Big Data, Spatial Analytics, Machine Learning

Workflows and Applications

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2021 ESRI USER CONFERENCE

Agenda

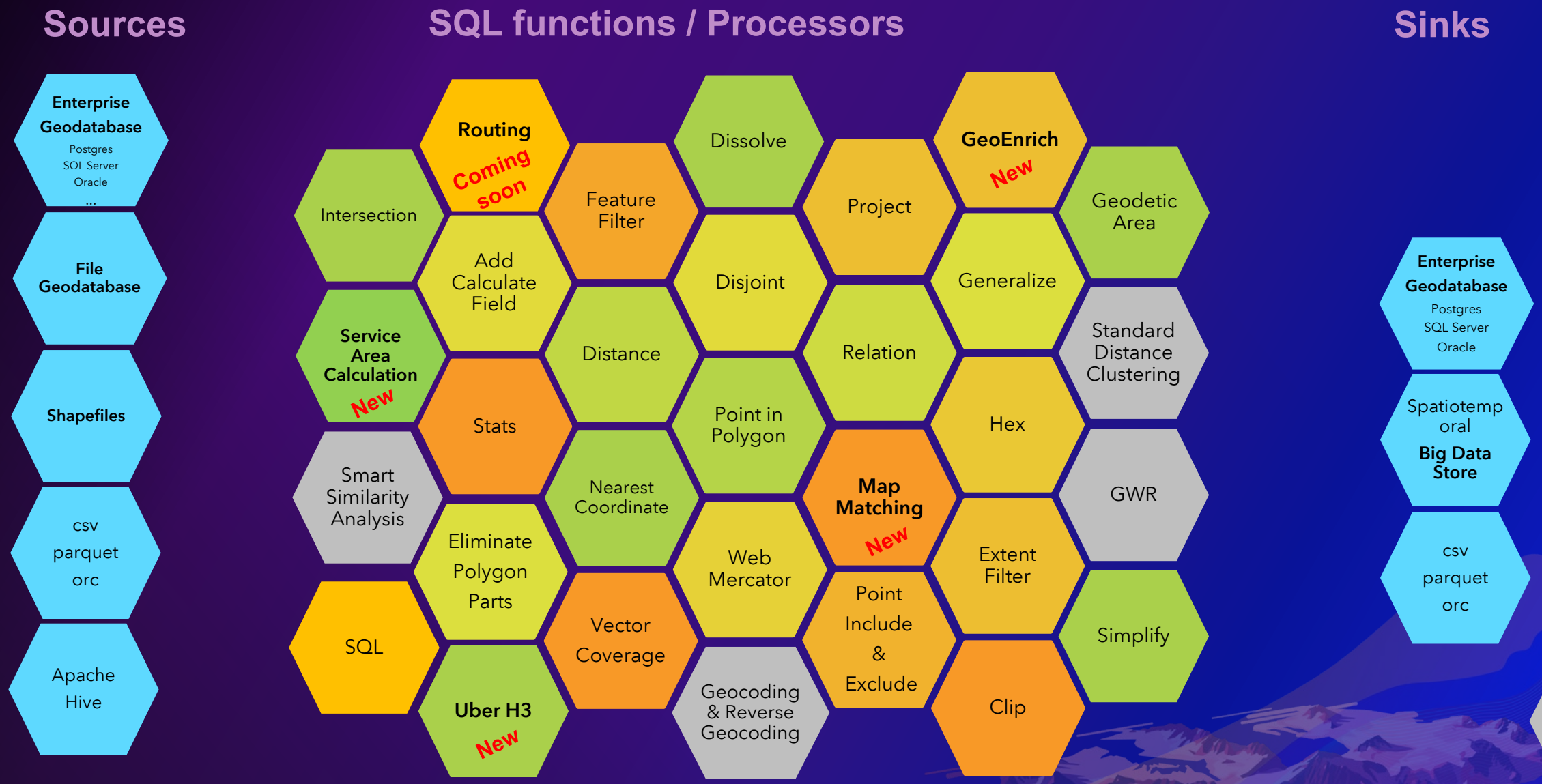
- Who We Are
- What’s New in Big Data Toolkit
- Customer Use Cases
- Live Q&A (15 mins)

Who We Are

- Advanced Spatial Analytics Team in Professional Services
  - Data Engineers
  - Data Analysts
  - Data Scientists
  - Software Developers

- Improve customer businesses by applying
  - Big Data
  - Spatial Analytics
  - Computer Vision
    - Object Detection, Object Segmentation
  - Natural Language Processing

What is Big Data Toolkit?



Big Data Toolkit

- You know SQL?
  - You can do Big Data!

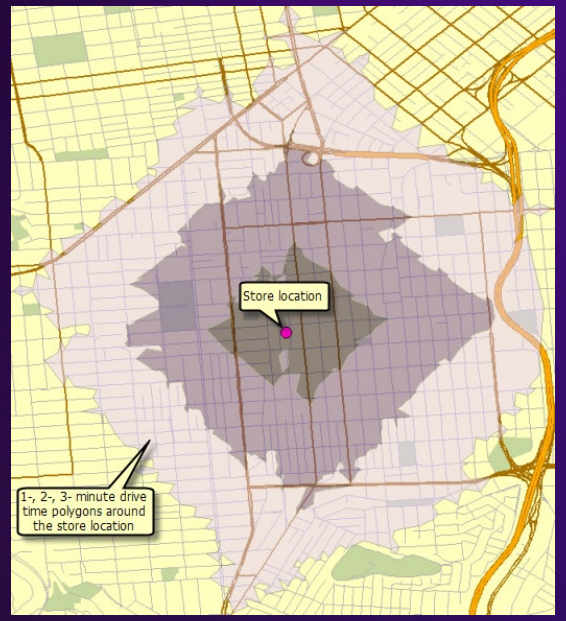
  - SELECT ST_Buffer(Shape, 2.5) FROM Locations
  - SELECT * FROM Locations A, TradeAreas B WHERE ST_Contains(B.Shape, A.Shape)

- More in-depth sessions:
  - 2020 DevSummit https://youtu.be/qgdFn6p2gpM
  - 2019 DevSummit https://youtu.be/_BJk_LKlxXc

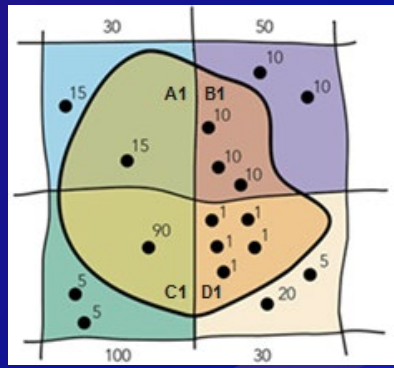
Big Data Toolkit

- Rich geo-context while feature engineering
- Understand phenomena around the world

- Massive Service Areas New



- Massive GeoEnrichment New
  - Apportions & appends 2,800 variables
    - Demographic
    - Consumer Spending
    - Market Potential

