Florida 2021

Pedestrian Observation of Transit Accessibility Pilot Study

Florida Department of Transportation

Report

September 2021

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Pedestrian Observation of Transit Accessibility
Pilot Study

Report Prepared for FDOT by
The Public Opinion Research Lab
at the University of North Florida

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Disclaimer

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Introduction

Florida has historically ranked among the highest in pedestrian and bicyclist fatalities in the United States. According to the Governors Highway Safety Association's report on Pedestrian Traffic Fatalities, Florida ranked second in the country in 2019 for pedestrian fatality rates, at 3.3 per 100,000 population. In addition, Florida had the highest rate of bicyclist fatality in 2018 at 0.76 per 100,000 population according to the NHTSA, compared to the national average of 0.262.

To combat these issues, the Florida Department of Transportation (FDOT) implemented the *Alert Today Alive Tomorrow* media campaign in the summer of 2012. The purpose of the *Alert Today Alive Tomorrow* media campaign is to increase awareness of pedestrian and bicyclist laws and share safety tips with the purpose of decreasing pedestrian and bicycle crashes, injuries, and fatalities.

Project Background

FDOT contracted the Public Opinion Research Lab (PORL) at the University of North Florida in 2019 to evaluate the effectiveness of the pedestrian and bicyclist safety media campaigns. In order to accomplish this, PORL conducts an annual survey of respondents in the top 25 Florida counties in pedestrian and bike fatalities. The survey measures respondents' awareness of the various campaign slogans, as well as self-reported behavior associated with pedestrian and bicyclist safety.

While this survey is useful in understanding *reported* behaviors surrounding pedestrian and bicyclist safety, FDOT and PORL are also interested in their *actual* behavior. In-person observational studies were implemented in previous project years; however, they encountered some methodological difficulties. First, when pedestrians or bicyclists are aware of being observed, they tend to alter their behavior, hindering accurate data collection[1]. Second, observers were stationed at "hot spots" for pedestrian and bicyclist crashes, however the data collected did not include road characteristics, light conditions, or other important factors. In addition, in-person observations were conducted in short time increments at various times of day, rather than over a 24-hour span, limiting the scope of analysis to the times of day an observer was present.[2]

In order to mitigate these concerns, PORL contracted with software developers at Tryolabs to digitally analyze video footage gathered from FDOT traffic cameras around the state of Florida. In this pilot study, the technology was used to observe pedestrians at a variety of locations to determine whether they behaved in accordance with Florida Law. Specifically, the software highlighted individuals who crossed the street outside of a crosswalk or did not use a sidewalk when one was available. Video footage was obtained from Broward County Transit, Jacksonville Transportation Authority, Indian River Transit, Gainesville Regional Transit System, and the South Florida Regional Transportation Authority (SFRTA) stations in Palm Beach, Miami-Dade, and Broward counties.

All of the video cameras used in this study were located at public transit hubs, such as bus stops and rail stations, where pedestrians are expected to be boarding and exiting public transportation. It should be noted that the video footage was chosen purely based on availability, and no systematic sampling procedure was used to select the locations, camera

[1] Eckmanns, T., Bessert, J., Behnke, M., Gastmeier, P., & Ruden, H. (2006). Compliance with antiseptic hand rub use in intensive care units: the Hawthorne effect. *Infection control and hospital epidemiology, 27*(9), 931–934. https://doi.org/10.1086/507294

[2] Binder, M., Hopkins, A., & Stainfield, C. (2019). *Florida 2019 Pedestrian and Bicycle Safety Evaluation Analysis Report.* Florida Department of Transportation. https://www.unf.edu/uploadedFiles/aa/coas/porl/2019%20Ped%20CUTR%20Eval%20FINAL.pdf

angles, or road characteristics. Consequently, observations in the data is not reflective of the counties or the state of Florida. The purpose of this study is to establish an accurate and efficient methodological approach to observational data collection using video detection software and obtain a cursory understanding of pedestrian behavior around these transportation hubs.

Further discussion of the data collection, analysis, and goals for future research can be found in the “Methodology” section of this report.

