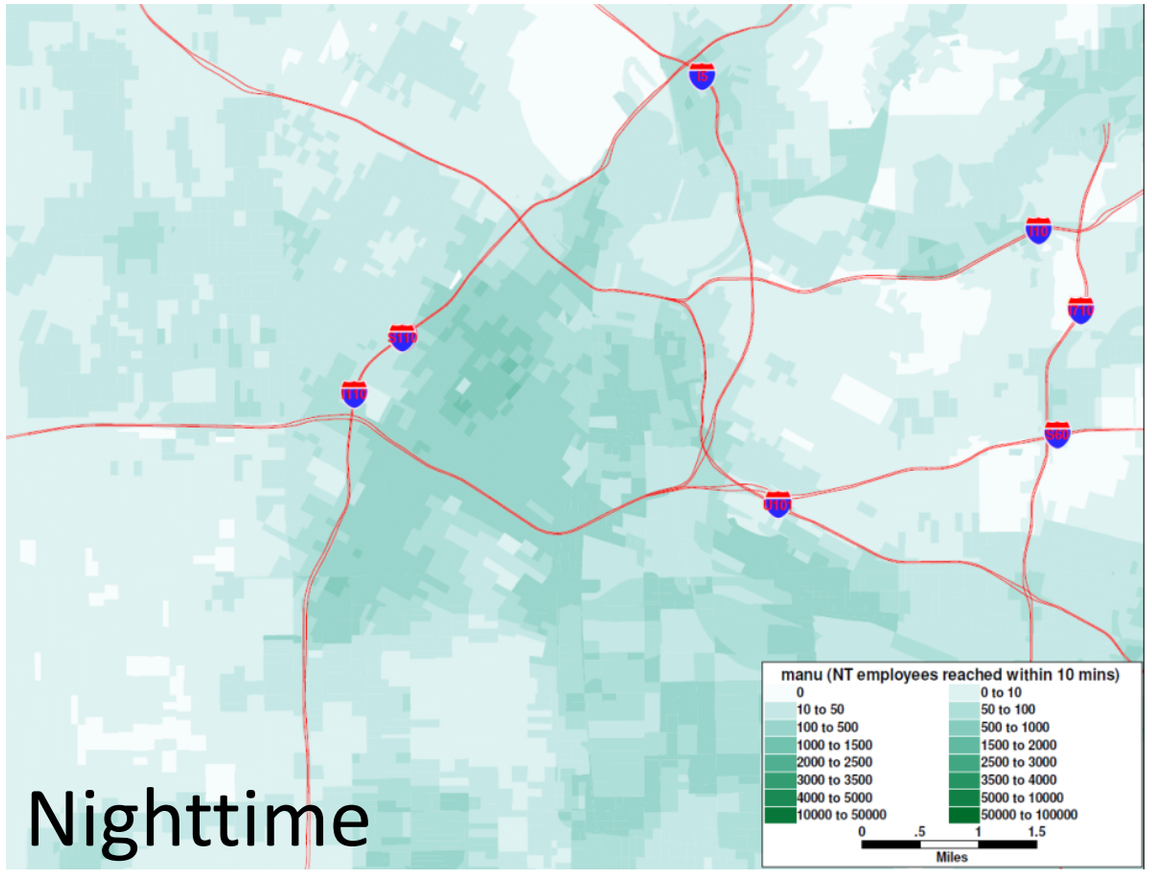
AM Peak



Midday

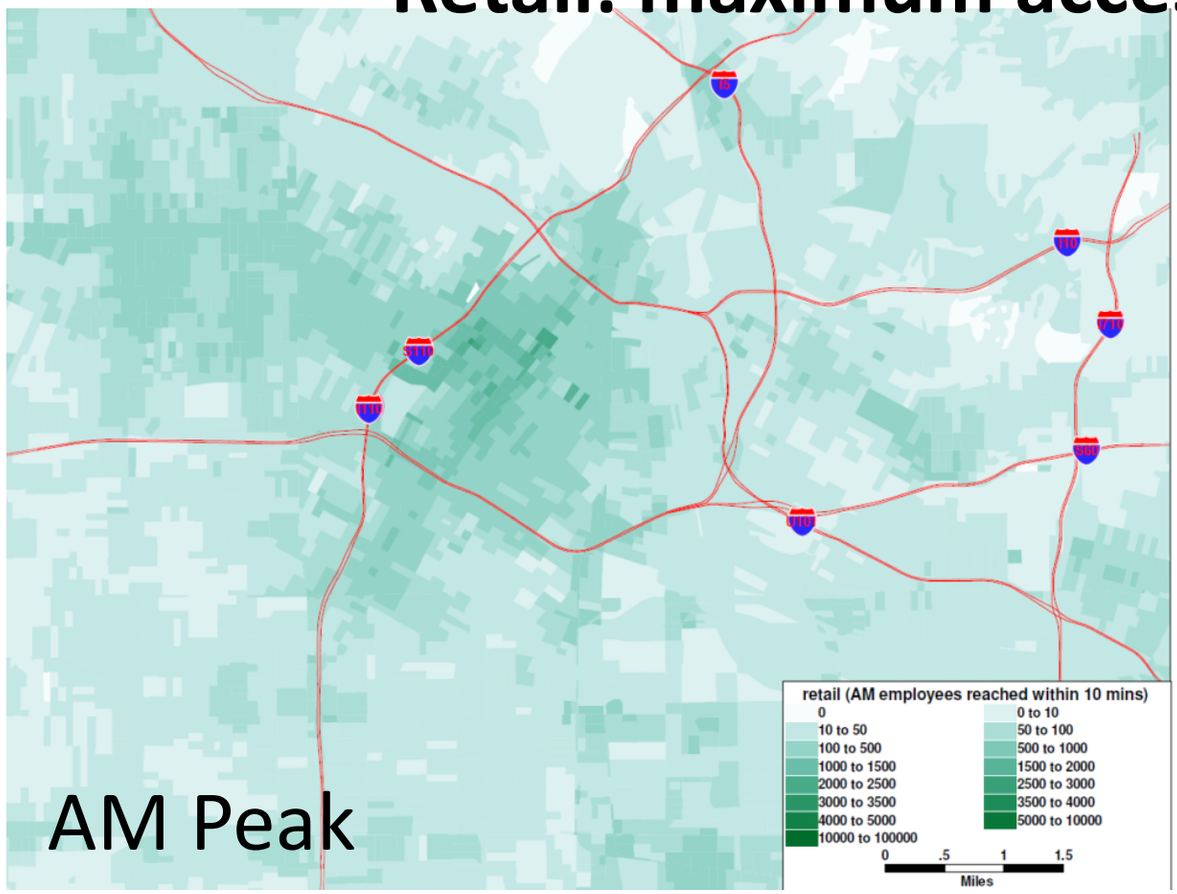


PM Peak

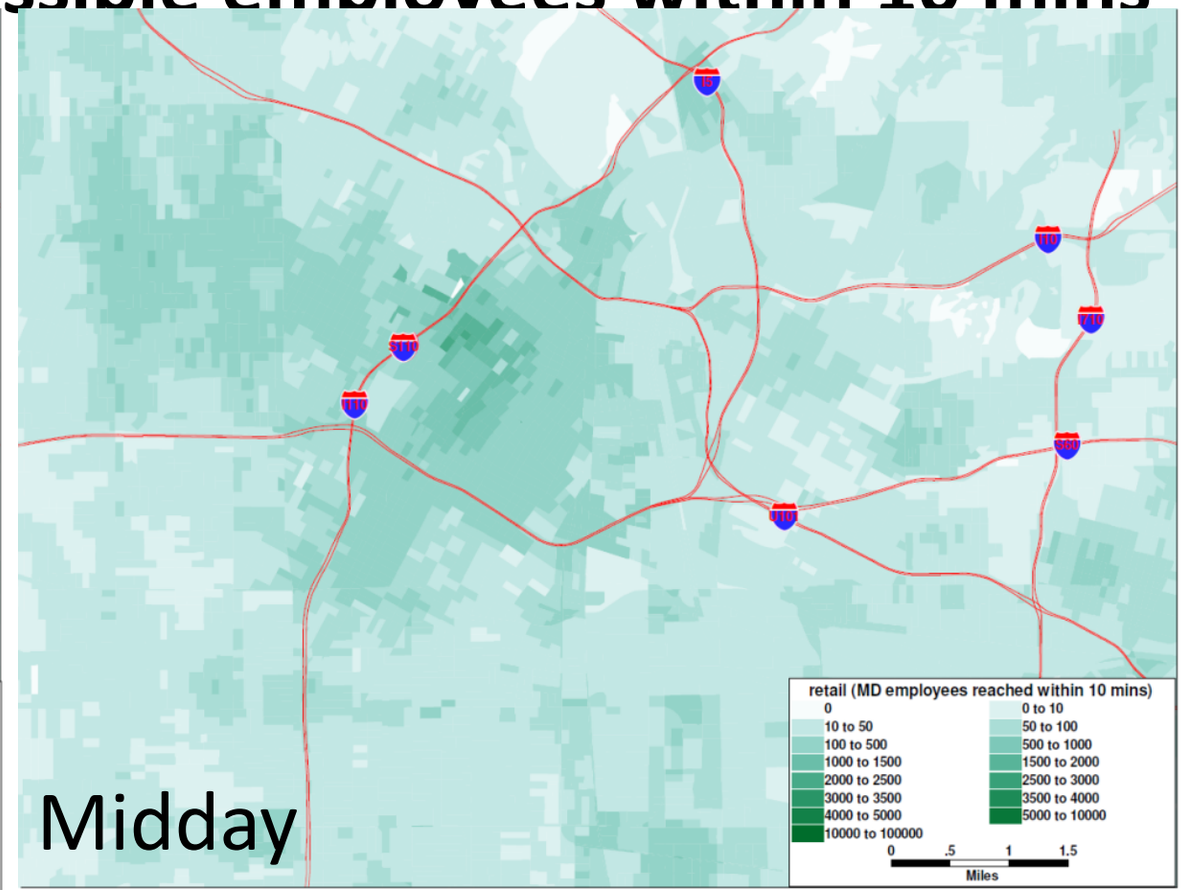


Nighttime

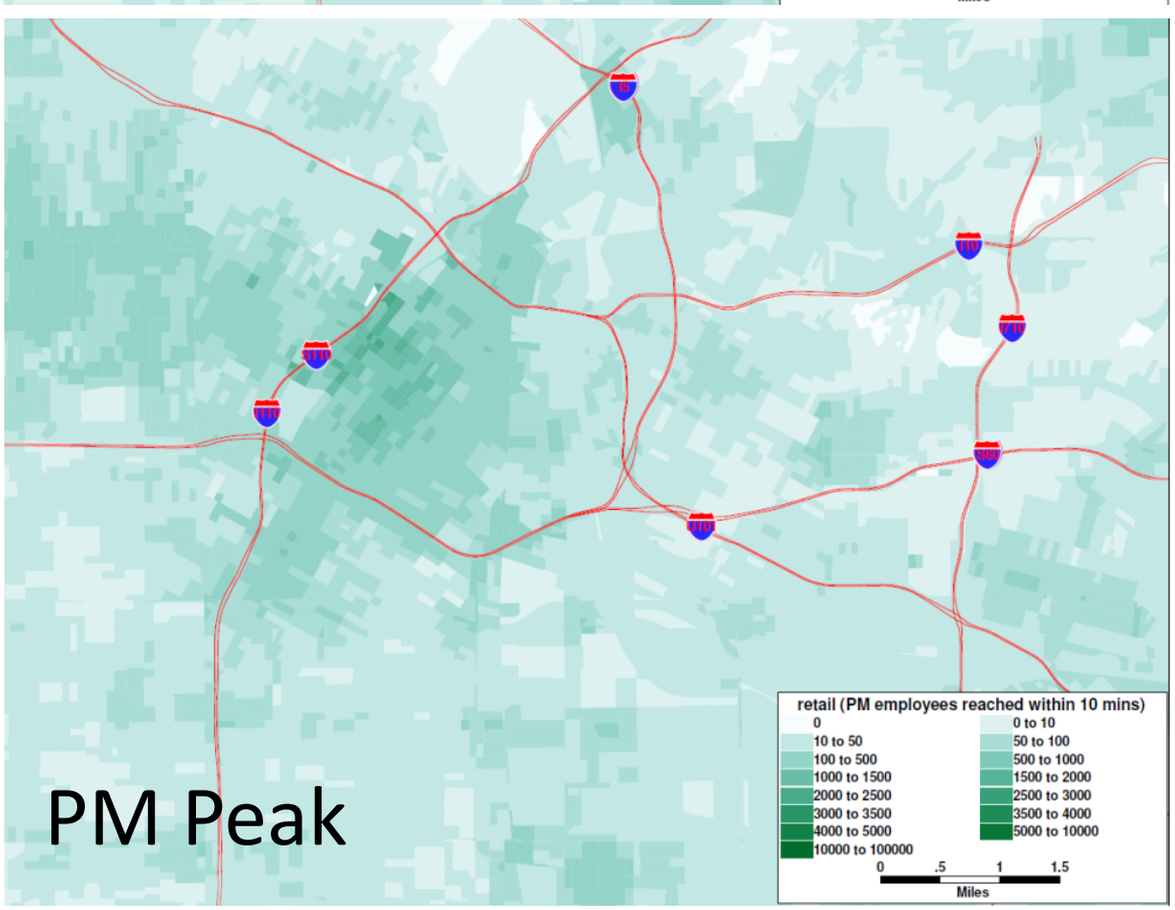
Retail: maximum accessible employees within 10 mins