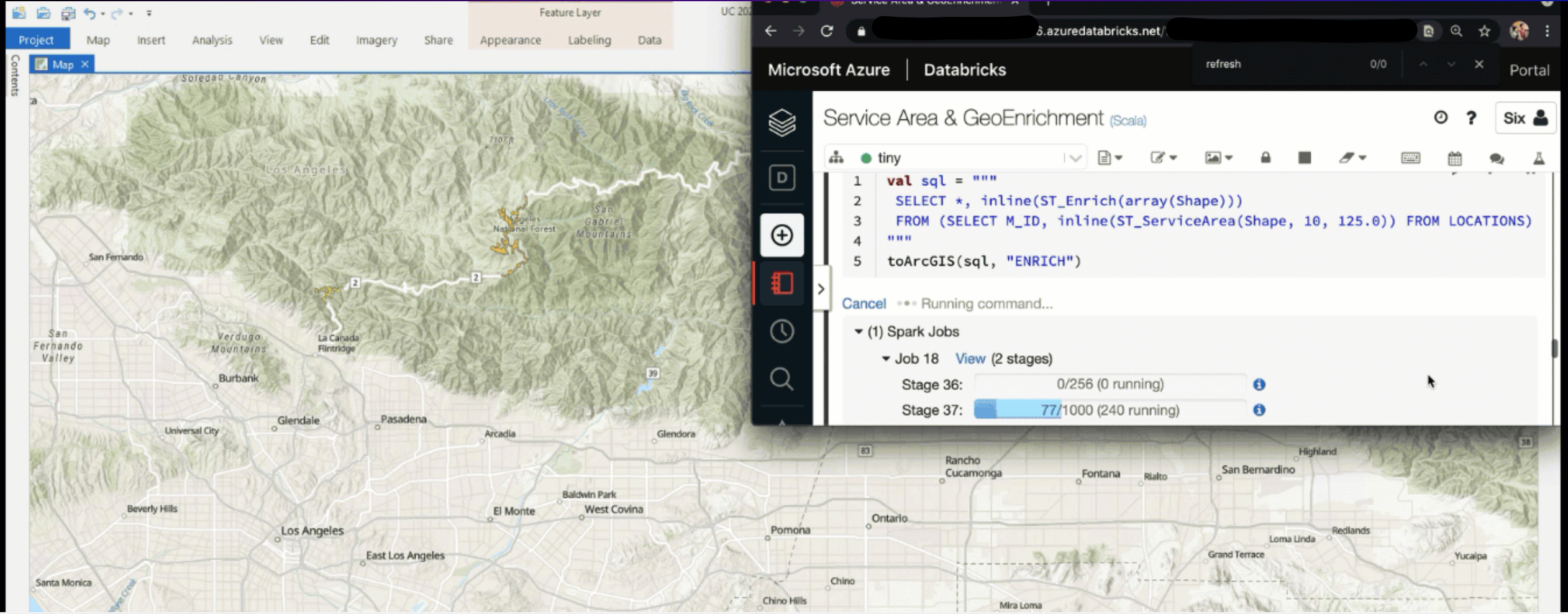


Weighted Block %

	Pop	
A1	15	(15/30 = 50% x 30)
B1	30	(30/50 = 60% x 50)
C1	90	(90/100 = 90% x 100)
D1	5	(5/30 = 16% x 30)

$$w_i = \sum_{B \in P_i \cap T} W_i(B).$$

$$W_i(B) = V^{TOTPOP}(B) \Big/ \sum_{B' \in P_i} V^{TOTPOP}(B').$$

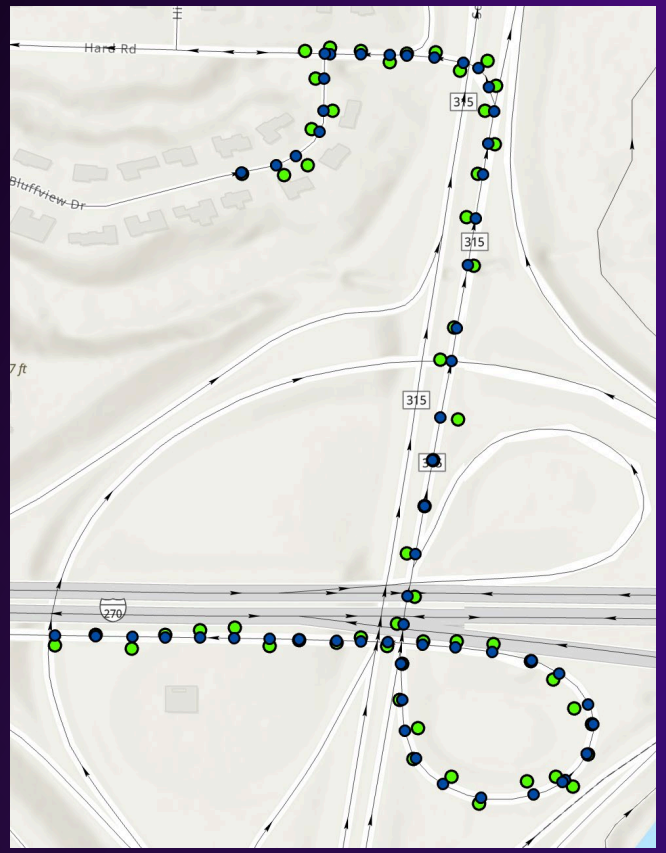


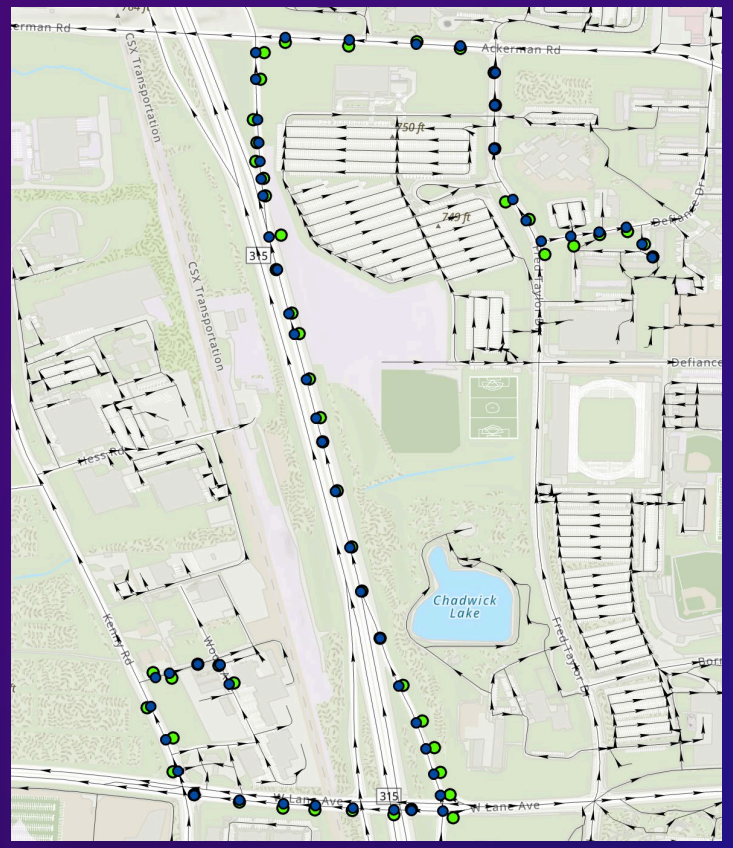
	TOTPOP_CY	HHPOP_CY	FAMPOP_CY	GQPOP_CY	POPDENS_CY	TOTHH_CY	AVGHHSZ_CY	FAMHH_CY	AVGFMSZ_CY	TOTHU_CY	OWNER_CY
1	361606	356430	308505	5175	9124.9	104694	3.4	82098	3.76	109110	54148
2	294723	290226	250936	4497	9244.8	85			3.75	89233	45327
3	225024	221428	191494	3597	9097.2	65215	3.4	51045	3.75	67875	35434

