Leveraging Technology for Safer Streets: Innovations for Vulnerable Road Users

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City of Seattle

Innovation Timeline

- 2019
  Adaptive Signals
- 2021
  Probe-Based Travel Times
- 2024
  VRU Responsive Signals

Innovation Results

- 2019
  Adaptive Signals
- 2021
  Probe-Based Travel Times
- 2024
  VRU Responsive Signals

When piloting new technology:

Verify your use case.

2019: Adaptive Signals Evaluation

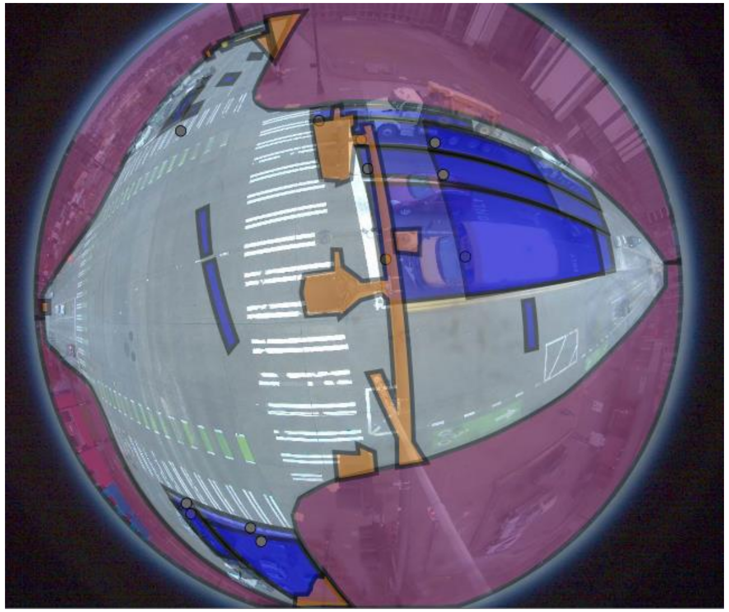
Is video detection a feasible alternative to loops for signal operations?

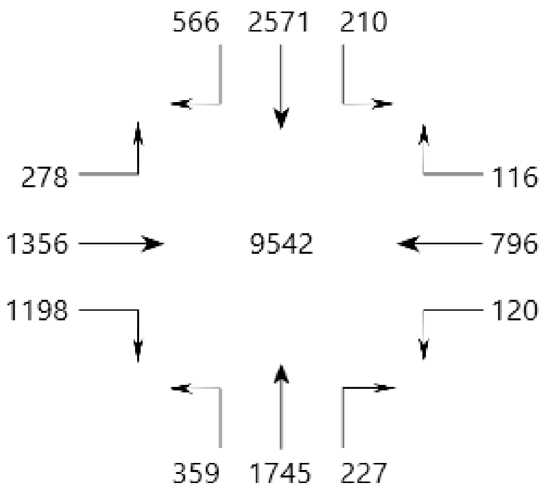
- Evaluated 3 video-based signal detection systems
- Compared light and heavy traffic volumes, day and night light levels, rain and sun factors
- No Camera could accurately detect vehicles in the stop bar and the advanced zones with the same view
- **2 systems could accurately detect vehicles at the stop bars**

Figure 1: Location of Video Detection Evaluation

Adaptive Signals in Action

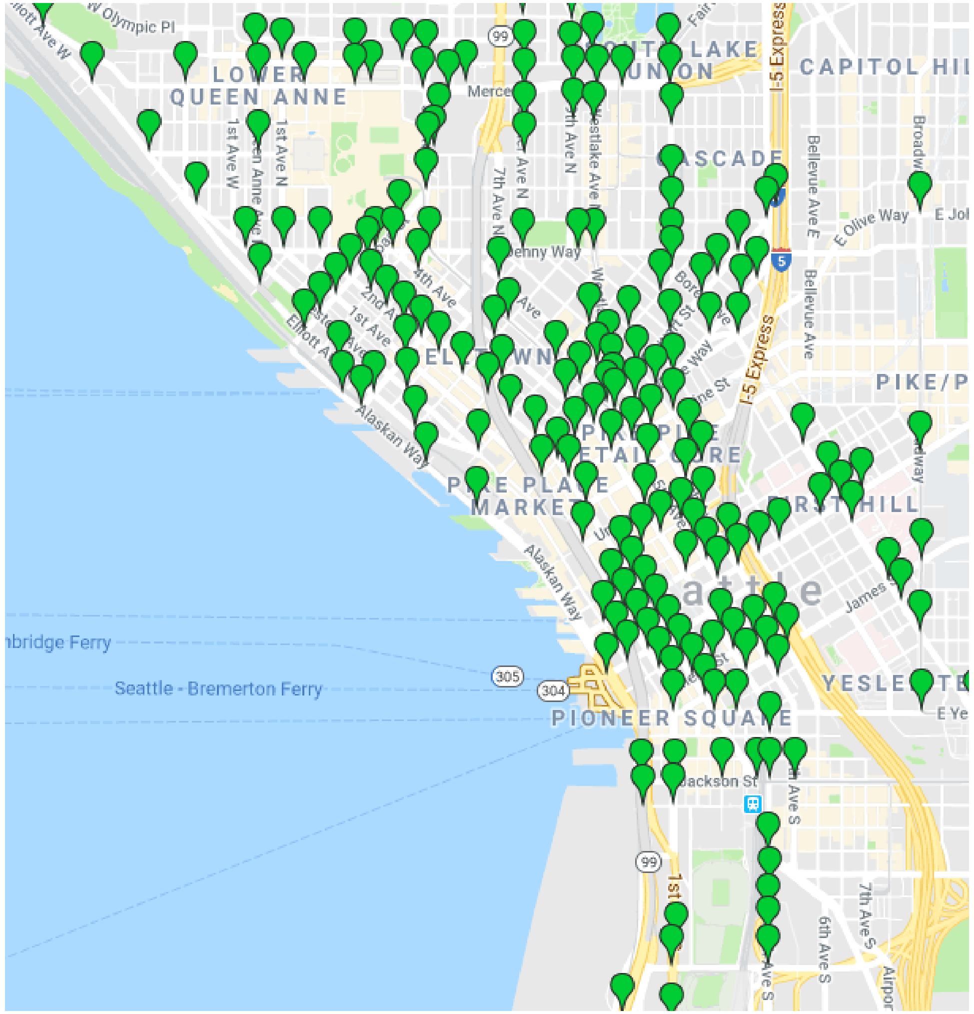
- 130+ intersections with detection from 1-2 bell cameras
- Allows for 24/7 **vehicle** counts, although often 20+% undercounting at night