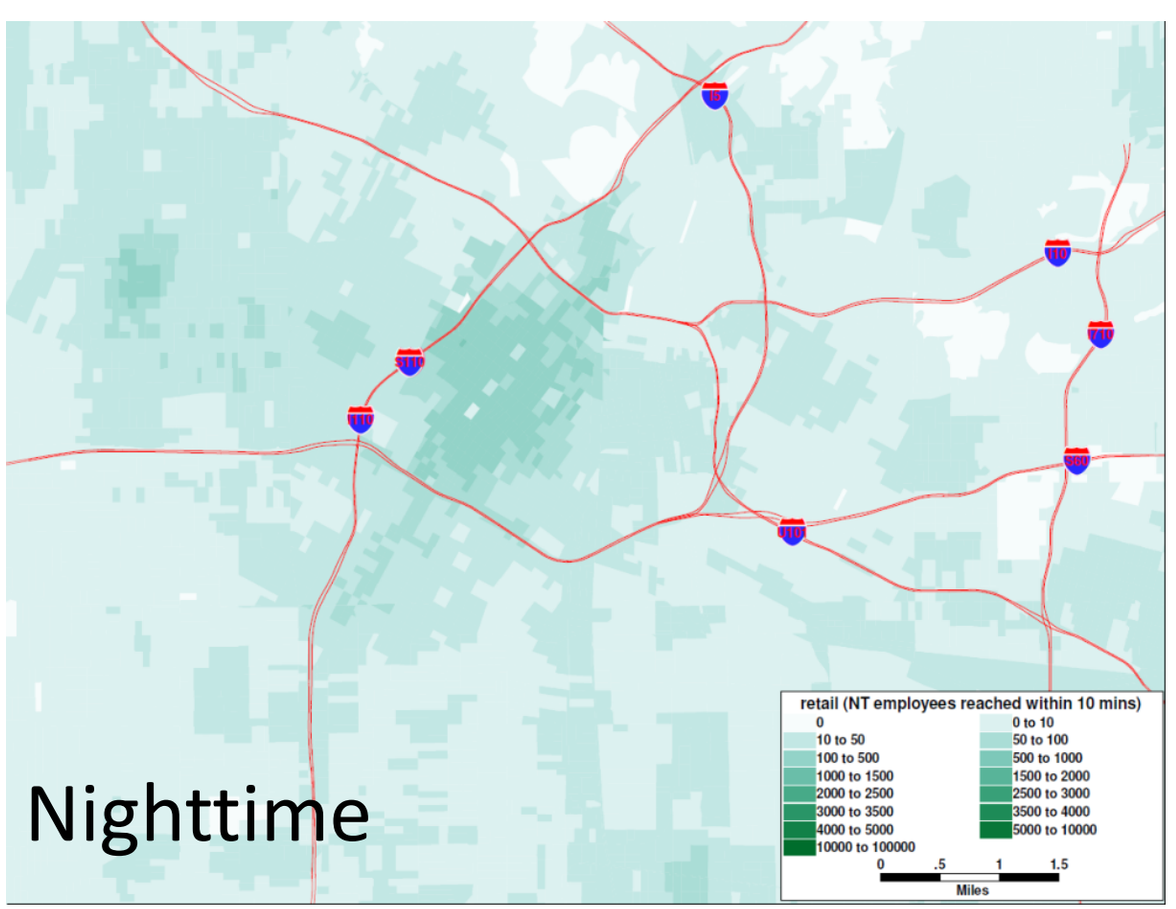
AM Peak



Midday

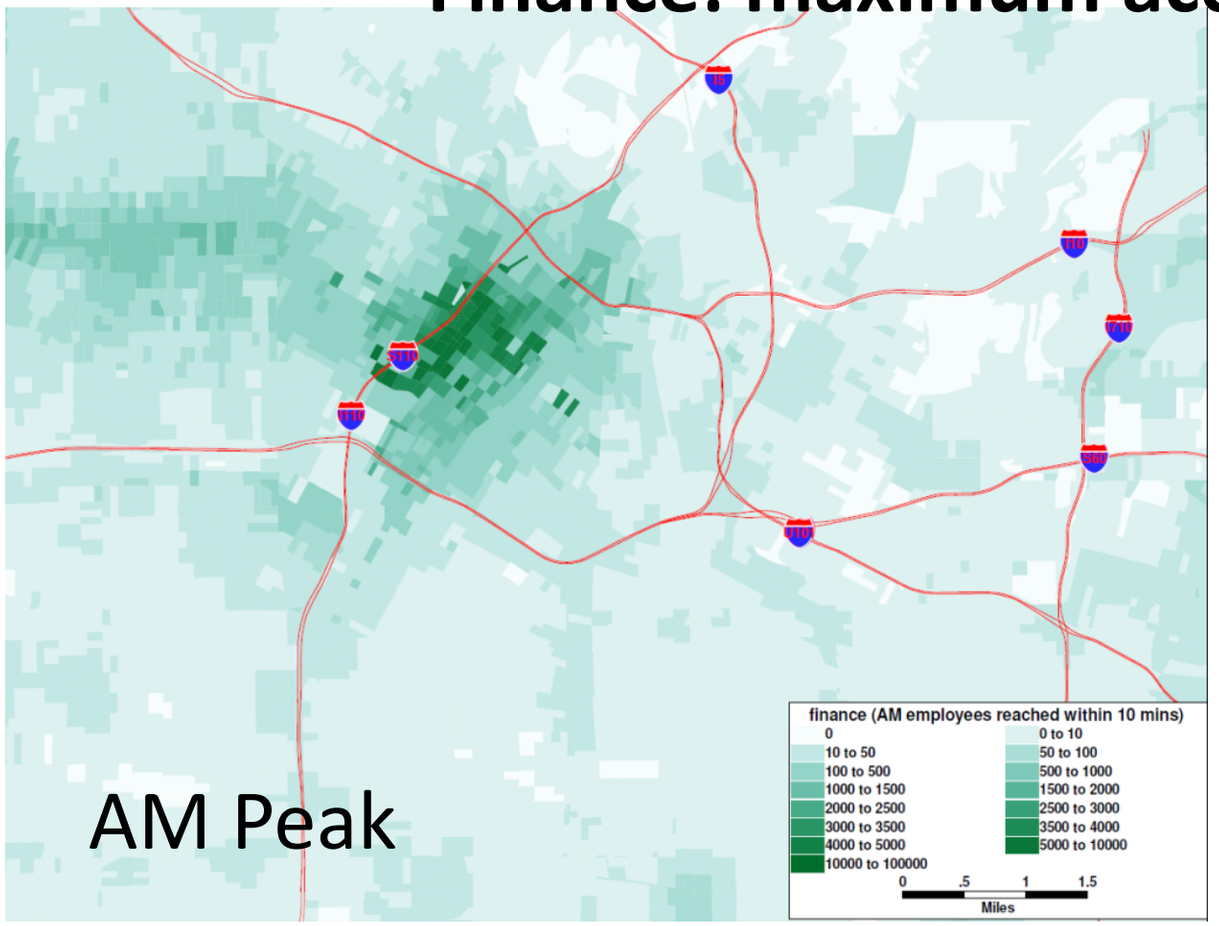


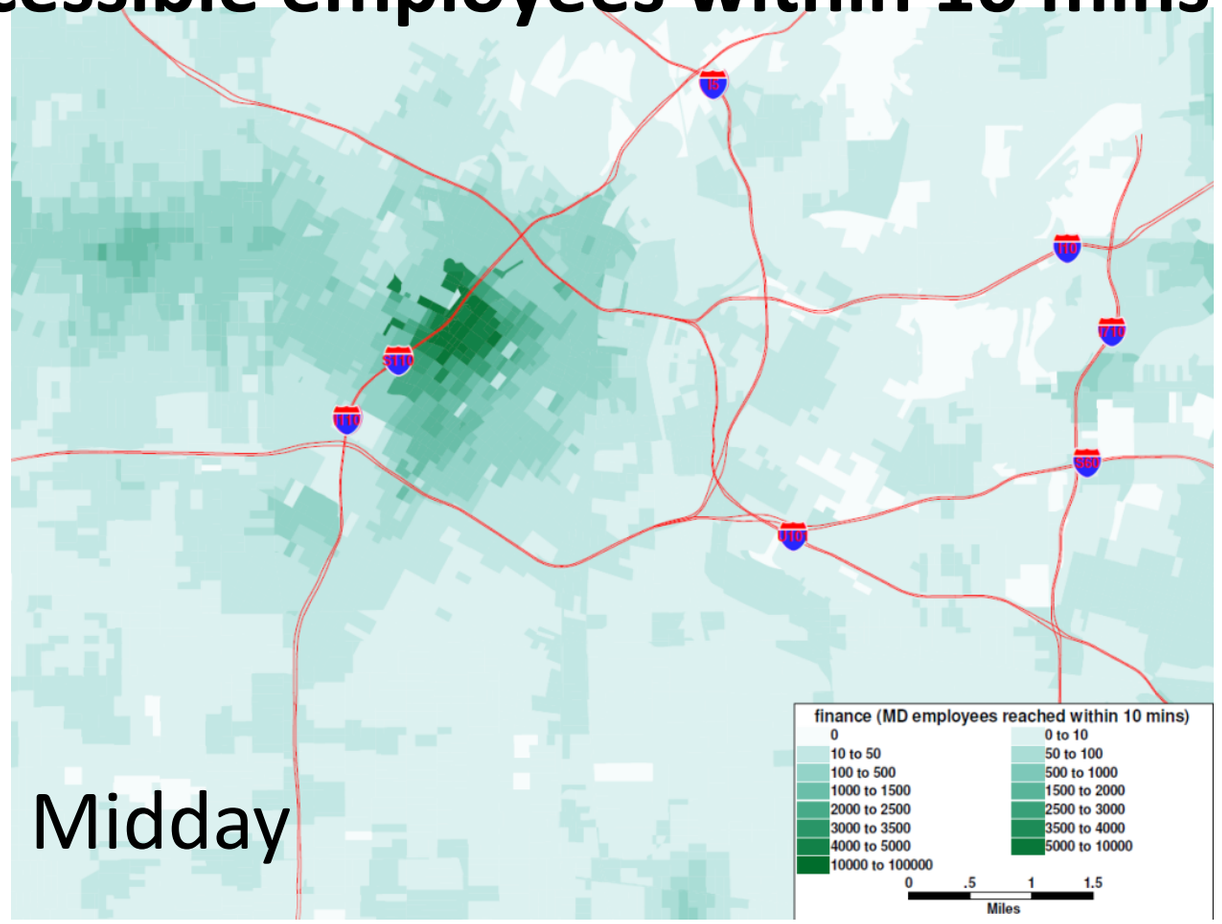
PM Peak

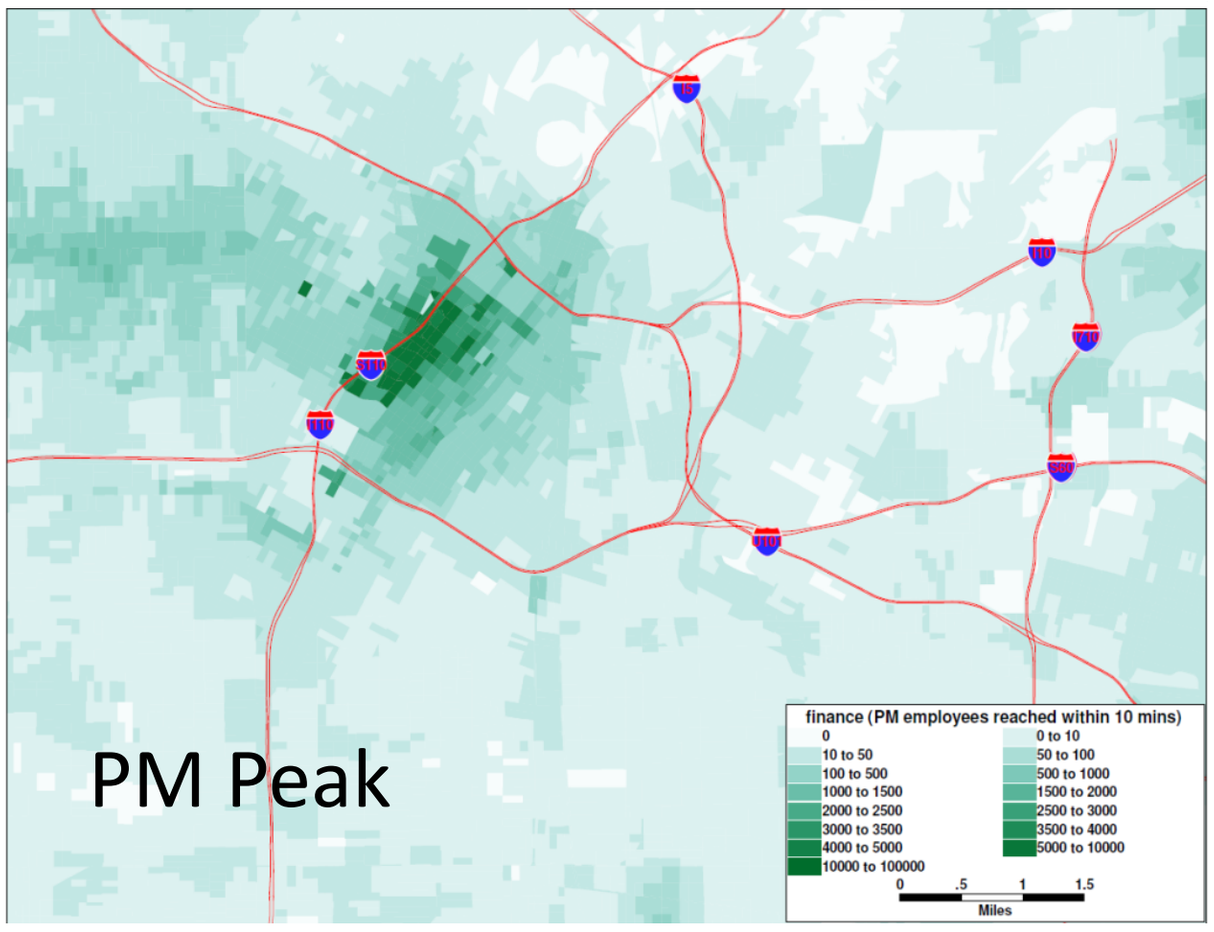


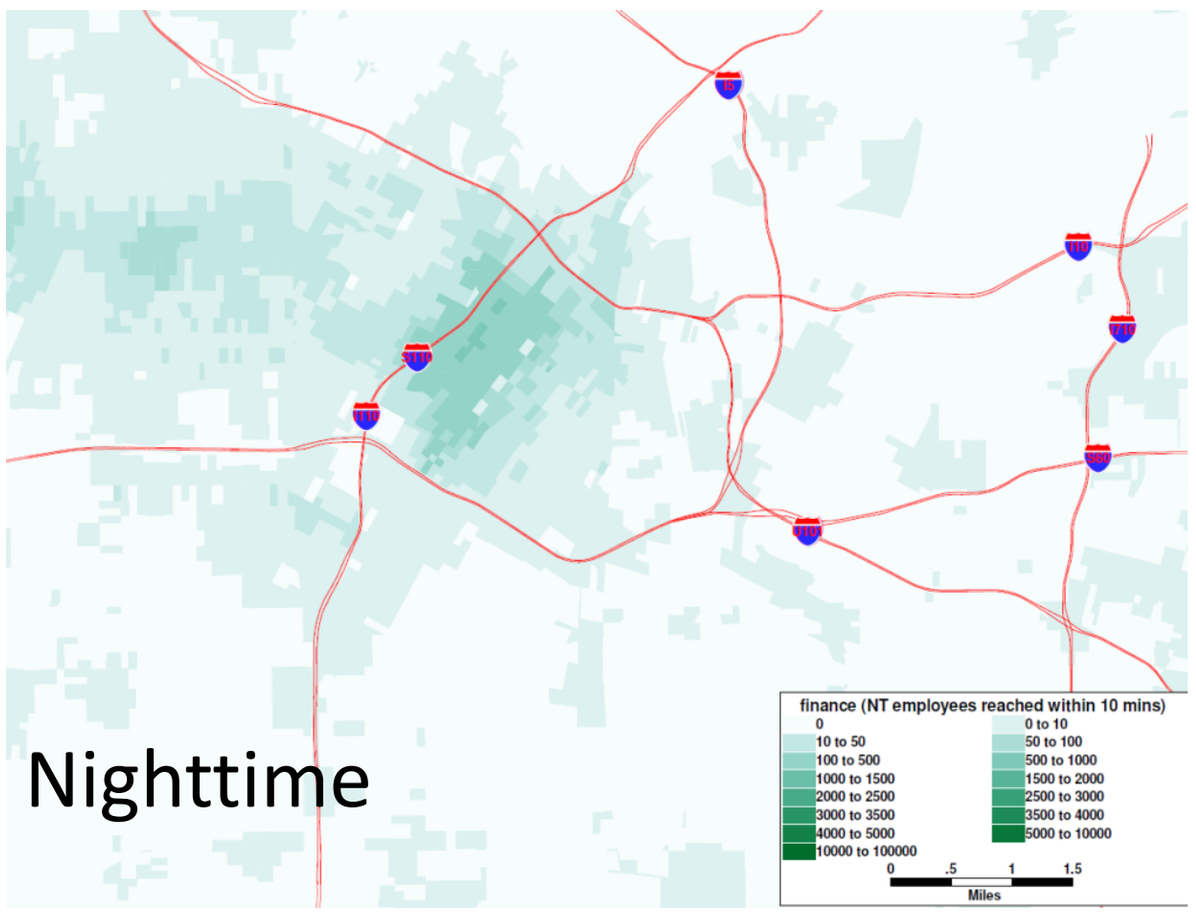
Nighttime

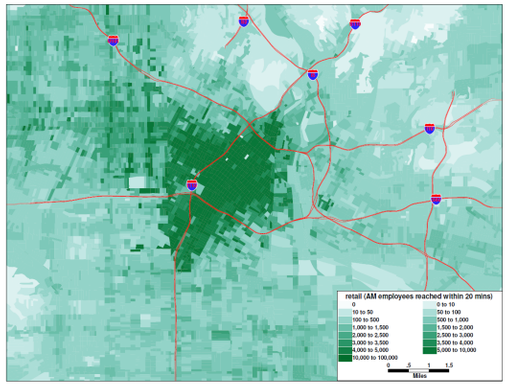
Finance: maximum accessible employees within 10 mins



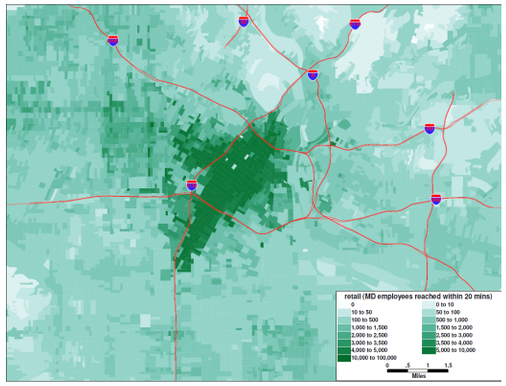




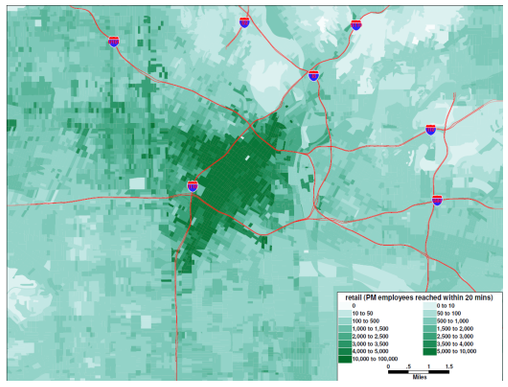




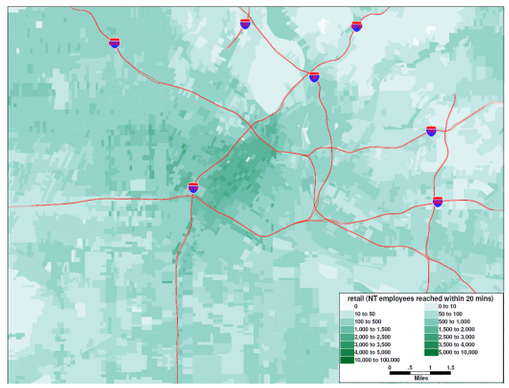
AM Peak



Midday



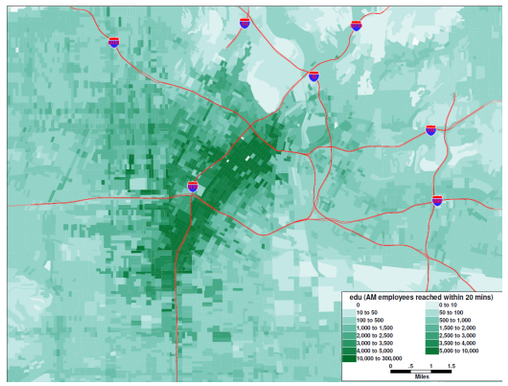
PM Peak



Night Time

Maximum number of reachable retail employees for a 20-minute buffer by transit by time of day in Central Los Angeles.

OPORTUNITY-BASED ACCESSIBILITY



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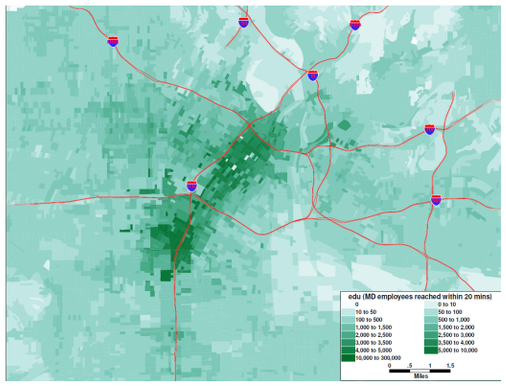

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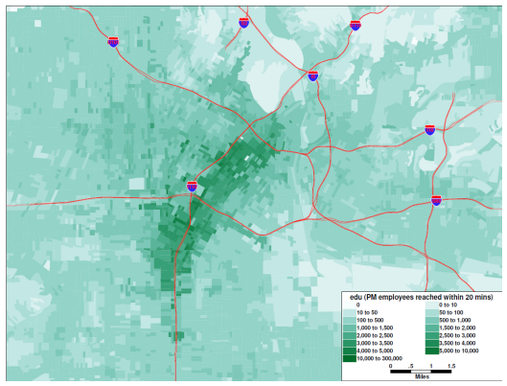

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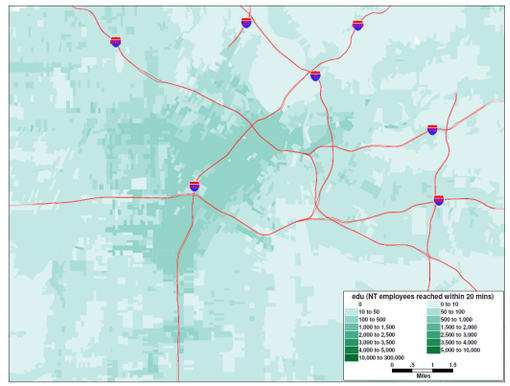
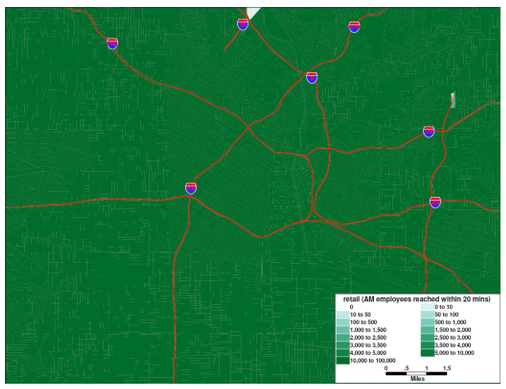


Night Time

Maximum number of reachable education employees for a 20-minute buffer by transit by time of day in Central Los Angeles.



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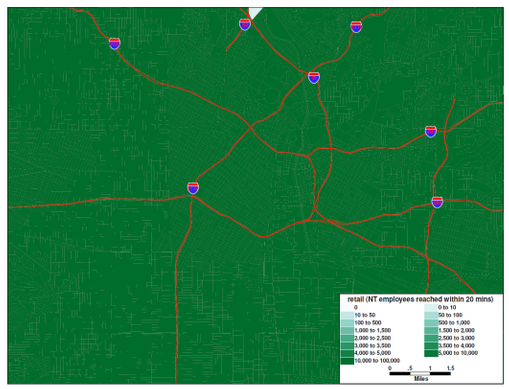
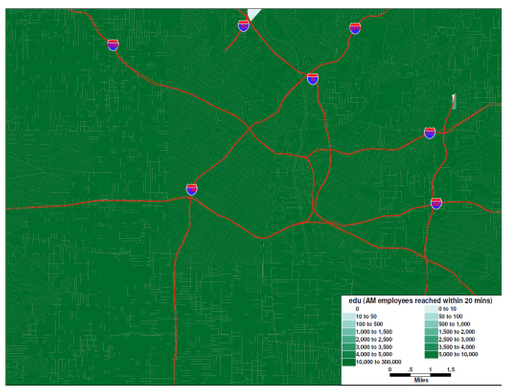
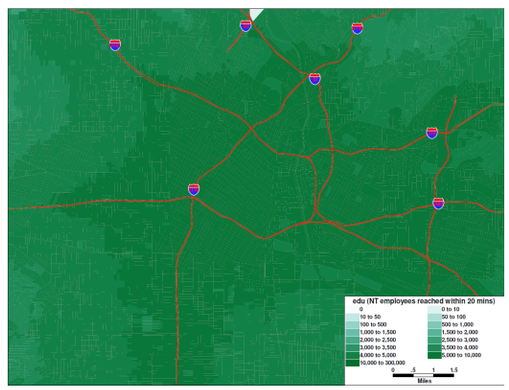


Night Time

Maximum number of reachable retail employees for a 20-minute buffer by time of day in Central Los Angeles by Private Car



AM Peak



Night Time

Maximum number of reachable education employees for a 20-minute buffer by time of day in Central Los Angeles by Private Car

Representing Activity-travel Patterns

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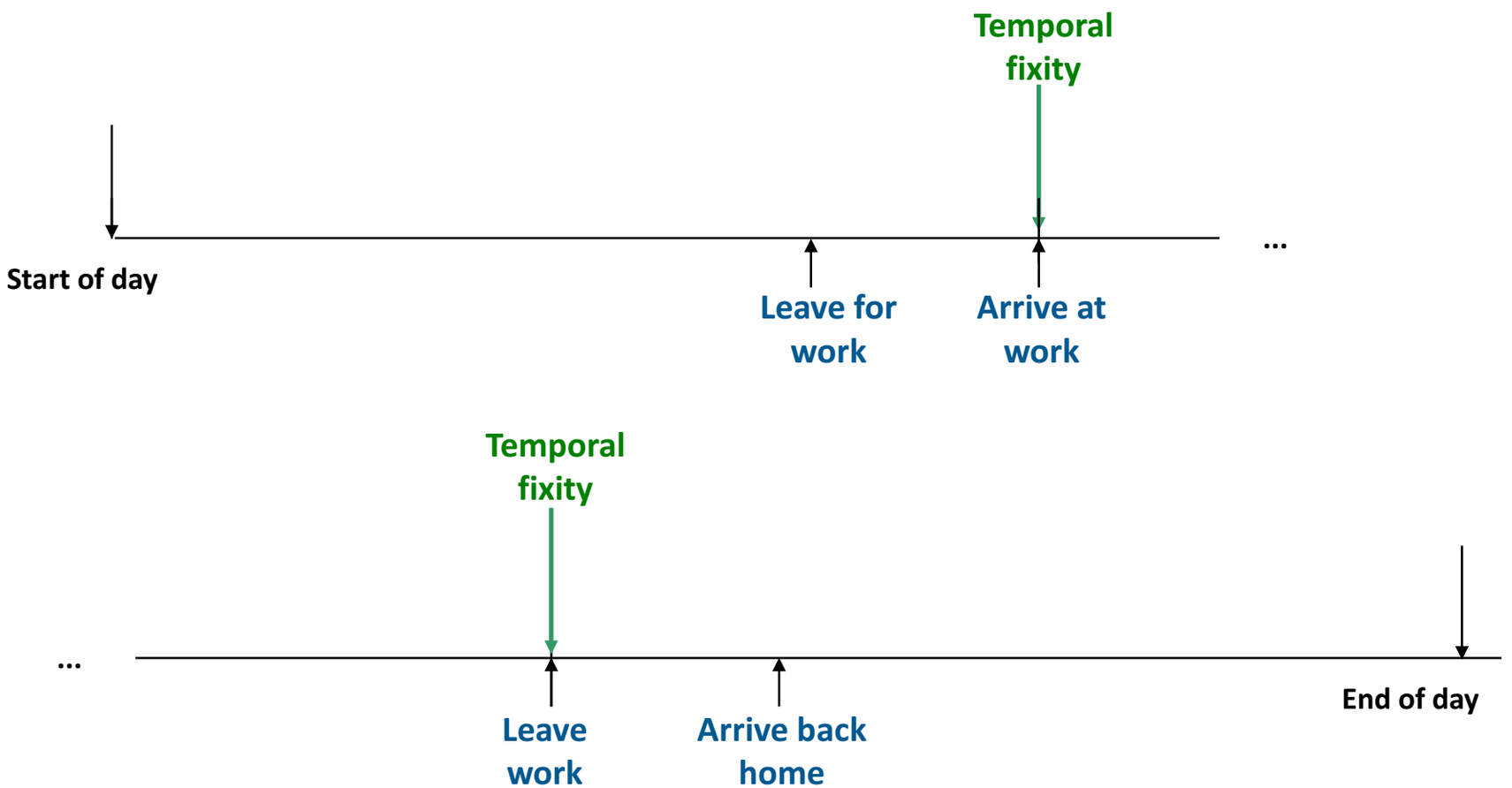
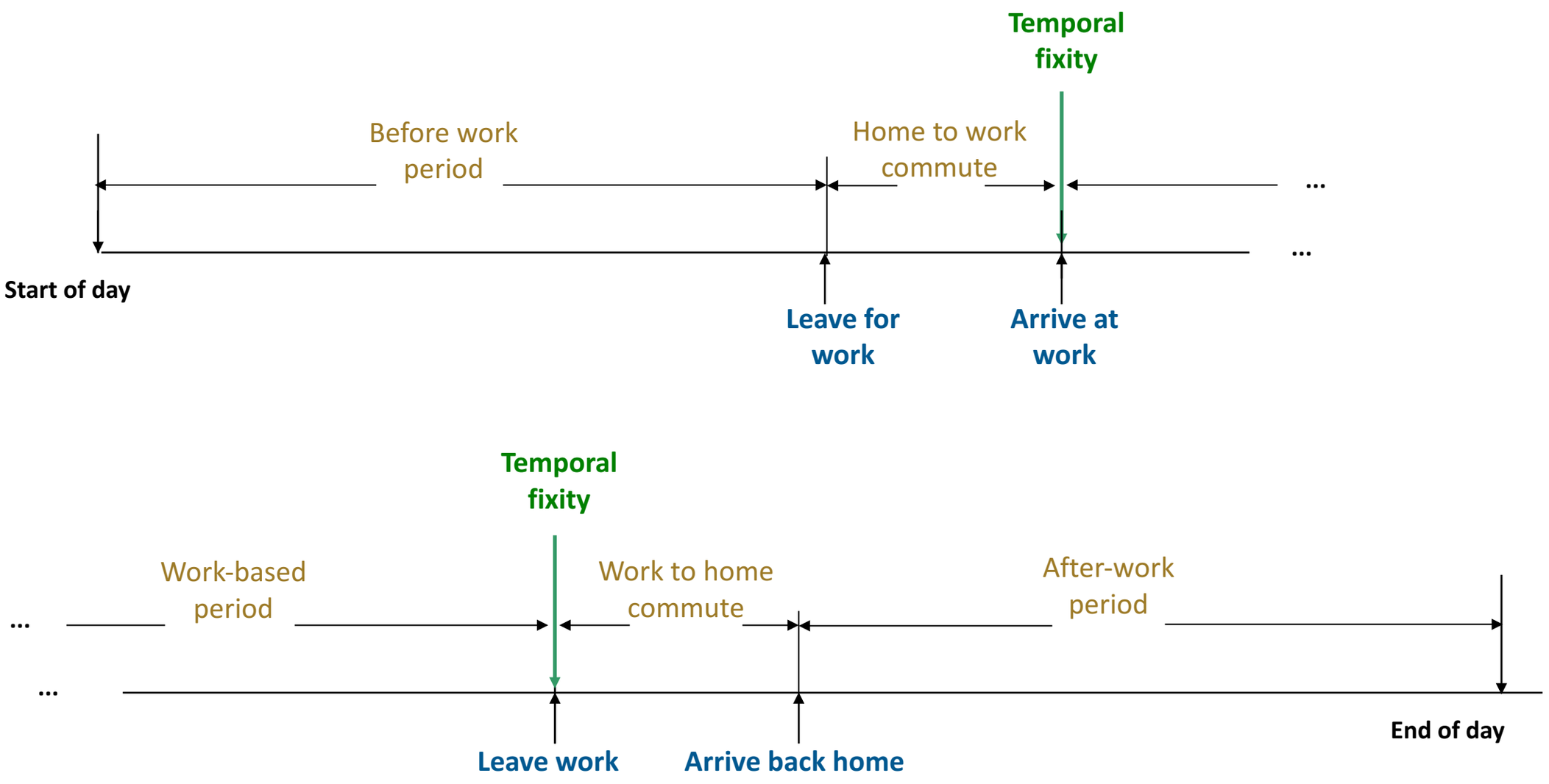
Workers



Representing Activity-travel Patterns

Workers

...



