Understanding active mobility using computer vision and data visualisation

Panel 1: Science-Based Approach to Planning Future Scenarios

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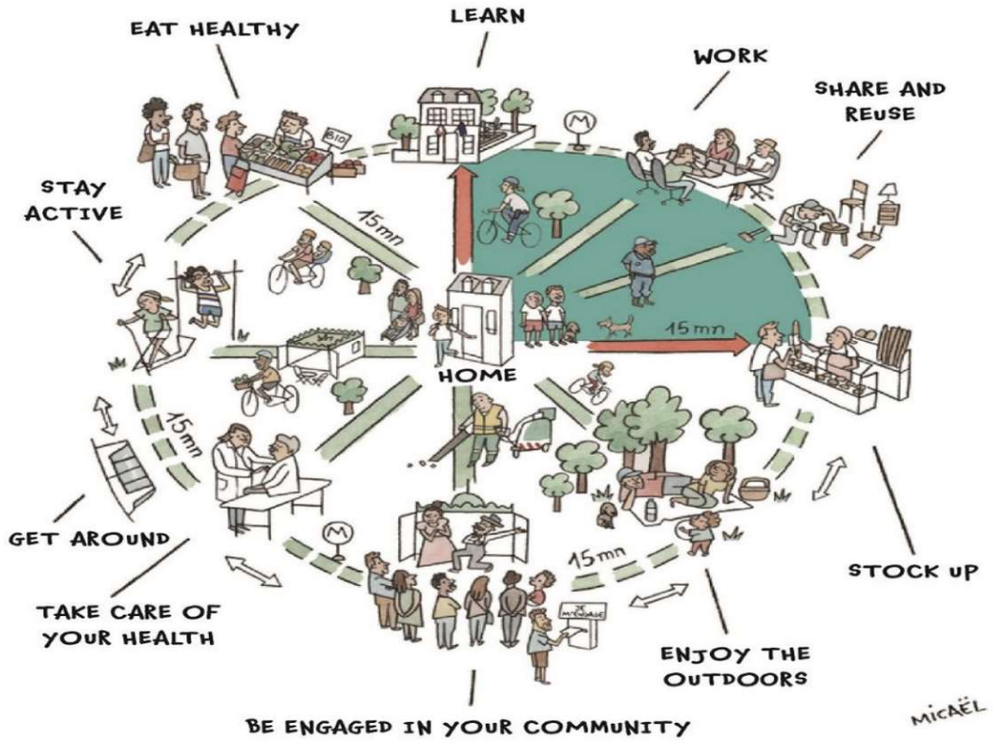
Sam Conrad Joyce, Ibrahim Nazim, Meriky Lo Alexander

URBAN SOLUTIONS AND SUSTAINABILITY
R&D CONGRESS 2023
BUILDING SUSTAINABLE, RESILIENT, AND LIVEABLE CITIES OF TOMORROW

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Active mobility (walking + cycling), have been widely identified as a key element in promoting healthy lifestyle and creating liveable cities.



15-minute city (Carlos Moreno)

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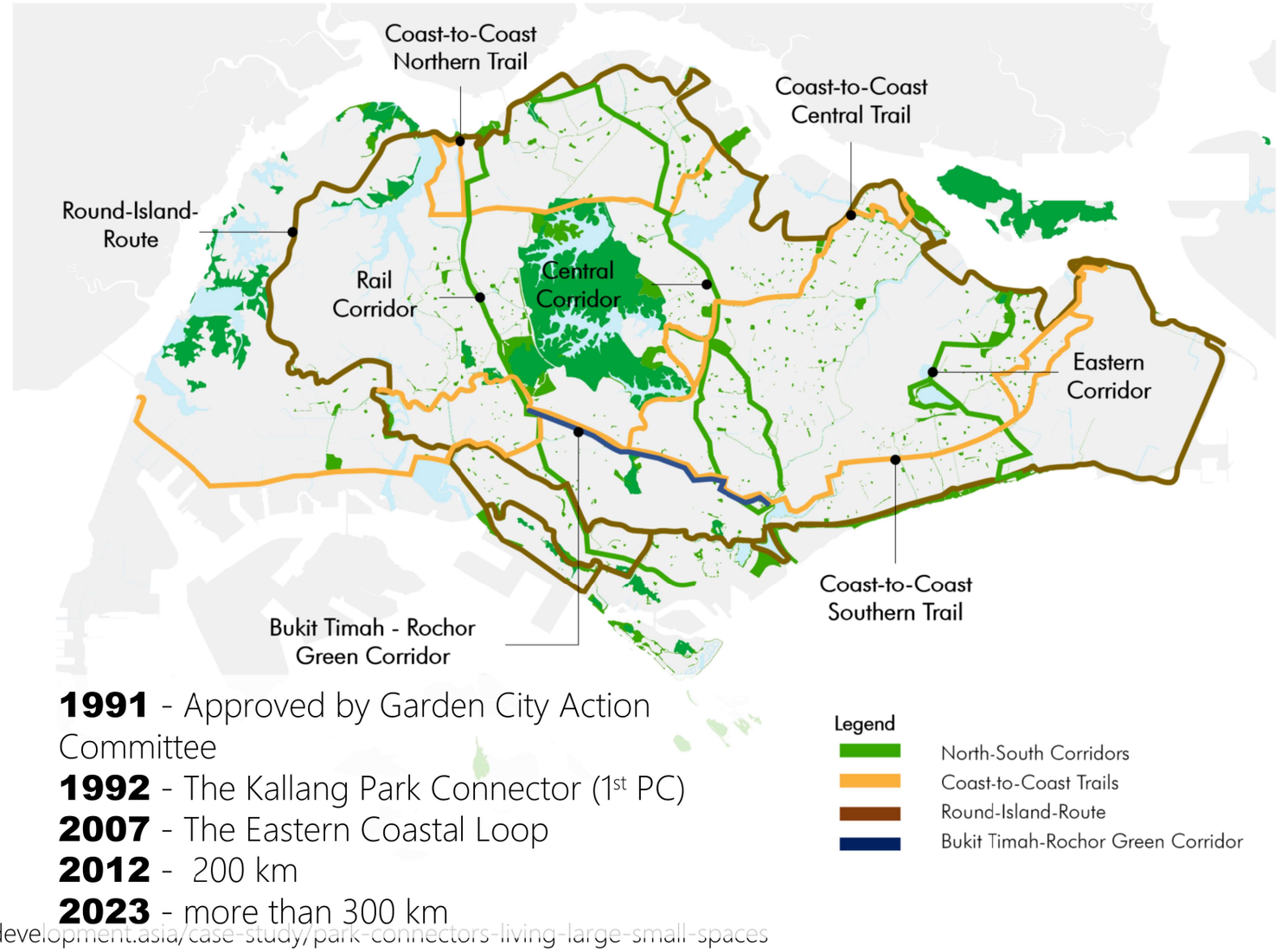
Active mobility zones like Park Connector Networks (PCN) have been a goal for Singapore's policy planning and infrastructure construction