2021: Probe-Based Travel Times

- Initial Solution: Wi-Fi signal monitoring
  - 300+ sensors
  - Linear increase in annual fees and maintenance
    - Where’s the budget?



2021: Probe-Based Travel Times

Probe Data: real-time data from connected vehicles, GPS and navigation devices.

- Evaluated 7 vendor solutions on
  - Features offered
  - Data quality

	HERE	ITERIS	Moonshadow	Otonomo	SMATS	Wejo	INRIX	TomTom
Data Sources	**HERE**	**ITERIS**	**Moonshadow**	**Otonomo**	**SMATS**	**Wejo**	**INRIX**	**TomTom**
If many sources, can we isolate them separately or is it all rolled up?	No. All Rolled Up.	Yes, when provided by the dataset	Yes	Yes	Not beyond "Google is one source, HERE is the other"	Some Isolation possible	No - Real Time Yes - Trips Data Yes - Historic	Yes for Historical No for real-time
Can we separate devices vs vehicles?	No	Yes, when provided by the dataset	Only with OEM data	Yes for Vehicle data only. No for app-based data.	Yes, if done by the providers	Yes. Vehicle data only. No app-based data.	Yes	Yes
Your Product(s)	**HERE**	**ITERIS**	**Moonshadow**	**Otonomo**	**SMATS**	**Wejo**	**INRIX**	**TomTom**
Do you have OD Capability?	Yes, but through a partner	Yes	Yes	No	No.	Yes	Yes	Yes
Real-time	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Data Quality	**HERE**	**ITERIS**	**Moonshadow**	**Otonomo**	**SMATS**	**Wejo**	**INRIX**	**TomTom**
Do you regularly compare your speed/travel time data to other sources (outside your control)? If so, what data (bluetooth, Wi-Fi, LPR, floating-car other vendors)? How often?	Some	Yes. Bluetooth/Wi-Fi	Can filter out invalid data, but mostly trust the vendors	No	Yes, with our client's Bluetooth/WiFi	No	Yes. Bluetooth/WiFi reader tests 4X/year	Yes
If any data is "filled in", will the system clearly report that to the user? In other words, can the user understand immediately if data is "real" or filled in?	Yes - Confidence Factor	Yes	N/A	N/A	No for Google Yes for HERE	N/A	Yes - Confidence Score	Yes
Do you have actual trip numbers that a client can access? For a given time period and a given segment, can your system report how many individual observations or trips were captured?	No	Yes, for historical data	Yes	See Note	No	Yes	Yes	Yes
If you do have actual trip numbers, do you compare those to any volume ground-truth in order to get true penetration rates? If so, what sources of volume ground-truth? What is the scale of these penetration rate tests? What extent? How often?	N/A	No	No	No	N/A	No	See Note	No
Privacy	**HERE**	**ITERIS**	**Moonshadow**	**Otonomo**	**SMATS**	**Wejo**	**INRIX**	**TomTom**
Can you provide raw data (individual trips/datapoints)?	Yes	Yes, Only through Iteris data	Yes	Yes	No	Yes	No	No
If raw data is available in your system, can a client opt out? In other words, can they definitively say that they cannot access raw data?	Yes	Yes	Yes	No	N/A	Yes	N/A	N/A
Does your system report on neighborhood streets? If not, describe where your breakpoint is between mainlines and neighborhood streets? Only large arterials? Small connectors? Any info you can give on coverage would be appreciated.	If sufficient volume	Yes	Depends on Data Provider	Depends on Provider	Some	Yes	Some	Yes
Platform*	**HERE**	**ITERIS**	**Moonshadow**	**Otonomo**	**SMATS**	**Wejo**	**INRIX**	**TomTom**
Do you have a web-based, client-facing platform?	Not directly	Yes	Yes	Yes	Yes	No	Yes	Yes
Is it a map-based interface?	Yes, via HERE partner Iteris.	Yes	Yes	Yes	Yes	No	Yes	Yes
Can the client build their own studies?	Yes, via HERE partner Iteris.	Yes	Yes	No	Yes	No	Yes	Yes
Can the client edit studies?	Yes, via HERE partner Iteris.	Yes	Yes	No	Yes	No	Yes	Yes
Can the client pull reports?	Yes, via HERE partner Iteris.	Yes	Yes	Yes	Yes	No	Yes	Yes
Does the platform allow real-time analysis?	Yes, via HERE partner Iteris.	Yes	Yes	Yes	Yes	No	Yes	Yes
Map-based reporting/visualization?	Yes, via HERE partner Iteris.	Yes	Yes	Yes	Yes	No	Yes	Yes
Can the client create custom, automated reports and alerts that can push to email/text/DMS?	Yes, via HERE partner Iteris.	Yes	Not yet, but we can prioritize that development if needed.	No	Yes	No	Yes	Yes
Origin-destination analysis and reporting?	Yes, via HERE partner Streetlight Data.	No	Yes	Yes	No	No	Yes, through the Trip Paths/Analytics.	Yes
Other Questions/Features?	**HERE**	**ITERIS**	**Moonshadow**	**Otonomo**	**SMATS**	**Wejo**	**INRIX**	**TomTom**