Representing Activity-travel Patterns

Workers

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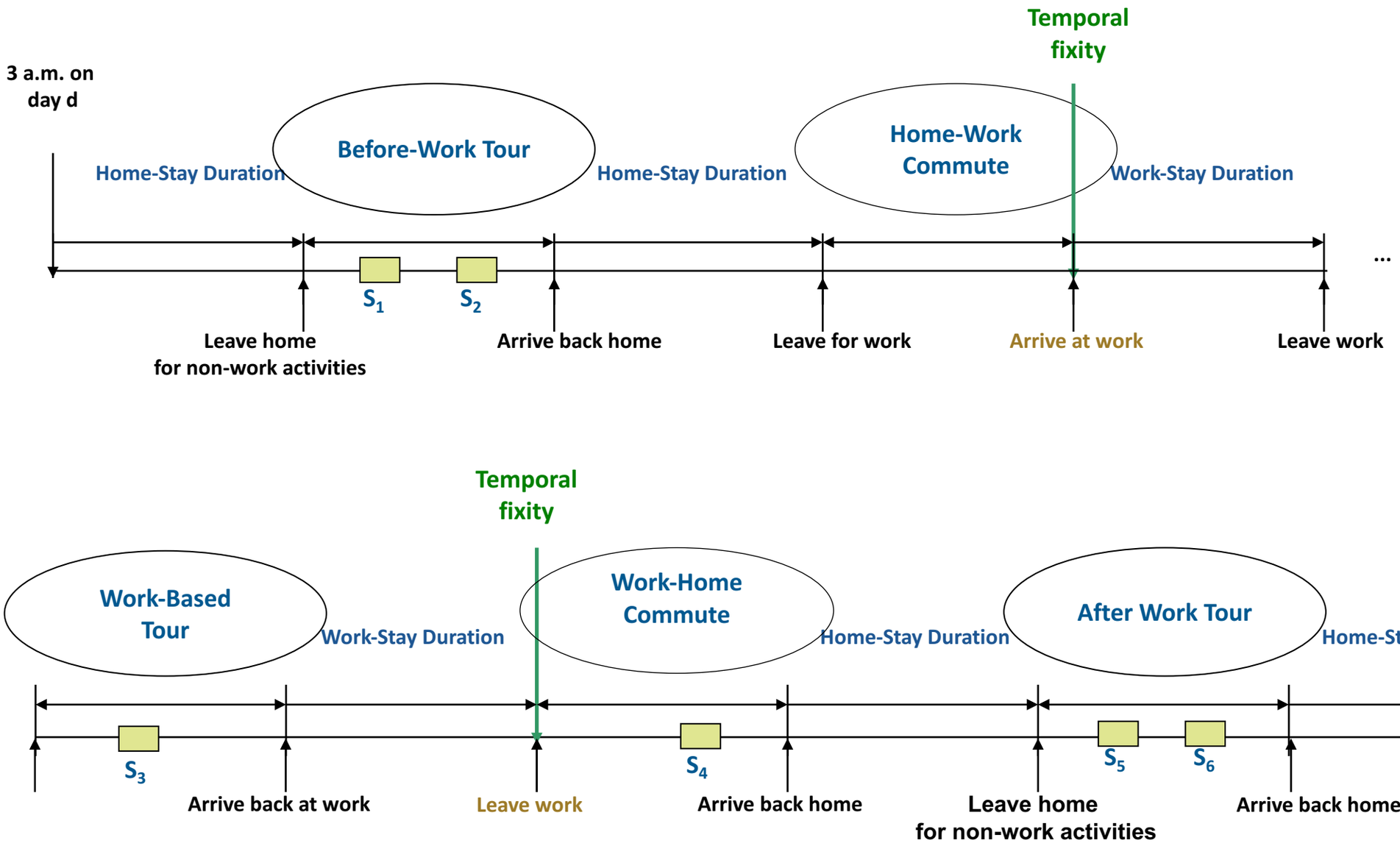


Representing Activity-travel Patterns

Workers

- Start and end times of the work activity
- For the Work-Home and Home-Work commutes:
  - Mode(s)
  - Number of stops
  - Duration
- Number of tours
  - Before work, based at work, and after work

Representing Activity-travel Patterns

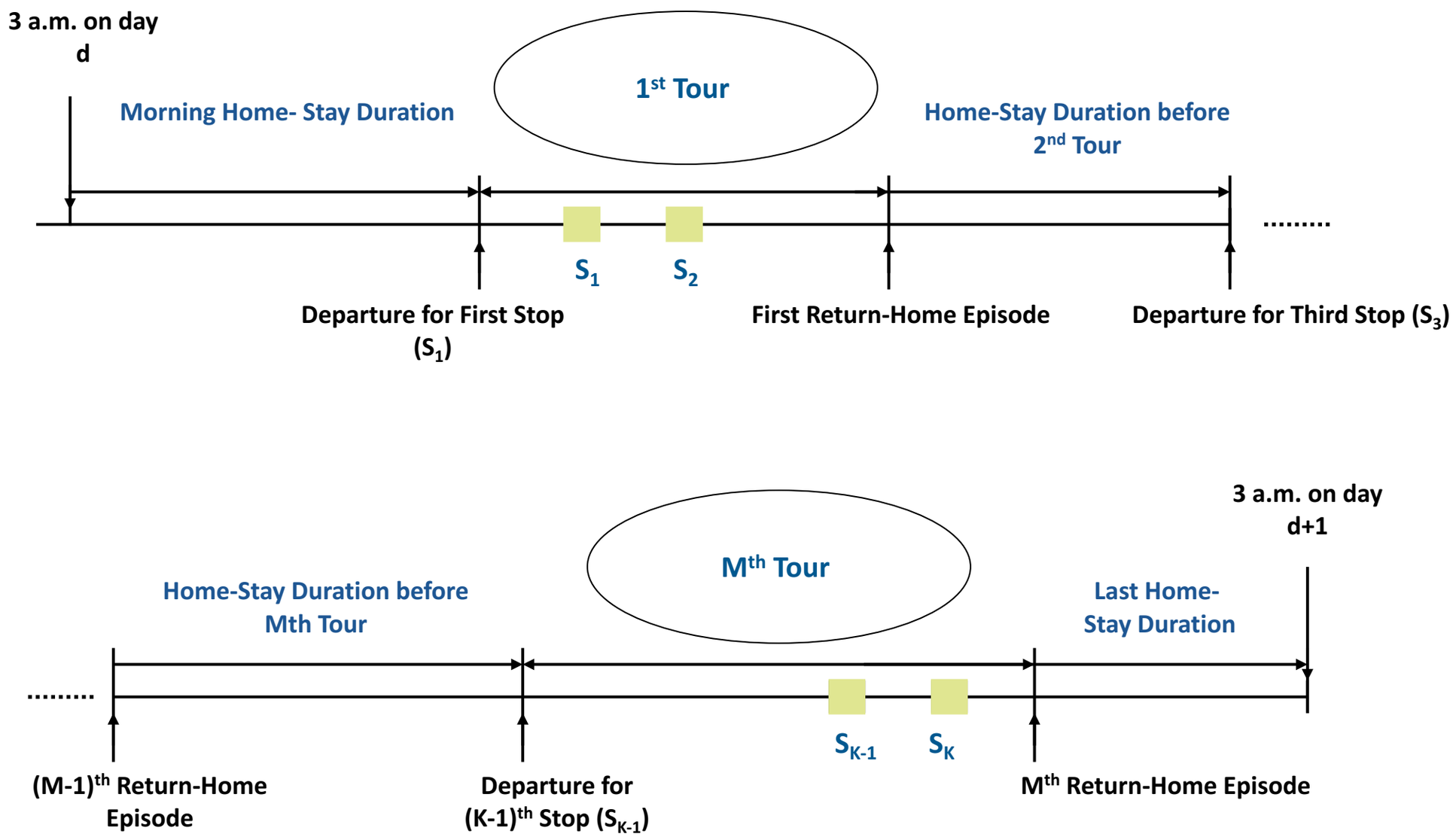
...

Workers

- **For each tour:**
  - Mode(s)
  - Number of stops
  - Duration
  - Home-stay duration before tour
  - Work-stay duration before tour
- **For each stop:**
  - Activity type
  - Activity duration
  - Travel time to activity
  - Location of activity
  - Mode to the location

Representing Activity-travel Patterns

Non-Workers

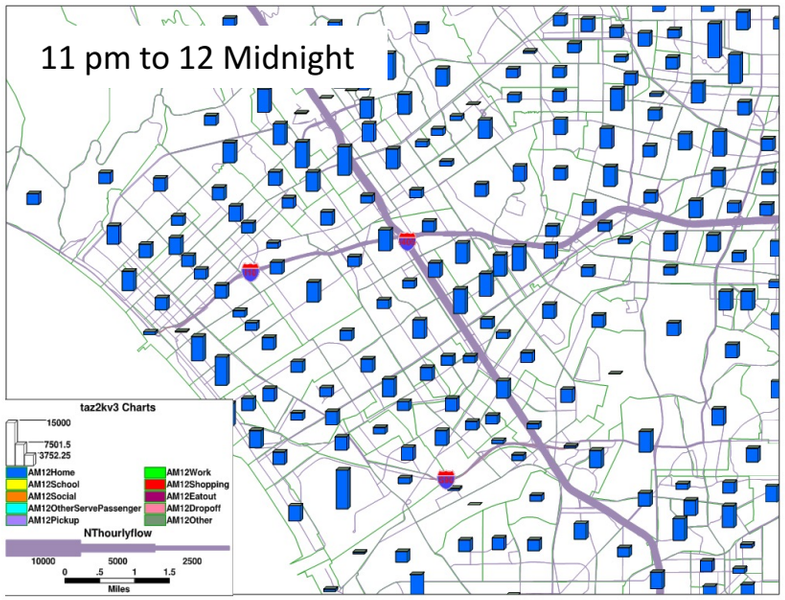


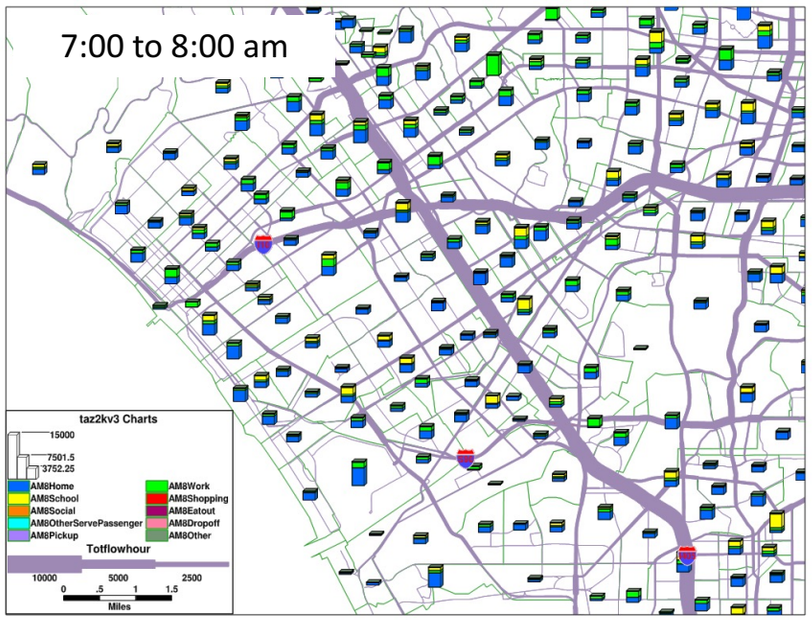
Representing Activity-travel Patterns

Non-Workers

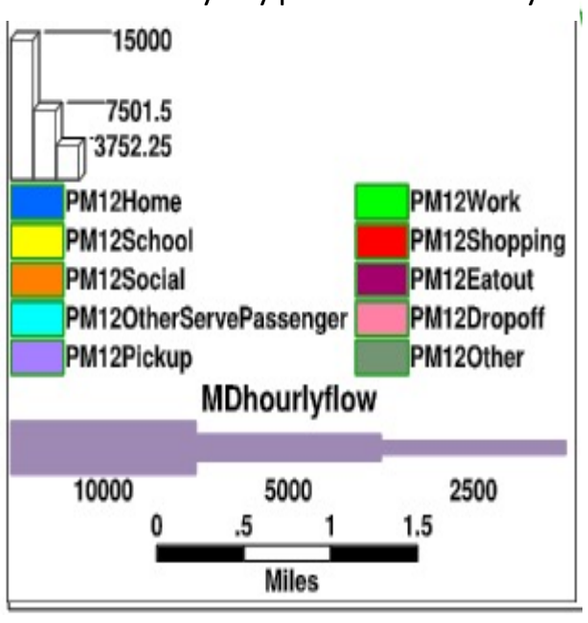
- Number of tours during the day
- **For each tour:**
  - Mode(s)
  - Number of stops
  - Duration
  - Home-stay duration before tour
- **For each stop:**
  - Activity type
  - Activity duration
  - Travel time to activity
  - Location of activity
  - Mode to the location

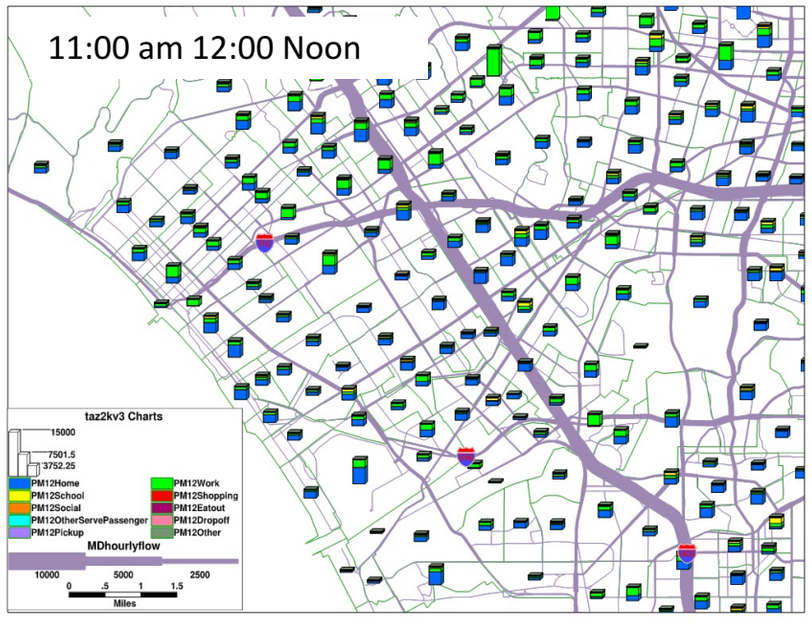
Representing Activity-travel Patterns





Presence of Persons at Places by Type of Activity



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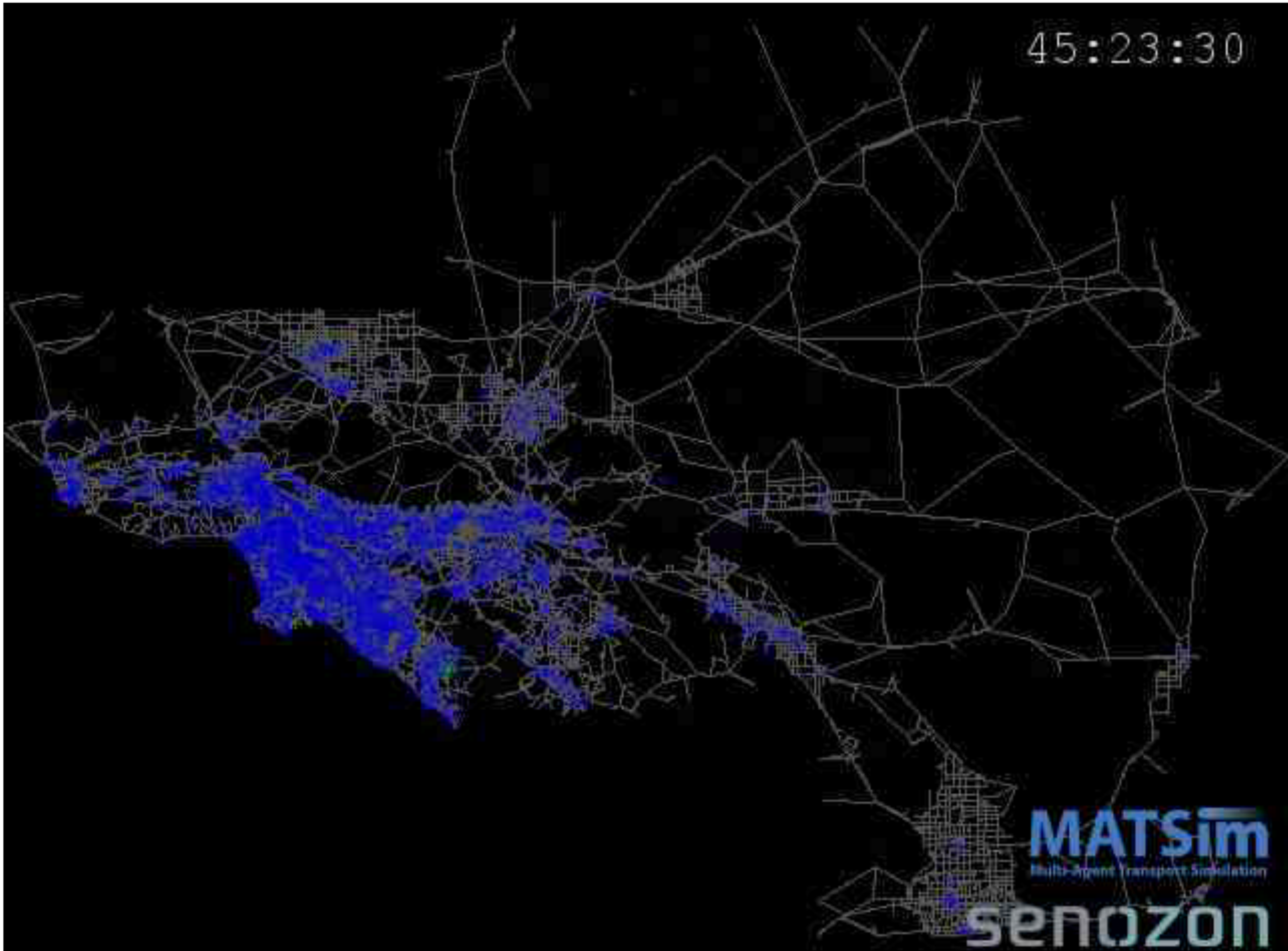
MATSim
Multi-Agent Transport Simulation
senozon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MATSim
Multi-Agent Transport Simulation
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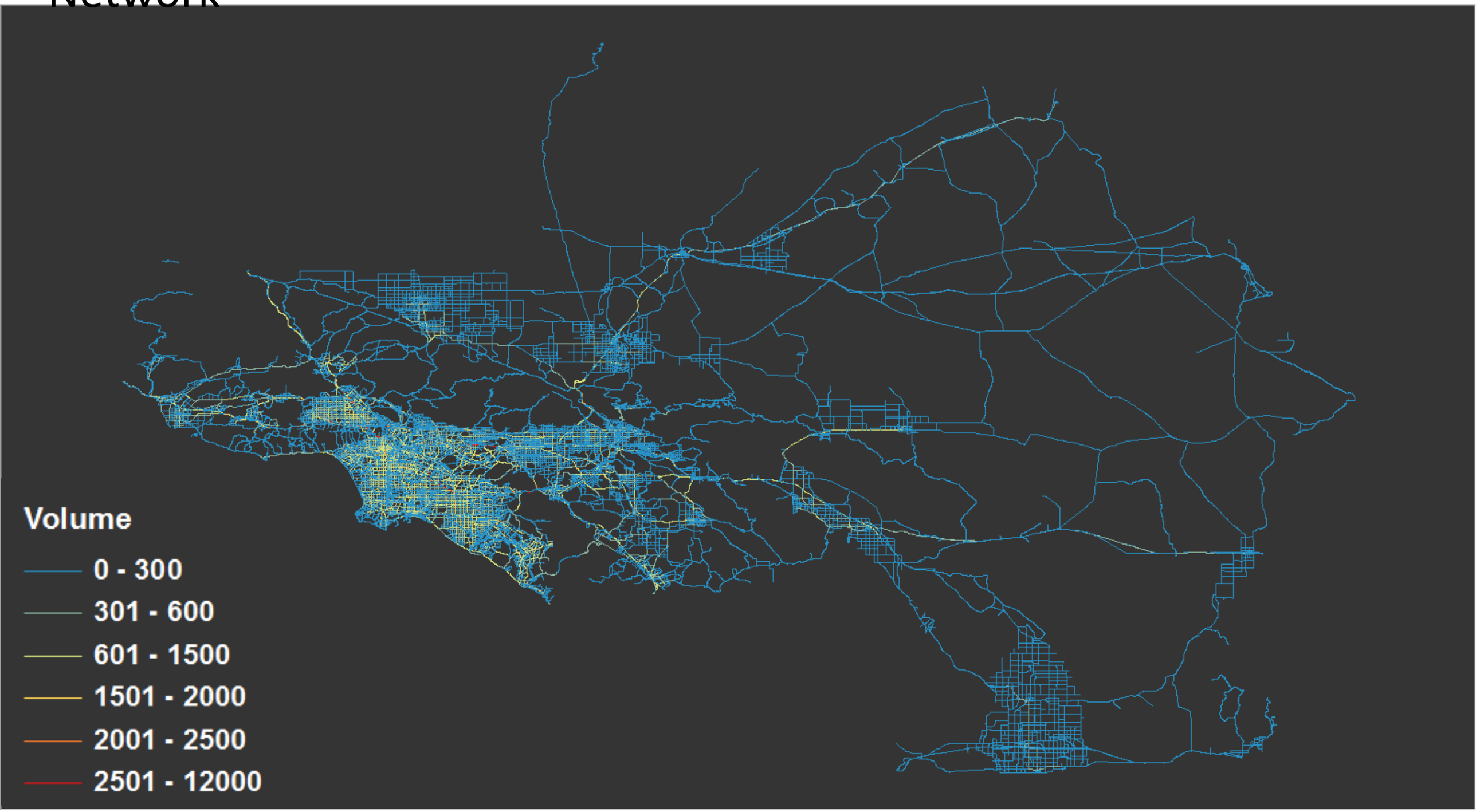
Volume on Network