2,800+ variables

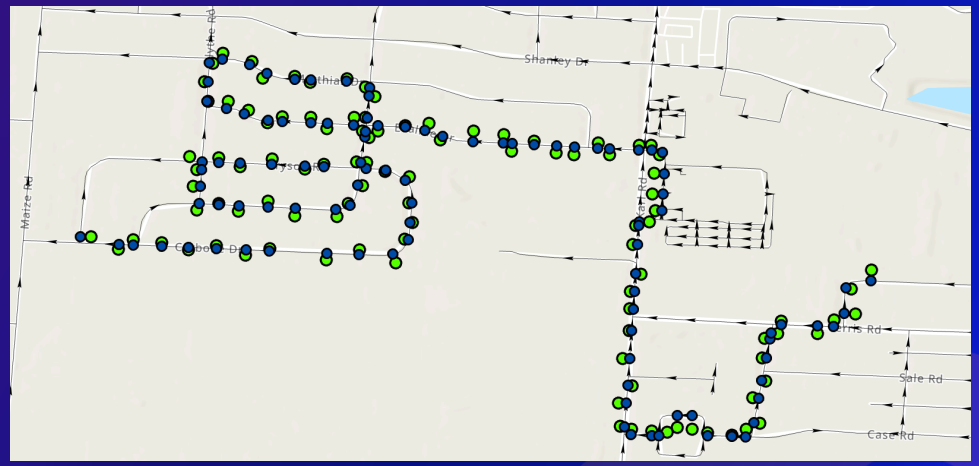
Map Matching (aka Smart Snapping)

Infer patterns & behaviours





- Snapped GPS Point
- Noisy GPS Breadcrumb



Trade Area Delineation and Location Planning
Using Human Movement Data, Business Analyst, and Big Data Toolkit

Trade Areas: Traditional Approach

- Common approaches
  - Hand-drawn using natural geographic attributes (highways, bridges, rivers, block groups, etc.)
  - Buffers, drive-times
  - Gather attributes within boundary
  - Store-centric (what customers are available to each store)
- Challenges with common approach
  - Selection bias
  - Market conversion and cannibalization
  - Boundaries and edge cases
  - Locus of competition
  - Competitive landscape
  - Temporal factors

Trade Areas and Location Planning

Data Inputs

AOIs
Stores
Competitors
Human Movement

Pre-processing

Big Data Toolkit

Customer-Centered Origin Geography

Demographics (BA)
Proximity features
Aggregate visits

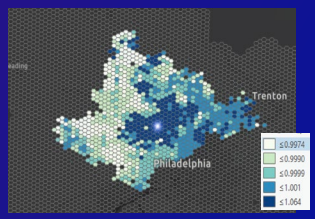
Geoenrichment

Business Analyst

Forecasting Model

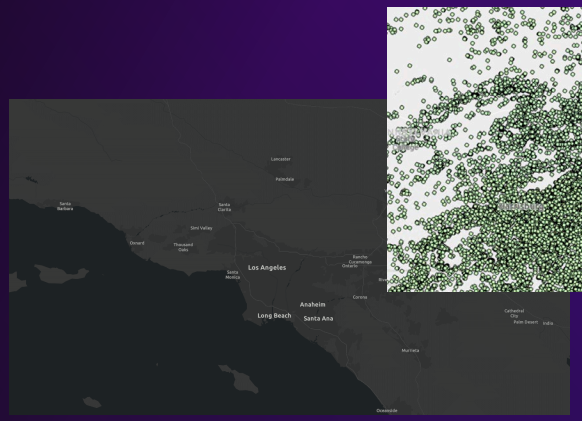
Derive Trade Areas

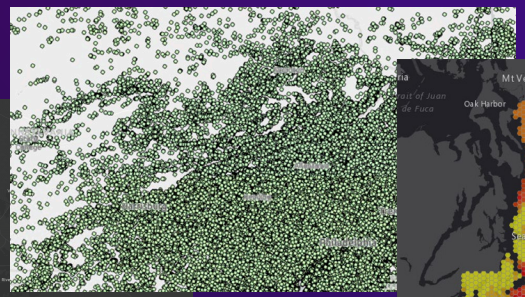
Simulation Tool

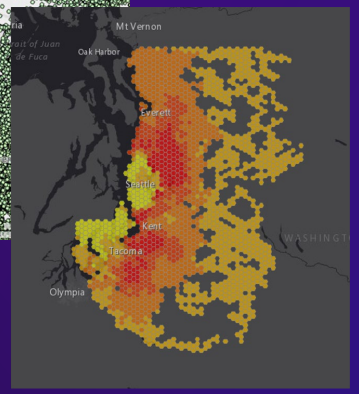


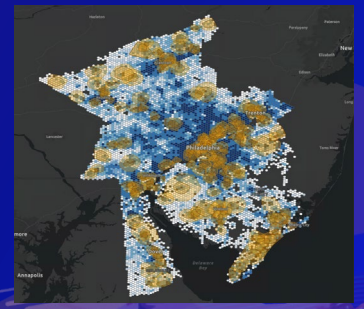
Add, Remove, and/or Relocate
Visualize areas most likely impacted
Compare to existing trade areas

