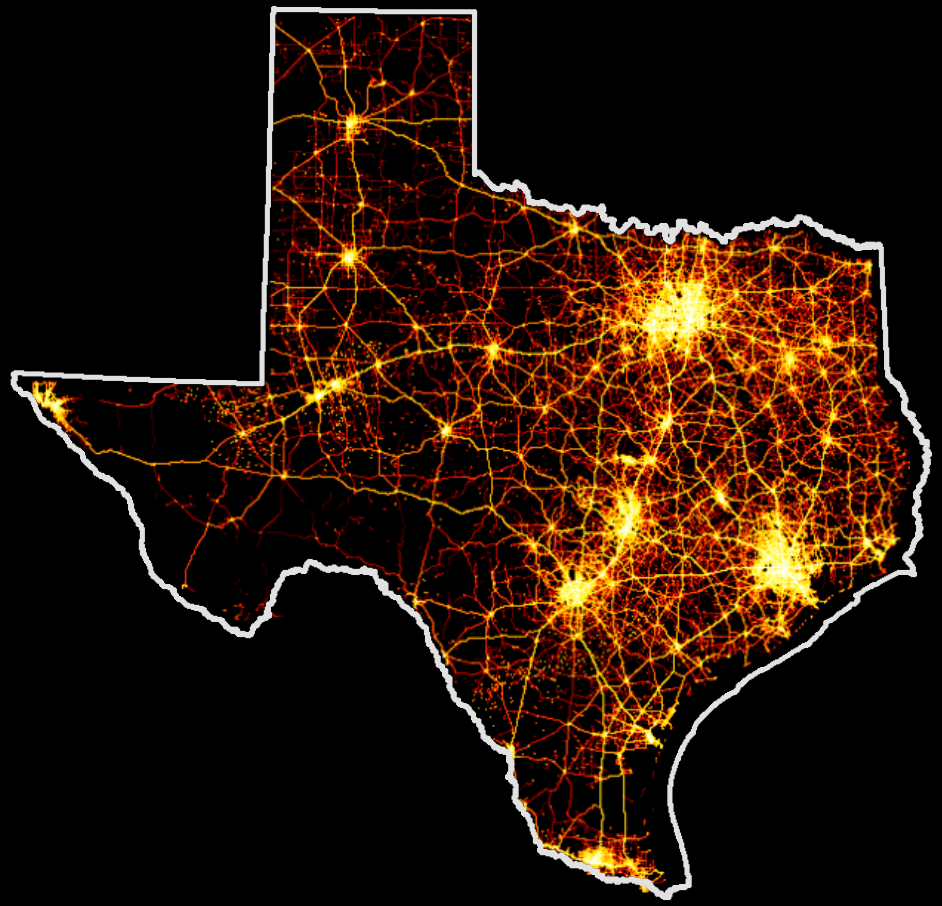


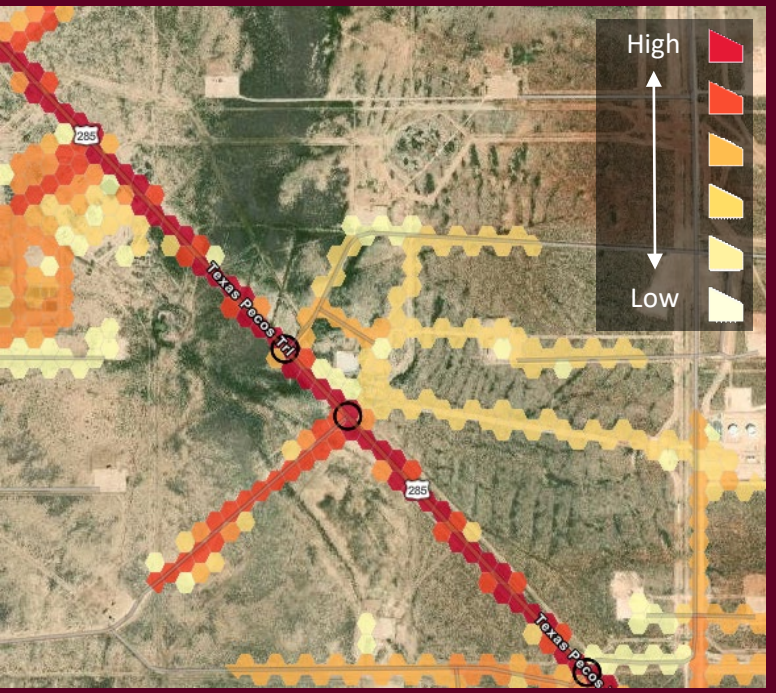
CARC 601 Foundation of Research

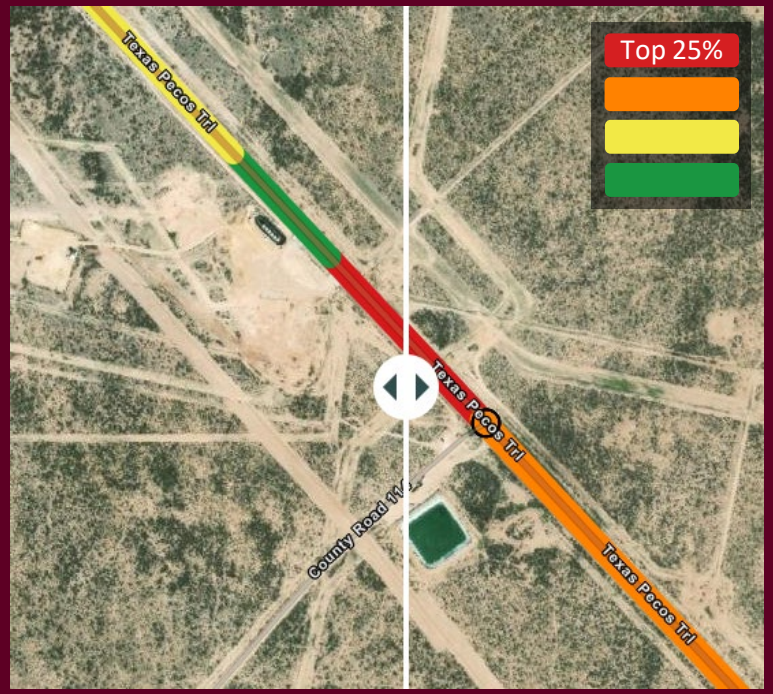
Connected Vehicle Data Safety Applications

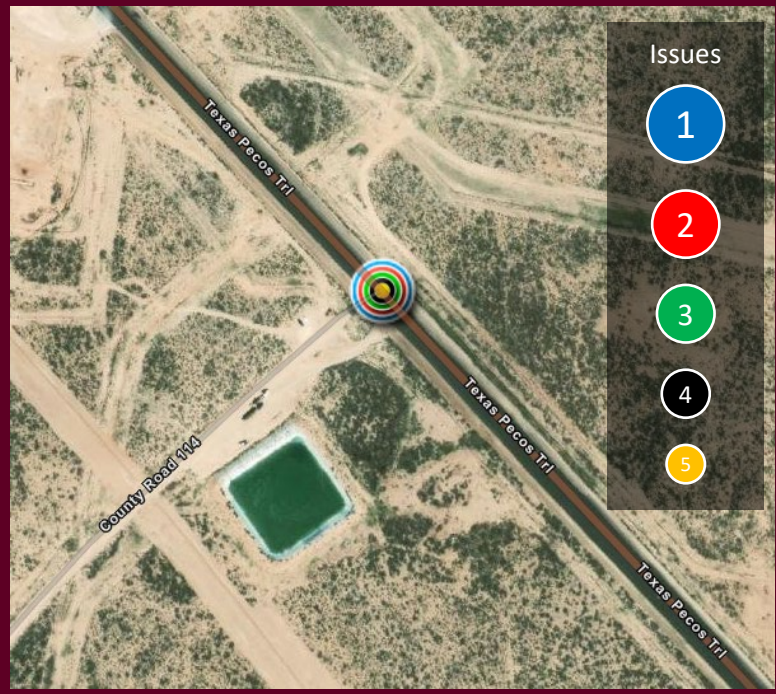
Michael Martin, Dr. Lingtao Wu, Mahin Ramezani
Texas A&M Transportation Institute