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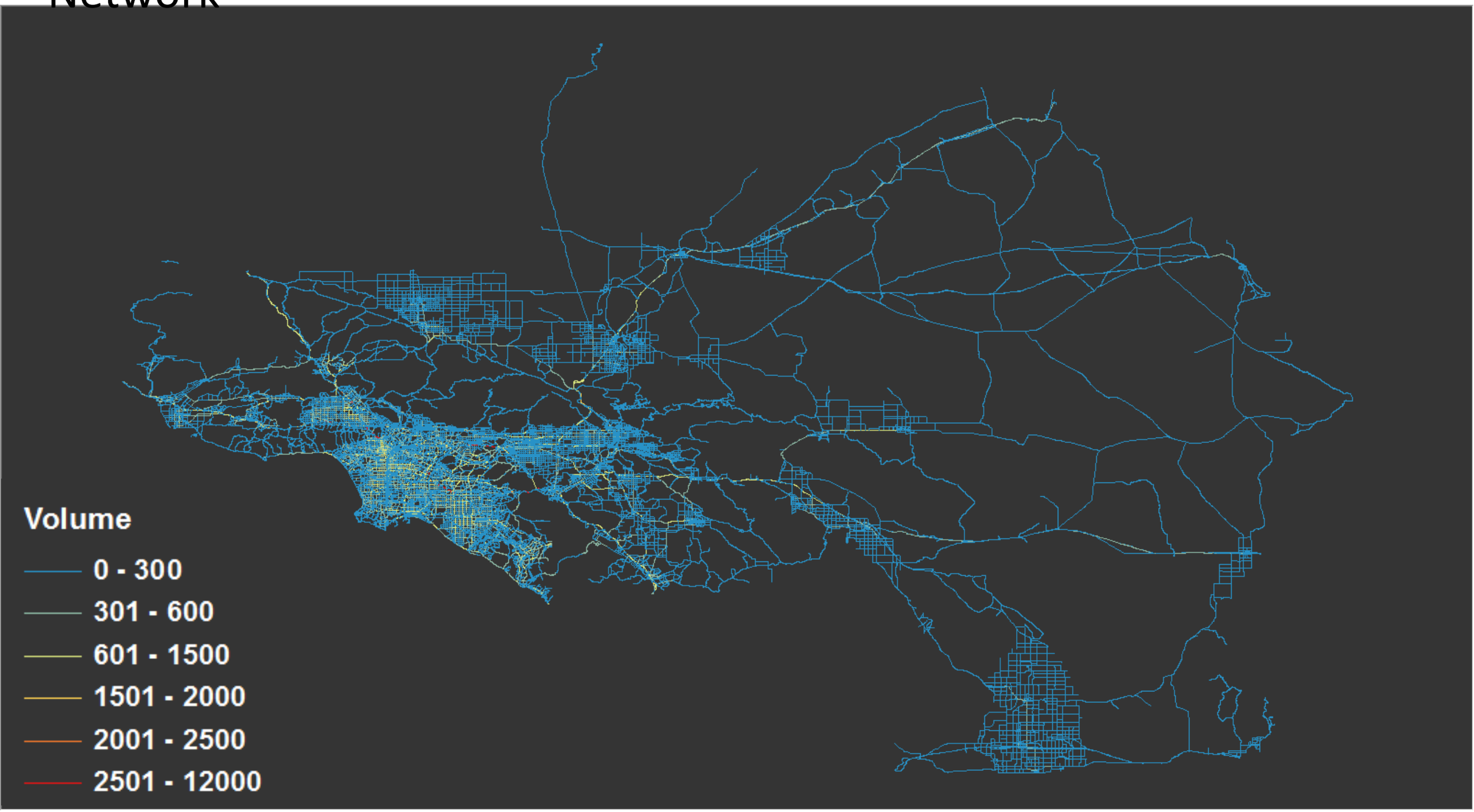
Volume on Network



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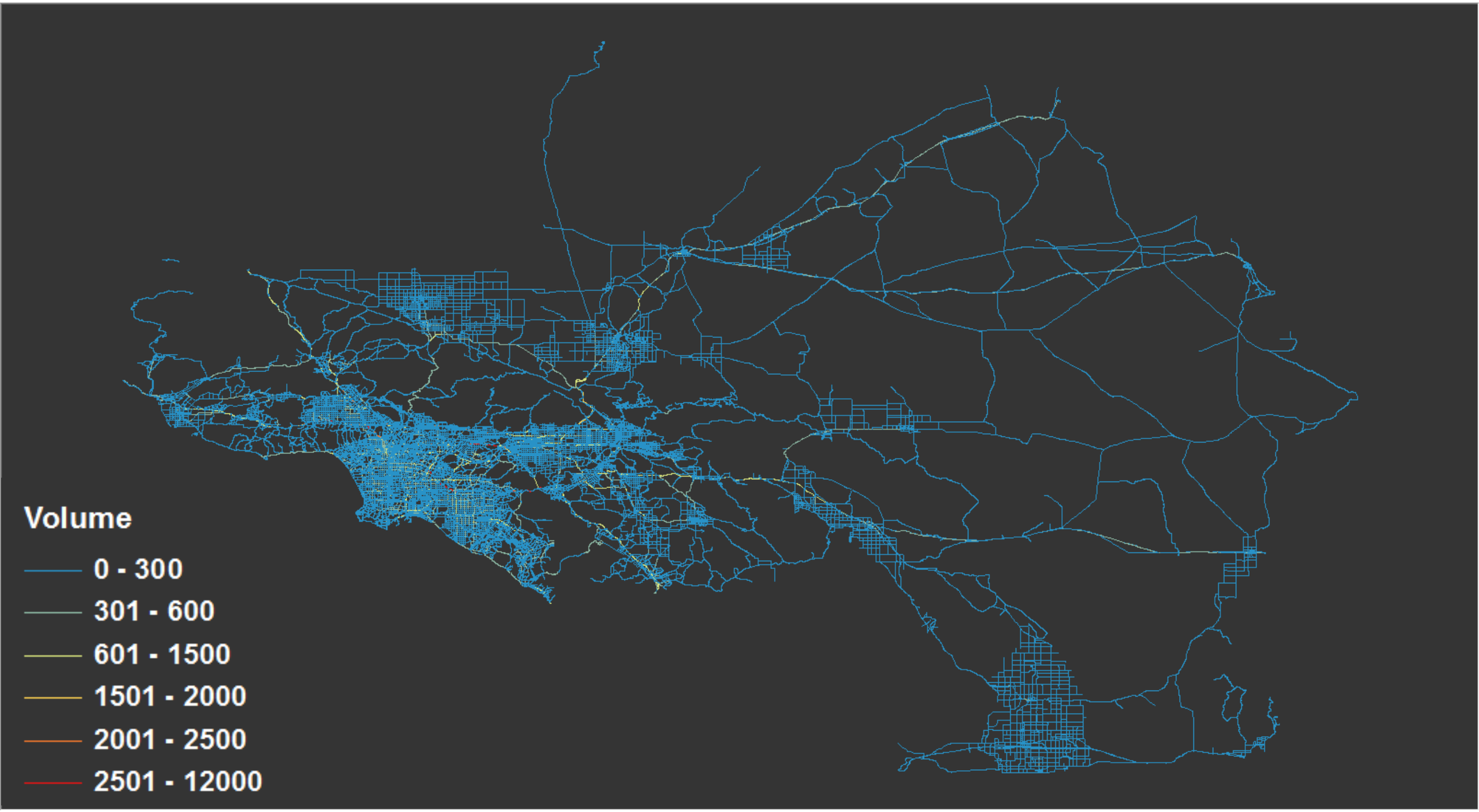

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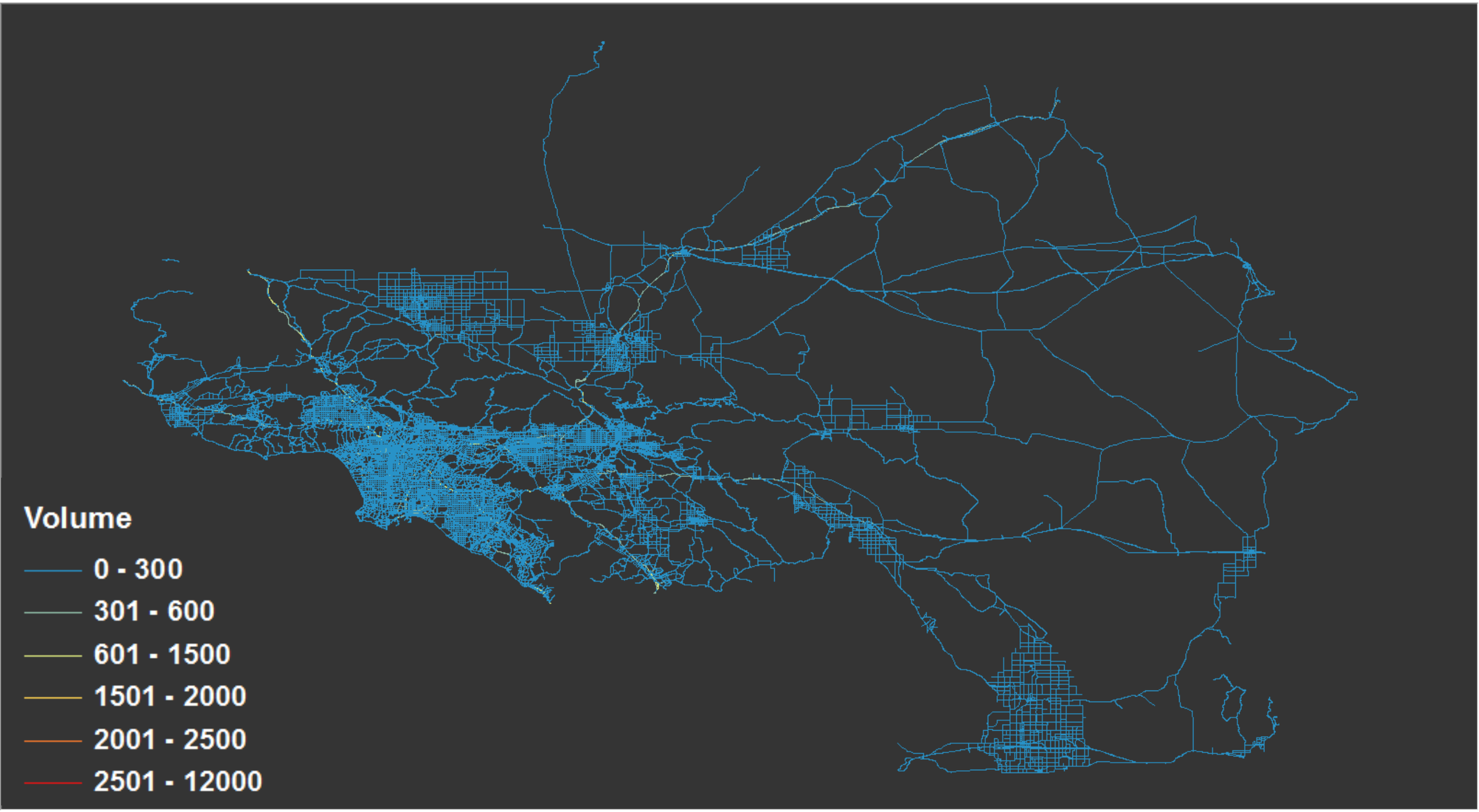

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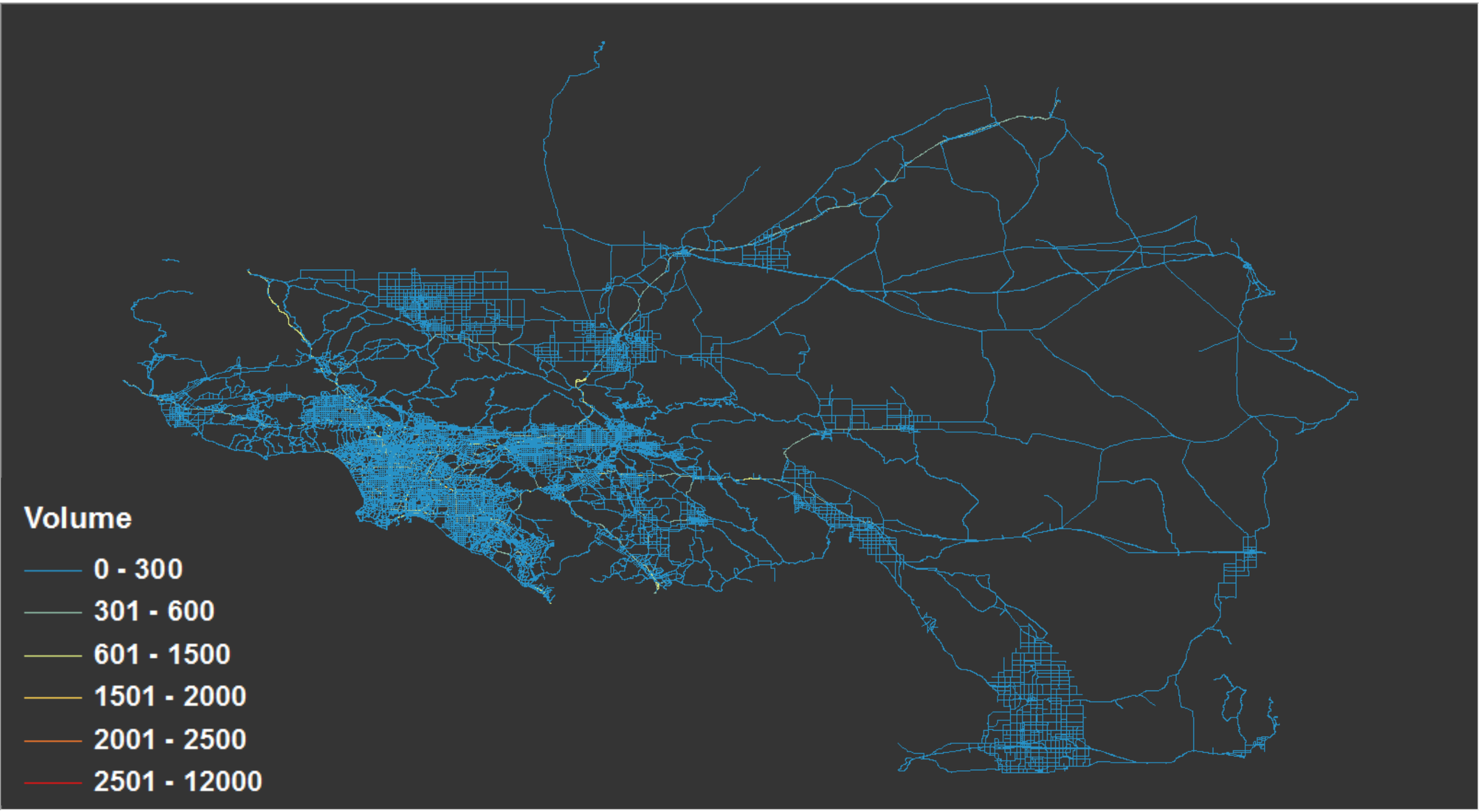

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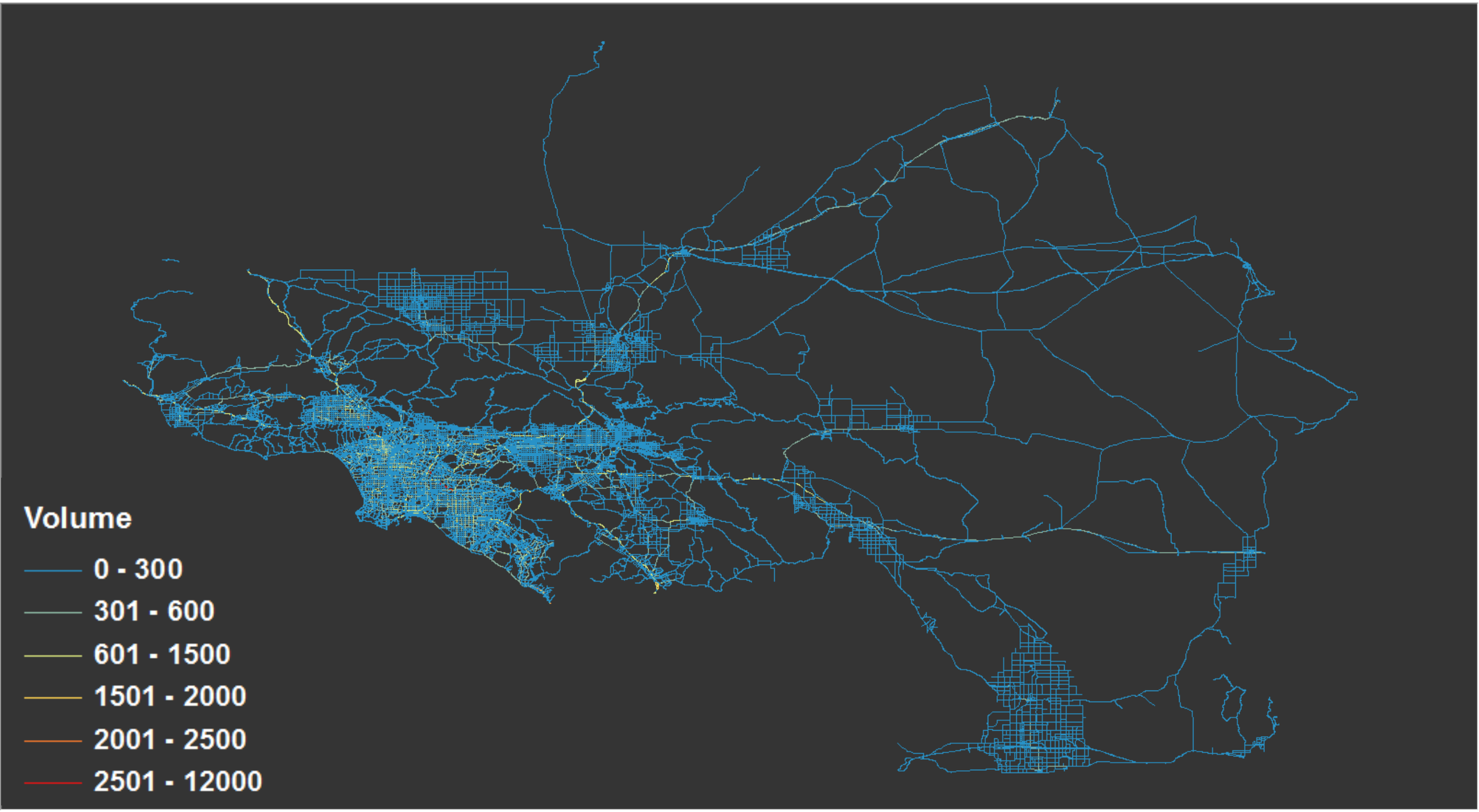

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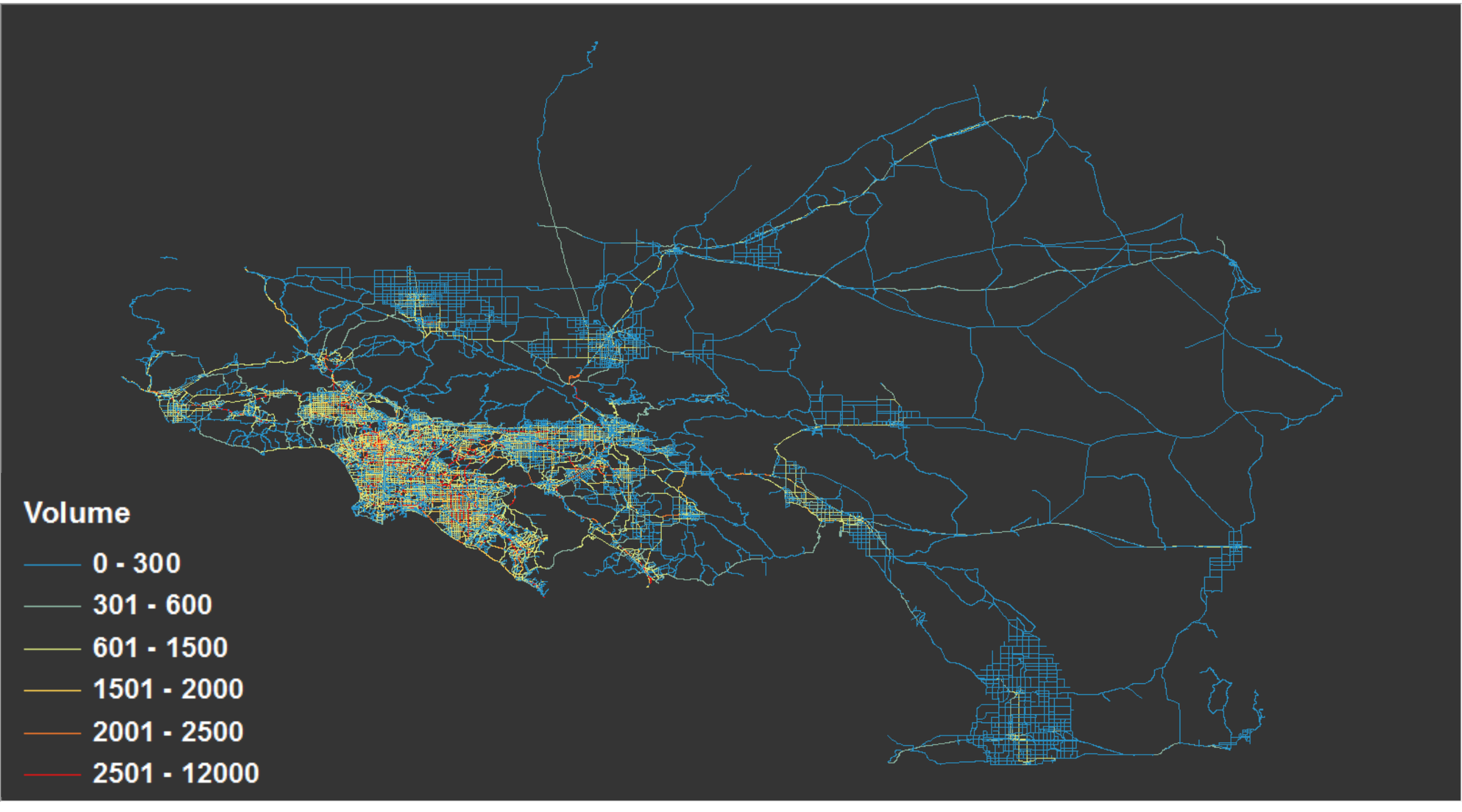