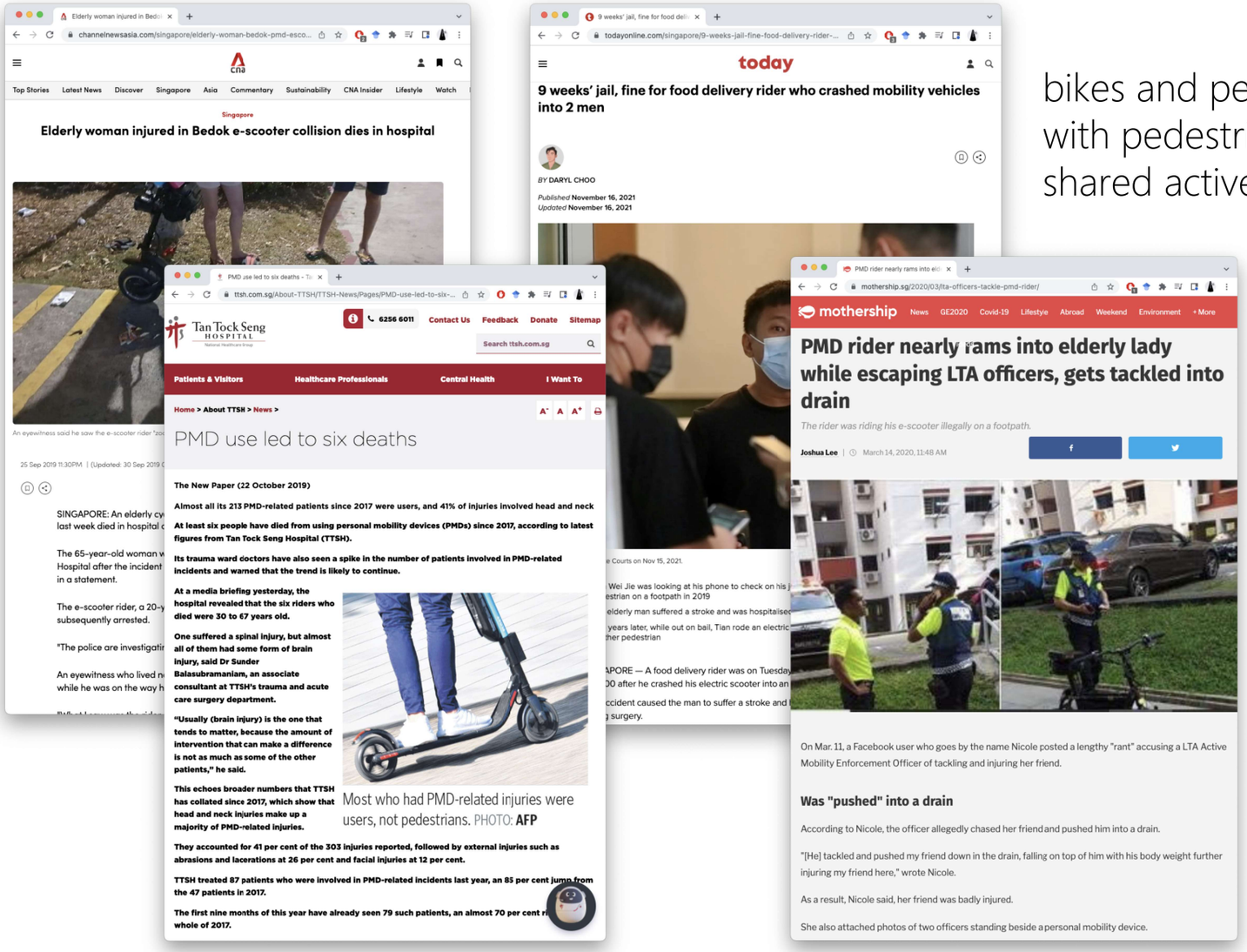


1991 - Approved by Garden City Action Committee
1992 - The Kallang Park Connector (1st PC)
2007 - The Eastern Coastal Loop
2012 - 200 km
2023 - more than 300 km