Summary of Findings

Figure 1. Number of Noncompliant Behaviors by Time of Day

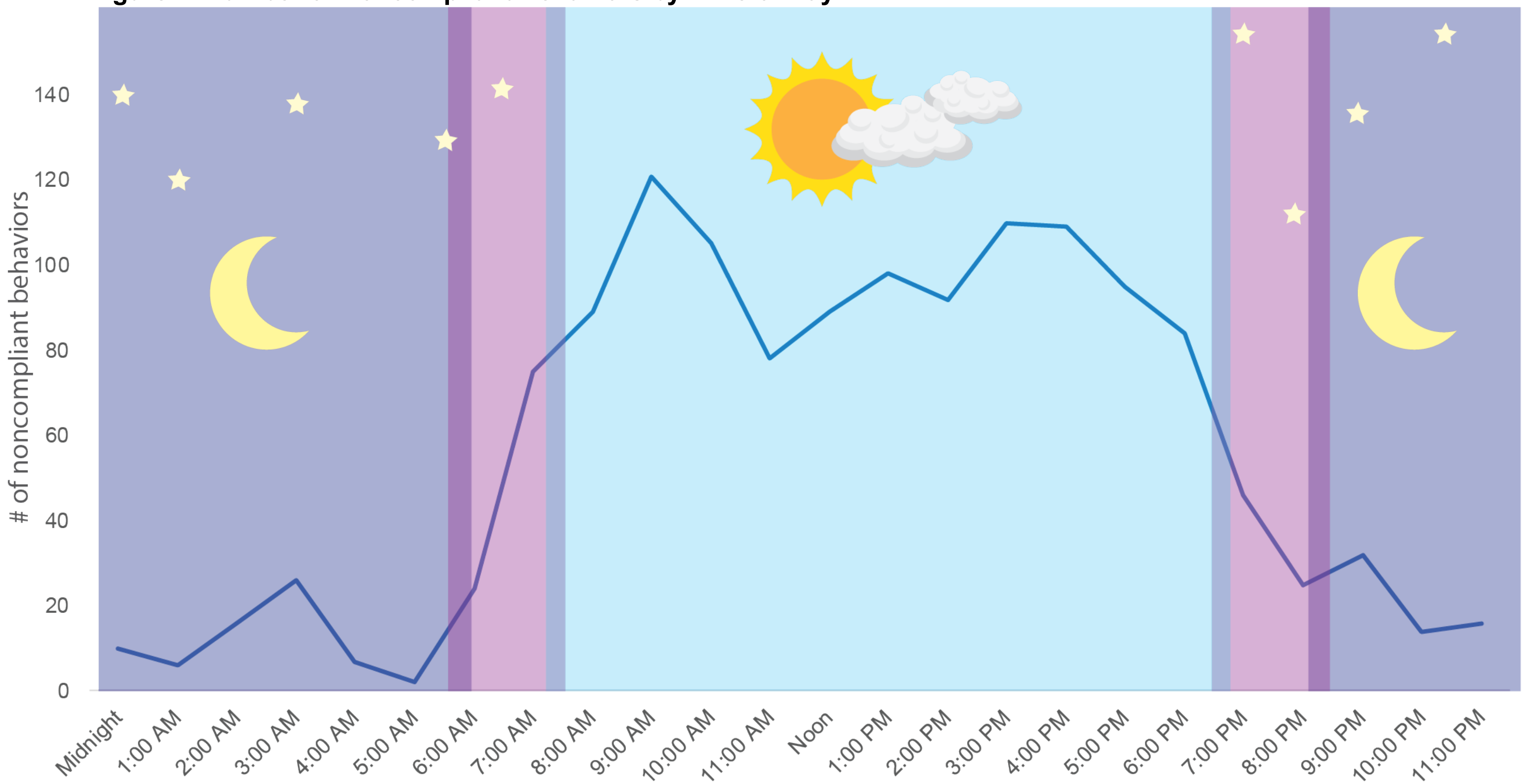
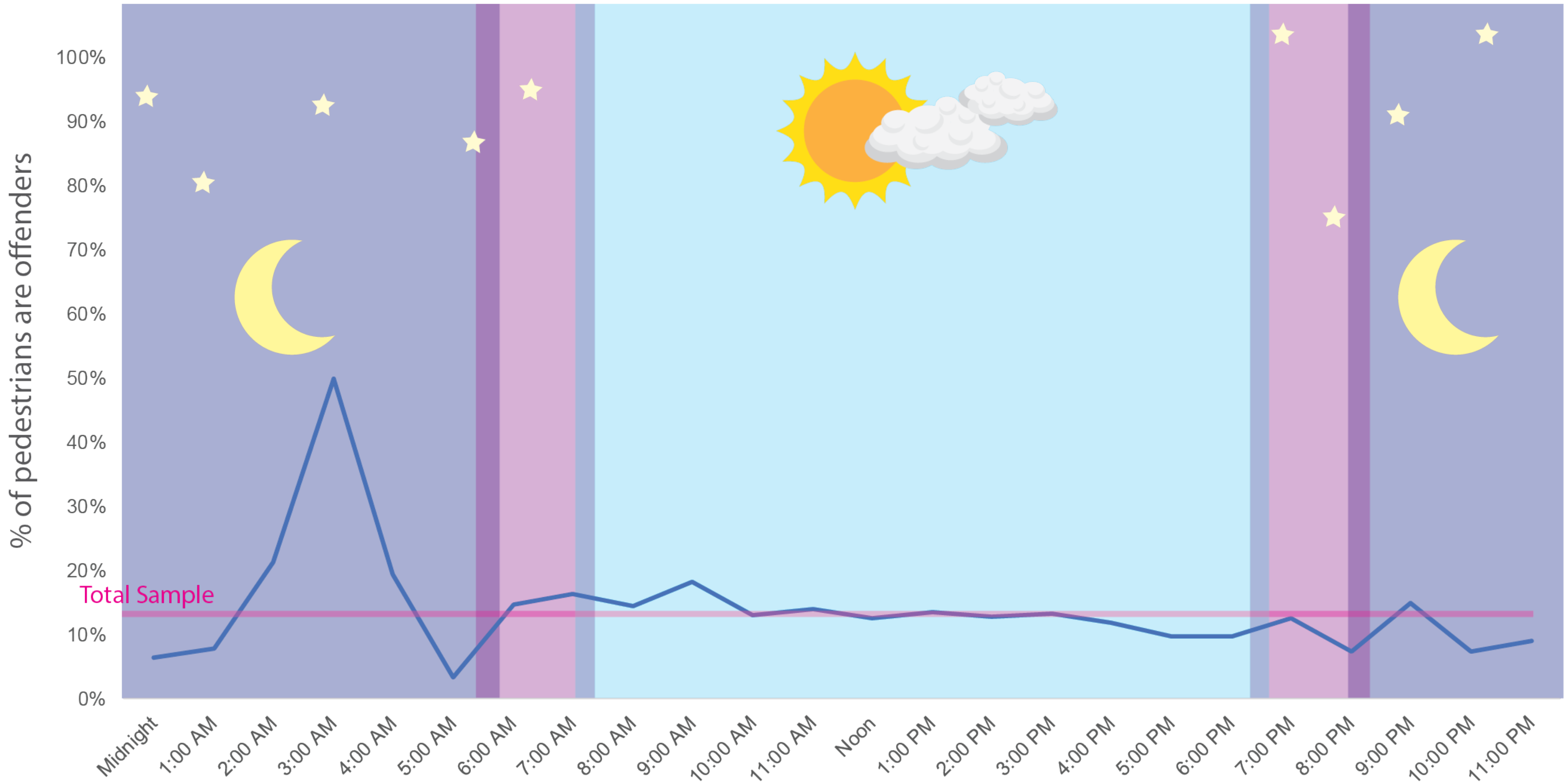


Figure 1 above shows the number of noncompliant behaviors that occurred over all locations, broken down by time of day. The number of noncompliant behaviors is relatively low during nighttime hours and peaks during the daylight hours with 10:00 AM being the highest with 121 noncompliant behaviors. The time with the fewest total noncompliant behaviors is 5:00 AM, with just two.