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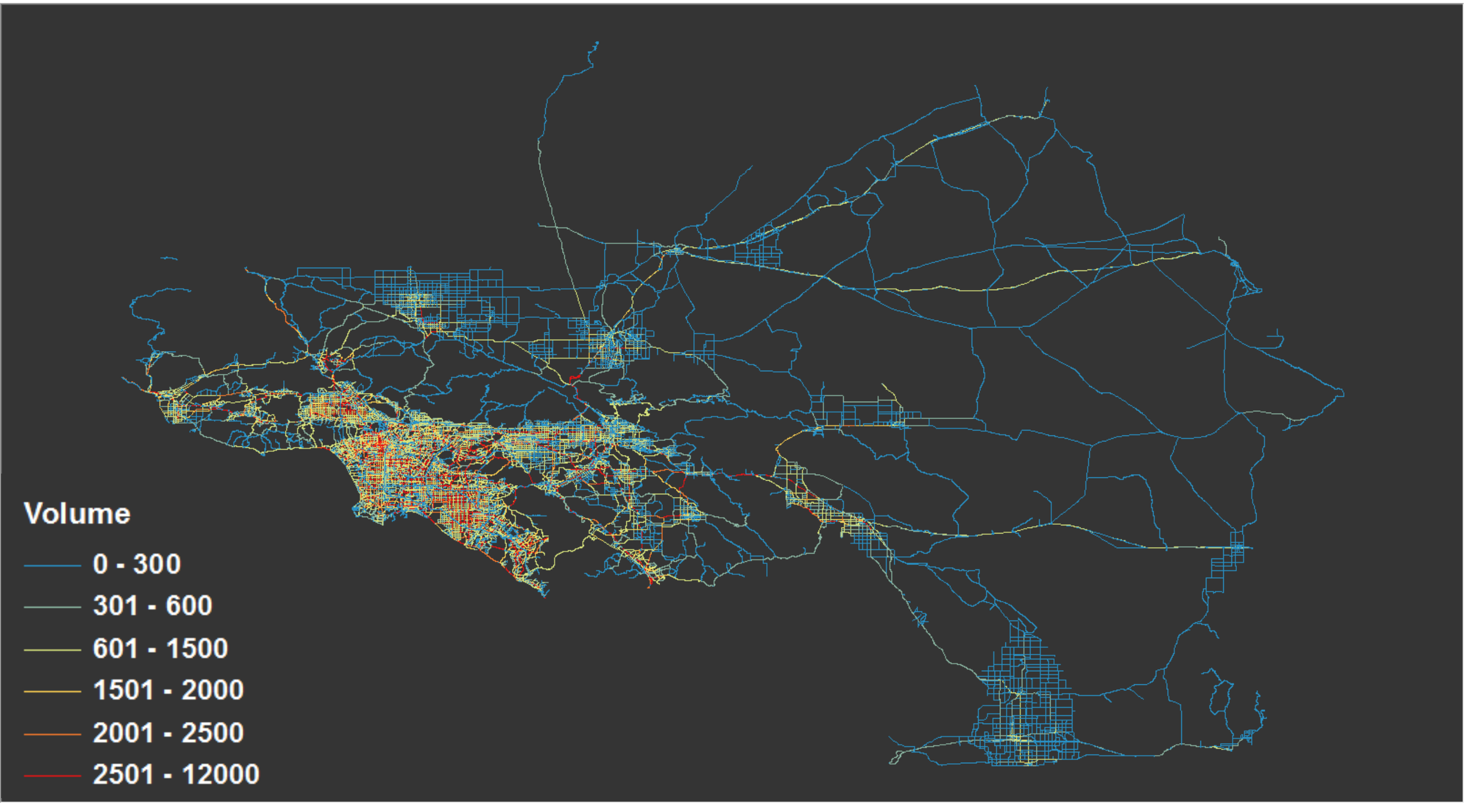

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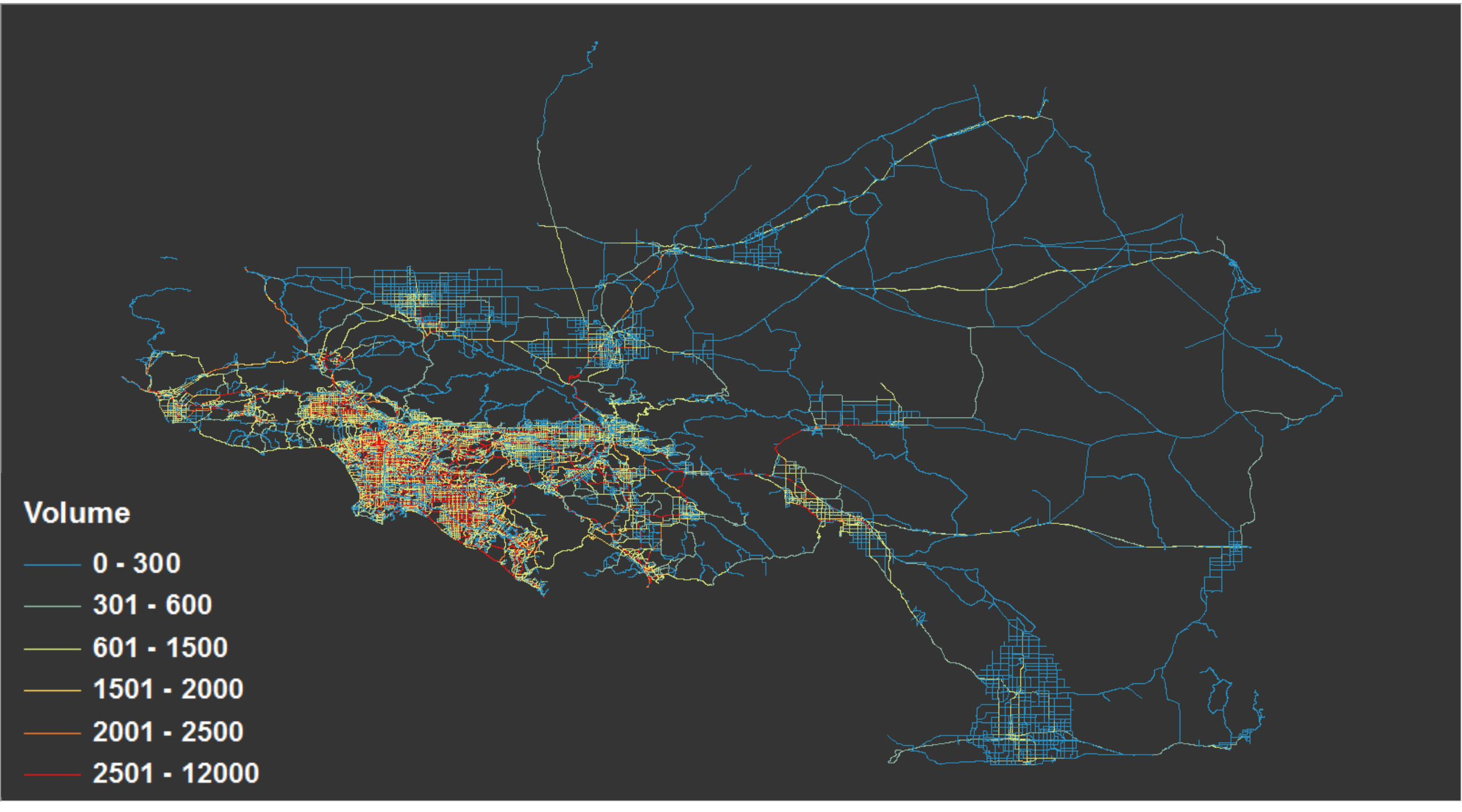

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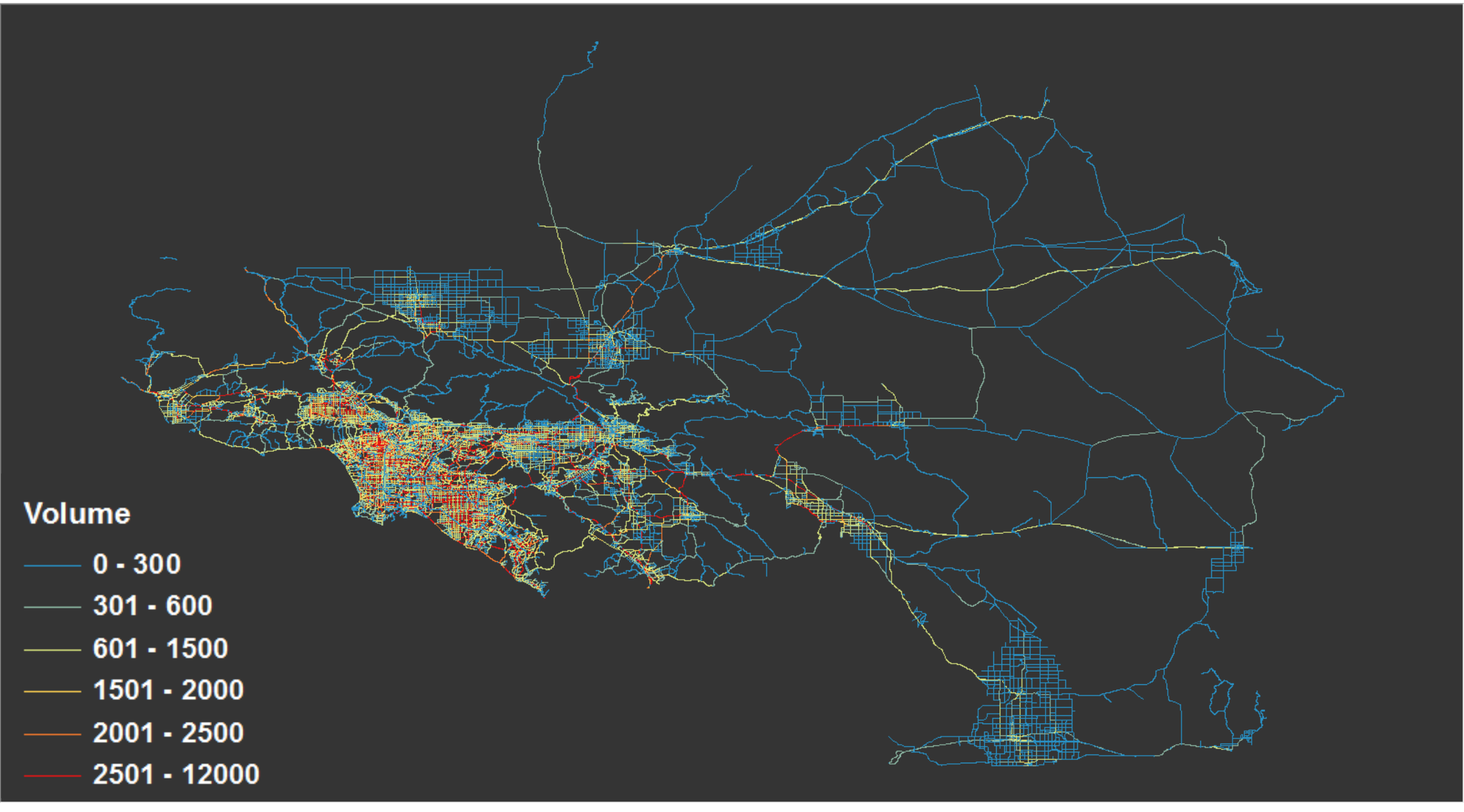

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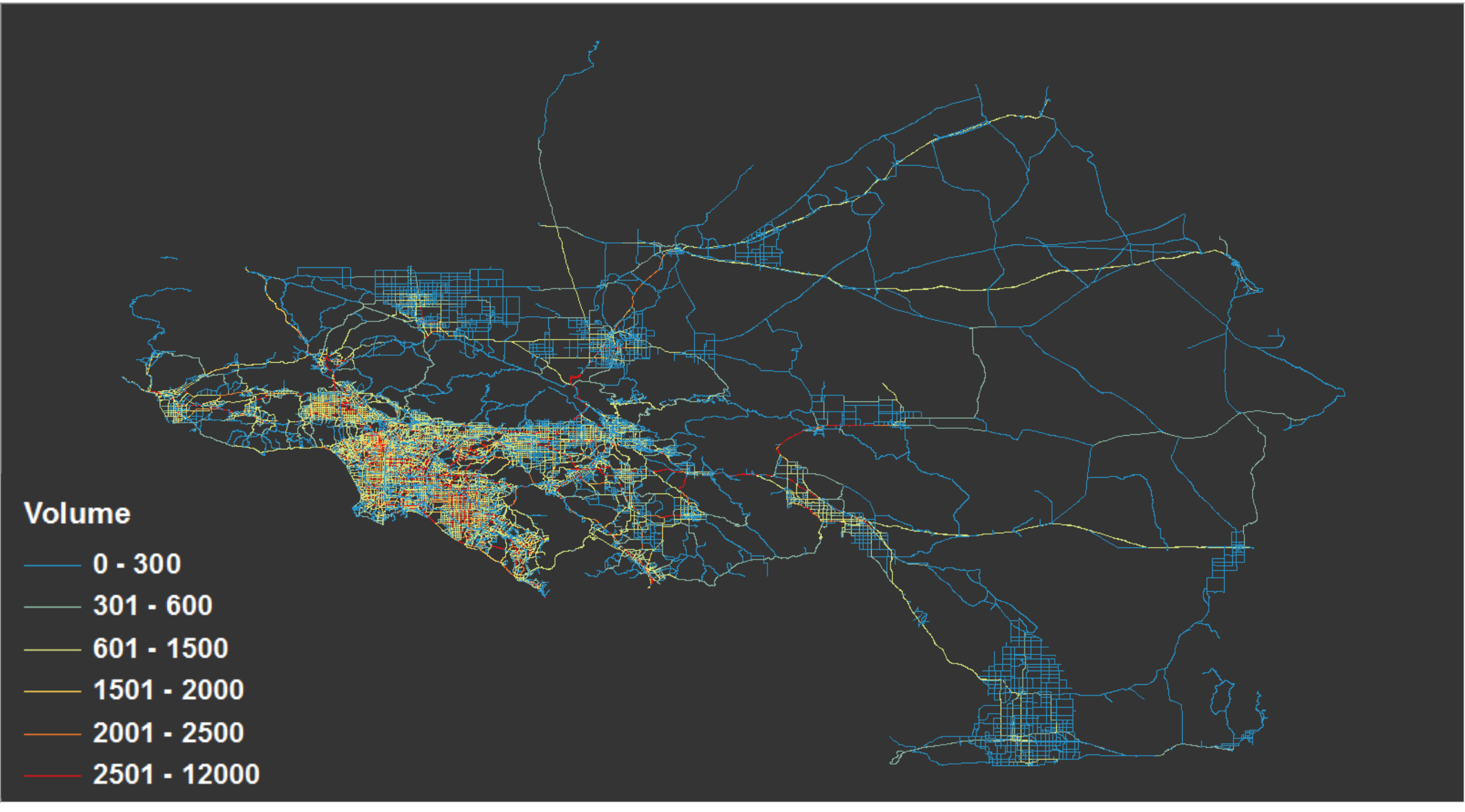

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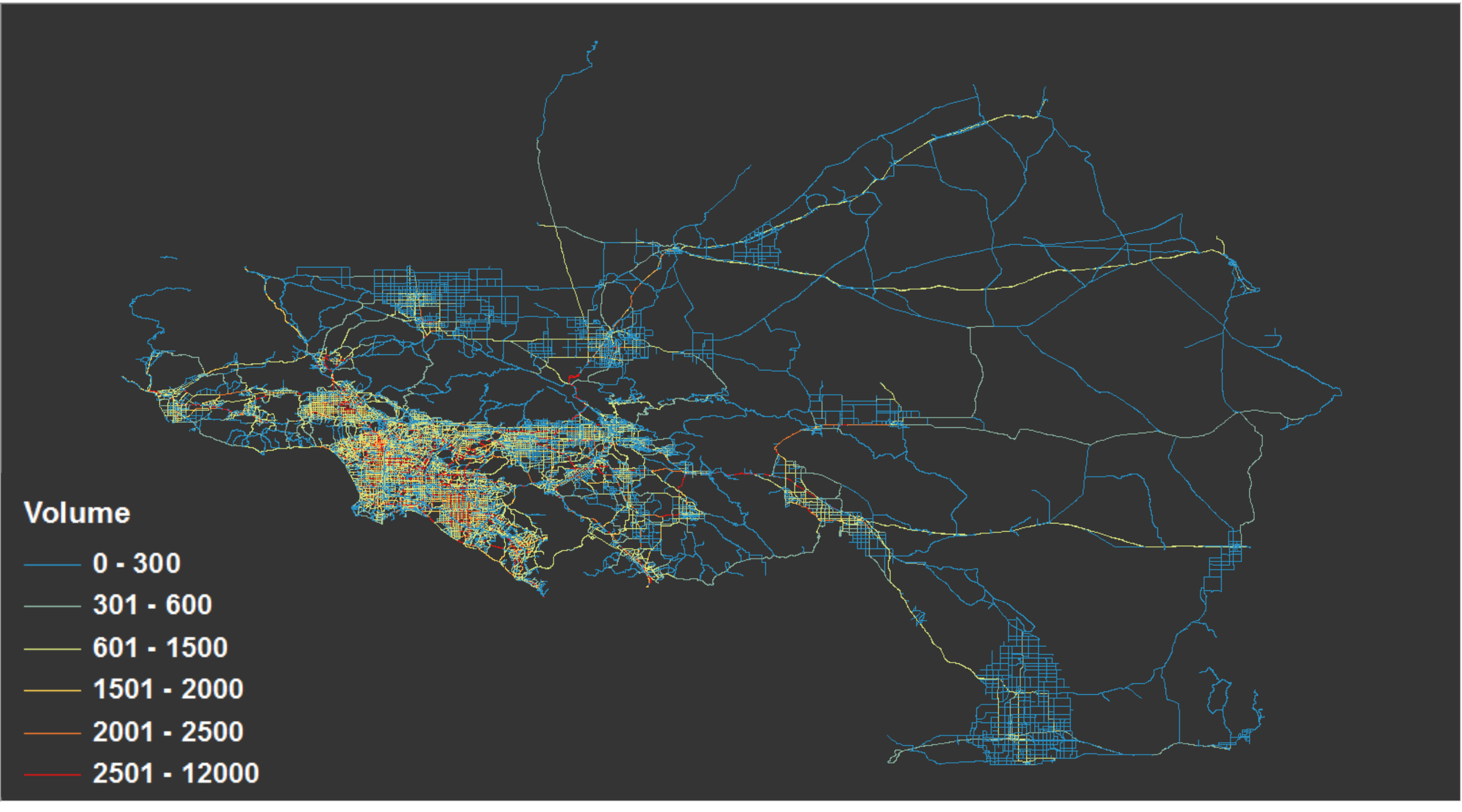

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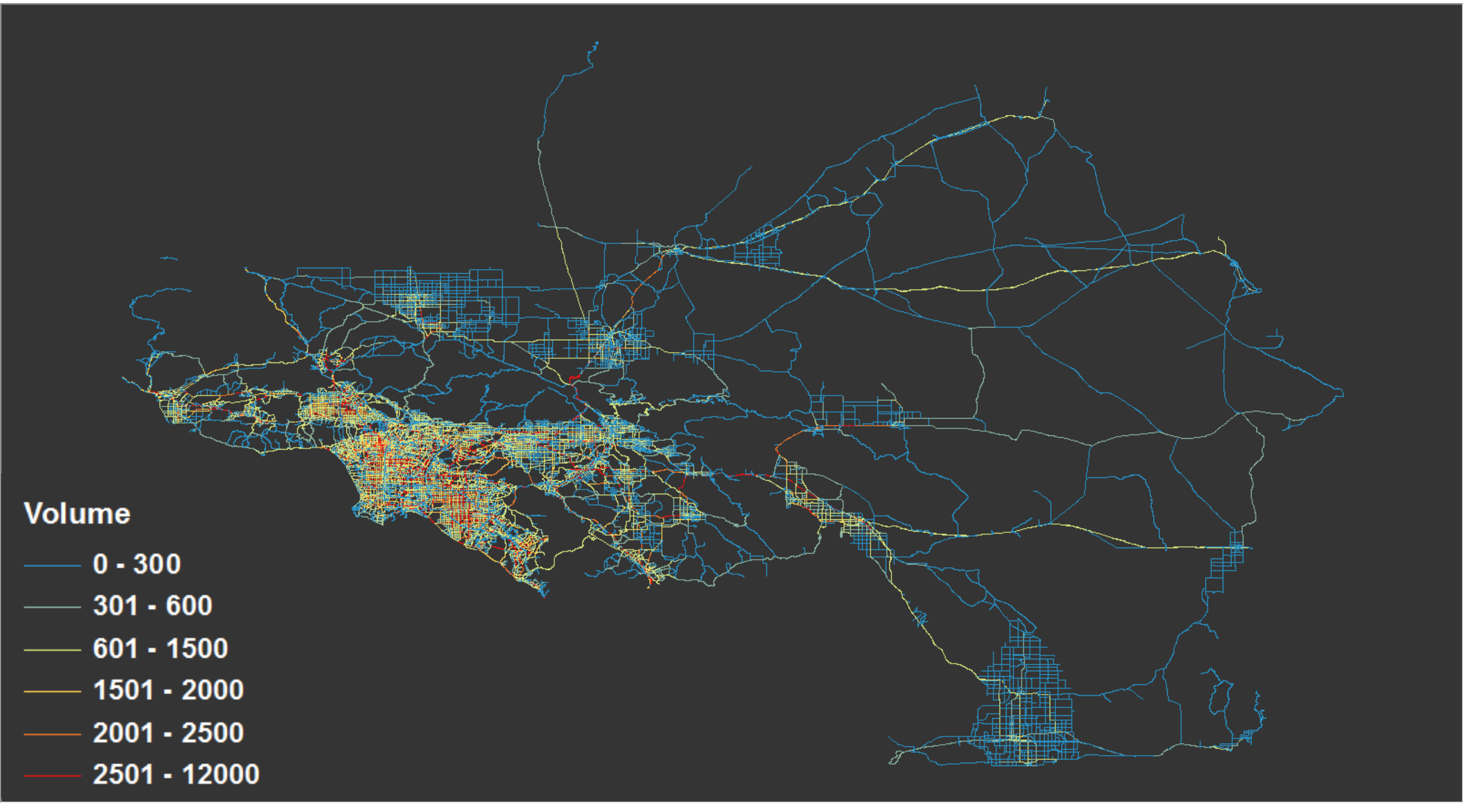