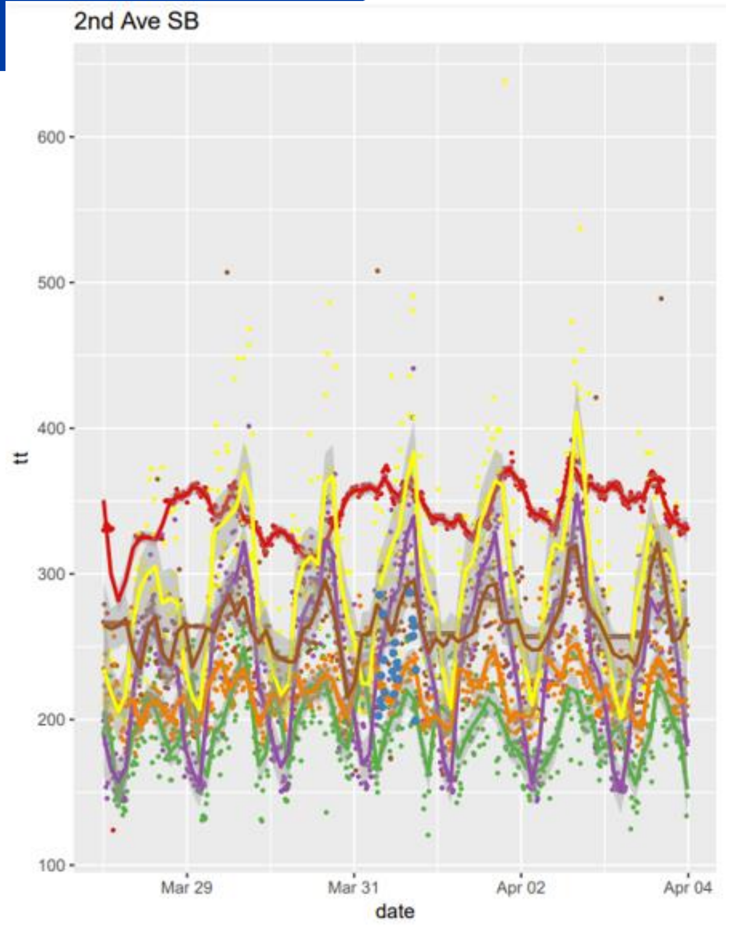
2021: Probe-Based Travel Times

Travel times can be accurate

- Seven vendor solutions compared with a floating car on four Seattle arterials

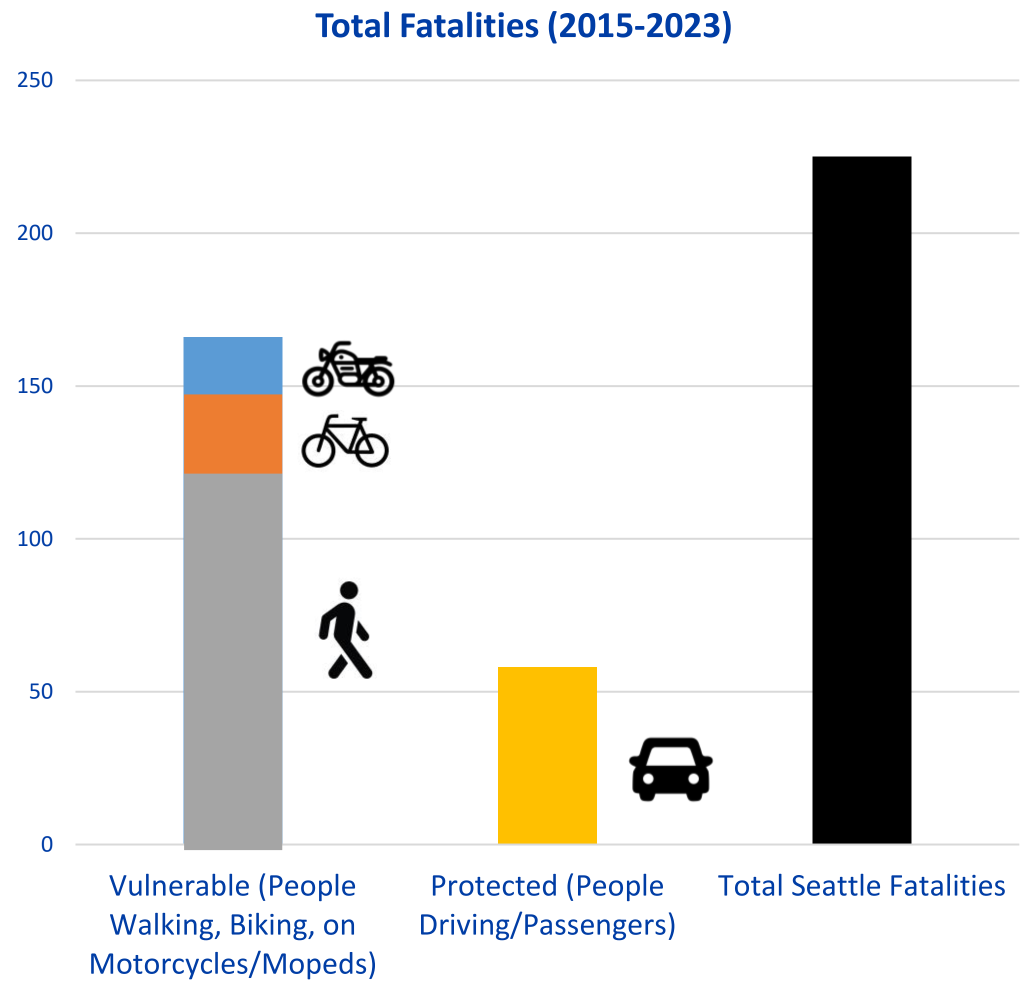
Speeds can be are accurate

- Average speeds on the Aurora Bridge matched our own pneumatic tube speed study



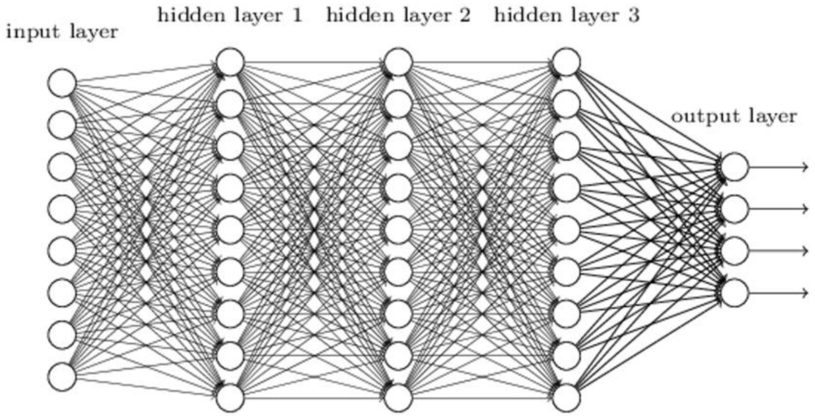
"Performance on the slowdown analysis – the current preferred way to quantify operational performance on arterials – improved dramatically" when comparing probe data from 2013 to 2018.
-University of Maryland Vehicle Probe Project

Increased Focus: Vulnerable Road Users



Shift in Technology: AI/ML Video Analytics for Cyclist & Pedestrian Responsive Signals