Figure 2. Noncompliant behavior Rate by Time of Day



Although the total number of noncompliant behaviors is higher during the day, the *noncompliant behavior rate* is highest in the pre-dawn hours, shown in Figure 2 above. The noncompliant behavior rate is calculated as the noncompliant behaviors divided by the total number of pedestrian behaviors picked up on video. Noncompliant behavior rate peaked at 3:00 AM, with 50 percent of pedestrians exhibiting behavior not in accordance with Florida law, compared to an average noncompliant behavior rate of 13 percent. This suggests that, while far more people tend to walk on the sidewalk or roadway during the day than at night, pedestrians are more likely to behave dangerously at night than during the day.

Figure 3. Noncompliant Behavior Rate by Number of Lanes

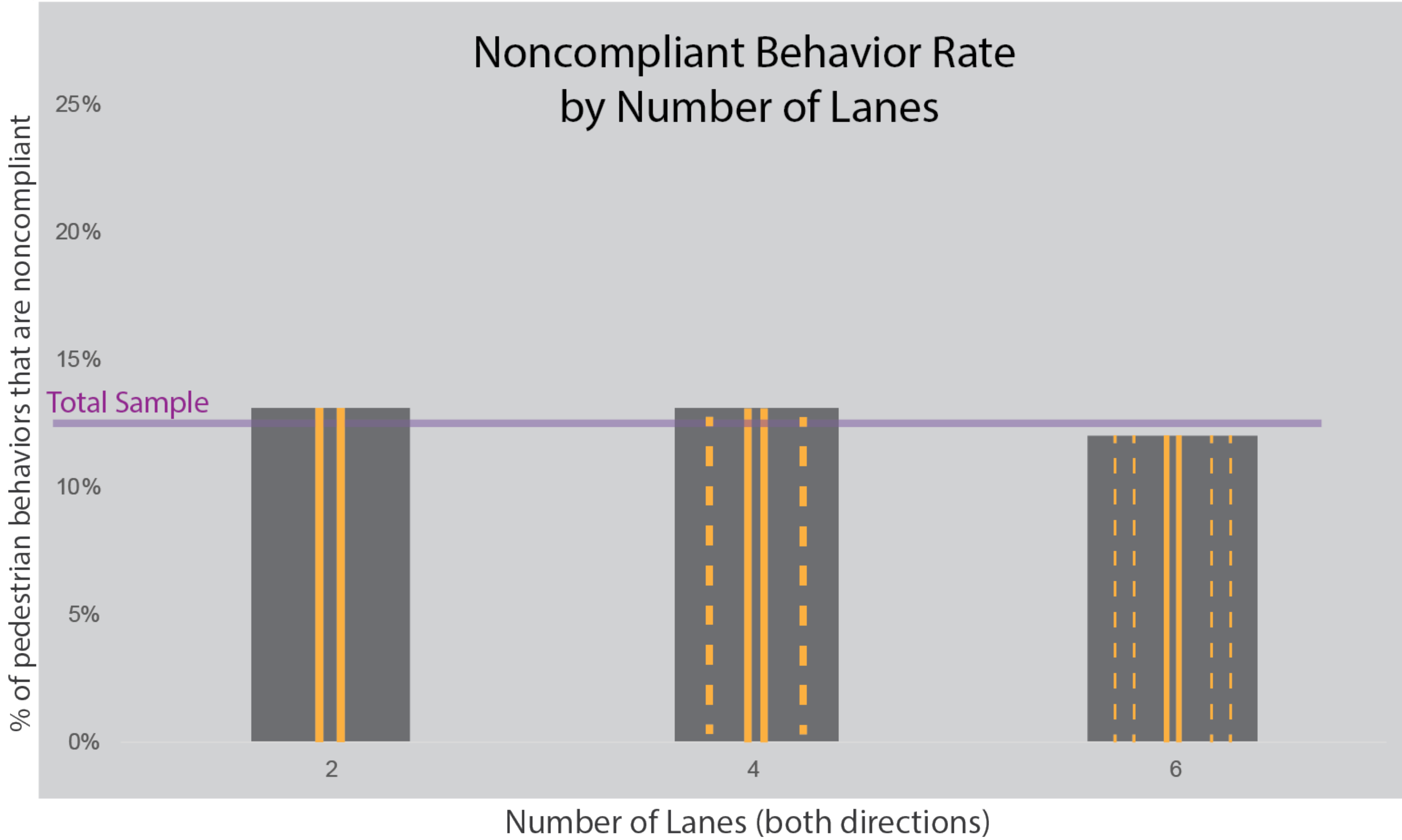


Figure 3 shows noncompliant behavior rates broken down by the number of lanes on the roadway. The chart shows the total number of lanes going both directions (e.g., two lanes is one lane going each way). Interestingly, there was little difference in pedestrian behavior between the two, four, and six-lane roads. Noncompliant behavior rates on two- and four-lane roads were slightly above the average rate of the total sample, and six-lane roads were just below.