Informing Engineering Decisions

Where & How People Travel → Safety Assessments → Targeting Opportunities



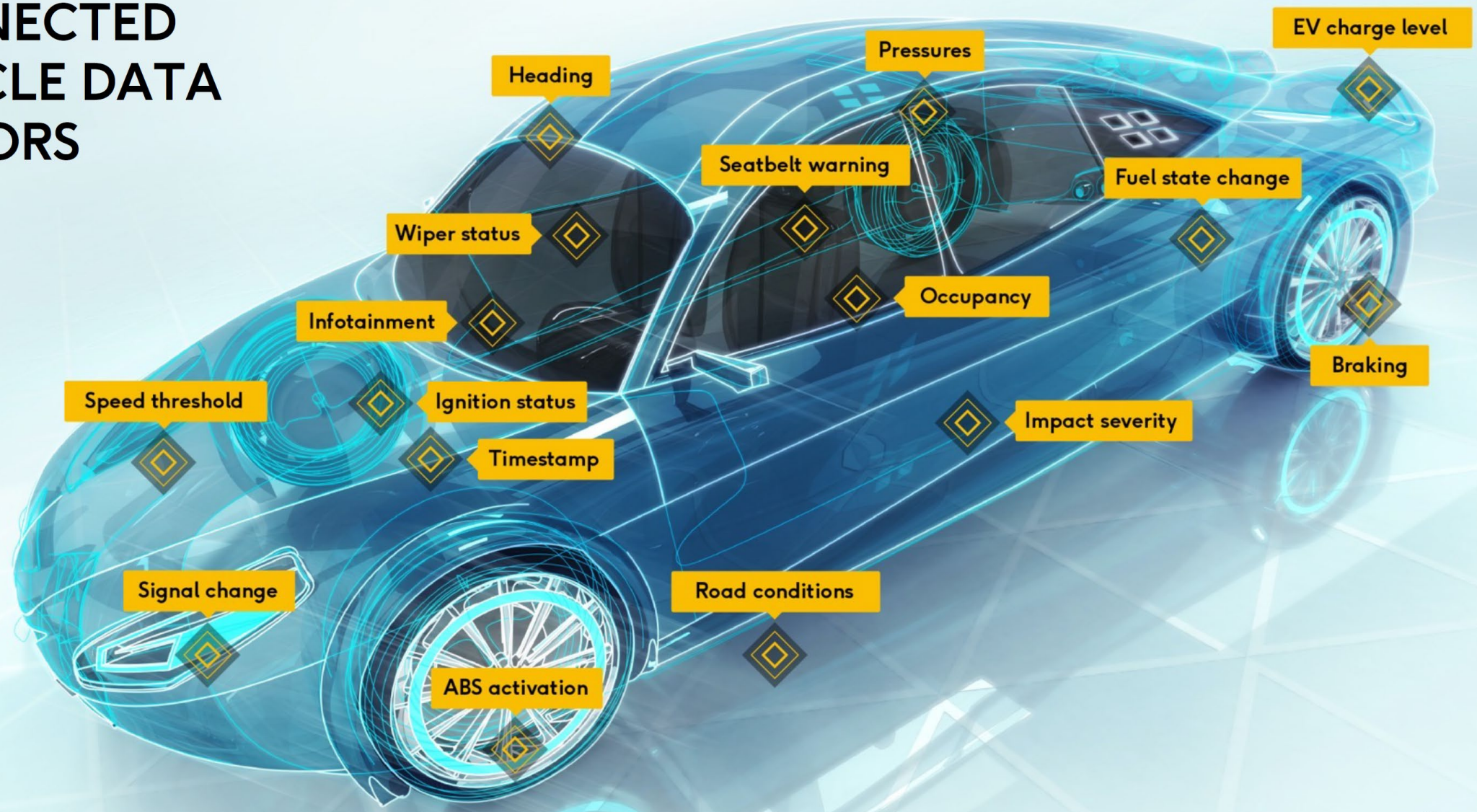




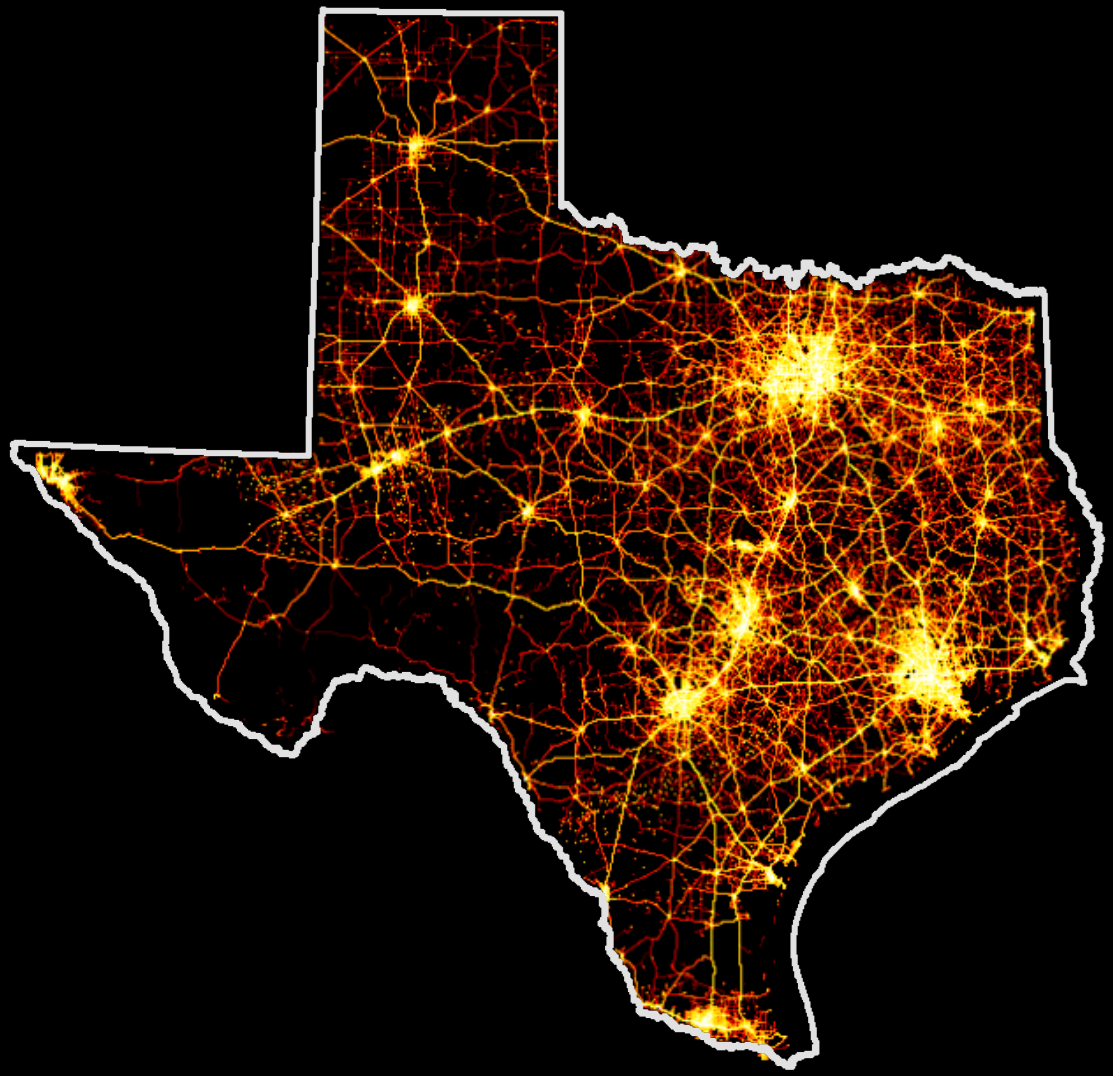
Weather
Intersections
Traffic Control
Driver Behaviors
Traffic Counts
Roadway Inventory
Crashes
Curves