New Models



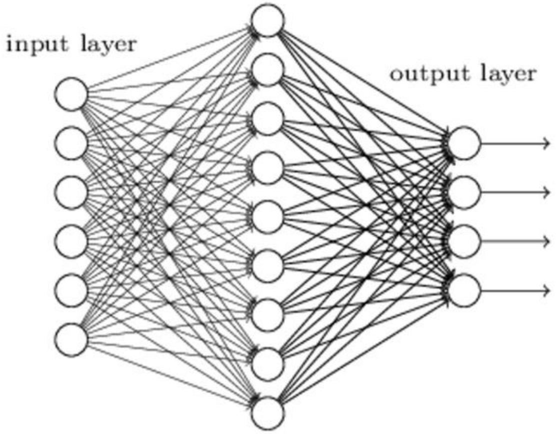
Extensive Classifications

- Cars, Trucks, Pedestrians, Bicycles, Strollers, Wheelchairs, Pets

Extensive Reinforced Learning

- Years of model training
- Specific to transportation

Initial Models



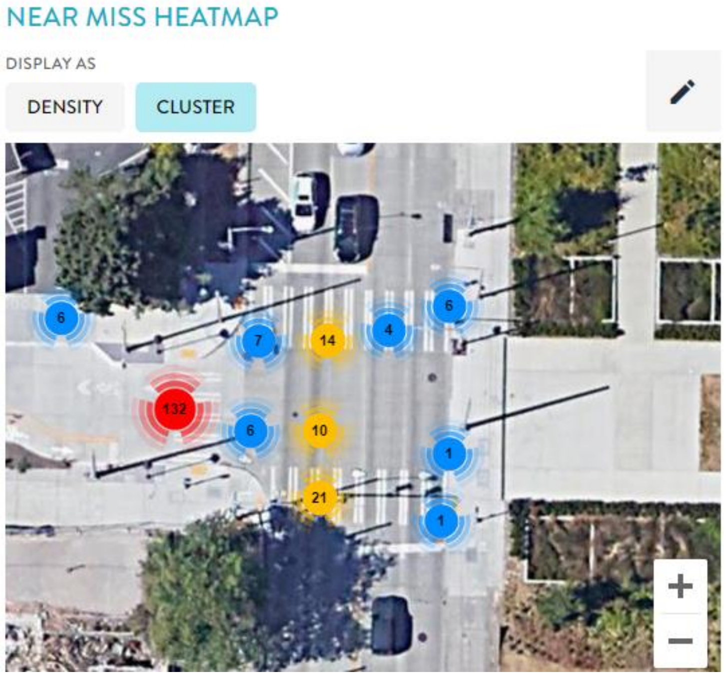
Basic Video Detection & Classification

- Use of public domain models and learning sets
- Not specific for transportation

Video Analytics: Edge Detection

Near Miss Analysis

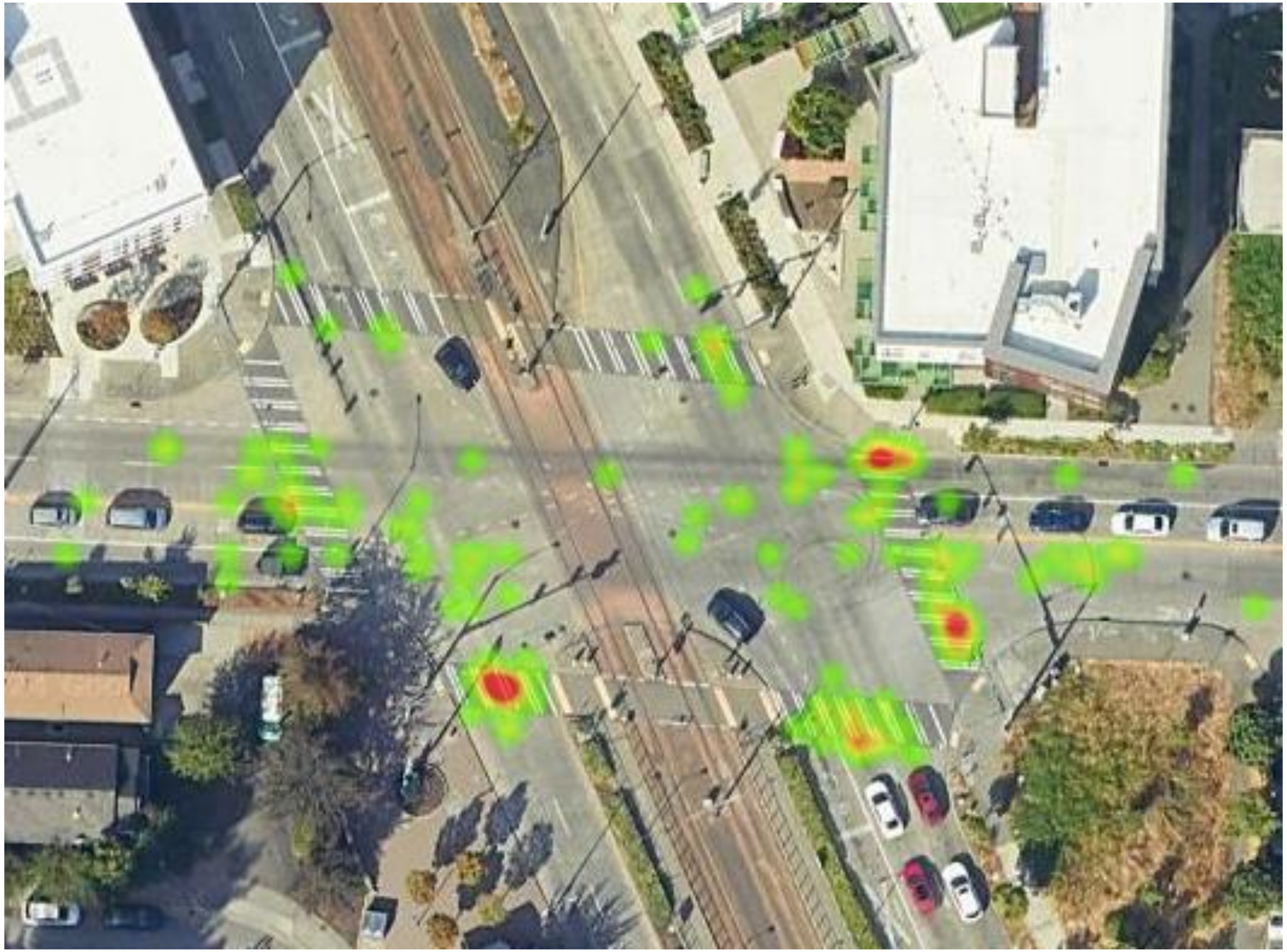
- Red light running (Car and Pedestrian)
- Lane compliance
- Wrong way driving
- Stopped vehicle detection
- Near Miss heat maps