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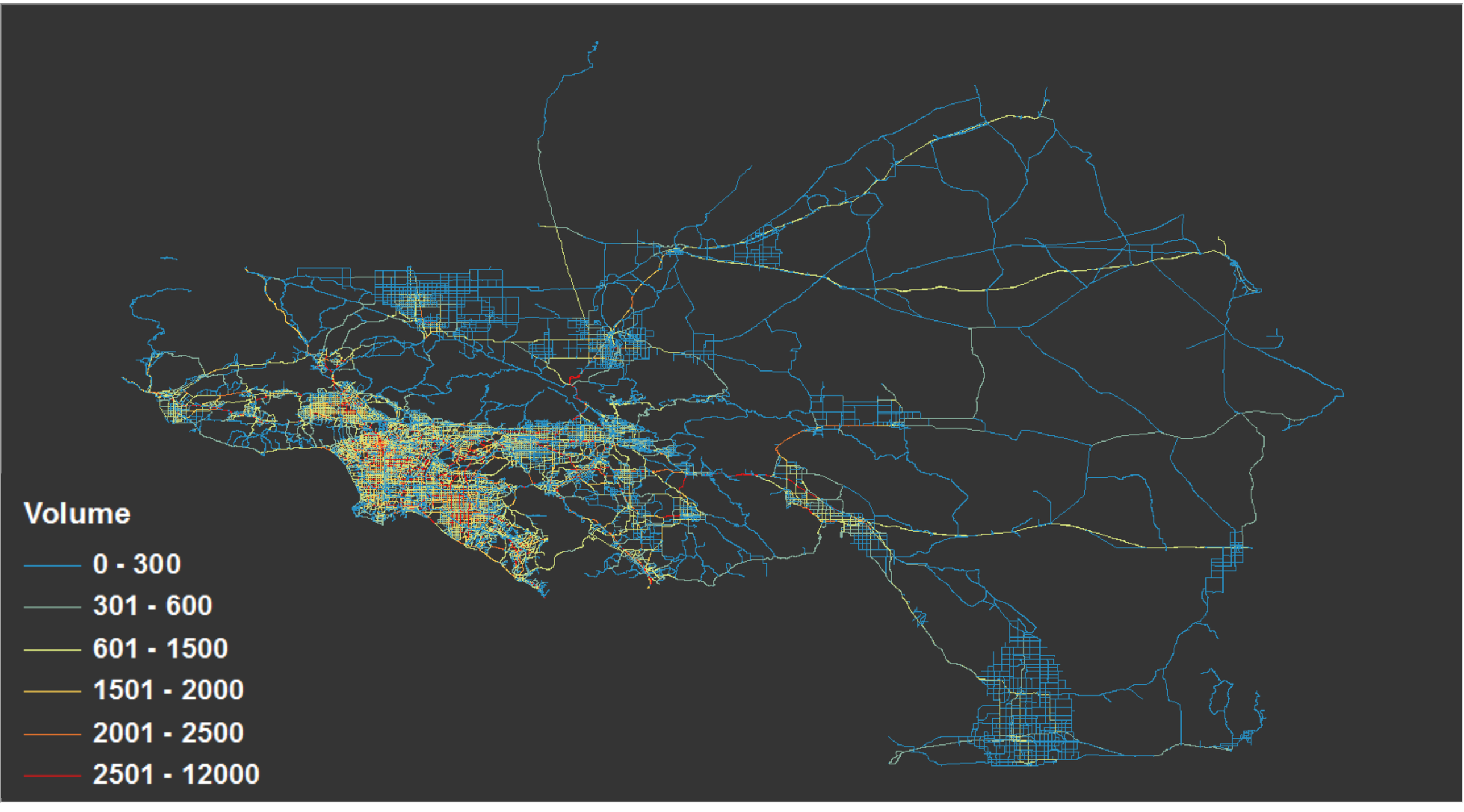

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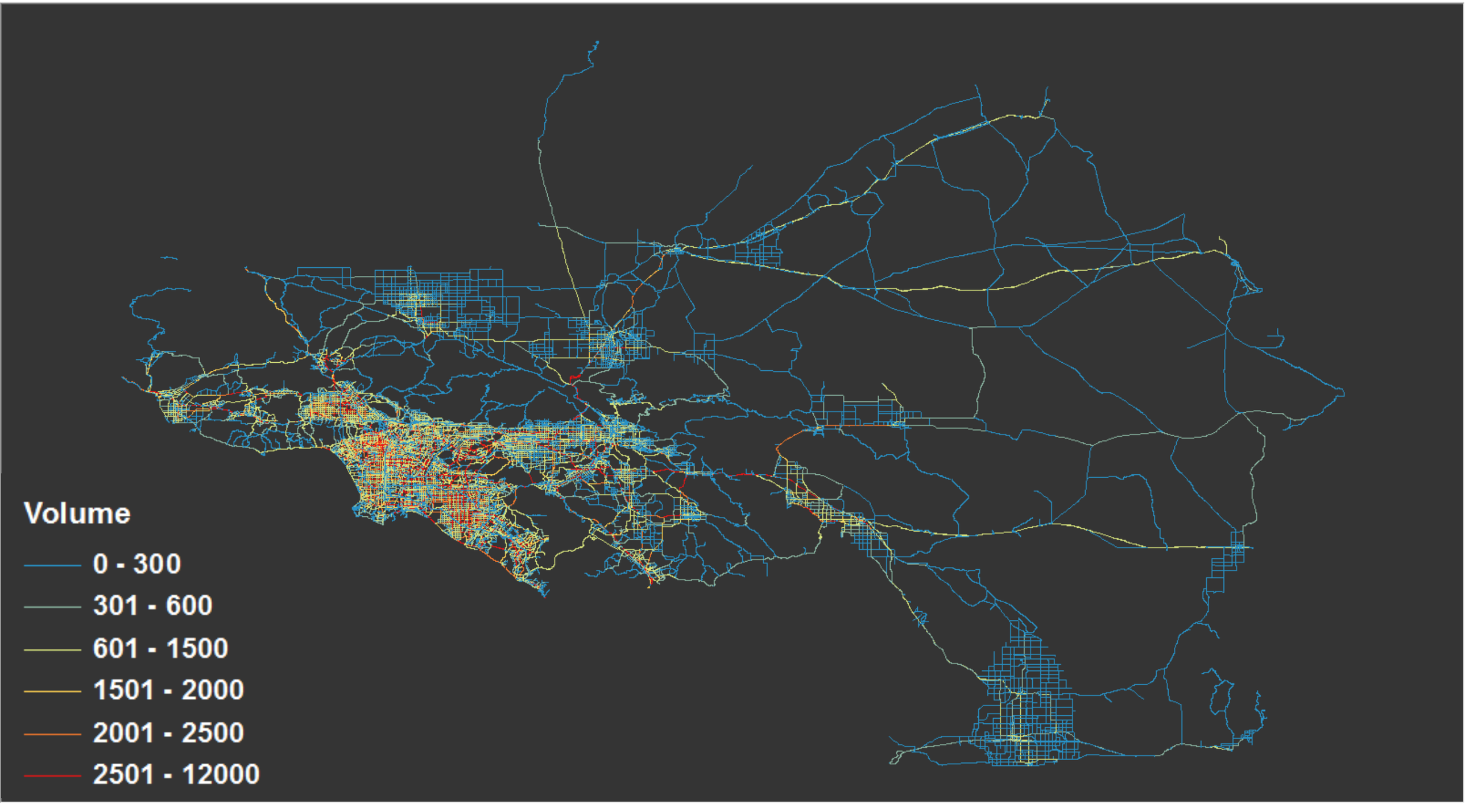

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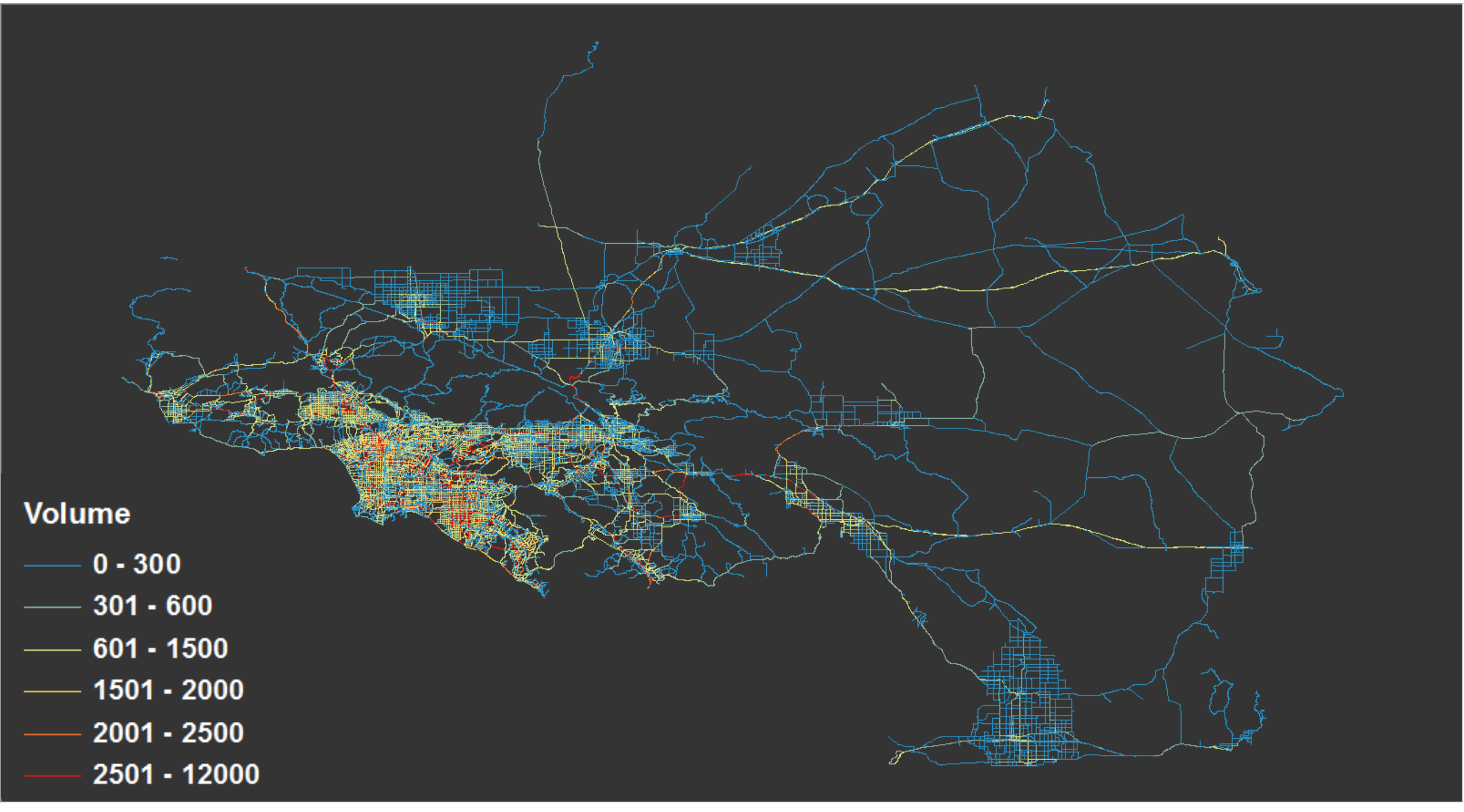

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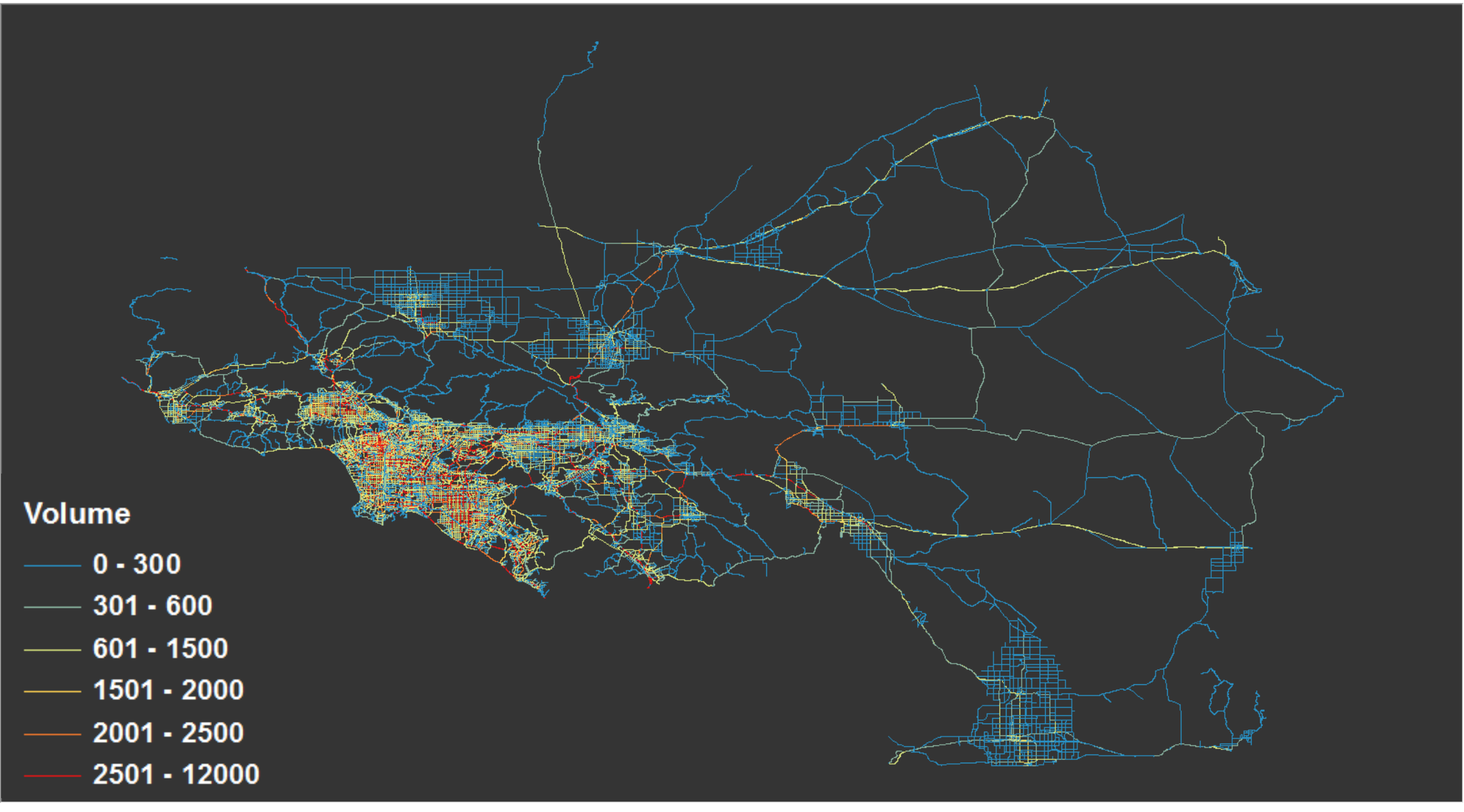

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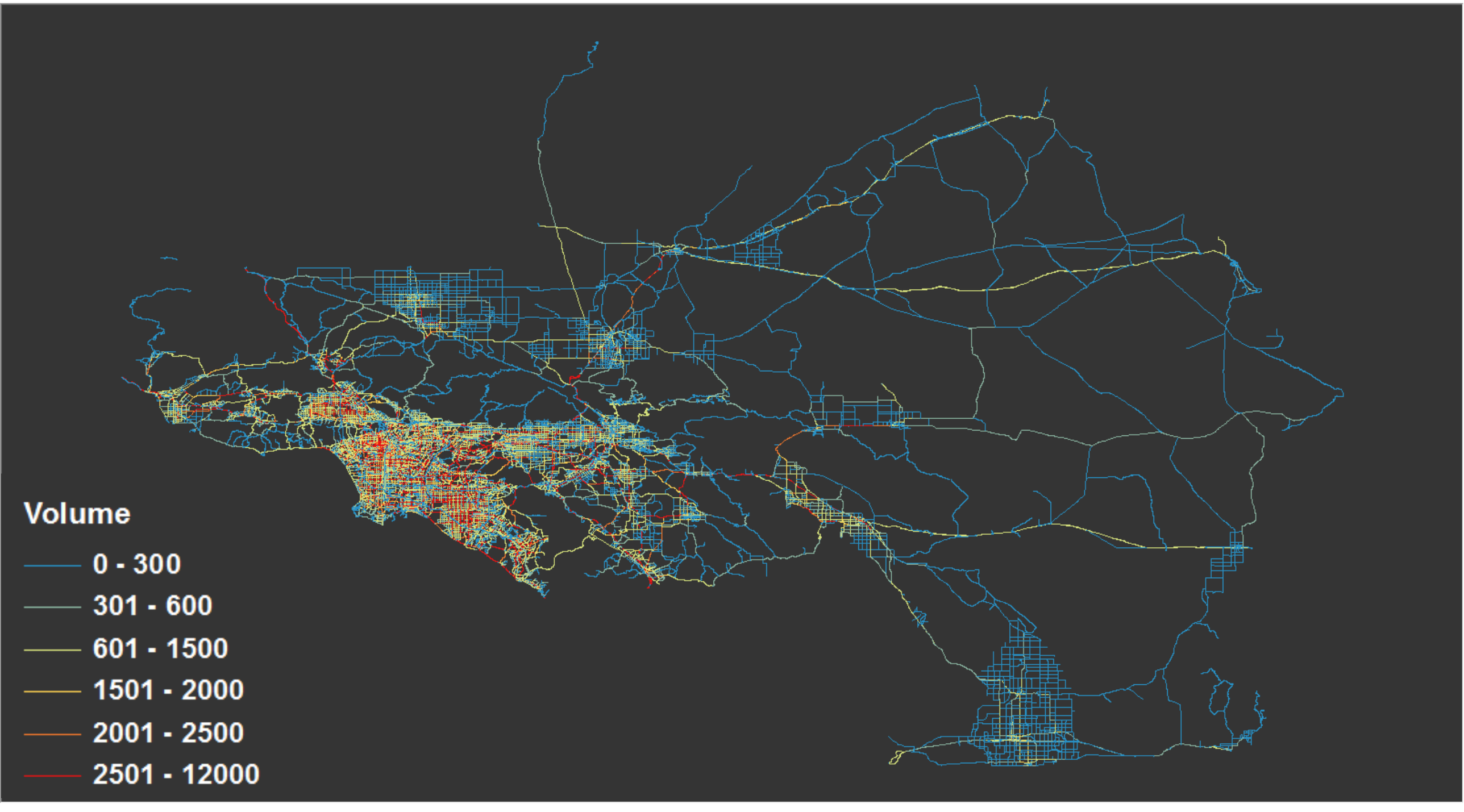

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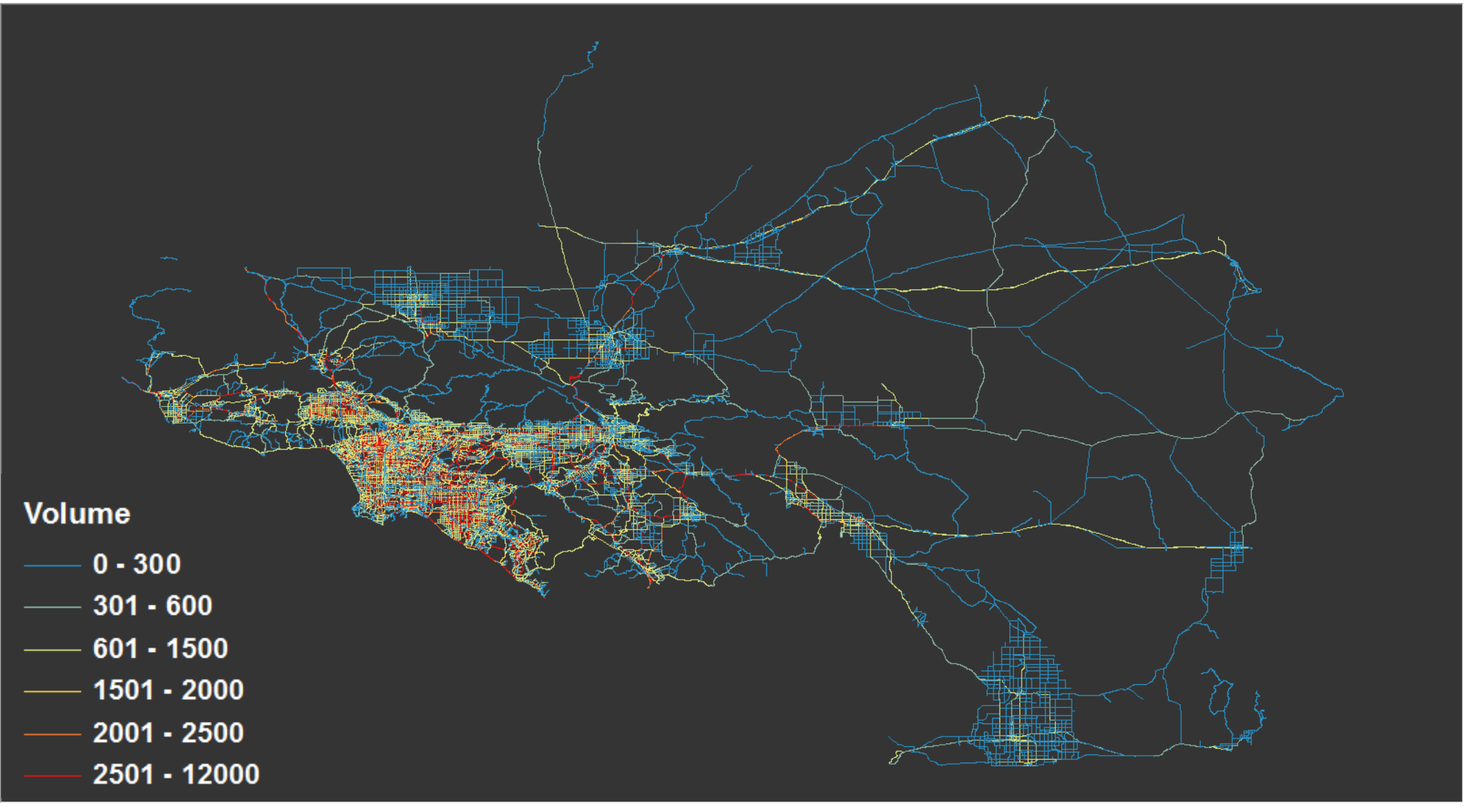