Figure 4. Noncompliant behavior Rate by Median

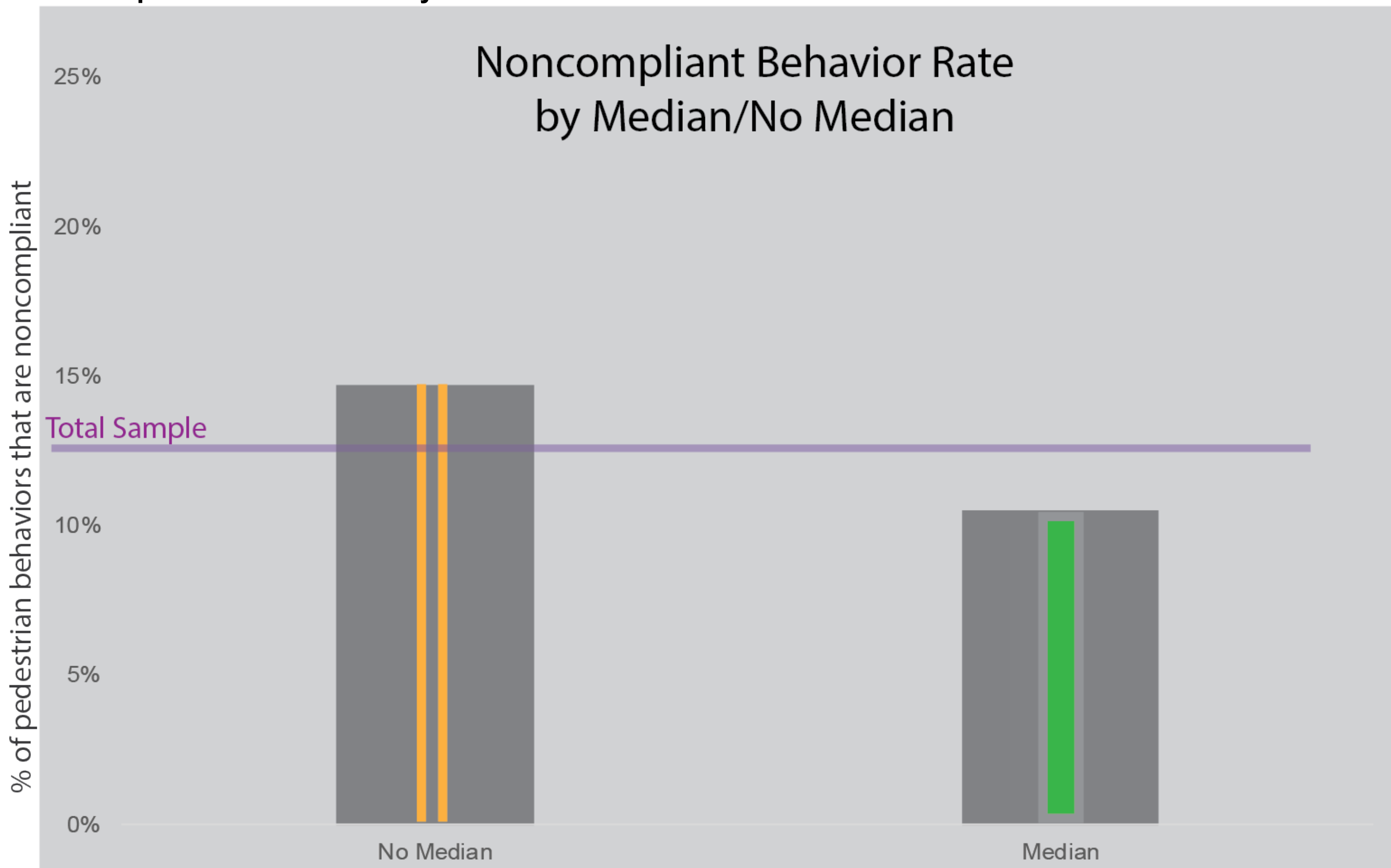
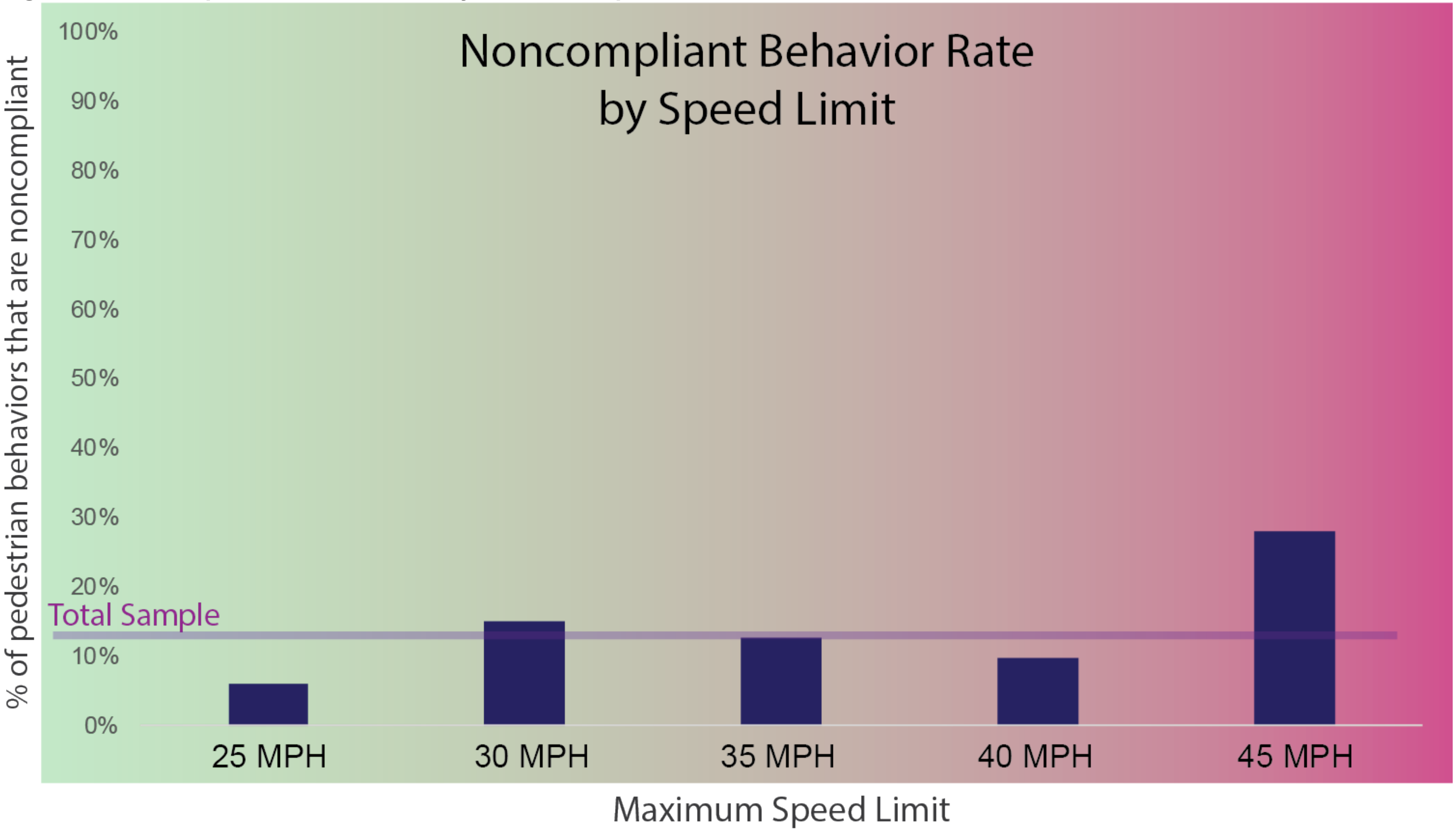