HAAS ALERT
ATRI American Transportation Research Institute
iCone
H1
AppGeo
PlaceIQ
here
atom
On
FLOW LABS
FOURKITES
GEICO DriveEasy
Continental The Future in Motion
Velodyne Lidar
Zendrive
URBANSDK
URBAN LOGIQ
DATAPOINT
BASEMAP
vhb
Verisk
MOPRIM
tomorrow.io
DENSO
Uber Movement
Commutifi
wejo
TOMTOM
The Floow an OTONOMO company
AIRSAGE
Trimble
TOYOTA connected
TERALYTICS
SYNAPTIV
Streetscope
STREETLIGHT DATA Big Data for Mobility
Ecopia
inspiring smart mobility
UrbanOS Delivered by accenture
Swiftly
mobileye An Intel Company
STRAVA
PROGRESSIVE
waze
unacast.
blyncsy MOVEMENT DATA INTELLIGENCE
Spireon
factual
SMATS
SCOPE TECHNOLOGY
samsara
SAFEGRAPH
QUADRANT an appen company
GroundTruth
SOLERA
RITIS
remix by Via
LOCUS
REKOR
FleetComplete
ROUTE REPORTS
RoadBotics by Michelin
cubic telecom
MobilityData
TELENAV
QUANERGY
verizon connect
OTONOMO
one.network
cuebiq
Omnimodal
NUMINA
FOURSQUARE
PENSKE
WAYMO
nexar
MVNIC CAR DATA
Moonshadow
Drivewyze
MIOVISION
CUBIC
NexTraq A MICHELIN GROUP COMPANY
arity
FLEETUP
Liberty Mutual INSURANCE
MICHELIN DRIVING DATA TO INTELLIGENCE
MAVEN
mapbox
NIRA DYNAMICS
lytx
LINDSAY
Cellint
ECONOLITE
SKYHOOK
idax DATA SOLUTIONS
remix by Via
INRIX
INNOVIZ TECHNOLOGIES
IMS Insurance & Mobility Solutions
iteris
LexisNexis RISK SOLUTIONS
KORE
HiveSafety
GEOTAB
Teletrac Navman

CONNECTED VEHICLE DATA SENSORS



wejo

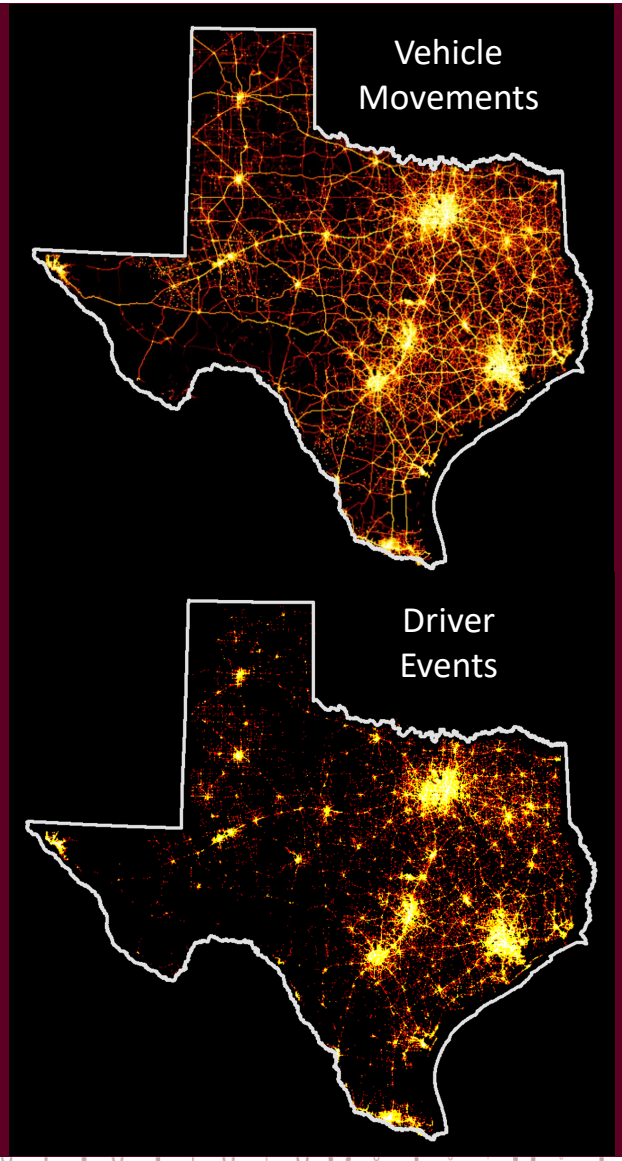


Texas-size Data:

Urban & Rural

TxDOT Statewide Wejo Data

- Statewide coverage
- Nov. 2021 – May 2023
- Vehicle movements
  - 1.2 trillion points
  - Every 3-seconds: location, speed, heading, etc.
- Driver events
  - 27 billion points
  - When an event occurs: hard braking, seatbelt latch, etc.