https://development.asia/case-study/park-connectors-living-large-small-spaces

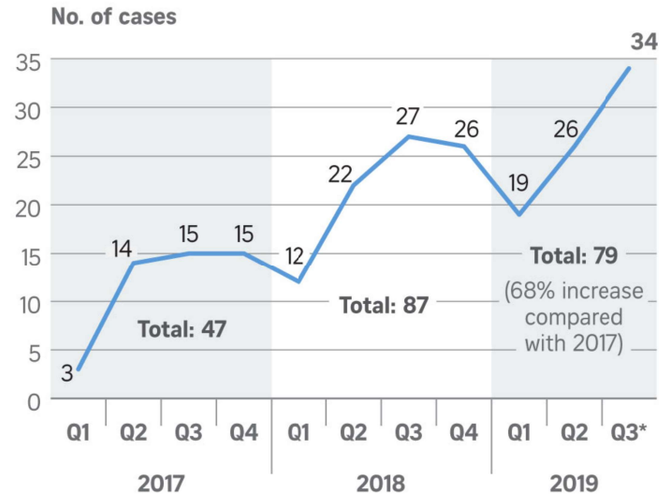
Management :
National Parks Board
Implementing agency :
Housing Development Board
JTC Corporation
Land Transport Authority
Public Utilities Board
Urban Redevelopment Authority

Pedestrian-PMD collisions: A safety concern



bikes and personal mobility devices (PMD) collision with pedestrians have escalated safety concerns on shared active mobility paths.

Rising number of PMD accidents



*2019 Q3 includes data till 26/09/2019

Source: TAN TOCK SENG HOSPITAL
STRAITS TIMES GRAPHICS

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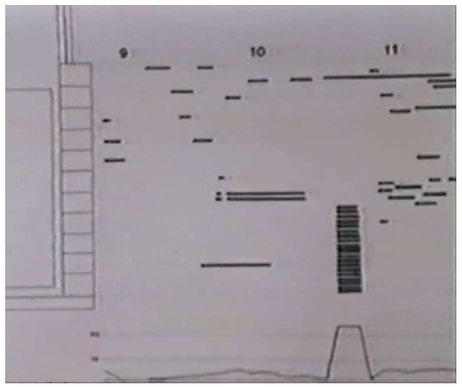
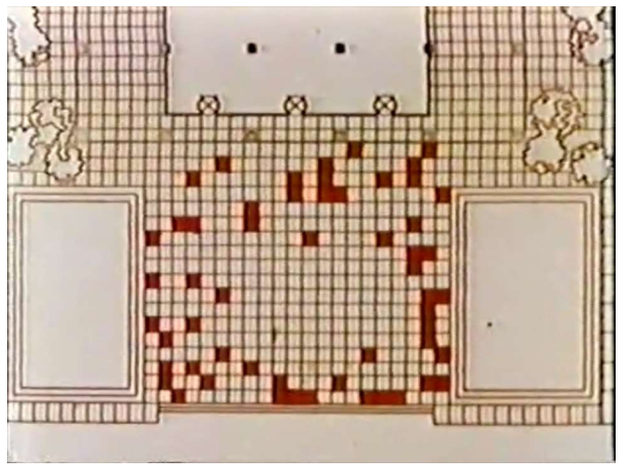
Objectively understanding how different users interact can inform design decision to safely incorporating active mobility into urban design

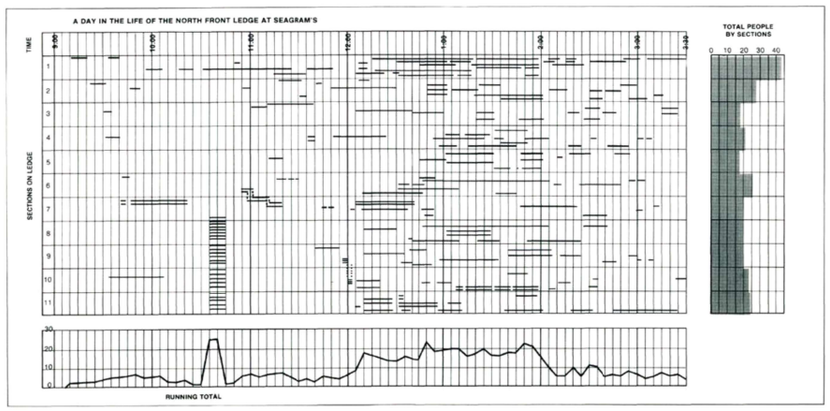
We should carefully consider and design the data we use to measure and improve our cities in a similar way that health tracking does for individuals...

This should include data collection techniques that embrace new data streams and AI to process them.

William Whyte - The Social Life of Small Urban Spaces







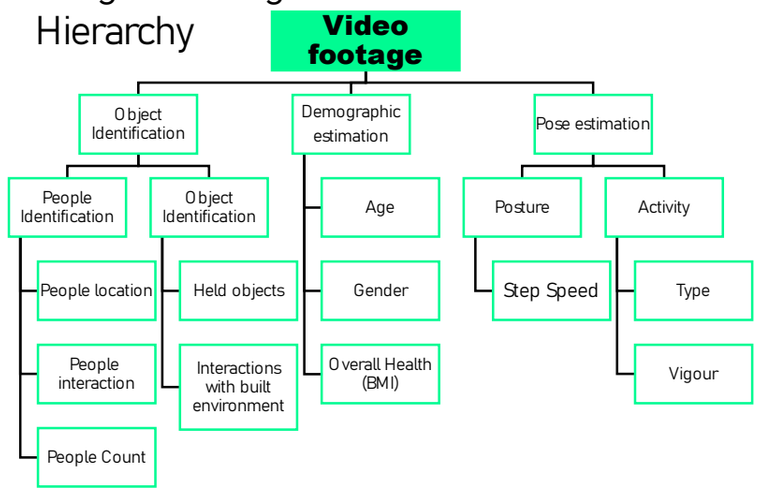
William Whyte The Social Life of Small Urban Spaces 1980