Figure 4 displays noncompliant behavior rates by the presence or absence of a median in the roadway. The data shows that pedestrians offended at a higher rate when there was no median (15 percent), than when there *was* a median (11 percent) in the roadway.

Figure 5. Noncompliant Behavior Rate by Maximum Speed Limit



Finally, Figure 5 breaks down noncompliant behavior rate by maximum speed limit. Interestingly, noncompliant behavior rates were highest on roadways with the highest speed limit in the dataset, 45 miles per hour, at 28 percent. The lowest noncompliant behavior rate, 6 percent, was observed at the lowest speed limit, 25 miles per hour.

Figure 6. County Demographic Profile (Map)

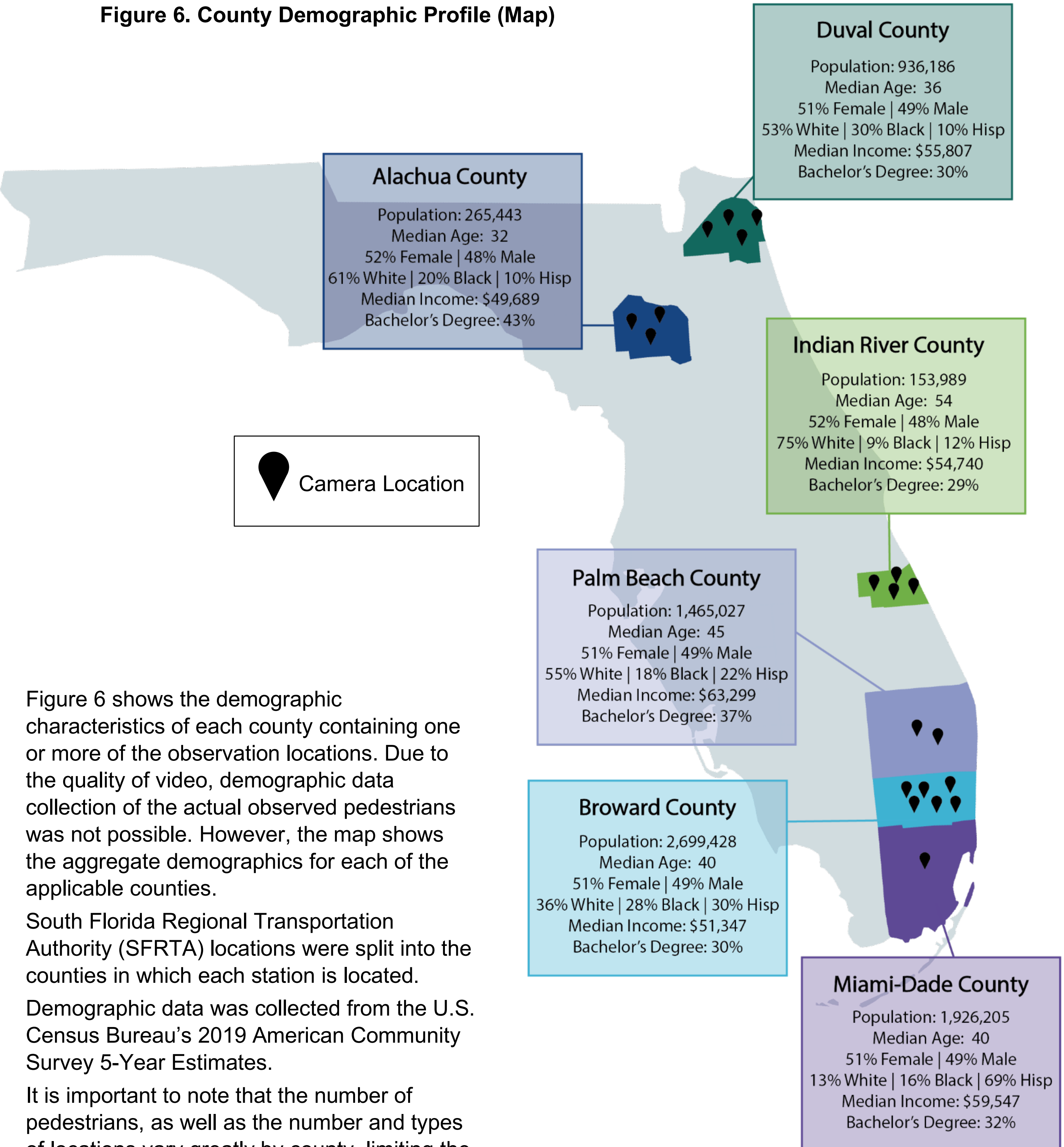


Figure 6 shows the demographic characteristics of each county containing one or more of the observation locations. Due to the quality of video, demographic data collection of the actual observed pedestrians was not possible. However, the map shows the aggregate demographics for each of the applicable counties.