Compare Trade Areas to Market Demand

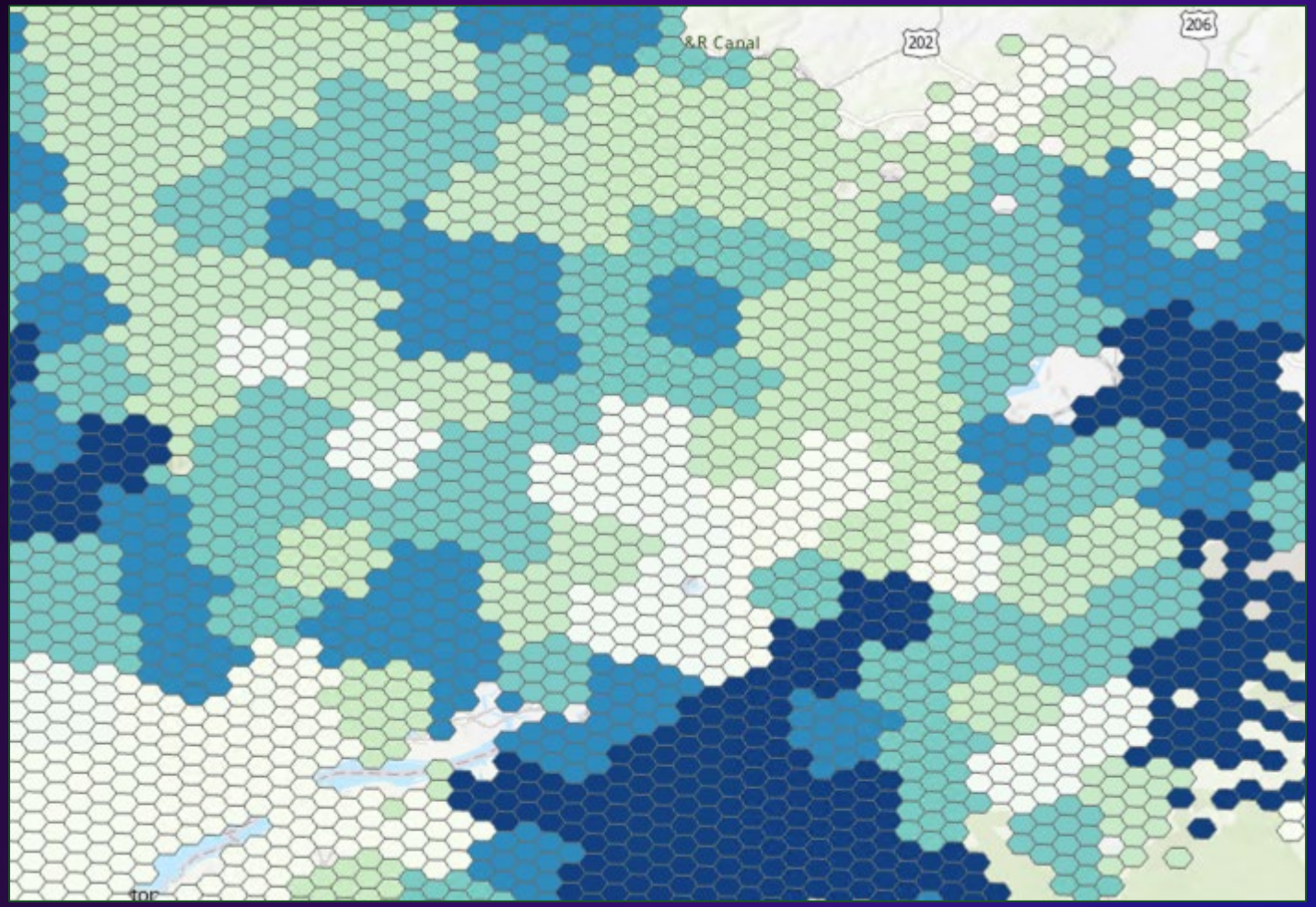






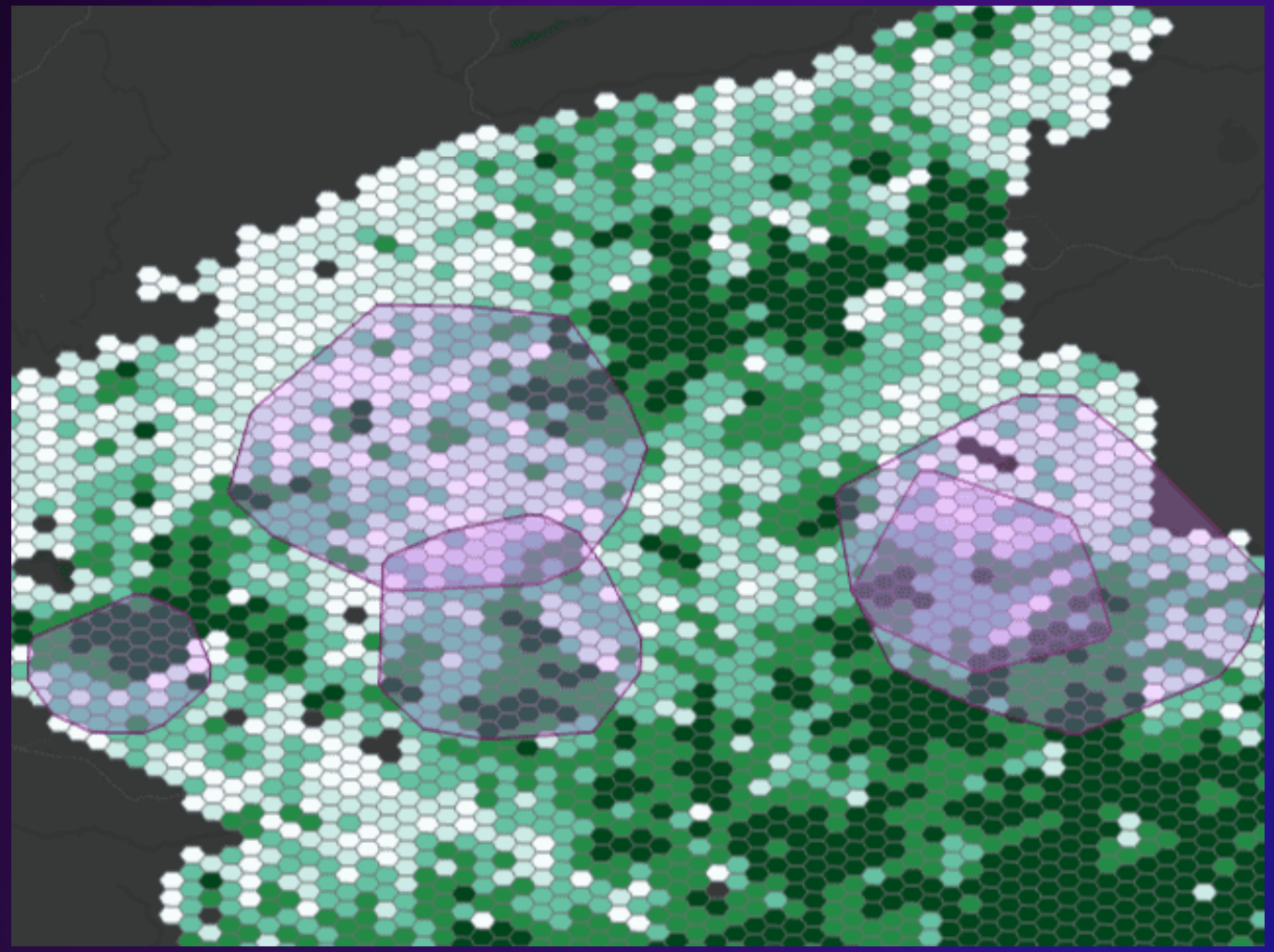


Relative Impact of Input Variable on Target



- Marginal impact of median income
- Relative impact varies across the area of interest
- Where does income matter most?