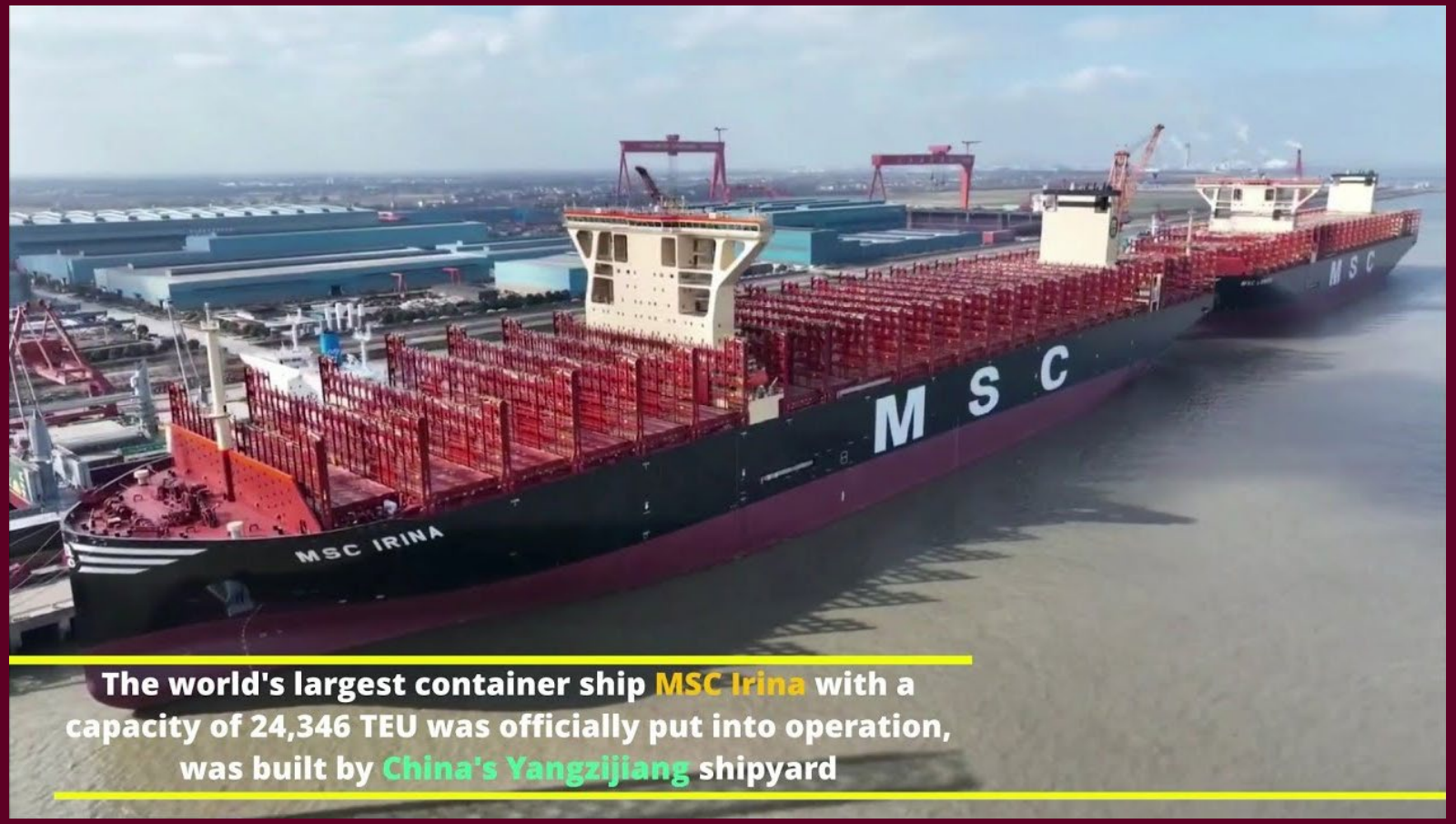


How can I relate to a trillion anything?

Lego bricks

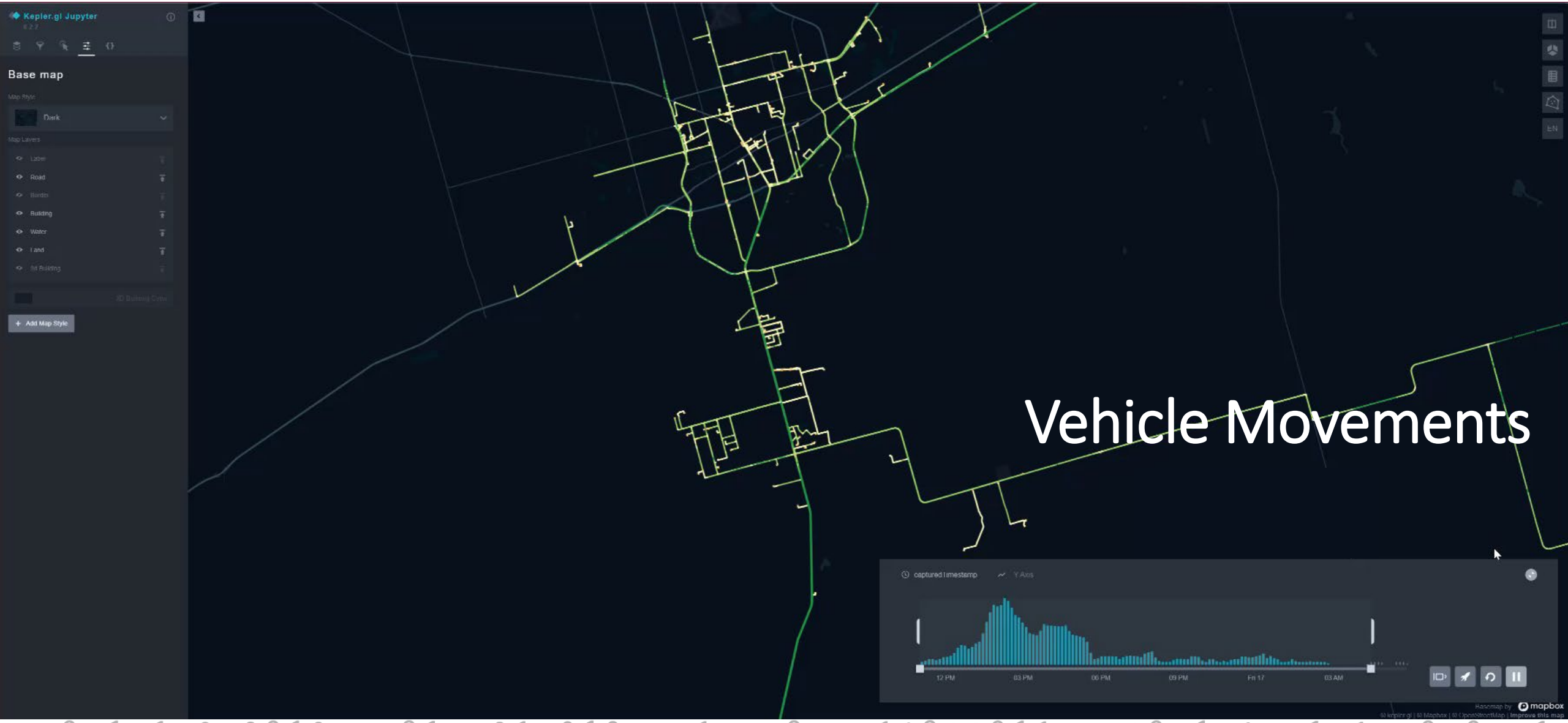
~64,000 Containers

5.2 MSC Irina



Texas A&M Transportation Institute

Vehicle Movements



Vehicle Movements

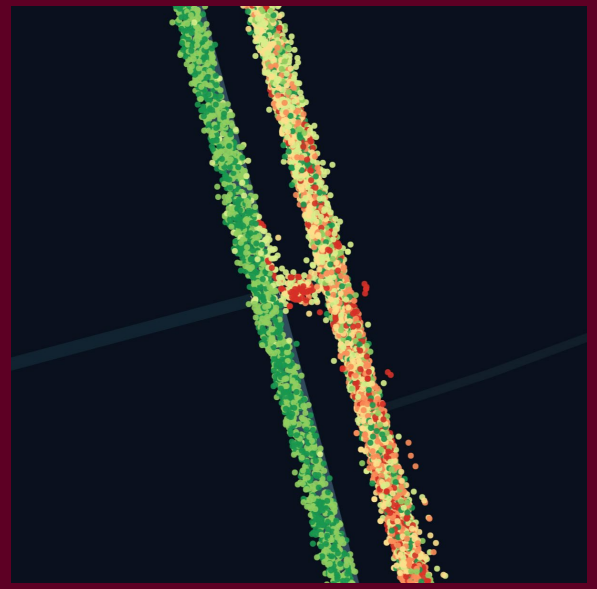
Hard braking

Seat belt latching
04/29/21
12:46:19pm
04/30/21
14:07:27pm
timestamp
Y Axis
Sat 03
Mon 05
Wed 07
Fri 09
Apr 11
Tue 13
Thu 15
Sat 17
Mon 19
Wed 21
Fri 23
Apr 25
Tue 27
Thu 29
mapbox