Better describe the problem

Detect and Classify
all objects in view

Near miss heatmap->

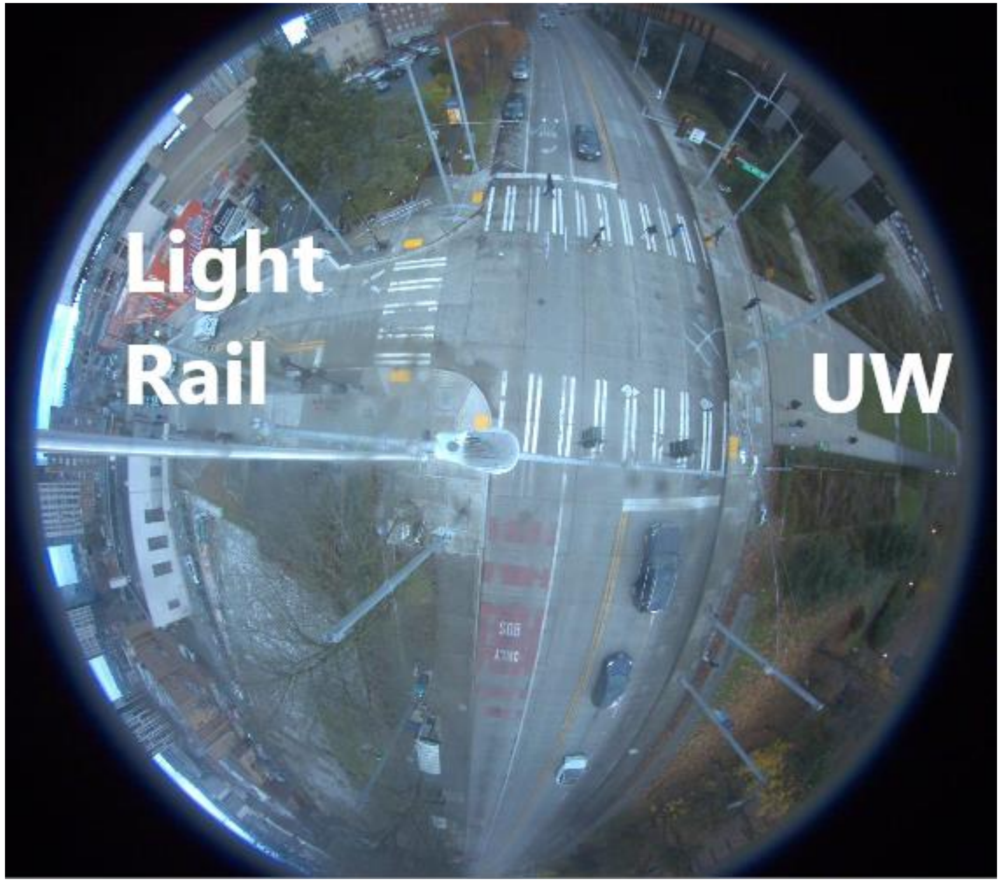


Better describe the problem

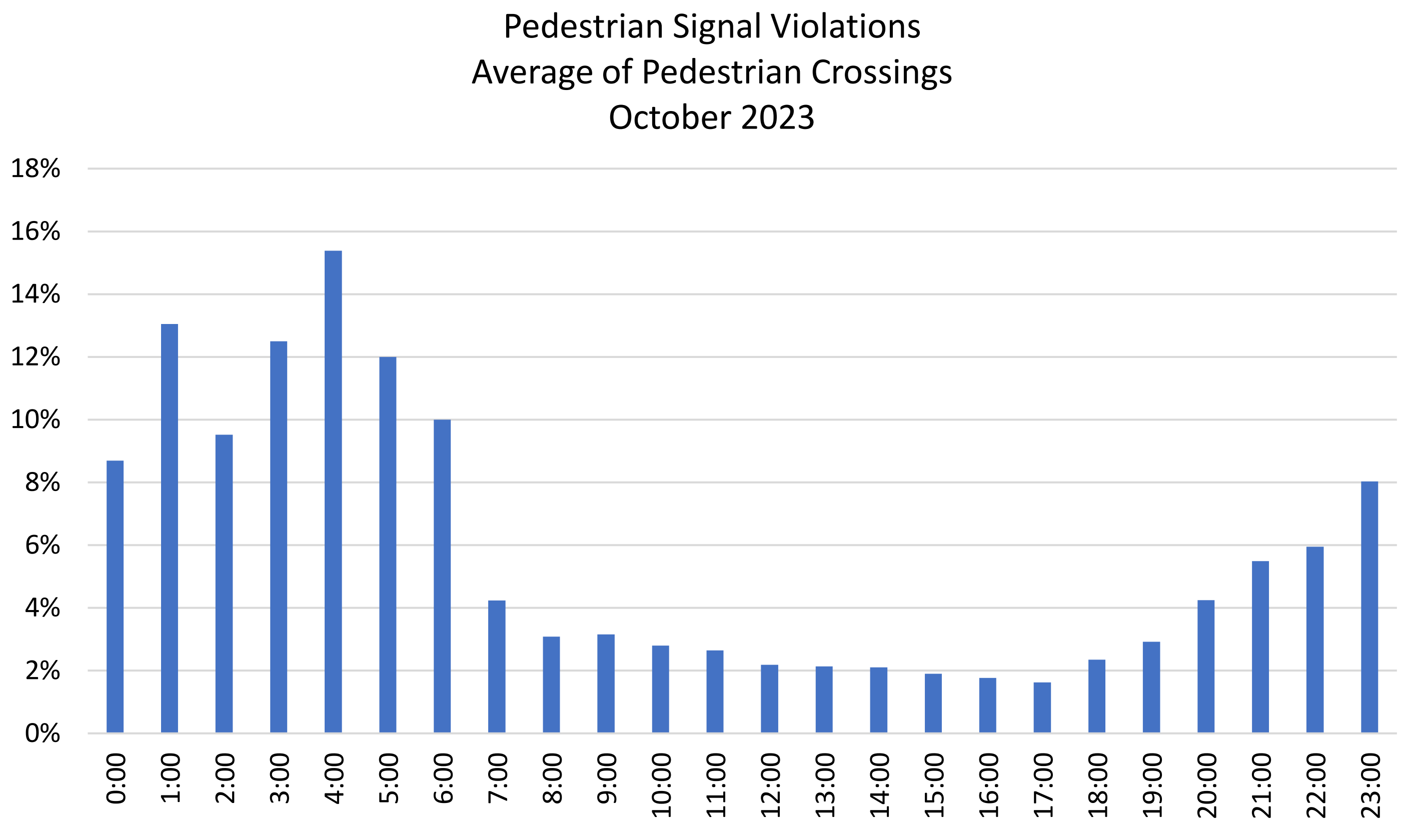
Detect and Classify all objects in view

Map of pedestrian movements not in crosswalk ->

Pedestrian Detection



What if the signal was responsive to pedestrians?



Can We Detect Cyclists?

- **Evaluation 1** utilized standard definition (SD) fisheye cameras
- **Evaluation 2** utilized SD cameras, with updated AI based detection software
- **Evaluation 3** utilized HD cameras, with updated AI based detection software