Evaluating the Market



- Trade Area (Polygons)
- Aggregated Visits (Hexbins)
- Under-served
- Over-saturated
- Optimizing locations

Asset Detection and Geo-Location Using Deep Learning and Photogrammetry (Charlotte Water)

Geo-Locating Water Meter Boxes

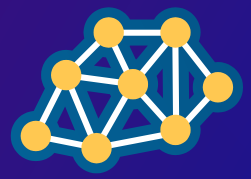
- Approximately 300,000 water meter boxes
- At least 5 different types of meters
- Up to $400,000 contracts for outside surveyors
- Goal: Find and geo-locate meter boxes
- Motivation: Significant cost savings

Deep Learning | Feature Extraction

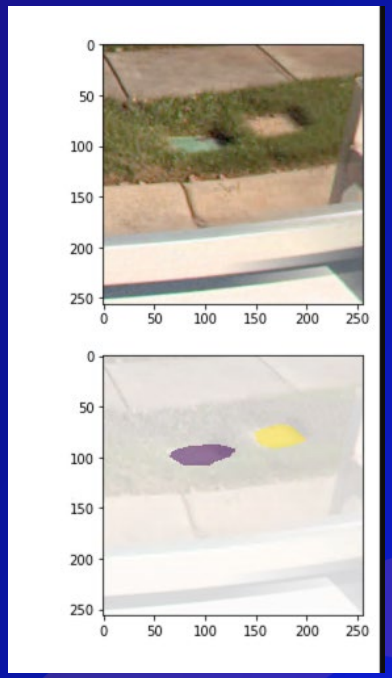
Image collection

360-degree pictures

Deep learning model

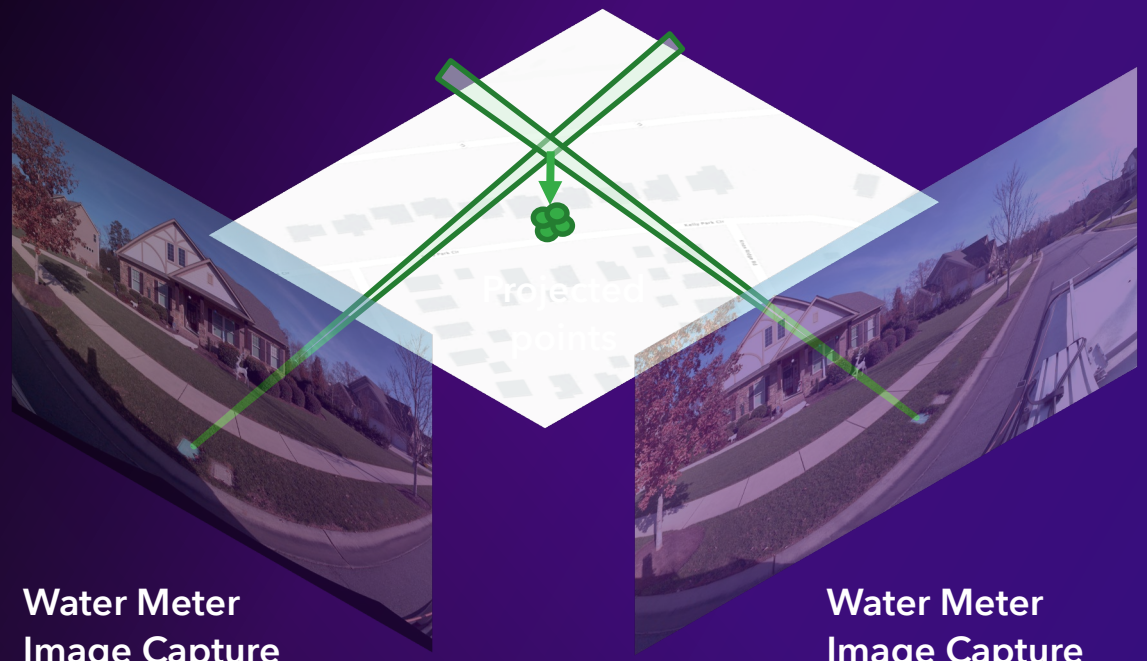


Machine learning results



Driving service routes

Photogrammetry | From Pixels to Geographic Coordinates



Water Meter Image Capture #1

Water Meter Image Capture #2

- Pictures of same meter from different angles
- Derive bearing lines
- Intersect bearing lines
- Project intersection points onto map
- Cluster points into distinct meter boxes

Crash Risk Analysis Using Hot Spots, Clustering and Space-Time Cubes (Pima County)

Use Case

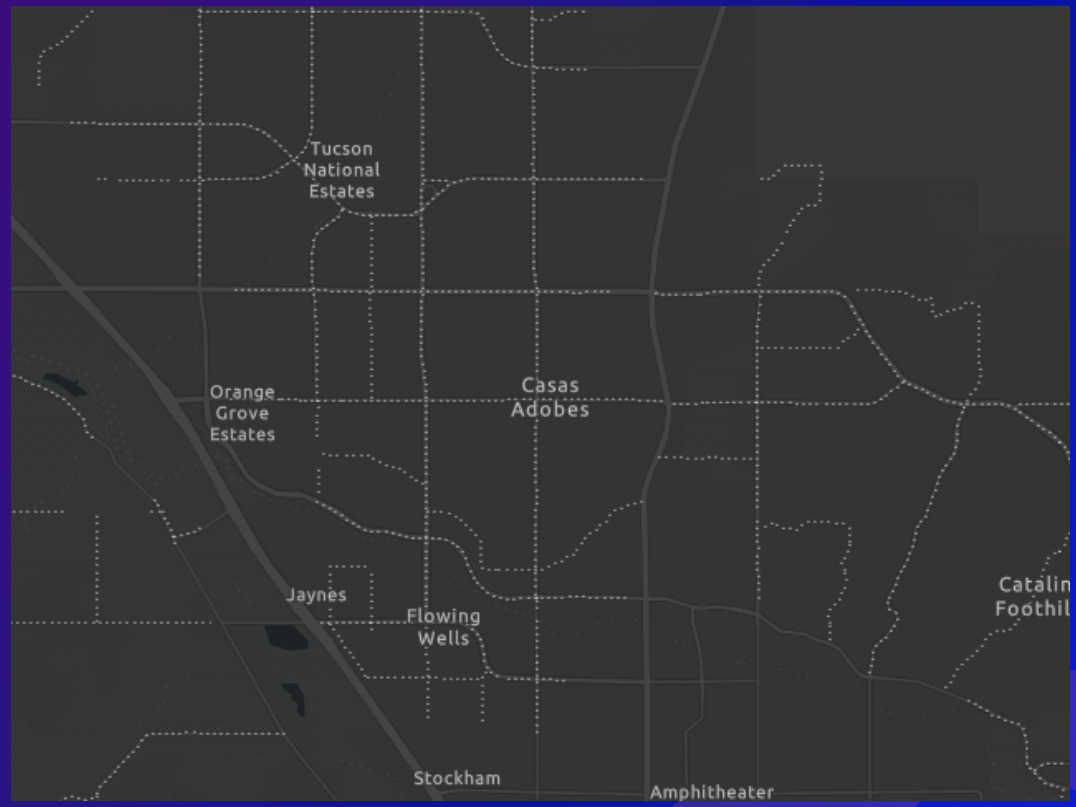
- Where are the statistically significant high incidence of crashes?
- Target high-risk areas for remediation