ML Urban and Recreation Activity Capture

Pose Estimation

Demographics and Health Estimation

Image Tracking Hierarchy



Object and Location Interaction Tracking

Activity and Health Tracking

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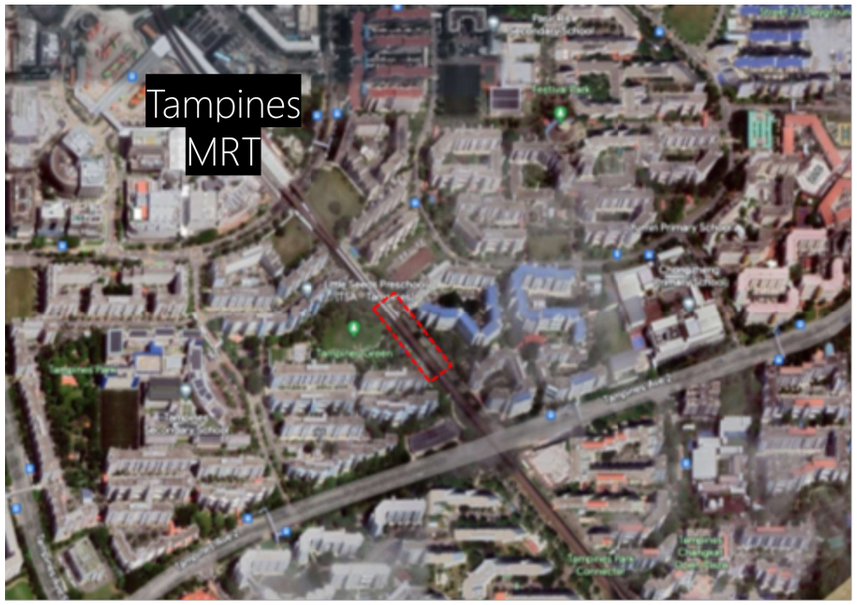
Research goals

- To deploy modern machine learning over long-duration video captures paired with spatiotemporal data-visualisation techniques to gain objective data and insights on active mobility use patterns
- To understand how different types of users behave and interact in shared spaces and how the design of those spaces influences them
- To appraise the applicability, opportunities, and limitations of computer vision in urban research

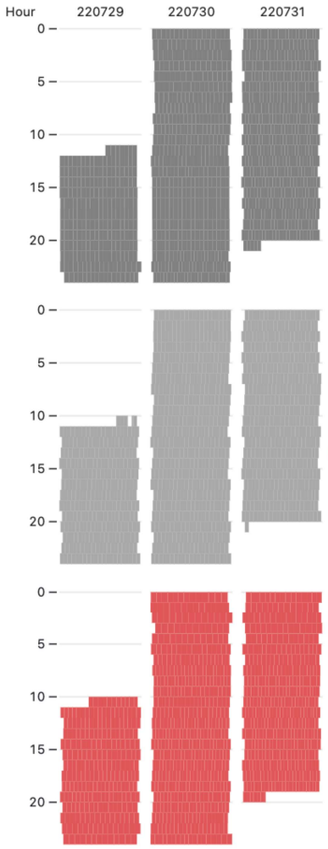
Methods

Data collection → Video processing → Projection → Data Analysis

Site location: Tampines PCN shared walkway

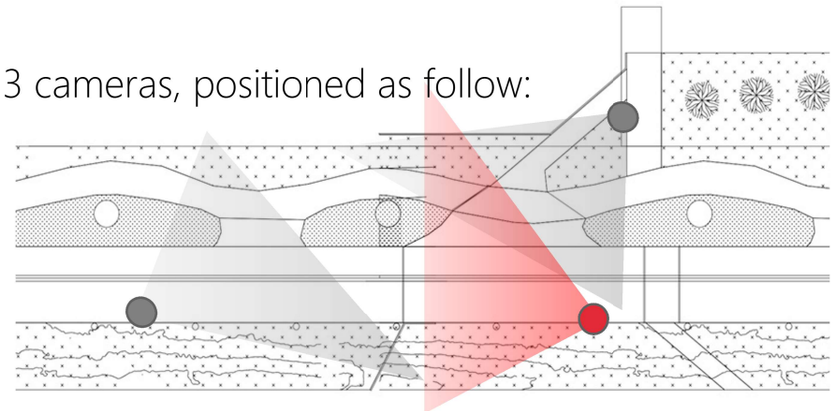


Battery operated/
Solar charged
Encrypted internal memory
mp4 video
1920 x 1080 res 15 fps



Selected Camera View

3 cameras, positioned as follow:



Data collection period:
29/07/2022 - 31/07/2022
Data: 169 hours (55 hours)

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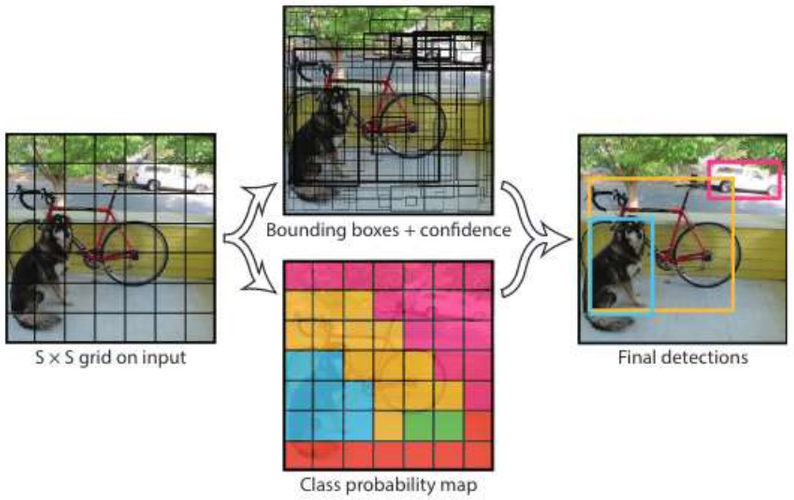
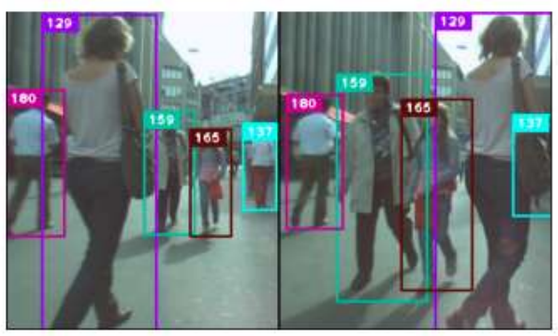
Methods