South Florida Regional Transportation Authority (SFRTA) locations were split into the counties in which each station is located.

Demographic data was collected from the U.S. Census Bureau's 2019 American Community Survey 5-Year Estimates.

It is important to note that the number of pedestrians, as well as the number and types of locations vary greatly by county, limiting the assertions that can be made by direct comparisons.

Methodology

This study used video footage obtained from the Florida Department of Transportation (FDOT) to observe pedestrian behaviors at bus stops and train stations in several locations across the state. The video was recorded between December 2019 and November 2020, over 24-hour periods.

Due to the quantity and length of the video footage, accurate manual video analysis was not feasible. Instead, PORL contracted with Tryolabs, headquartered in Montevideo, Uruguay.

The video analytics software was built leveraging years of experience using deep learning for solving computer vision problems in multiple industries. Video analysis also utilized Norfair, Tryolabs' open-source tracking library, which is designed to be flexible and extensible to a variety of use cases concerning video analytics.

The software platform was developed to accomplish two main objectives:

1. Vehicle identification and tracking, for counting or traffic intersection monitoring and vehicle type identification (cars, trucks, motorcycles, bicycles, and others).
2. Identification of pedestrian noncompliant behaviors, where pedestrians are tracked and their behavior is classified as noncompliant behavior (walks in a forbidden zone), or complaint behavior (walked on the sidewalk).

For understanding whether a pedestrian is a noncompliant behavior, input masks are defined as a one-time configuration for each camera view (Figure 1). The masks are simple images that are overlaid to the video, and specify:

- Forbidden zones (in red), where pedestrians are not allowed to walk.
- Allowed zones for pedestrians (in green).
- Areas that the algorithm should ignore, because they lead to regular errors with automated video processing because of very small or obstructed views, objects or glares (areas in neither red nor green).

Figure 7. Video with Mask Overlay

The platform supports multiple masks for each video in case some event (like the presence of a stopped bus) changes the shape and size of the permitted or forbidden areas, which are specified on a per-video basis. On every frame, a deep learning algorithm is able to detect the position of individuals and vehicles; individuals inside vehicles are ignored, while pedestrians are highlighted based on the corresponding video mask.

Data outputs from this software included counts of pedestrians and noncompliant behaviors, summary data of every detected pedestrian and path, as well as videos and heatmaps detailing the paths and trajectories of detected pedestrians (Figures 2 and 3).

The data output from this software was further analyzed by PORL, supplemented using existing FDOT data about road characteristics, and finalized in this report. The full results can be found in the Results section. Further discussion of Tryolabs and their methodologies can be found in Appendix A.

Figure 8. Noncompliant behavior as Line Trajectories

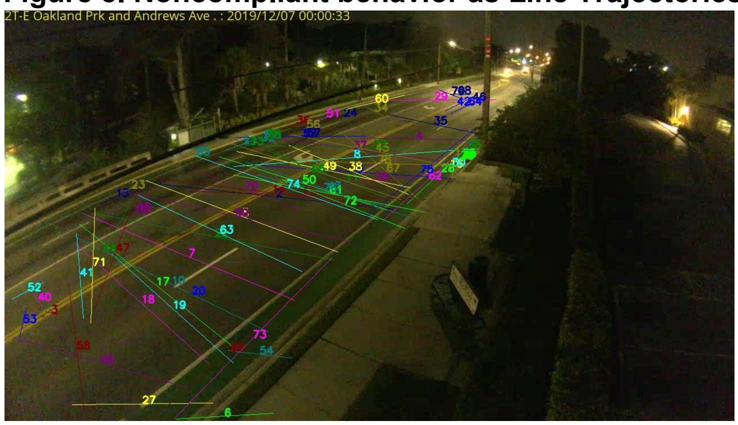


Figure 9. Processed Video with Overlays

Limitations and Direction of Future Research

As discussed above, the purpose of this pilot study was to establish video analytics capabilities, identify limitations and challenges, and build a sound methodological approach for future observational research.

Many of the challenges encountered in this project were due to the nature of available video footage, and the fact that PORL did not have direct control over the quality, locations, or characteristics of the footage chosen. In reviewing the footage, PORL has identified several challenges to be addressed in future iterations of this project, broken down into technical and substantive limitations:

Technical:

- Video resolution was not standardized across cameras, so some footage was suboptimal for the detection software, leading to missed noncompliant behaviors and/or compliant behaviors, as well as false detections
- Some cameras had a fish-eye lens, creating a bend in the frame that further inhibited the detection software
- Some cameras were mounted in a way that produced movement with wind or fast-moving vehicles
- Especially in low-quality, low-light footage, obstructions in the camera frame led to false detections; for example, pedestrians crossing behind an object were often counted twice, or a moving tree branch would be confused as a pedestrian

Substantive:

- No systematic sampling procedure to select representative footage
- Unequal distribution of urban and rural areas
- Not representative of all road characteristics, such as number of lanes, speed limits, intersection types, or sidewalks

To address these issues, PORL worked with the software team to identify key criteria for future video footage in order to ensure representativeness, as well as optimal conditions for video detection. These criteria are broken down into technical and substantive requirements, as follows:

Technical:

- Minimum resolution for cameras
- No fish-eye lens or other distortions
- Camera must be mounted securely to minimize movement
- Little or no obstructions in the camera frame (e.g., trees, road signs, etc.)