Preparing the Data

- Split road network into uniform segments, represented by a point
- Find nearest road point to each crash
- Aggregate crashes that occur at each road point

Hot Spot Analysis and Clustering

- Network Spatial Weights
- Hot Spot Analysis
- Clustering → Zones of Concern

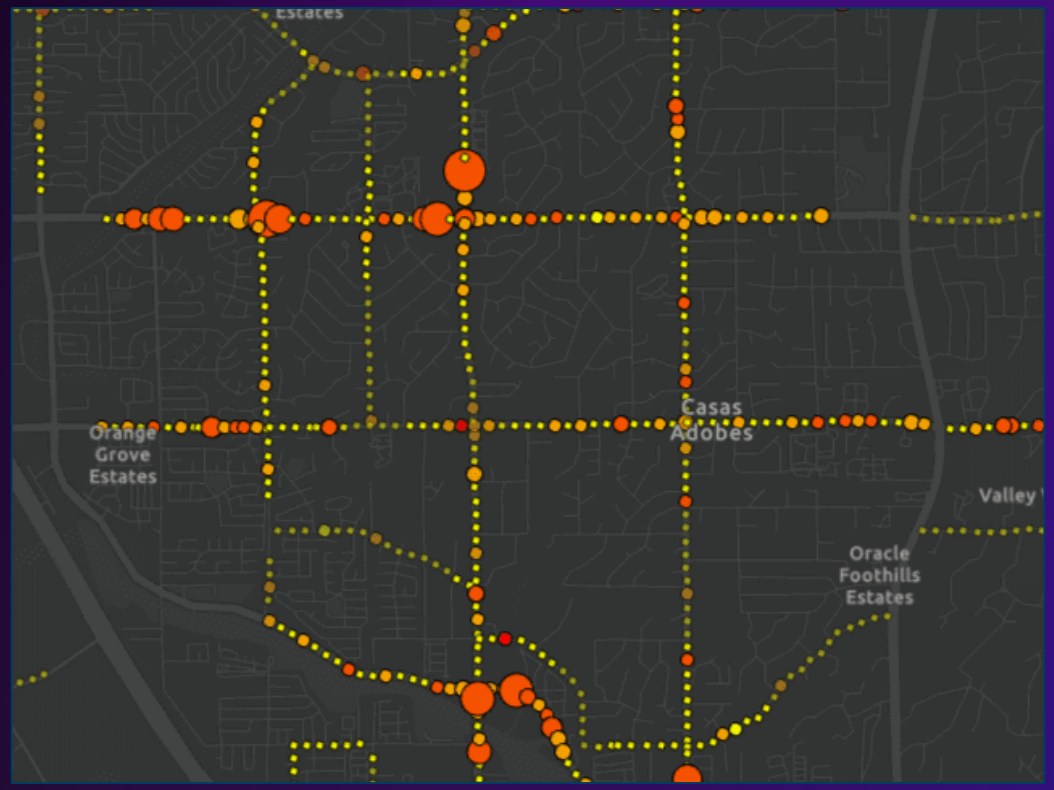


Score and Rank Zones

- Scoring criteria
  - Traffic exposure
  - Number of crashes
  - Severity of crashes