- **Evaluation 4** utilized HD cameras, with updated AI based detection software, updated Nvidia GPU hardware, and double-detection zones

Eval 3: Bicyclist Detection

Clear, Day/Evening

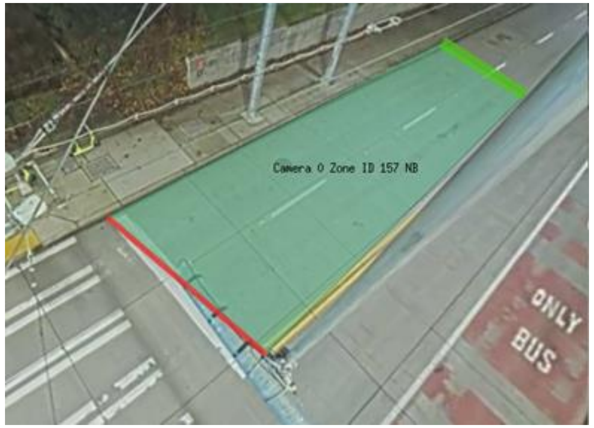
metric	bike_total	bike_eb	bike_nb
detected	99	54	45
detected_misclassified	0	0	0
no detection	4	2	2
actual	103	56	47
improper_detection	5	5	0
percent_classified	96.1%	96%	96%
percent_misclassified	0.0%	0%	0%
percent_detect	96.1%	96%	96%

- **Evaluation 3** utilized HD cameras, with updated AI based detection software

Eval 4: Bicyclist Detection

- Can we get there in the dark and rain?

- **Evaluation 4** utilized HD cameras, with updated AI based detection software, updated Nvidia GPU hardware, and double-detection zones