Substantive:

- Video footage should be geographically representative of the state of Florida, including counties in each of the 11 designated market areas
- Sufficient number of both urban and rural areas, with knowledge of surrounding landmarks (e.g., schools, bars and restaurants, etc.)
- Sufficient distribution of systematically selected road characteristics, such as number of lanes, speed limits, presence or absence of a median, intersection types, and other features
- Locations in pedestrian crash "hotspots," as well as areas with relatively lower crash rates

To implement these criteria, research will be conducted to identify optimal camera locations. This will include using FDOT data to locate roadways and intersections with the requisite road characteristics, as well as areas with high and low frequency of pedestrian crashes. Additional research will be conducted to gain knowledge of surrounding geography and landmarks, ensuring a sample more representative of the entire state of Florida.

Results

Location n=10,670	
Broward County	45% 4,840
Gainesville	13% 1,415
Indian River County	5% 571
Jacksonville	24% 2,580
SFRTA	12% 1,264

Streets n= 10,670	
Broward County	**45% 4,840**
SR7 South of NW 41st St	8% 801
Andrews Ave North of Oakland	10% 1,017
Andrews Ave South of SW 2nd	15% 1,561
Sunrise Blvd East of NE 25th	11% 1,197
University Dr of Southgate	3% 264
Gainesville	**13% 1,415**
Towne Park Apartments at SW 23rd Ter	3% 298
University Commons at SW Archer Rd	10% 1,087
Waldo Rd at 12th Ave	<1% 30
Indian River County	**5% 571**
27th Ave and 5th St SW	1% 153
Aviation Blvd and Airport Dr	<1% 30
Gifford Rd and 43rd Ave	1% 150
90th Ave Central Bus Hub	2% 237
Jacksonville	**24% 2,580**
Edgewood Ave and Post St	8% 805
Beaches Hub North of 3th Ave	13% 1,351
University Blvd and Baywood Ter	2% 182
Herschel St and St Johns Ave	2% 242
SFRTA	**12% 1,264**
Hollywood	7% 691
Opa-Locka	3% 342
Boynton Beach	2% 227
Mangonia Park	<1% 4

Noncompliant behavior * County
Crosstabulation

	Total Sample n=10,670	Broward n=4,840	Gainesville n=1,415	Indian River n=571	Jacksonville n=2,580	SFRTA n=1,264
Compliant	87% 9,301	89% 4,298	91% 1,289	73% 414	88% 2,272	81% 1,028
Noncompliant	13% 1,369	11% 542	9% 126	28% 157	12% 308	19% 236

Noncompliant behavior * Hour Interval
Crosstabulation

	Total Sample n=10,670	12-2:59 AM n=307	3-5:59 AM n=147	6-8:59 AM n=1,229	9-11:59 AM n=2,027	12-2:59 PM n=2,130	3-5:59 PM n=2,702	6-8:59 PM n=1,551	9-11:59 PM n=577
Compliant	87% 9,301	90% 275	76% 112	85% 1041	85% 1,723	87% 1,851	88% 2,388	90% 1,396	89% 515
Noncompliant	13% 1,369	10% 32	24% 35	15% 188	15% 304	13% 279	12% 314	10% 155	11% 62

Noncompliant behavior * Day/Night
Crosstabulation

	Total Sample n=10,670	Day n=9,019	Twilight n=1,022	Night n=629
Compliant	87% 9,301	87% 7,878	86% 877	87% 546
Noncompliant	13% 1,369	13% 1,141	14% 145	13% 83

Noncompliant behavior * Median
Crosstabulation

	Total Sample n=10,670	No Median n=5,944	Median n=4,726
Compliant	87% 9301	85% 5071	90% 4230
Noncompliant	13% 1369	15% 873	11% 496

Noncompliant behavior * Maximum Speed Limit
Crosstabulation

	Total Sample n=10,670	Max Speed Limit 25 MPH n=1,355	30 MPH n=2,703	35 MPH n=4,829	40 MPH n=1,252	45 MPH n=531
Compliant	87% 9,301	94% 1,273	85% 2299	87% 4,216	90% 1,130	72% 383
Noncompliant	13% 1,369	6% 82	15% 404	13% 613	10% 122	28% 148

UNF: Tryolabs & Platform description

About Tryolabs

Tryolabs is a specialized AI and machine learning solutions company.

With over 12 years of experience, Tryolabs helps other companies create business value by partnering with them through all the phases of their AI journey, from the very inception in building a PoC to putting these systems into production and scaling their data science teams.

The core expertise is around all things NLP (Natural Language Processing), computer vision (understanding images and videos), and predictive analytics, with a special emphasis on demand forecasting and price optimization.

Tryolabs fosters the *consulting with batteries included* approach, where over time, it has built its own set of proprietary solutions that aim to accelerate the implementation of a variety of use cases of AI for different industries.

Since its inception, Tryolabs has worked for various companies with a focus on the US market, and also numerous large international clients such as NVIDIA, The RealReal, Allianz Global Investors, Grubhub, SES, and Bain & Company.

Tryolabs counts with a team of over 60 people and offices in Montevideo, San Francisco, and Luxembourg.

Video analytics platform

What it is

Tryolabs' video analytics platform is a scalable solution for rapidly extracting **actionable insights** from thousands of **hours of video footage using AI**. These insights can be key for data-driven companies to make decisions that improve safety on public roads, compliance in construction zones or manufacturing lines, without the need for the tedious task of manually reviewing the footage captured by CCTV cameras.