Temporal Analysis

Time-enabled map of crashes along road network



Space-Time Cube for 3D analysis

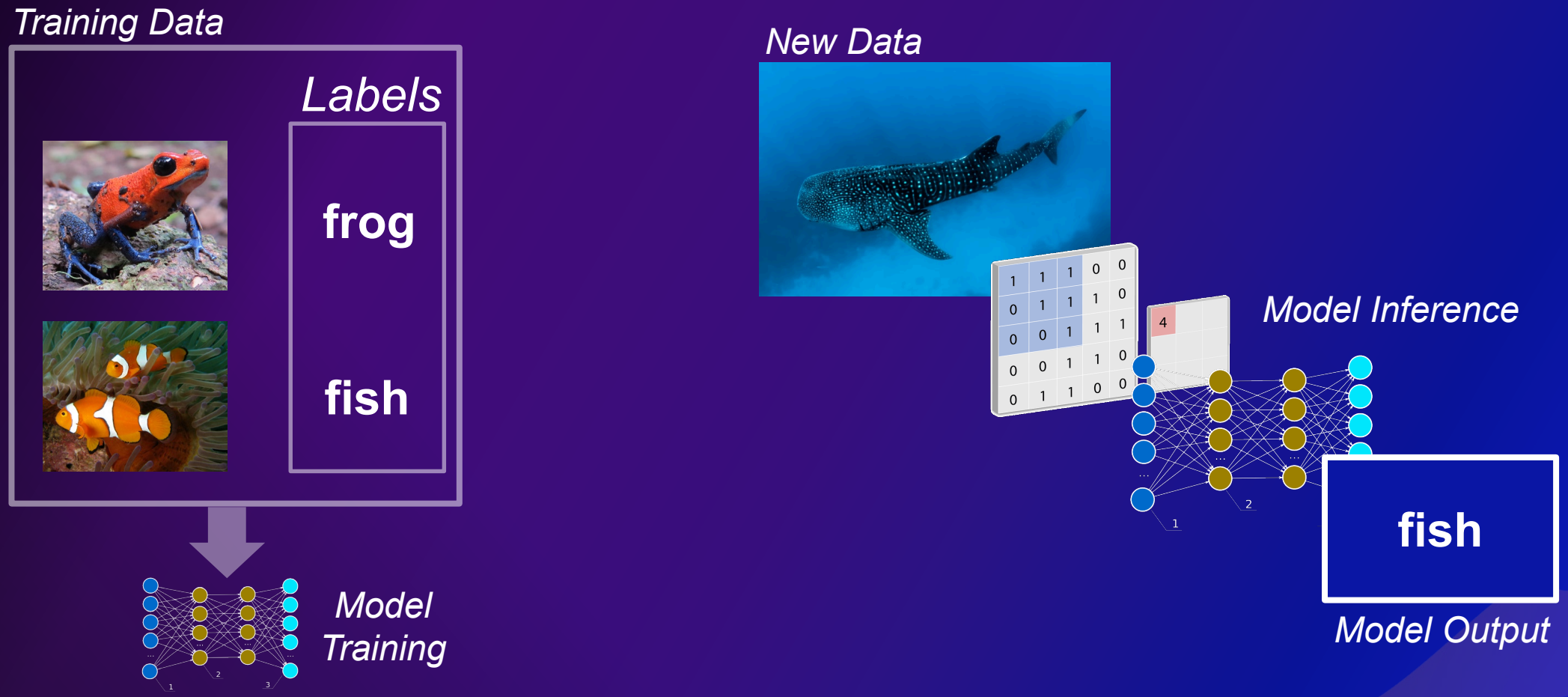
Further Iterations

- A/B Testing
- Pedestrian and Bicyclist Safety

Extracting geo-relevant data from images and video

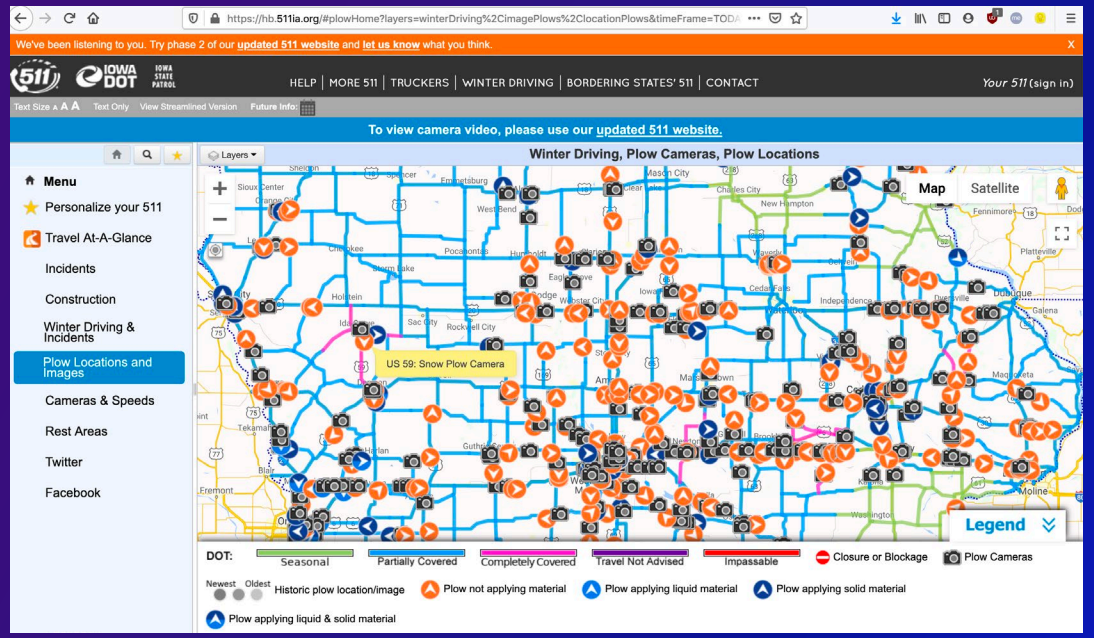
Customer use cases for machine learning

Machine learning models extract information from images and video



Winter road conditions from dashcam images

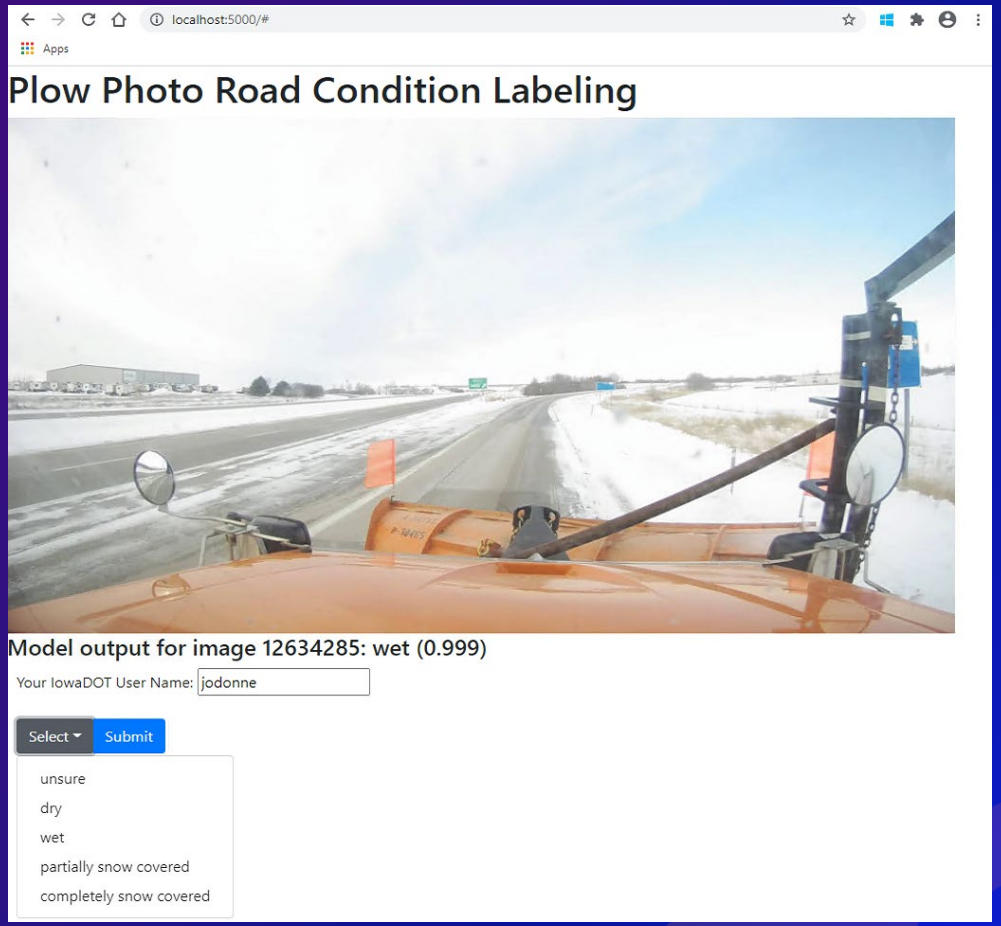
- Iowa Department of Transportation (DOT)
- Dashcams on ~700 plows
- 511 road condition reporting:
  - Dry, wet, partial or complete snow cover