Create Meaningful Results

Data → **Information** → **Intelligence**

Raw vehicle movements

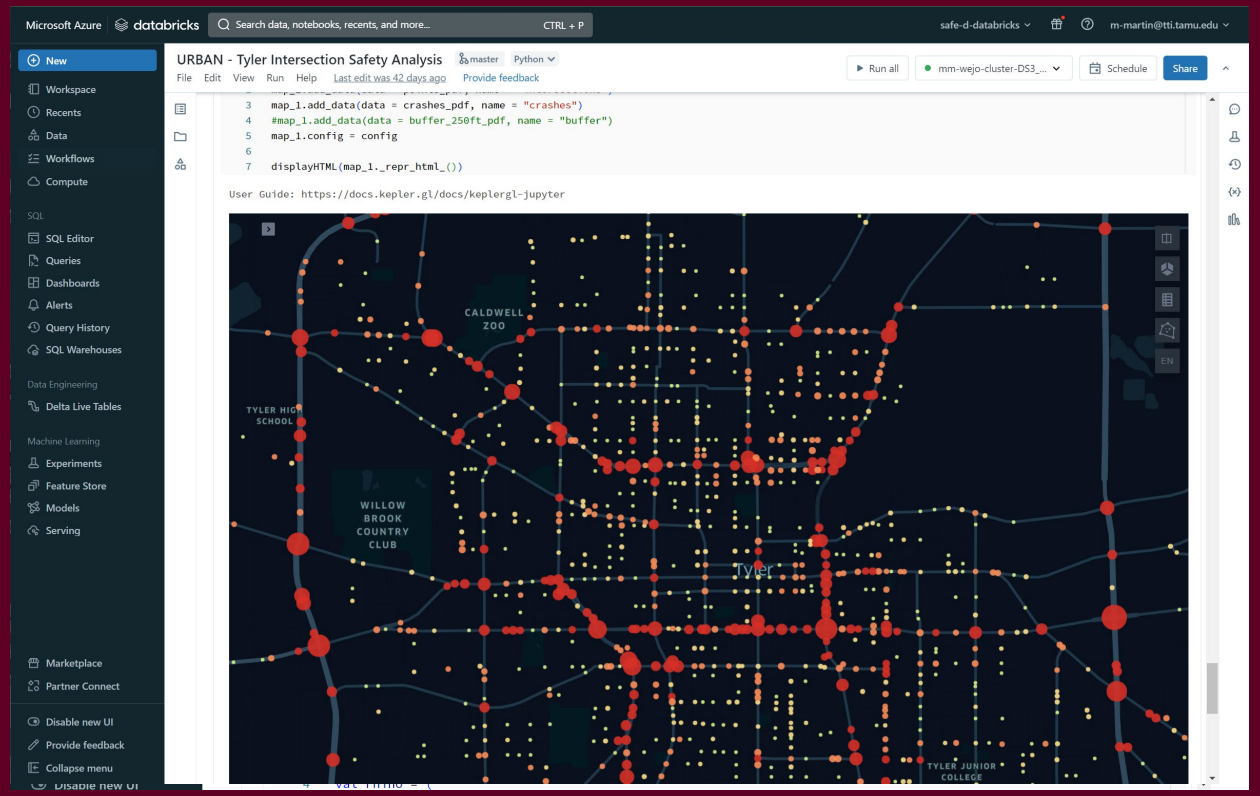


2.4% U-turns

Median crossover realignment opportunities where there are high U-turn percentages

Data wrangling skills required

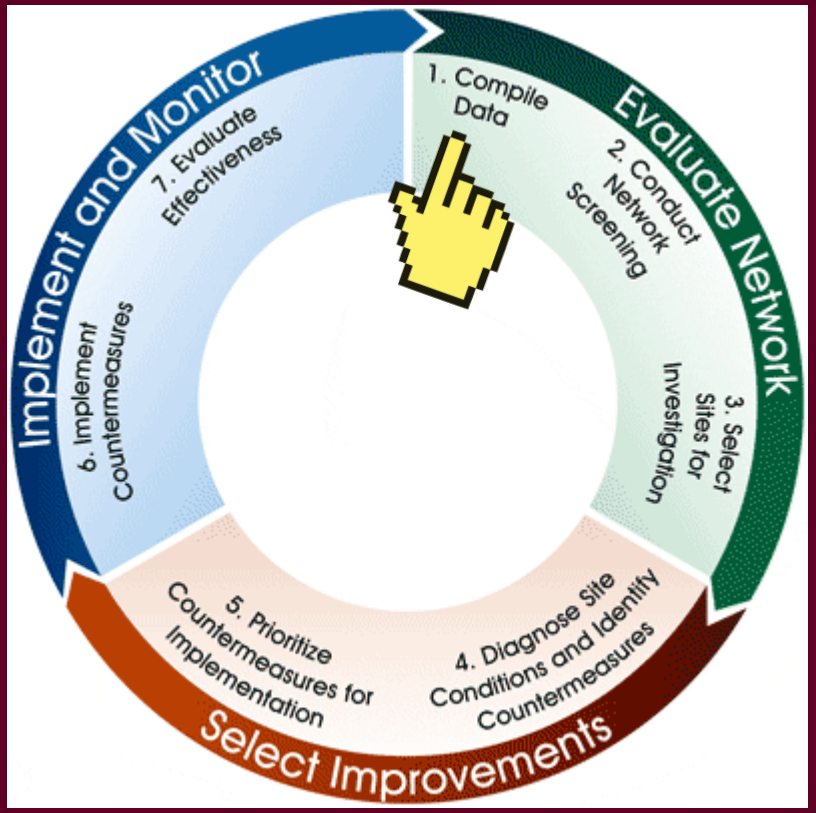
- Data engineering & analysis at this scale is different
- TTI's setup
  - Cloud storage
    - Microsoft Azure Cloud
    - Partitions are your friend
  - Compute options
    - Databricks
    - Flexible, distributed compute
  - Low/no code options
    - Moonshadow
    - XYZT.ai
- Dig into the details & test assumptions



Predicting Crashes

The data fundamentals:

- Crashes
- Exposure
- Driver behaviors
- Roadway characteristics
- Environmental conditions



https://highways.dot.gov/safety

Crash Data

- Location
- Time
- Severity
- Vehicle types
- Contributing factors
- Conditions
- Collision type