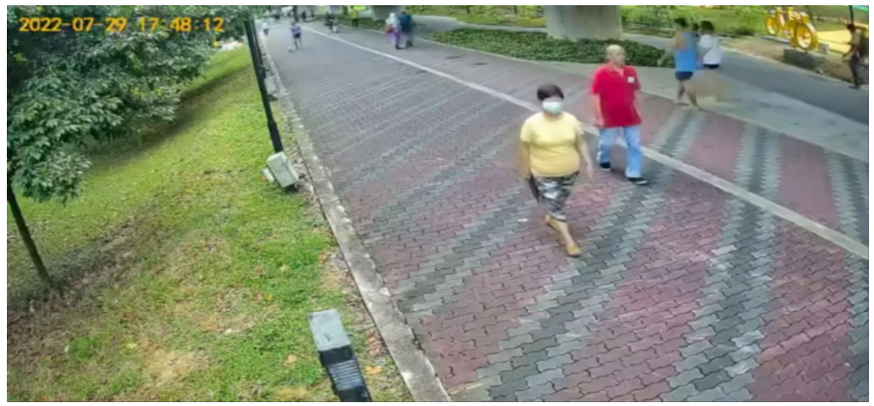
Data collection → **Video processing** → Projection → Data Analysis

YOLO: Object identification and classification



DeepSORT: Object tracking



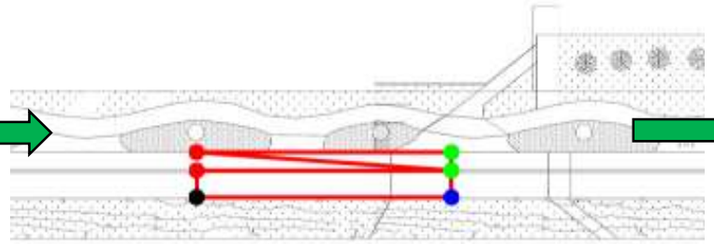


Methods

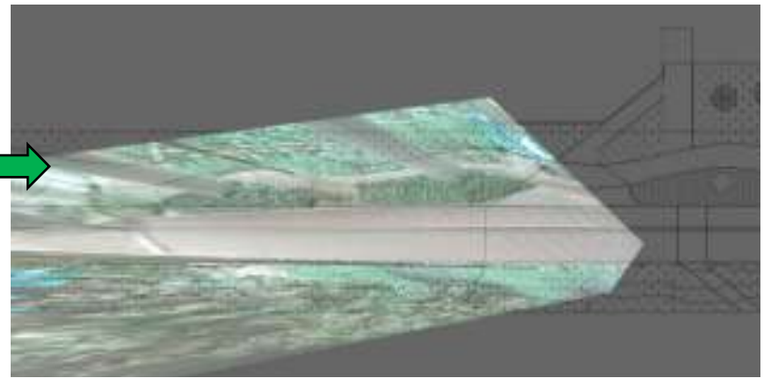
Data collection → Video processing → **Projection** → Data Analysis