- trackaplow.iowadot.gov
- data.iowadot.gov

Winter road conditions from dashcam images

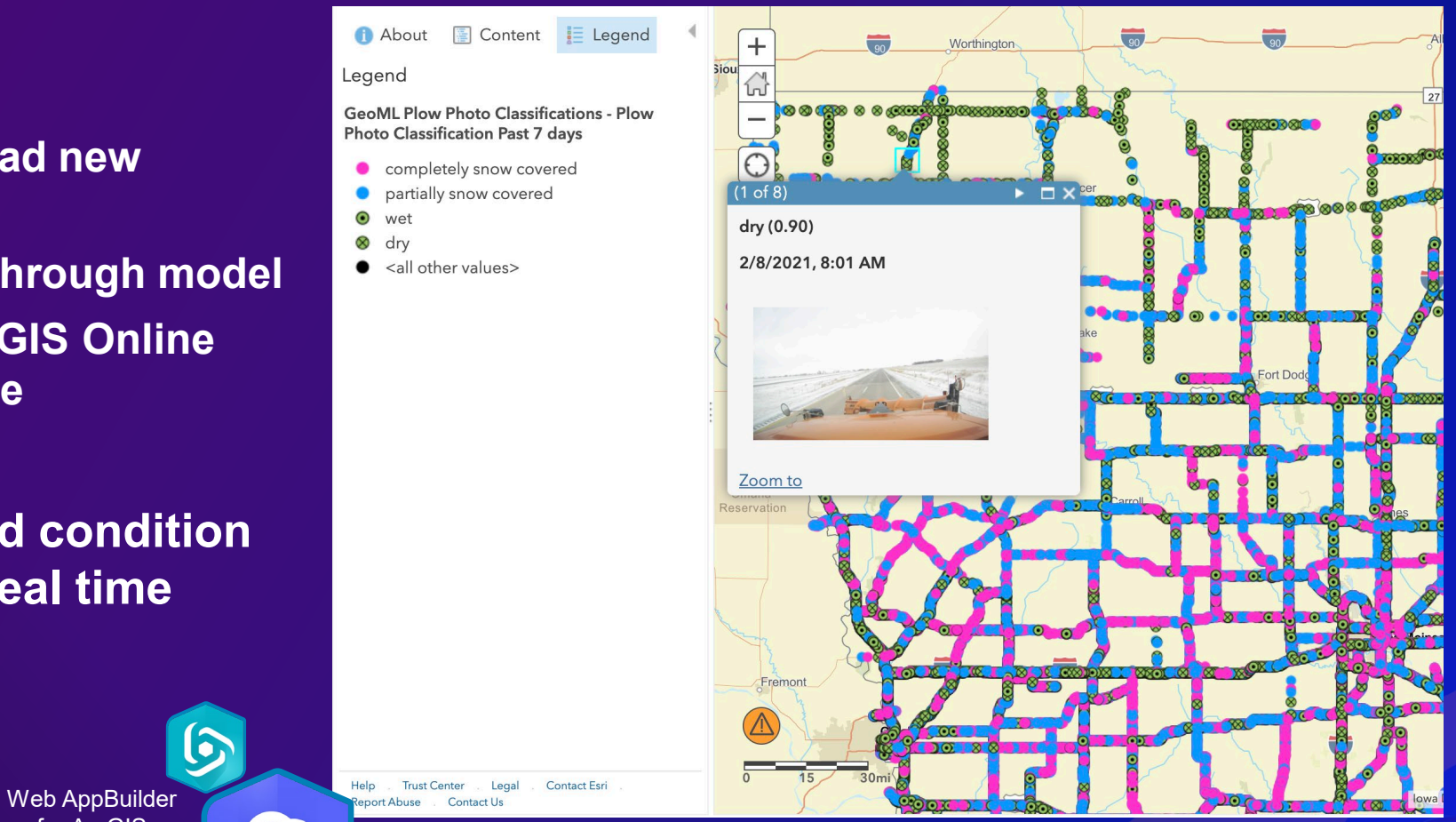
- Iowa DOT team labeled ~10,000 images to train the model
- Model trained on desktop with GPU
- Performance improved with data *quality*, not *quantity*



Winter road conditions from dashcam images

- **Every five minutes:**
  - **Check for and download new images**
  - **Run any new images through model**
  - **Write output to an ArcGIS Online Hosted Feature Service**

- **Documents winter road condition assessments in near real time**



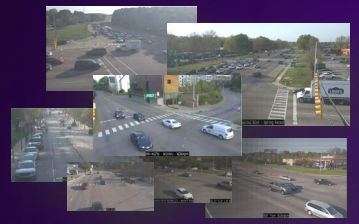
Web AppBuilder for ArcGIS

Real-time traffic analytics from streaming video

- City of Raleigh, North Carolina
- 200+ stationary networked traffic cameras
- Goal:
  - Leverage existing camera network and GIS to gain insights to traffic pattern and volume

Real-time traffic analytics from streaming video

Video Feeds (RTSP)



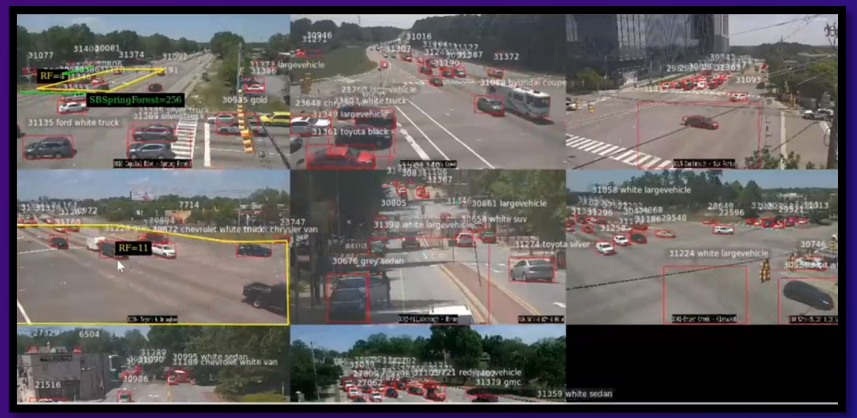
Deepstream

NVIDIA

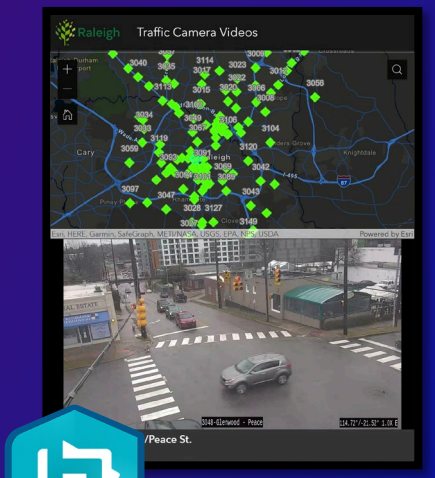
- Decode
- Pre-Process (CUDA)
- Detect, Track (TensorRT/CUDA)
- Encode, Composite

Dell R740; Nvidia Tesla T4

kafka



GeoEvent Server



ArcGIS Experience Builder

ArcGIS Online

Web AppBuilder for ArcGIS

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We want your feedback

Click on the Session Survey link
below this video window

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