Exposure Data

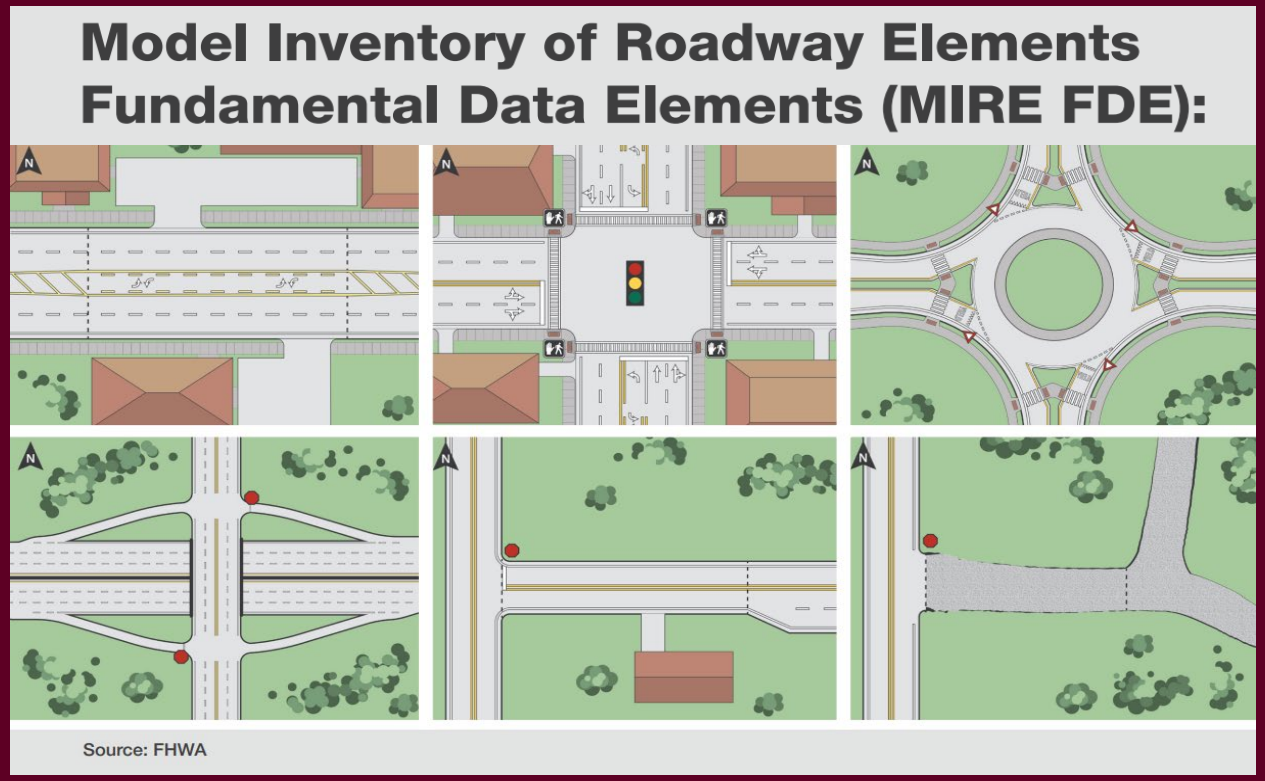
- Traffic volume (AADT)
- Trips
  - Counts
  - Length
  - Duration
- Turning movements

Driver Behavior Data

- Operating speeds
- Hard braking
- Hard acceleration
- Distractions
- Turning movements
- Lane departures
- Emergency braking
- Seat belt (un)latching
- Passengers

Roadway Characteristic Data

- Posted speed limit
- Segment
- Intersection / driveways
- Curves
- Functional class
- Number of lanes
- Shoulder width
- Median type
- Pavement type / condition



Environment Conditions Data

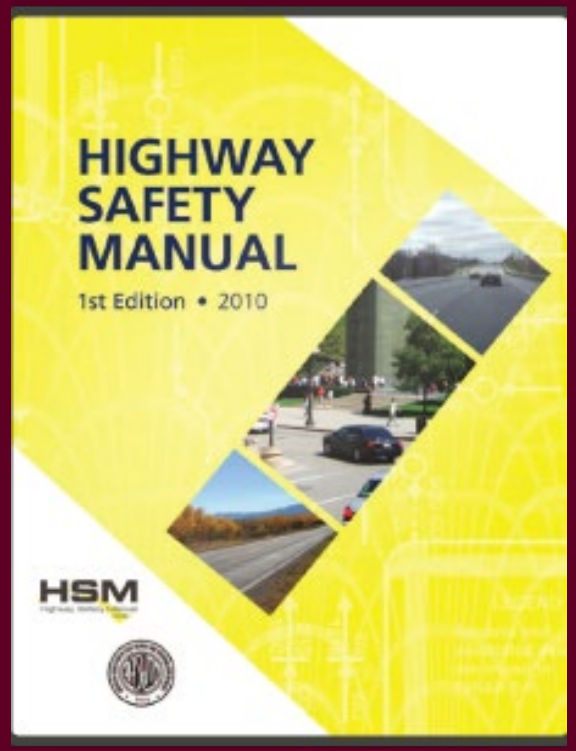
- Lighting conditions
- Precipitation
- Temperature
- Event intensity

CV Data Safety Application

Goals

- Reduce crash frequency
- Reduce crash severity

How do you get started?



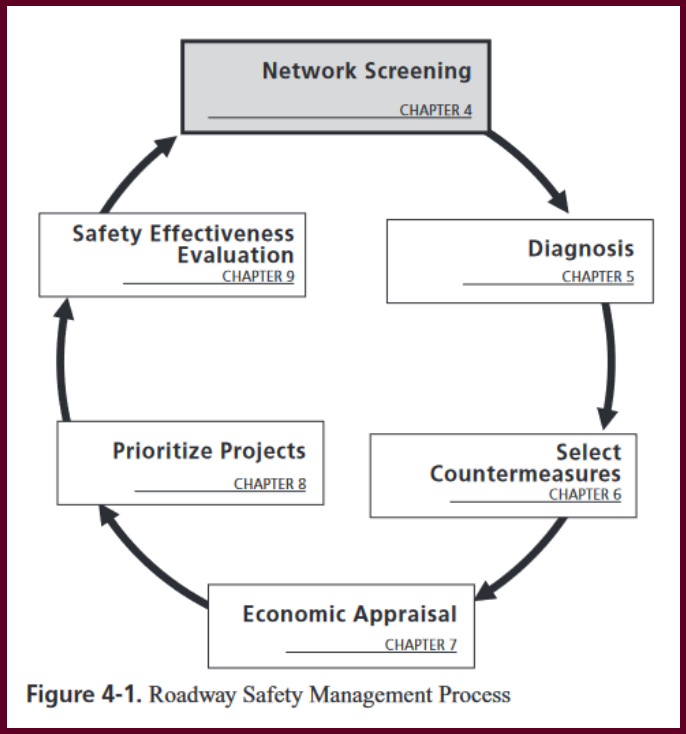
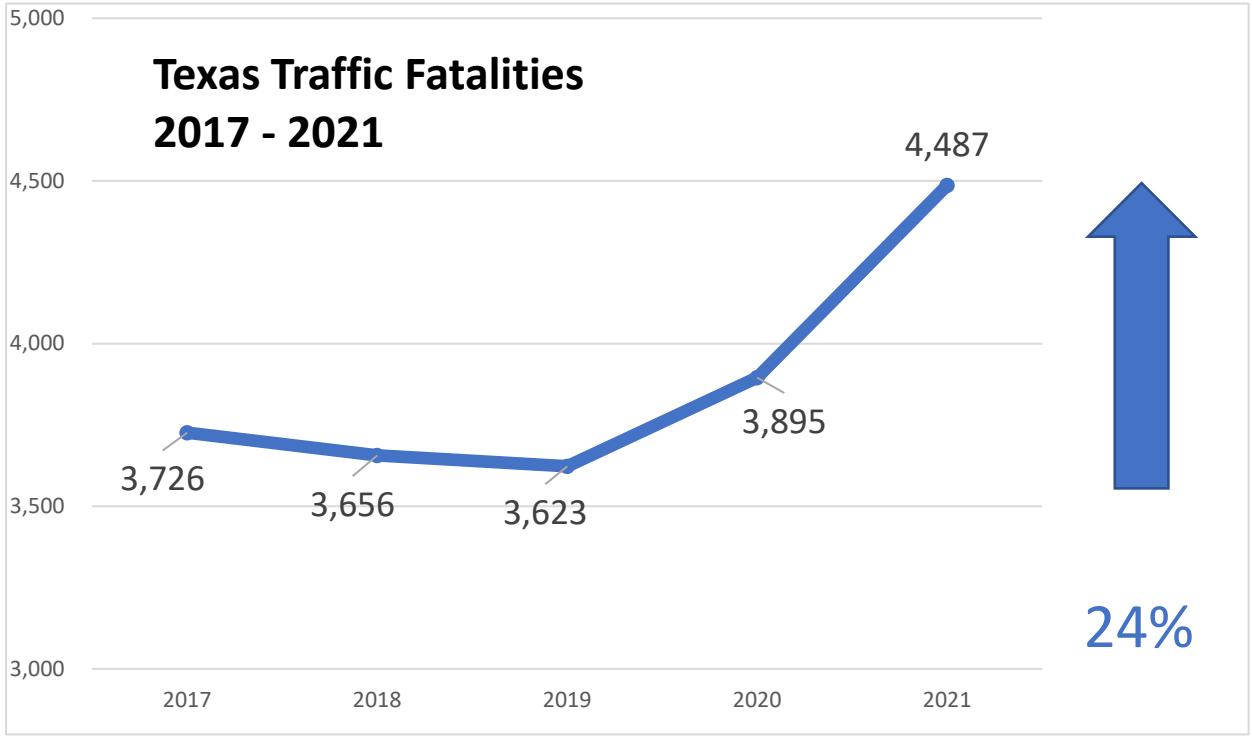