Source points

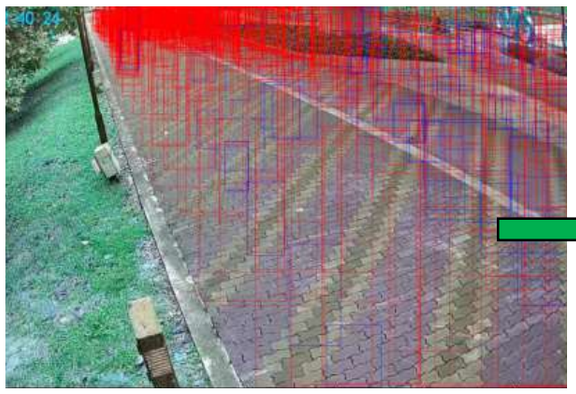
Target points



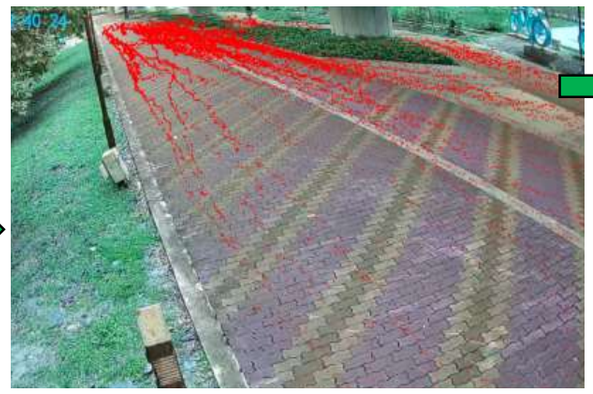
Transformation matrix



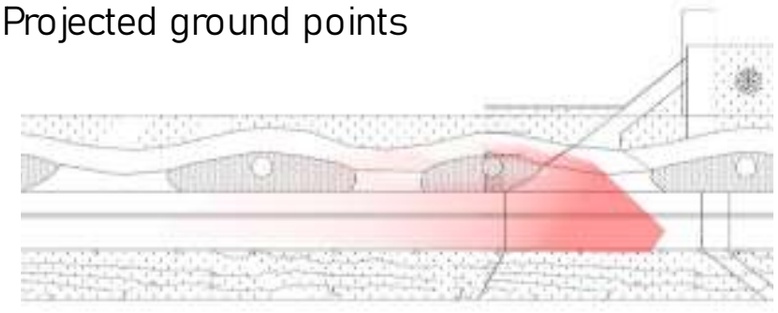
Bounding boxes



Ground centroid



Projected ground points



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Methods

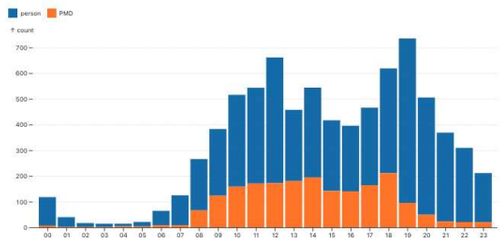
Data collection → Video processing → Projection → **Data Analysis**