Technical

Built leveraging years of experience using deep learning for solving computer vision problems in multiple industries, and Norfair, Tryolabs' open-source tracking library, the platform is designed to be flexible and extensible to a variety of use cases concerning video analytics.

Currently, the following cases are supported:

1. **Vehicle identification and tracking**, for counting or traffic intersection monitoring and vehicle type identification (cars, trucks, motorcycles, bicycles, and others).
2. **Identification of pedestrian offenses**, where pedestrians are tracked and their behaviour is classified as offender (walks in a forbidden zone), or regular.

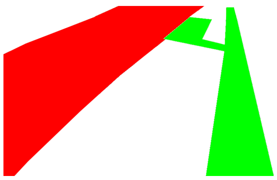
Identification of pedestrian offenders

Video setup: zone delimitation

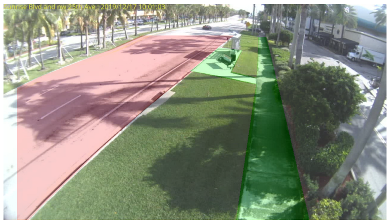
For understanding whether the pedestrians is an offender or not, input masks needs to be defined as a one-time configuration for each camera view. The masks are a simple image that will be overlaid to the video, and specify:

- Forbidden zones (in red), where pedestrians are not allowed to walk.
- Allowed zones for pedestrians (in green).
- Areas where the algorithm should ignore, because they will lead to regular errors with automated video processing (because of very small or obstructed views, objects or glares).

Original video.



The mask highlighting allowed and forbidden zones.



Video with its mask overlaid.

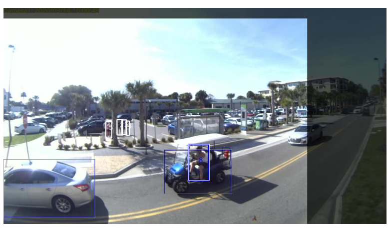
The platform supports **multiple masks** for each video, in case some event (like the presence of a stopped bus) repercutes on the shape and size of the permitted or forbidden areas. This needs to be specified on a per-video basis.

Detection and tracking

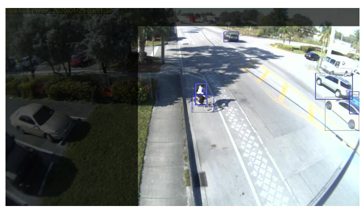
On every frame, a deep learning algorithm is able to detect the position of individuals and vehicles (such as cars, trucks, buses, bicycles and motorbikes).

Across multiple frames, the identified objects are tracked so that a unique id is assigned for each. This is accomplished using Norfair, an open source library for real-time 2D tracking also by Tryolabs.

Individuals inside vehicles are ignored, while pedestrians are highlighted according to the place they occupy in the frame based on the corresponding video mask.

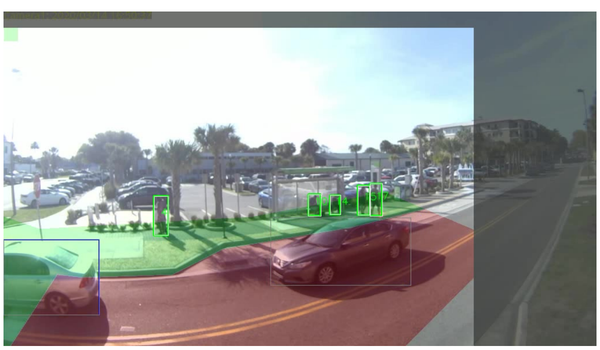


Person inside vehicle is detected but not considered a pedestrian.

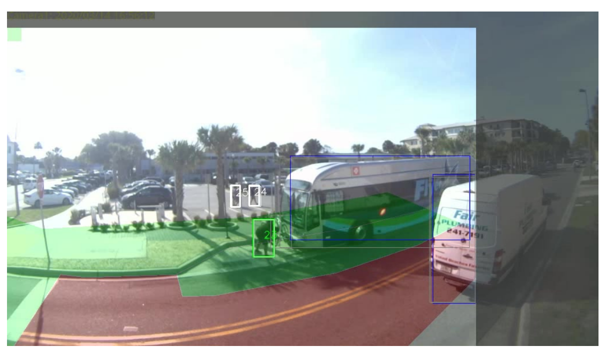


Algorithm correctly detecting a cyclist.

Regular pedestrian (green) and offender (red)



Pedestrians waiting in a bus stop.

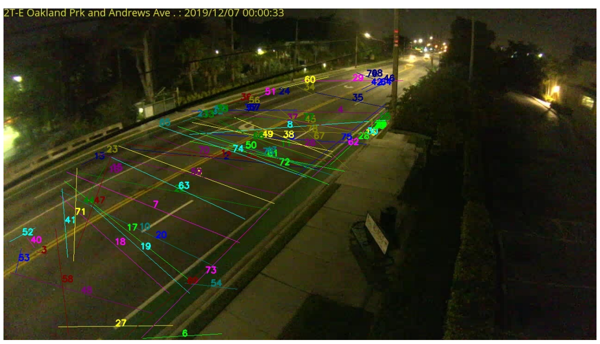


Alternative mask used when there are stopped buses.

Outputs

The platform outputs several files for each analyzed video. Depending on the particular needs, these can include:

- Metrics of interest, like the total number of pedestrians, ratio of offenders to regular pedestrians, and others.
- Summary containing information of every detected pedestrian, the time in which they were detected, the path taken in the video, and the classified behavior.
- Video snippets for manual review every detected offense.
- Heatmaps representing the location of every offense, or a frame with all the offenses of the video drawn as a line with their corresponding id.
- The entire processed video, with overlays highlighting every pedestrian with their corresponding behaviour (green/red), tracked vehicles, the paths taken by offenders with heatmaps, and statistics for every moment.



Offenses as line trajectories, with their id.

Snapshot of the entire processed video with overlays.