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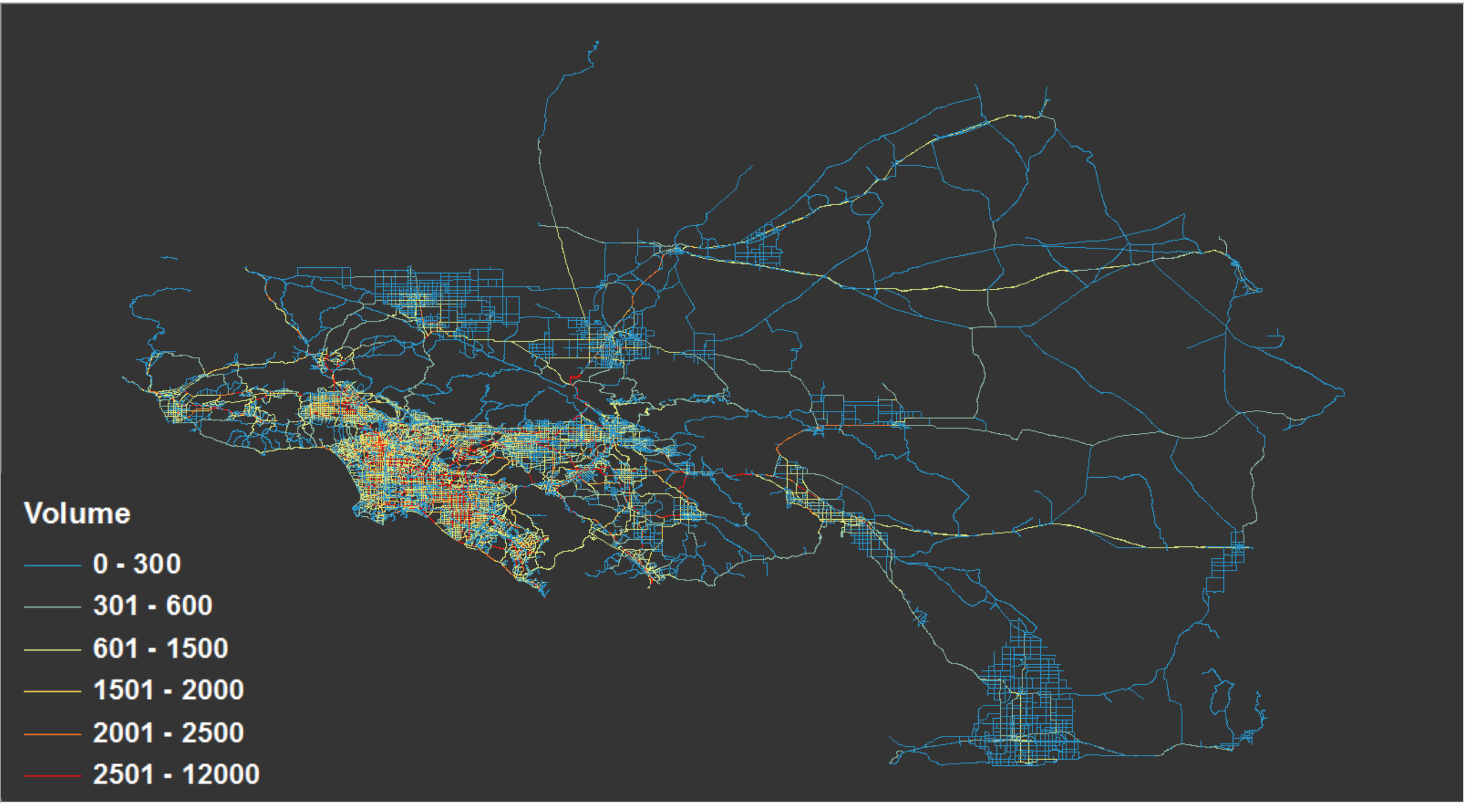

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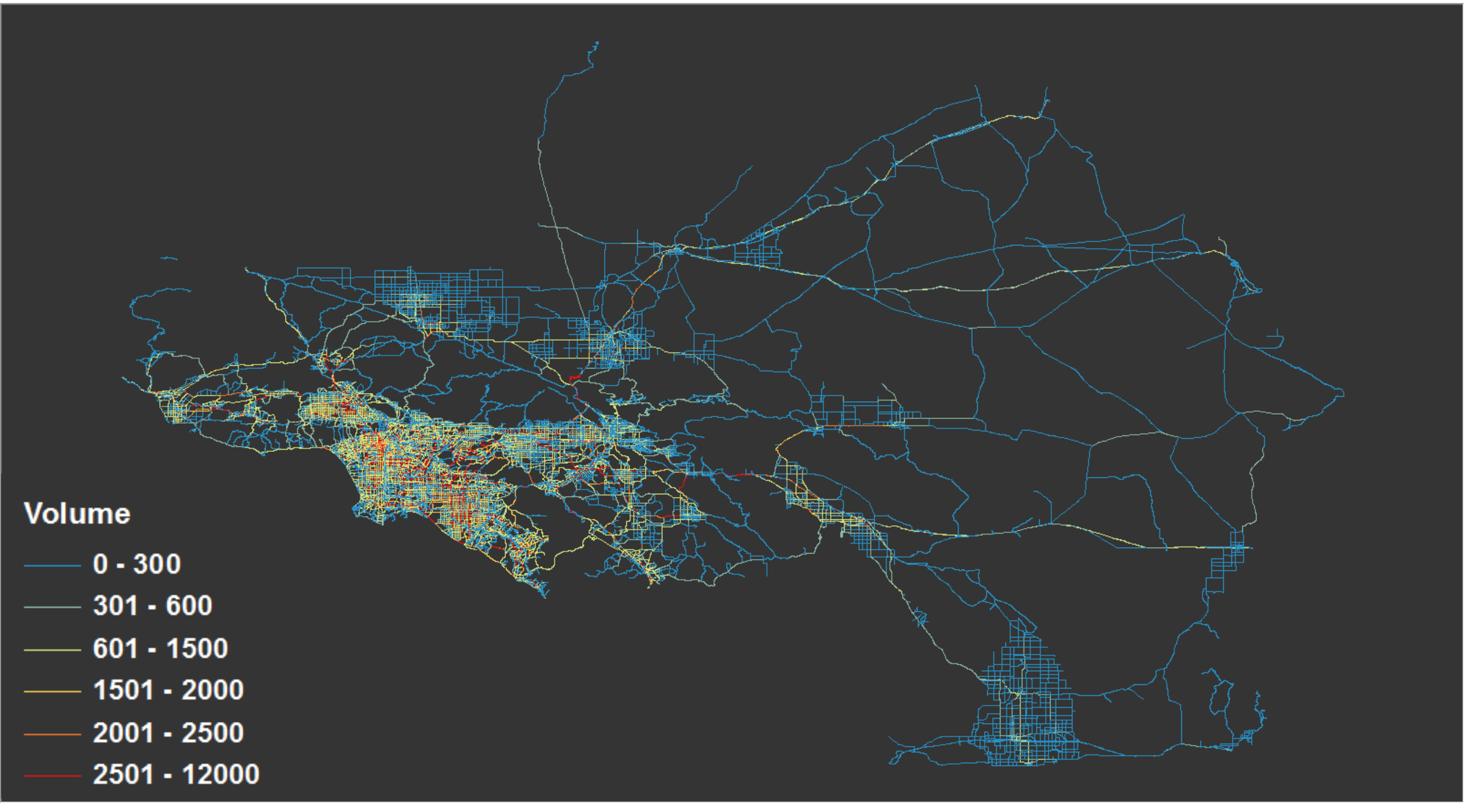

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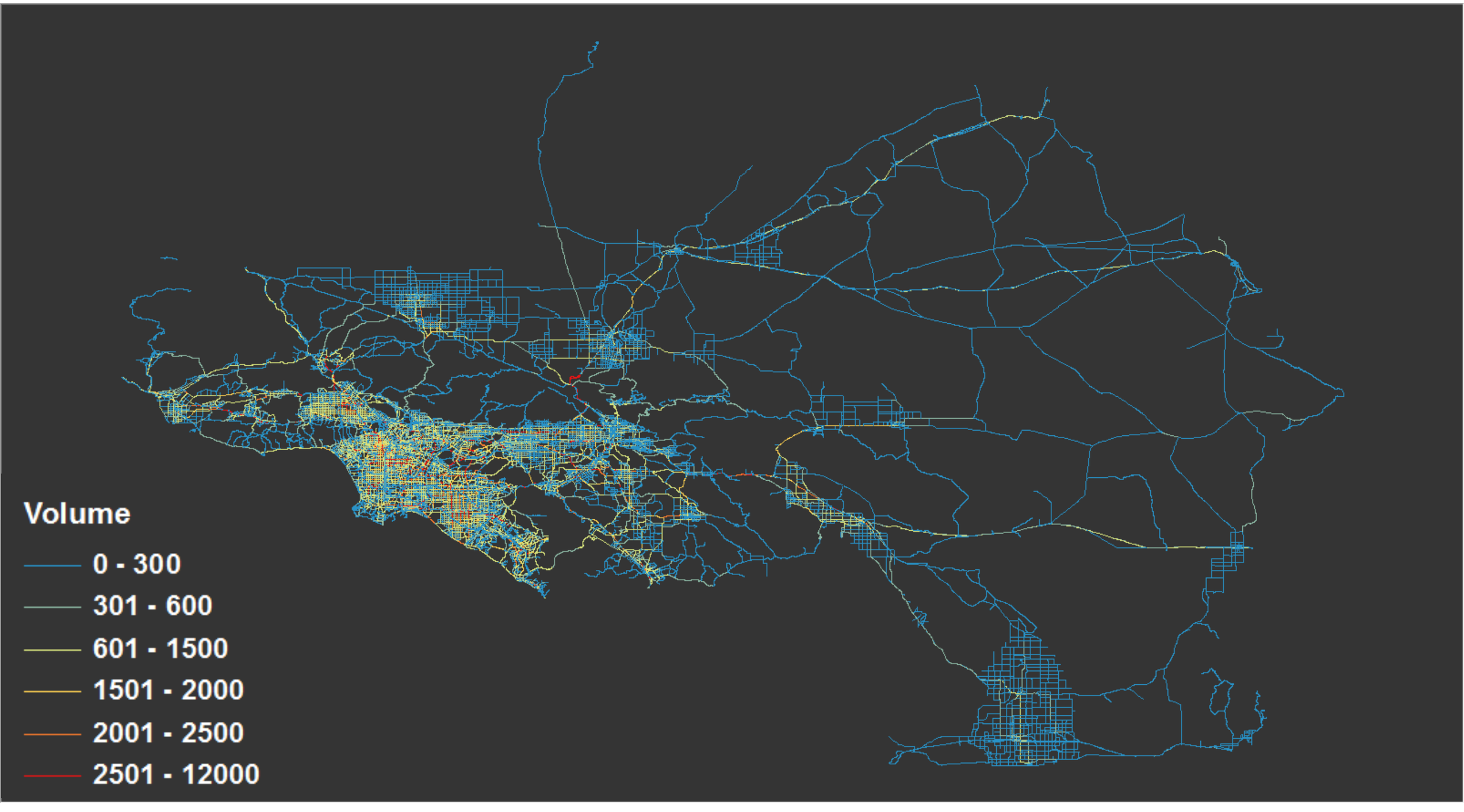

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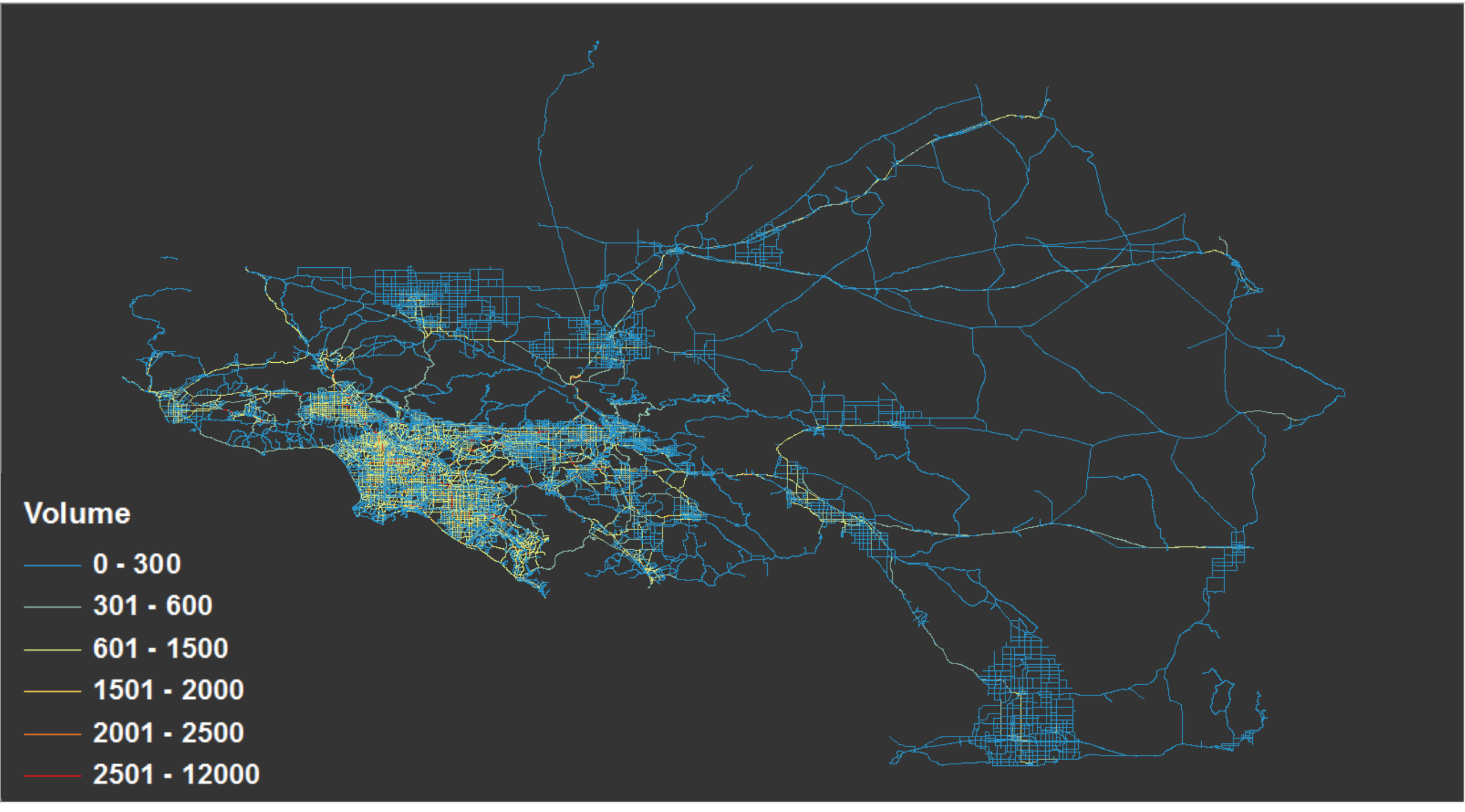

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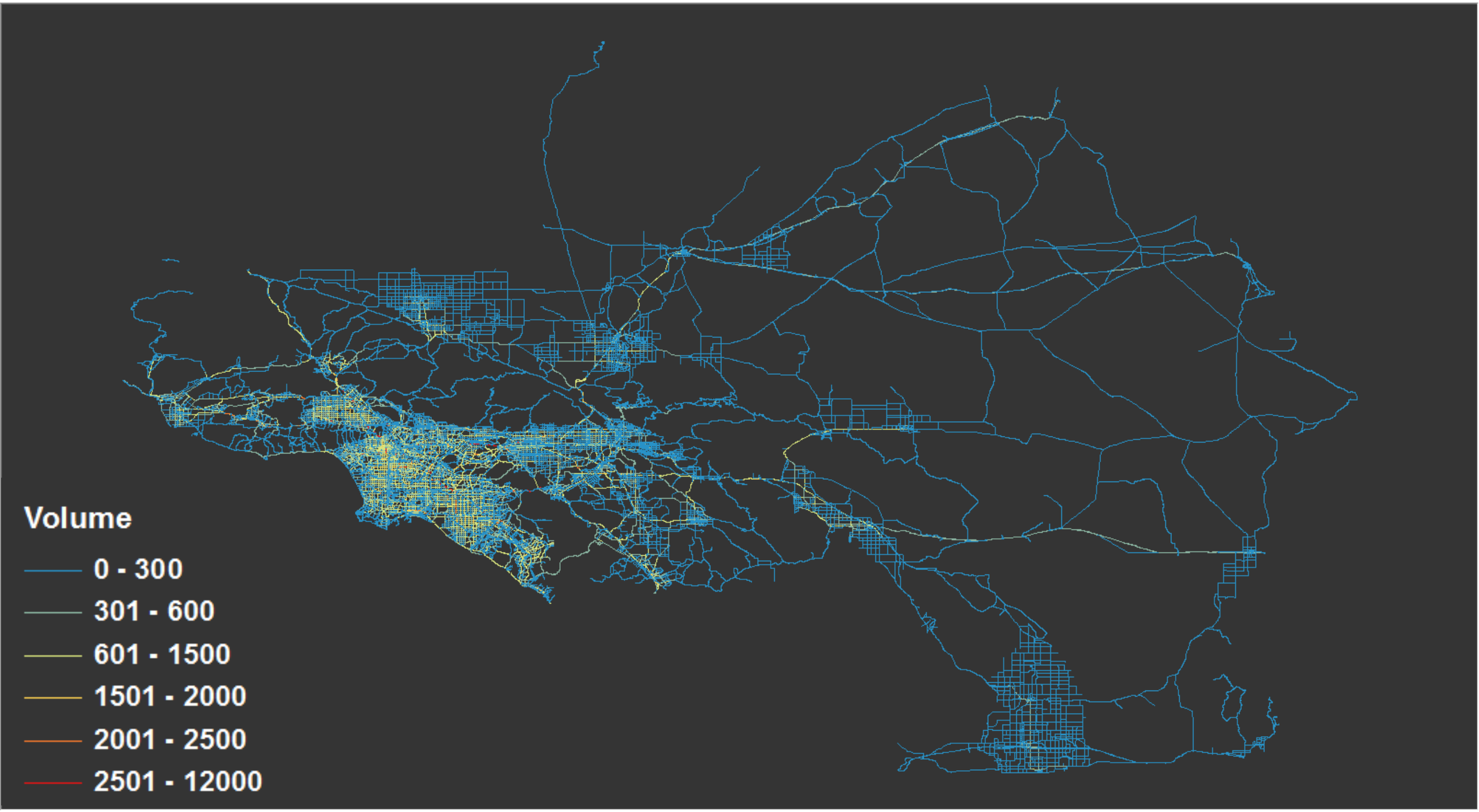

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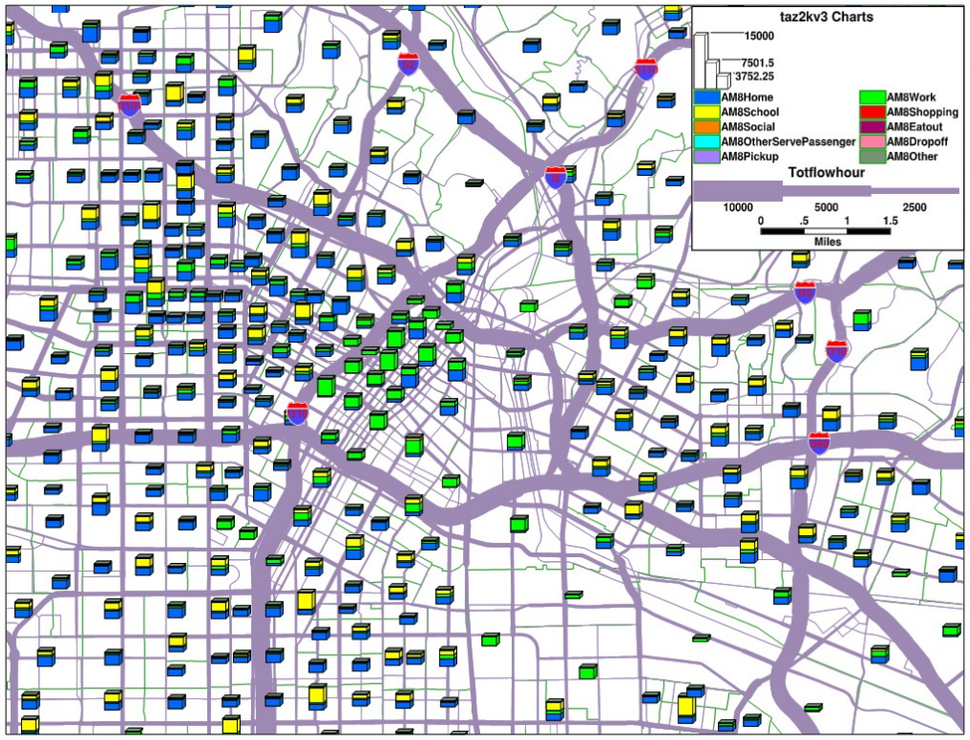
Output/Deliverables (typical travel model KPI summary)