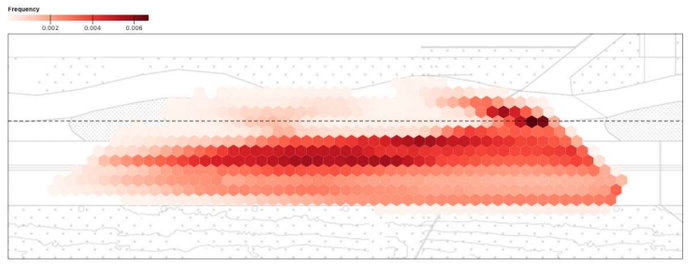
Temporal

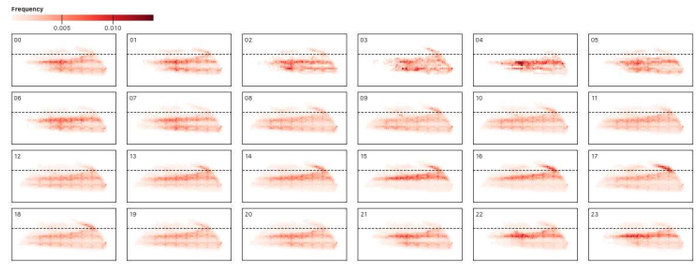
Spatial

Spatiotemporal

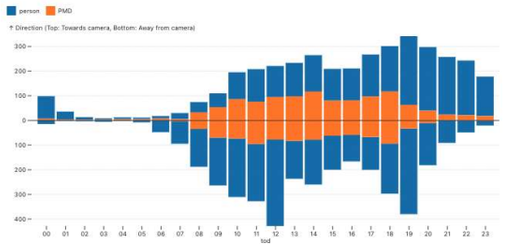
Volume

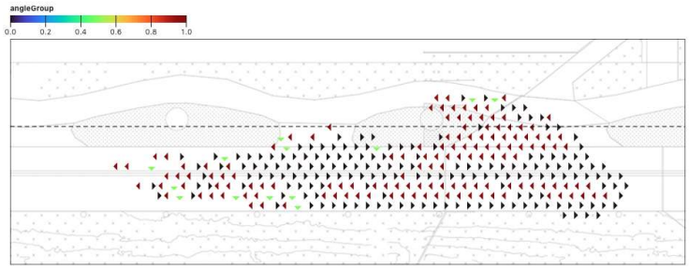




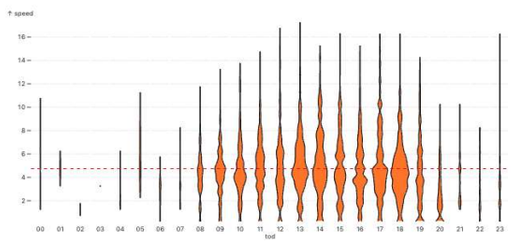


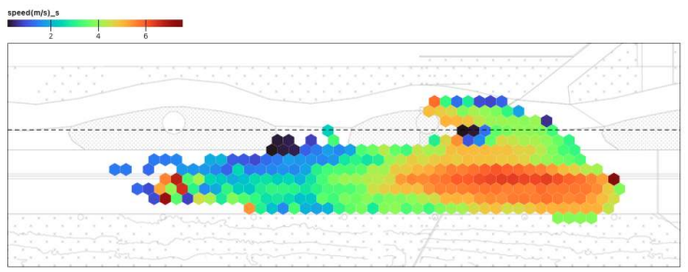
Direction

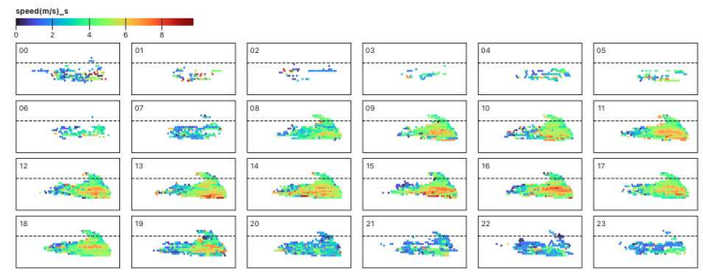




Speed







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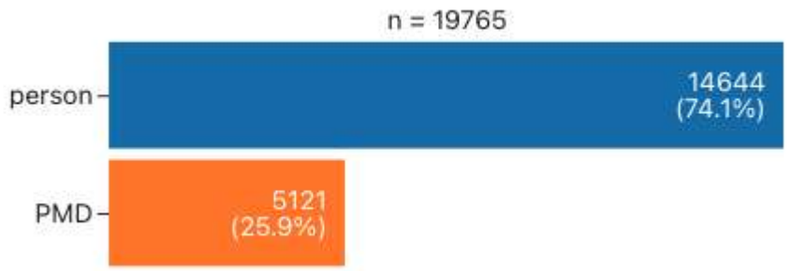
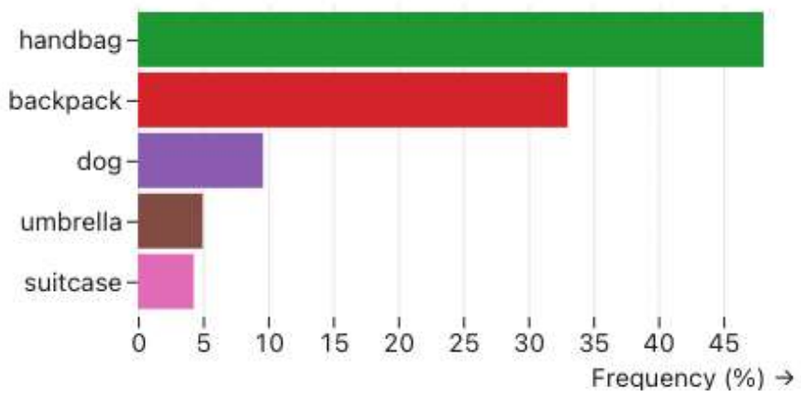
Users and Activities



PMD types:
Bikes
Scooters
Wheelchairs
Personal Mobility Aids (PMAs)
Strollers

Pedestrian Activities



Activity types:
Commuting
Jogging
Dog walking
Shopping

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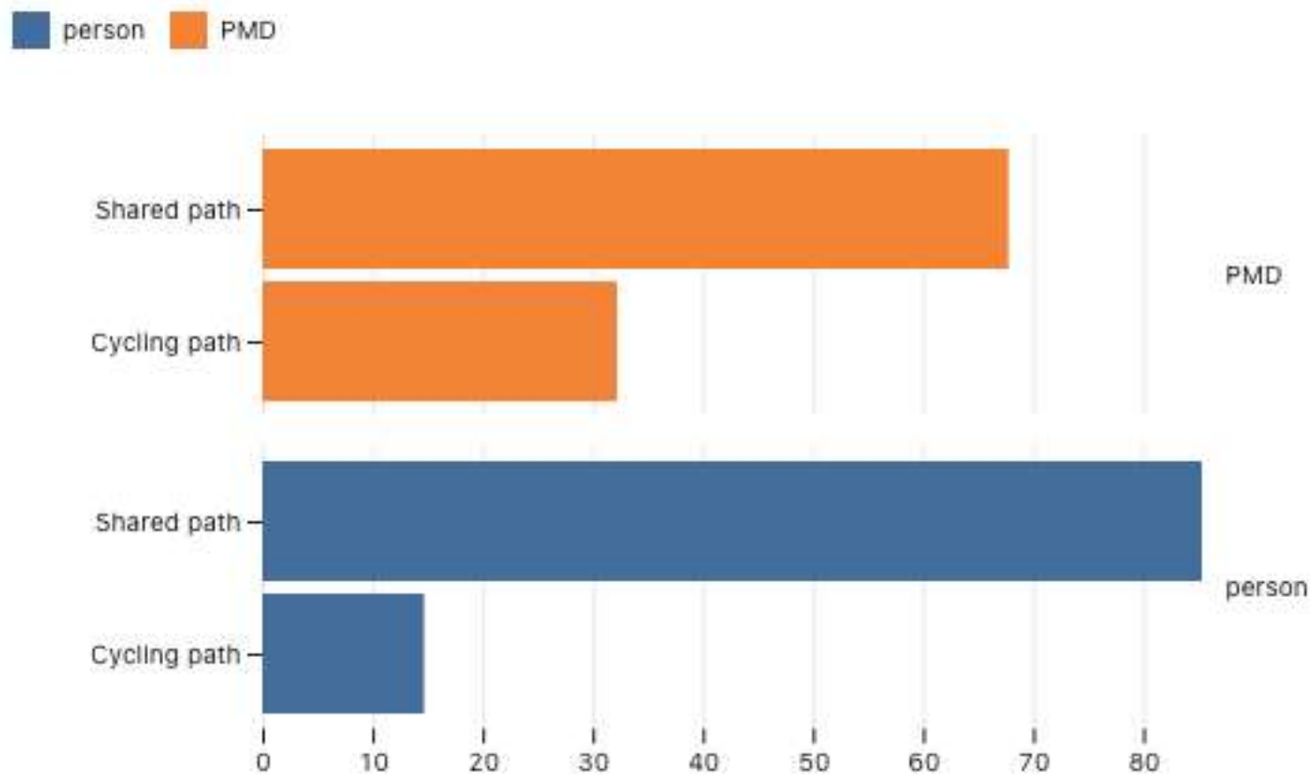
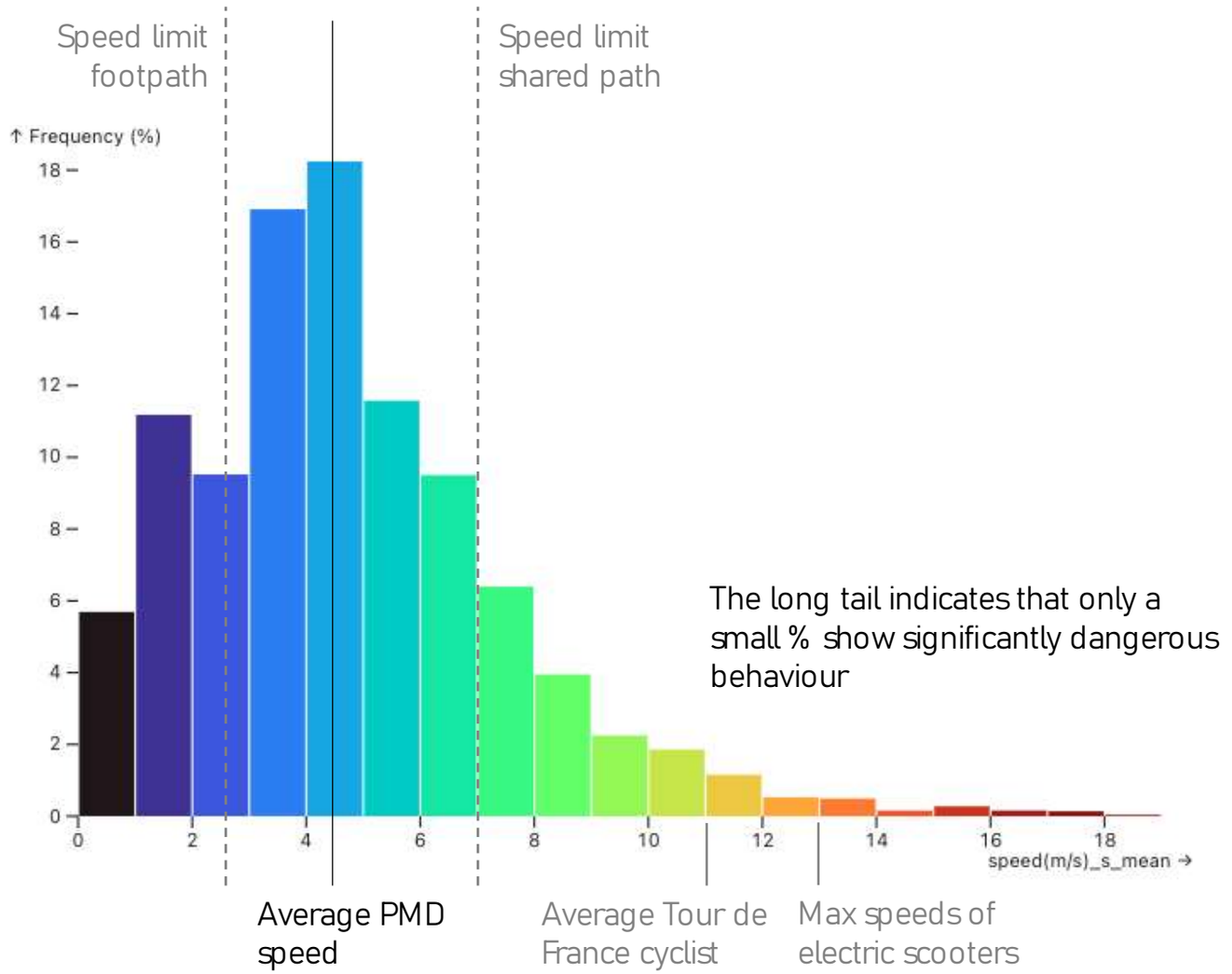
15 % of pedestrians use the cycling path
70 % of PMD use the shared path