Figure 4-1. Roadway Safety Management Process

Predicting Crashes

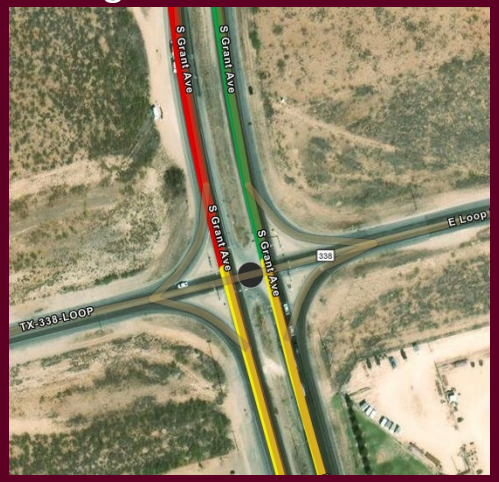
Suggestions:

- Pull together data fundamentals
- Use existing science-based methods
- HSM Network screening
  - Roadway “wellness check”
  - Predictive methods (SPF + EB)
  - Determine influential factors
- Remember context matters

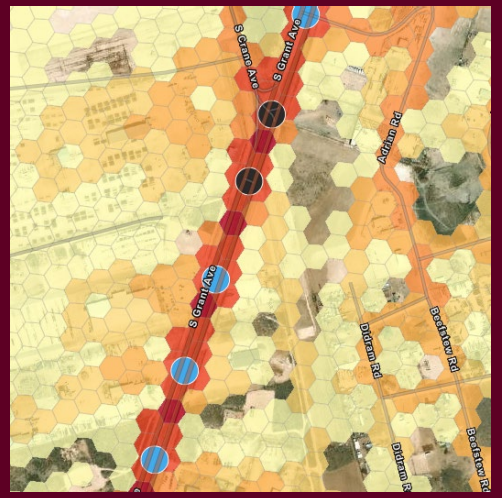


Meaningful Applications

Segment-based Rates

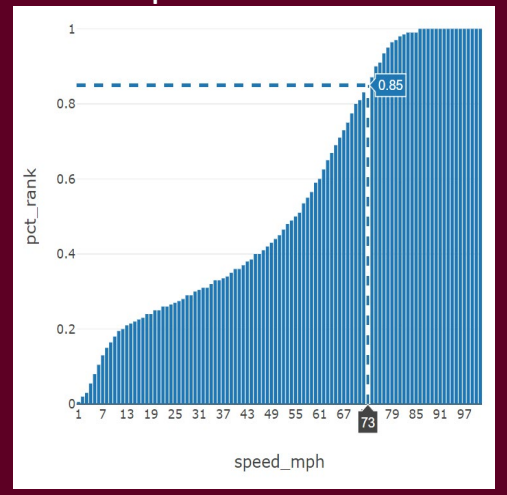


Relative Counts

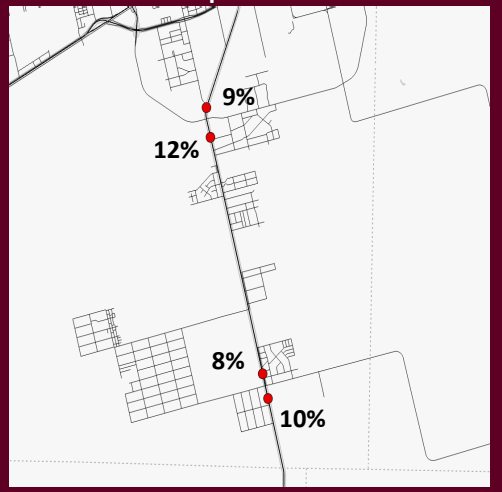


Turning Percentages

Speed Profiles



Sample Rates



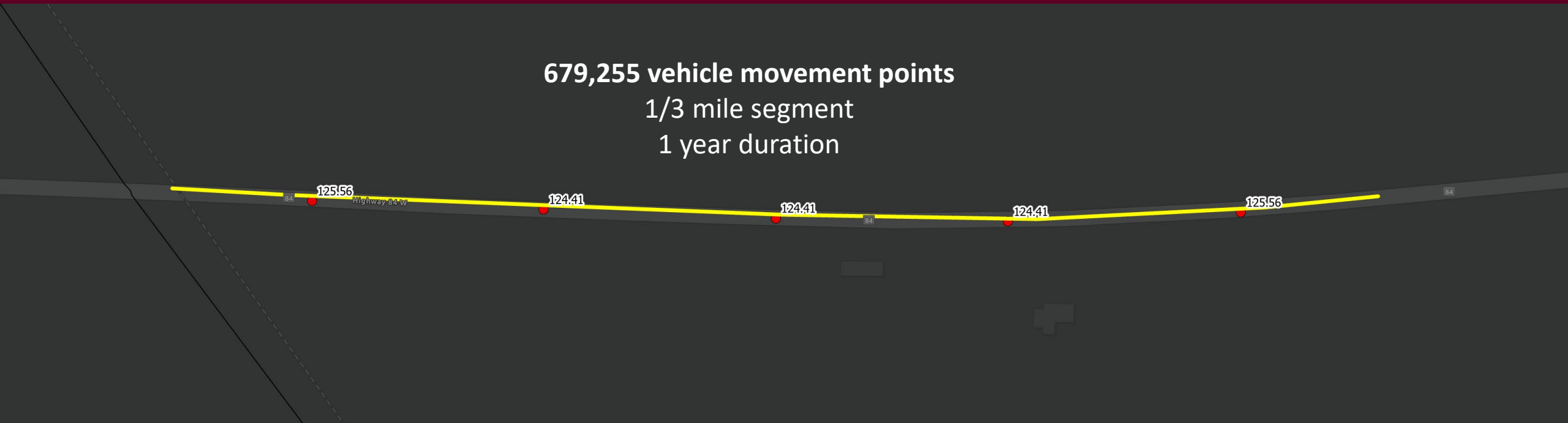
Speed Calculations

1. Space-Mean Speed
   The journey distance traveled divided by the journey travel time. Segment SMS is the average journey SMS per segment.
2. Time-Mean Speed
   The average of all waypoint speeds per journey. Segment TMS is the average journey TMS per segment.
3. Speed variance
4. 15th, 50th (Median), 85th, and 95th percentiles
5. 15th vs 85th percentiles speed differential
6. PSL vs 85th percentile speed differential
7. 10-MPH Pace