Thank You

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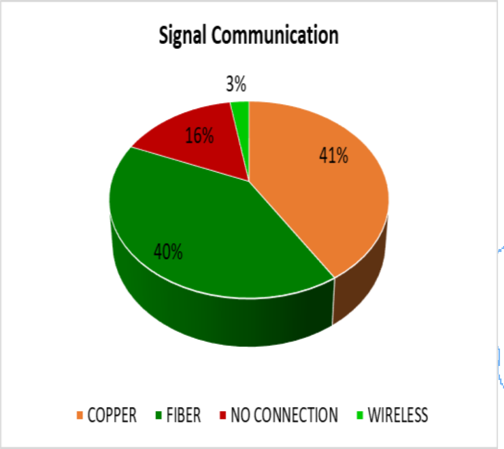
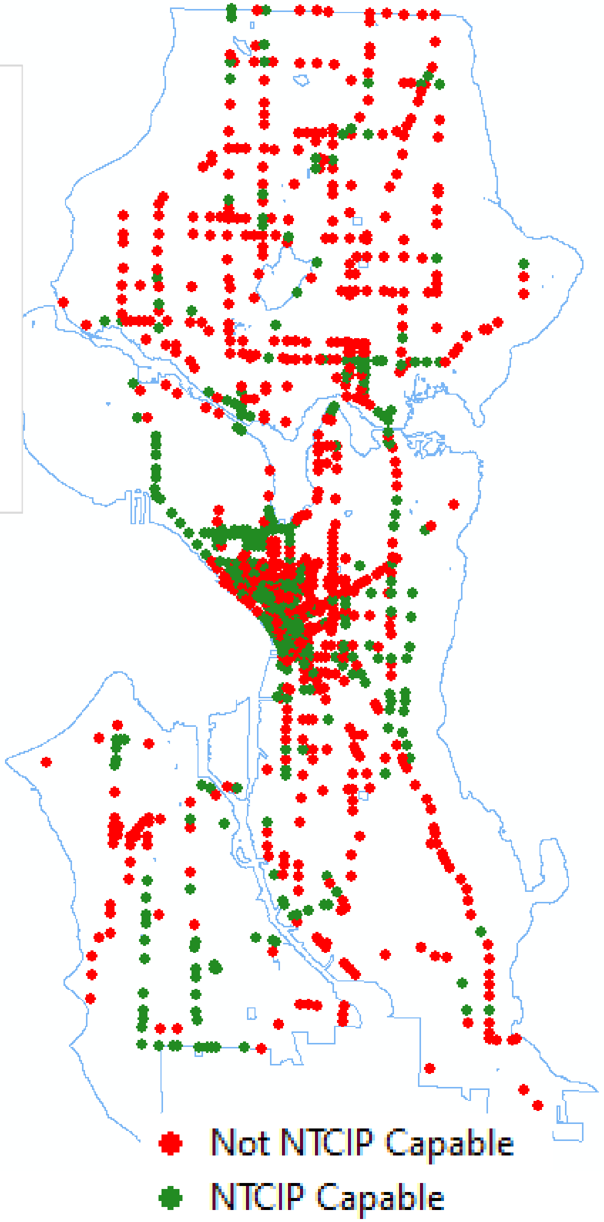
SDOT’s Intelligent Transportation System

- 1,100 traffic signals
- 550+ cameras
- 35+ Electronic signs, detection devices, bridge weather sensors, etc.





- Transportation Operations Center, Dispatch, and response teams
  - 24x7x365

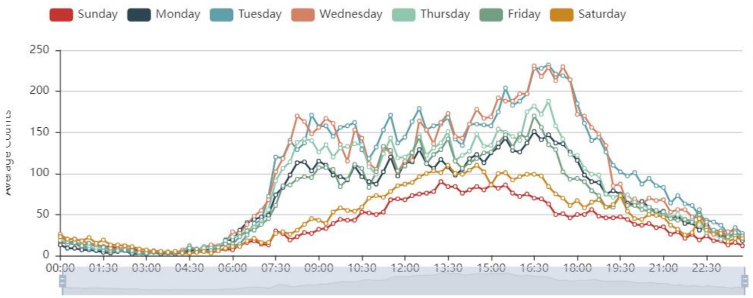
Result: Lower Speeds to Save Lives

- Full knowledge of vehicle speeds
  - Citywide
  - Historical and real-time data

- Enables better project prioritization, highlights areas of concern

Video Analytics: Traffic Data

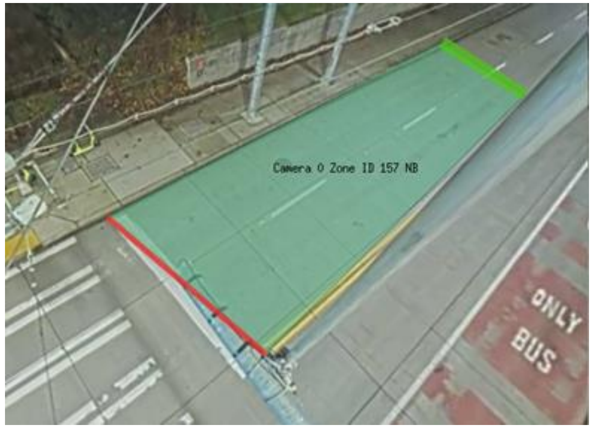
- Uses existing CCTV cameras
- Hardware-based video analytics in server room
- Volume, Classification, Speed
- Bus Lane Violations
- 2022 Pilot



Eval 4: Bicyclist Detection

- Can we get there?

Cyclists in the dark and rain	
Detected	44
Not detected	25
Actual	69
Percent Detected	64%



- Next steps:
  - Further train model
  - Add additional camera views
  - Explore increased intersection lighting