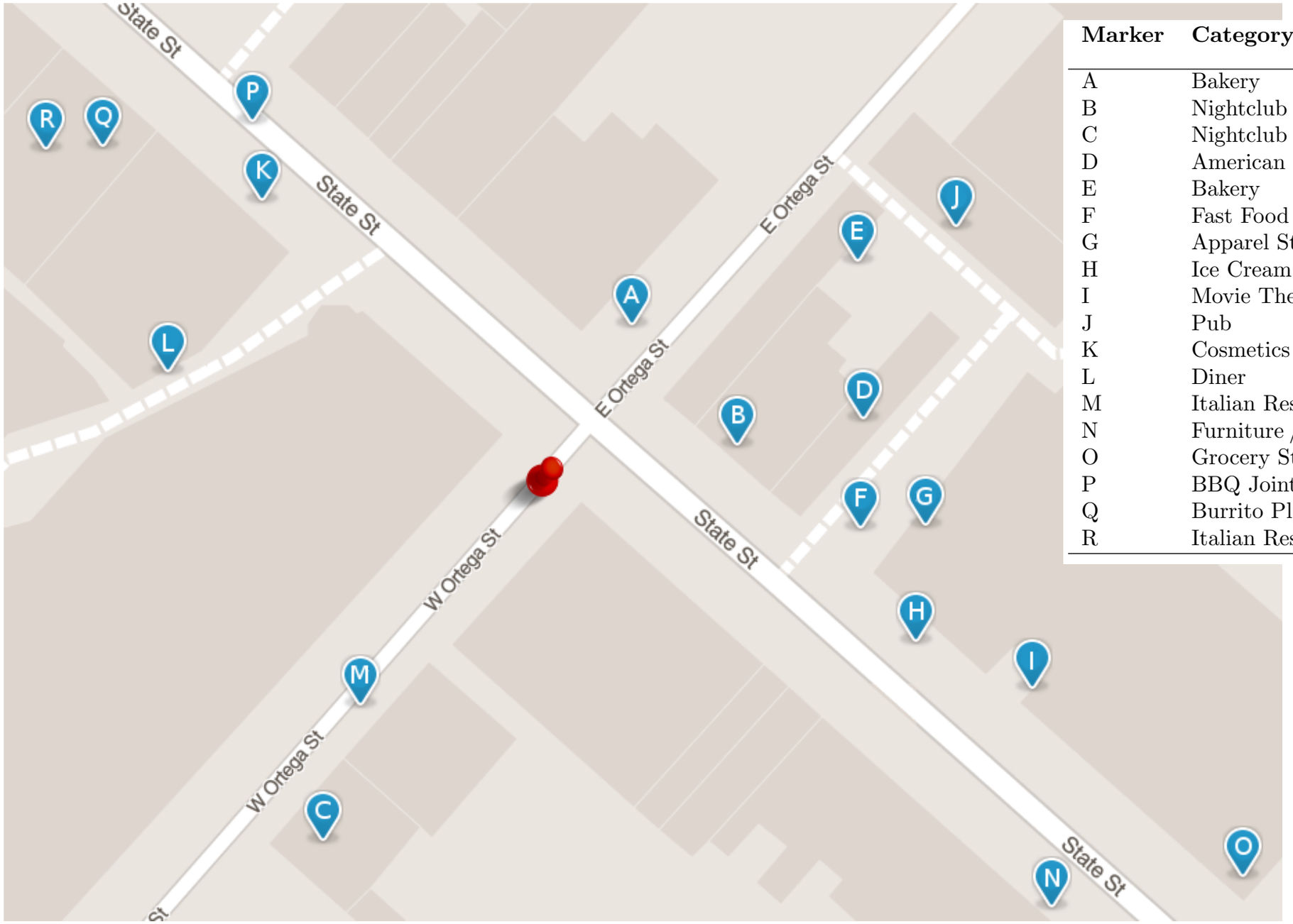
Emissions and Fuel Consumption	Model 1	Model 2
Organic Gases (g/mile)	0.943	0.926
CO (g/mile)	9.498	9.348
NOx (g/mile)	1.929	1.955
CO2 (g/mile)	561.340	543.545
Gasoline (gallons/mile)	0.051	0.050
Gasoline (mile/ gallons)	19.377	20.203
Diesel (gallons/mile)	0.102	0.101
Diesel (mile /gallons)	9.833	9.893
Organic Gases (g/person-day)	22.291	21.333
CO (g/person-day)	224.553	215.388
NOx (g/person-day)	45.606	45.050
CO2 (g/person-day)	13271.790	12524.452
Vehicle Km Travel/person-day	23.643	23.042

Output

- For each person daily schedule of activities and trips in tours
- For each household joint and joint activities with other members
- For each car a report on how it was used
- Sensitivity to policies at all levels (car ownership, daily pattern of activity and travel, tour level, duration of activities, destinations, mode to each destination)

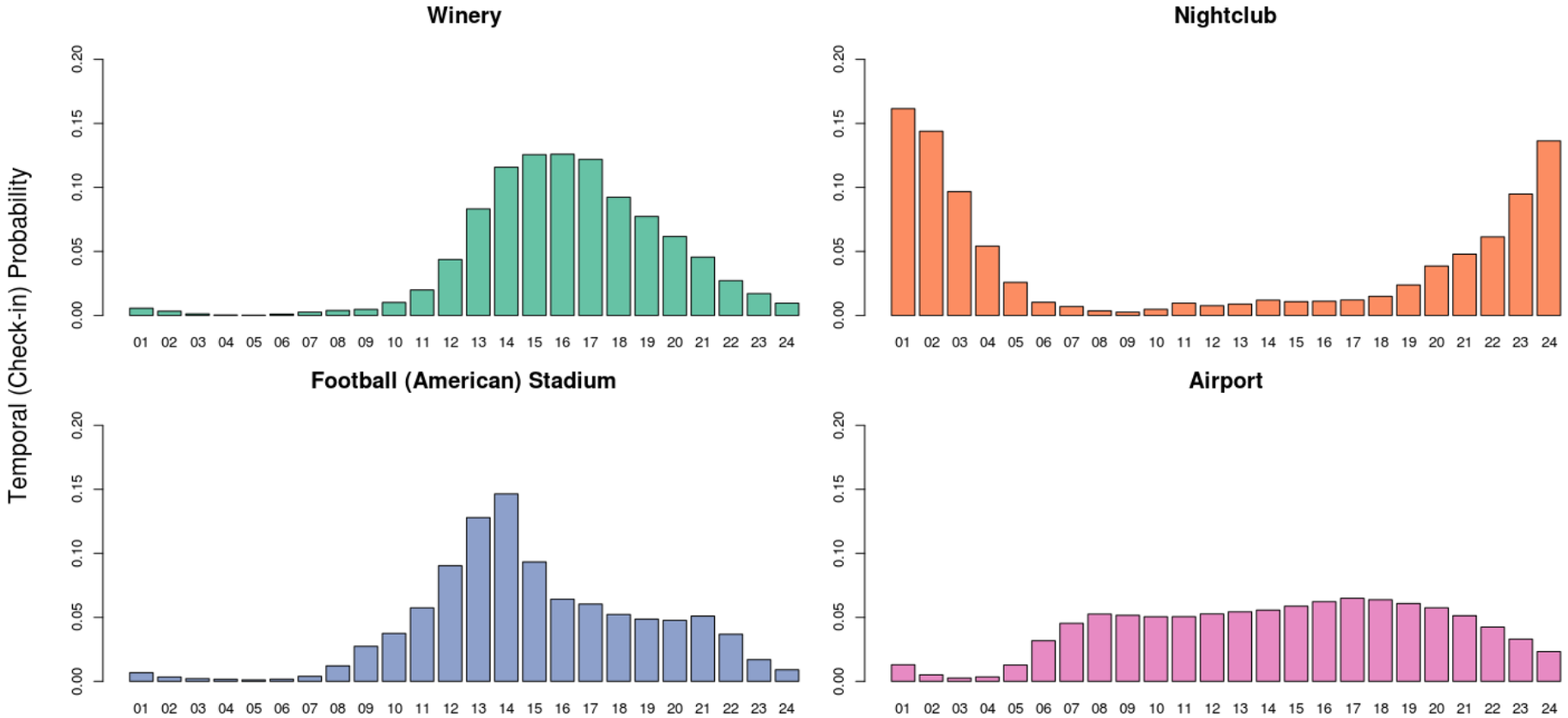


We want exact location from the destination choice(McKenzie's Dissertation)

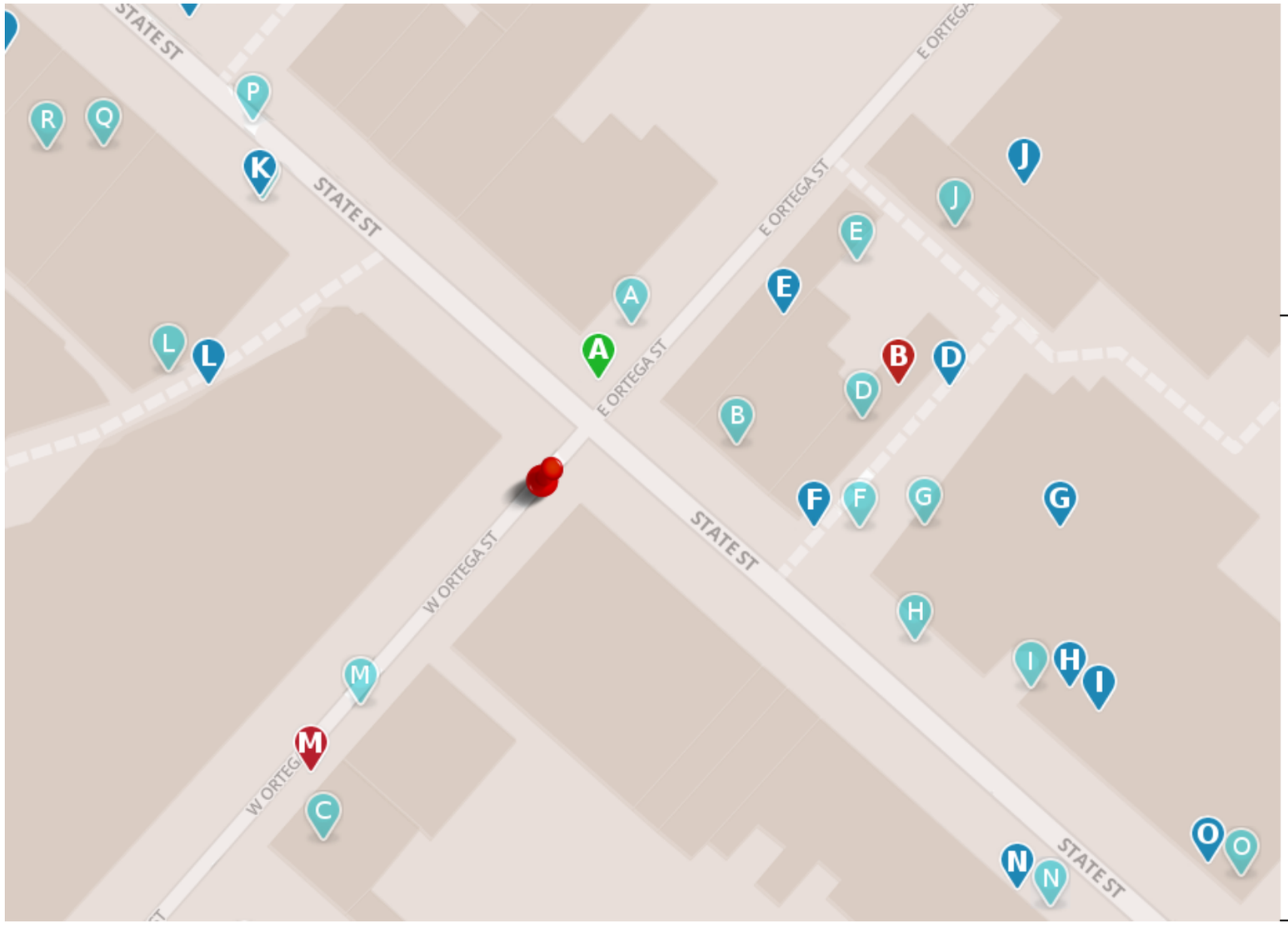


Marker	Category	Distance (m)
A	Bakery	39.2
B	Nightclub	41.4
C	Nightclub	69.9
D	American Restaurant	62.7
E	Bakery	73.7
F	Fast Food	65.0
G	Apparel Store	85.8
H	Ice Cream Shop	82.6
I	Movie Theater	94.2
J	Pub	88.9
K	Cosmetics Shop	60.9
L	Diner	70.0
M	Italian Restaurant	45.7
N	Furniture / Home Store	114.9
O	Grocery Store	147.8
P	BBQ Joint	82.3
Q	Burrito Place	88.1
R	Italian Restaurant	93.6

If we have temporal signatures for each place



We can “distort” space by the probability of most likely activity location

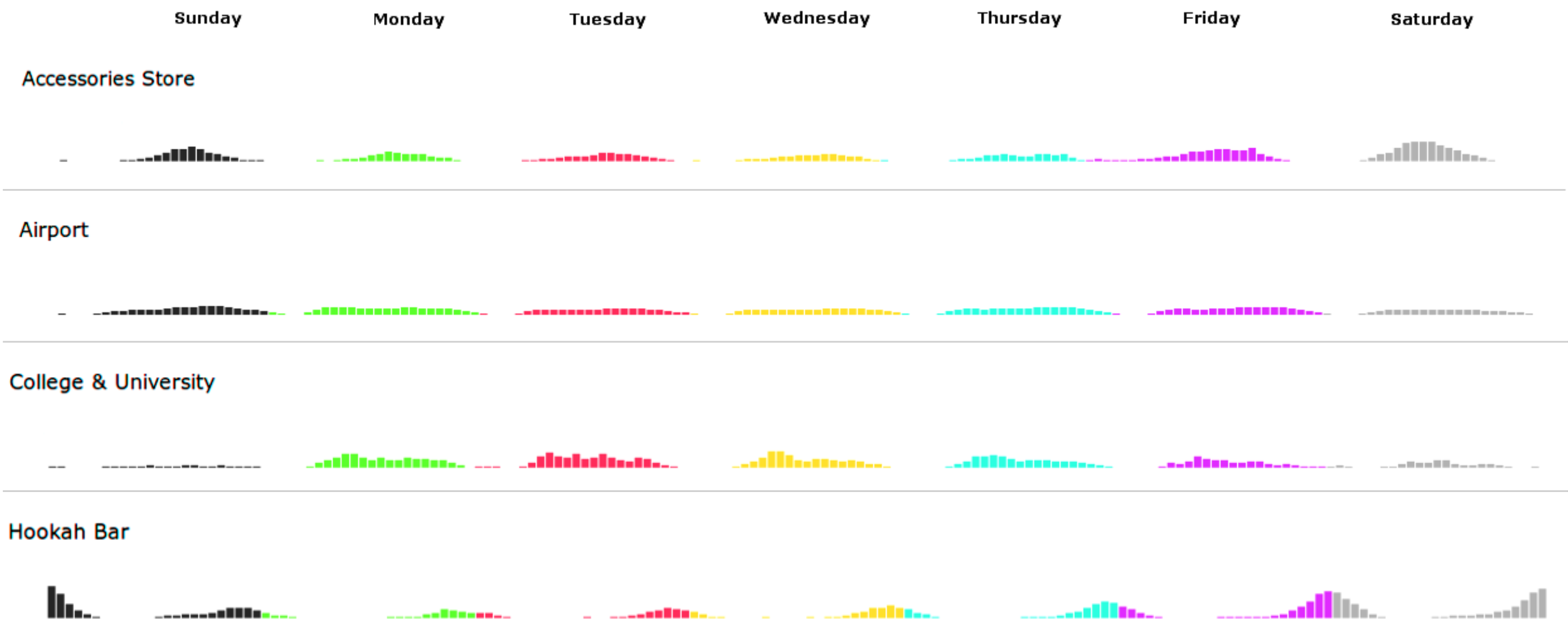


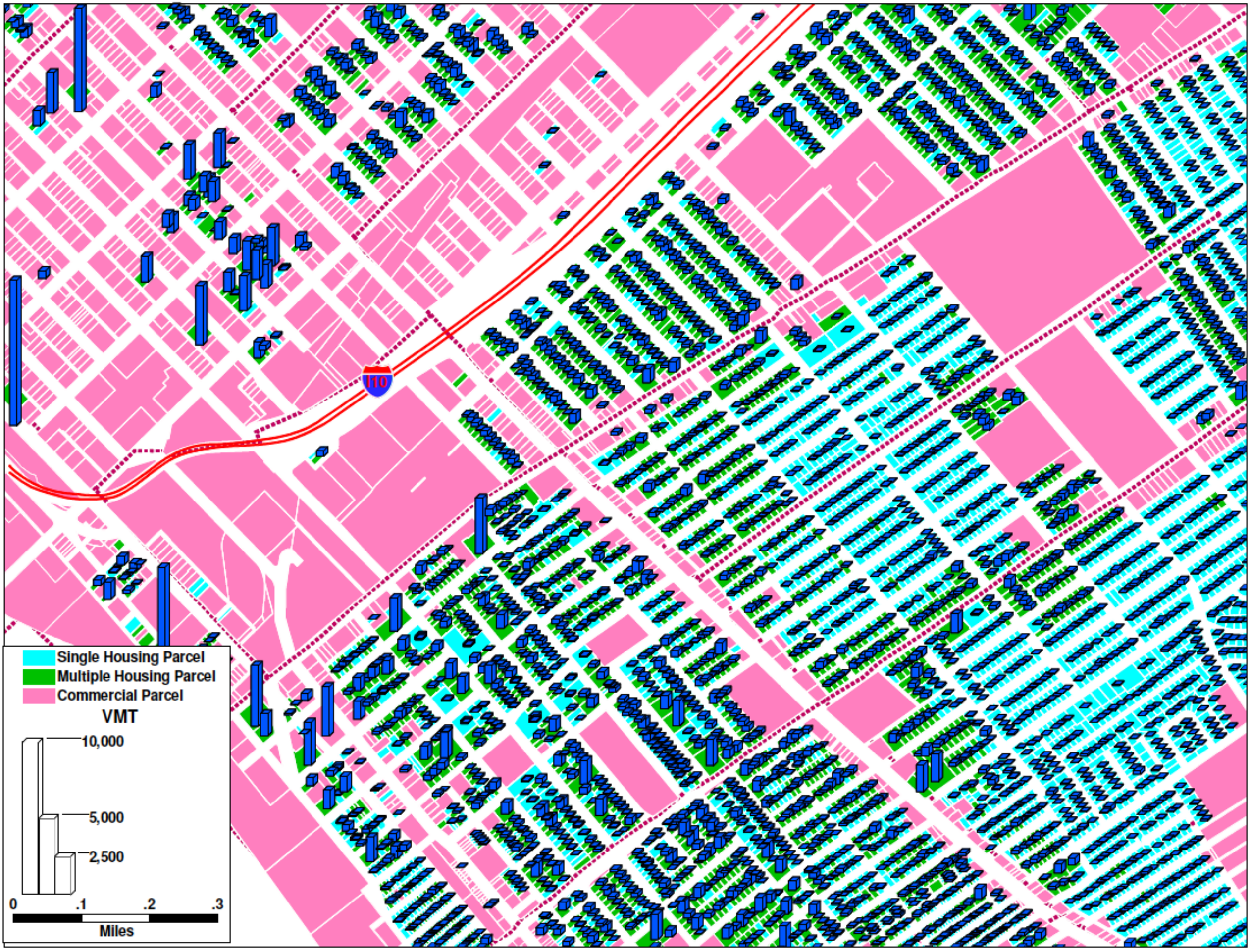
Marker	Actual Dist.(m)	Distorted Dist.(m)
A	39.2	**25.8**
B	41.4	**71.4**
C	69.9	99.9
D	62.7	79.8
E	73.7	60.3
F	65.0	59.5
G	85.8	95.6
H	82.6	106.7
I	94.2	112.8
J	88.9	116.1
K	60.9	61.1
L	70.0	60.6
M	45.7	**64.5**
N	114.9	109.5
O	147.8	143.9
P	82.3	110.5
Q	88.1	115.2
R	93.6	112.4

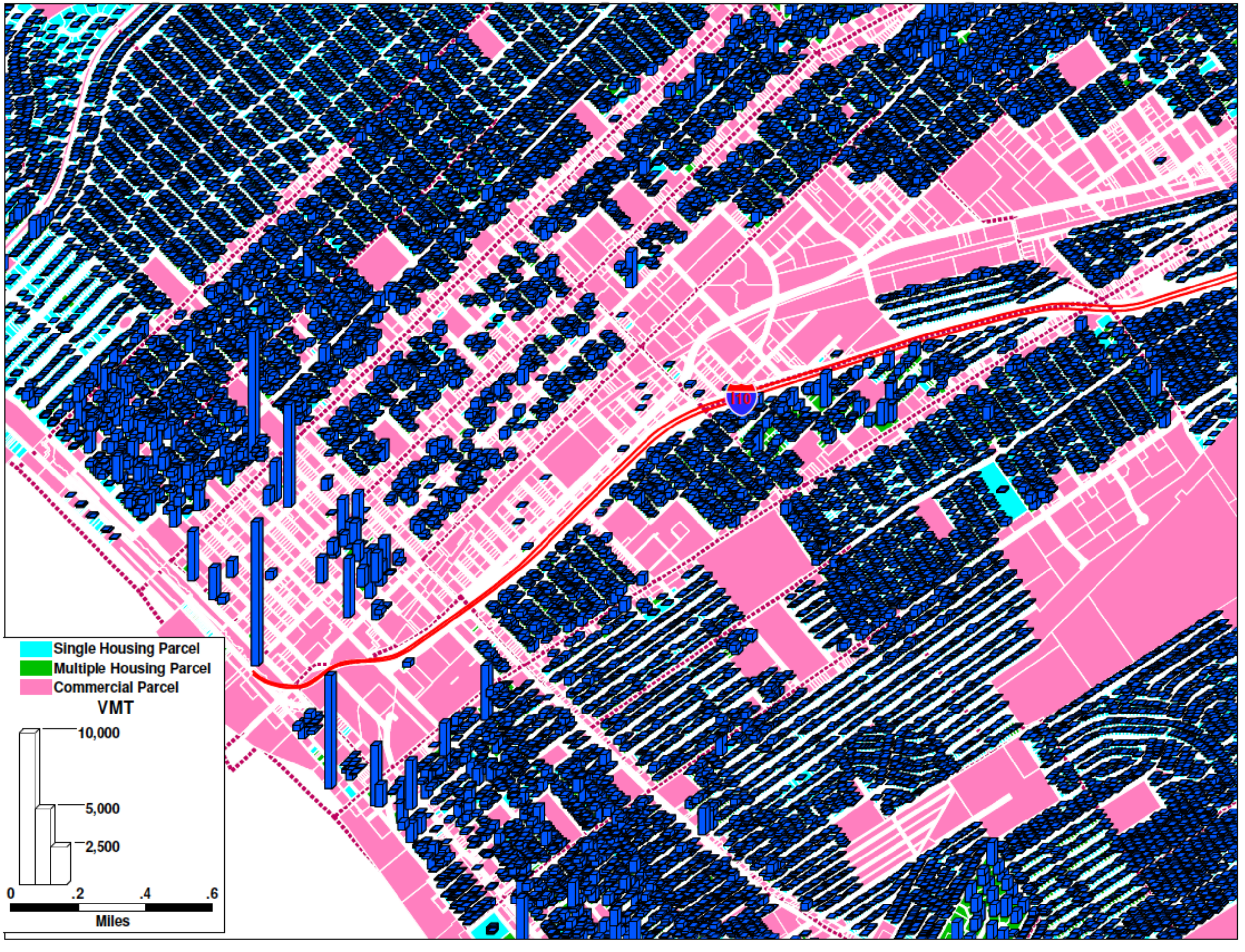
The bakery wins (point A)

Spatial allocation assignment probability can be done with a variety of other methods

McKenzie’s Dissertation on Temporal Signatures




I10
Single Housing Parcel
Multiple Housing Parcel
Commercial Parcel
VMT
10,000
5,000
2,500
0
.1
.2
.3
Miles


10
Single Housing Parcel
Multiple Housing Parcel
Commercial Parcel
VMT
10,000
5,000
2,500
0
.2
.4
.6
Miles

Big data in this case

- 18 million synthetic people, their households, and cars
- Millions of business establishments
- All networks for cars, buses, metro, railways
- Complete enumeration of opportunities and destination choices

- Imagine combinations of data we can test using a simulator like this as a test bed!