679,255 vehicle movement points

1/3 mile segment

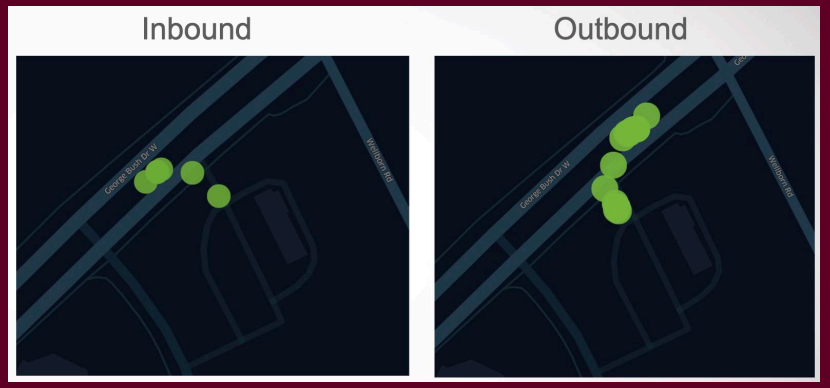
1 year duration



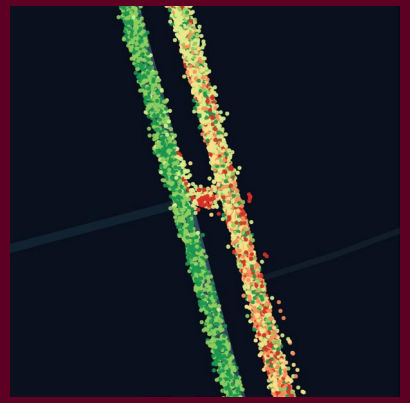
Turning Movements

Wejo Attributes
- Location
- Time
- Speed
- Heading
- Ignition on/off

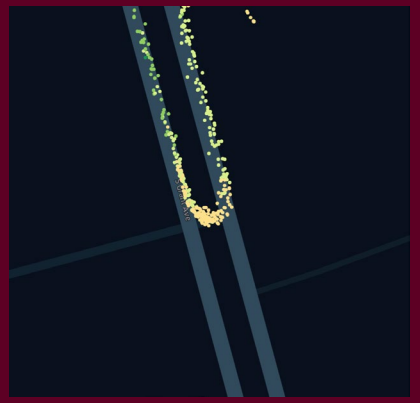
Algorithm
- Heading change
  - Left & right turn: ~ 90 degree
  - U-turn: ~ 180 degree
- Takes a few second
- Same location



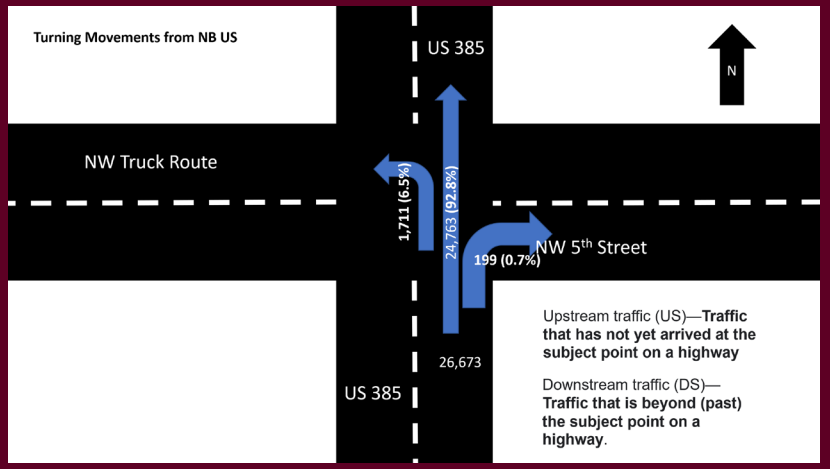
Raw vehicle movements

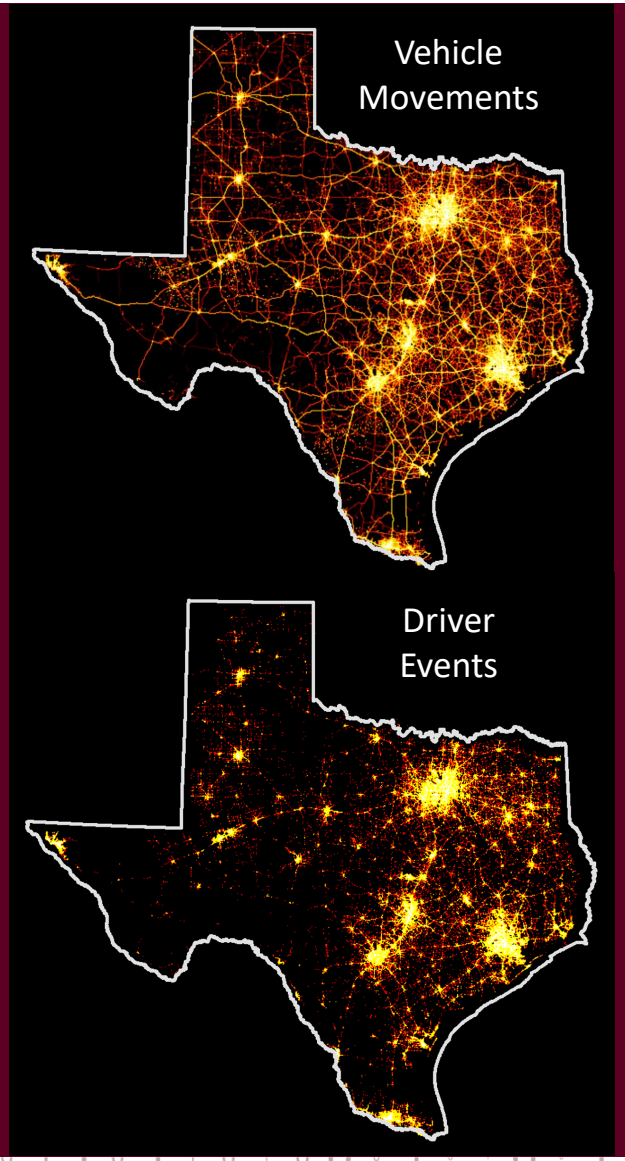


2.4% U-turns



Median crossover realignment opportunities where there are high U-turn percentages



Summary

- Raw ingredients
  - Statewide coverage / Nov. 2021 – May 2023
  - Vehicle movements (+1 trillion points)
    - Every 3-seconds: location, speed, heading, etc.
  - Driver events (28 billion points)
    - When an event occurs: hard braking, seatbelt latch, etc.
- Data engineering skills required
  - Cloud storage & compute options
  - Low/no code options
- Dig into the details & test assumptions
- Data → Information → Intelligence
  - Predictive crash modeling
  - Turning movements
  - Speeds for custom segments