Most PMD are under the speed limit

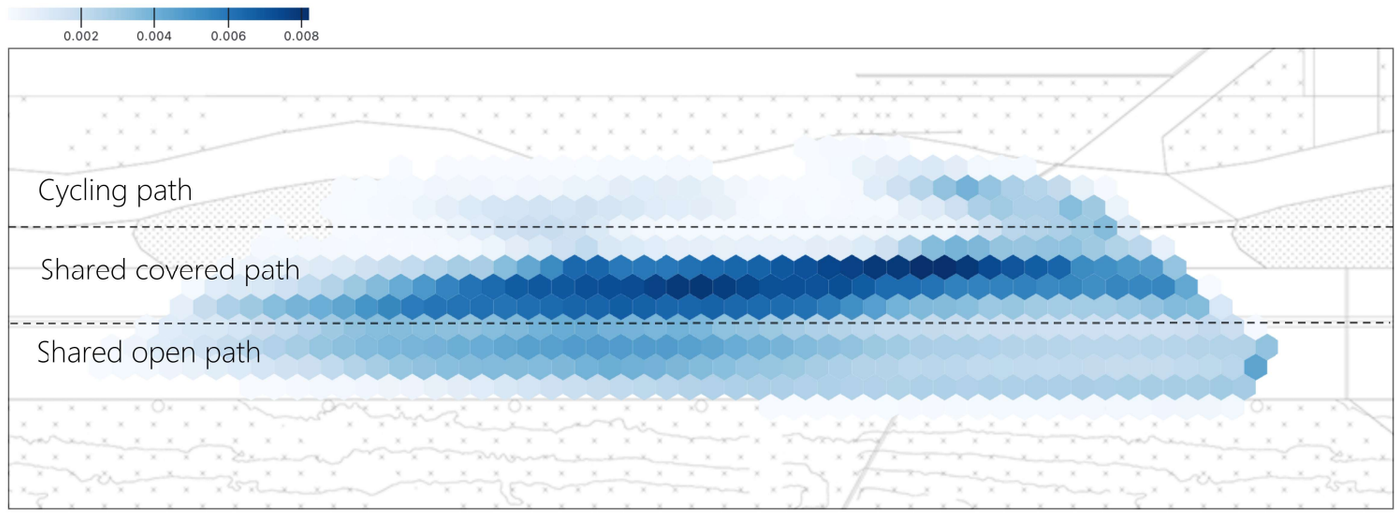


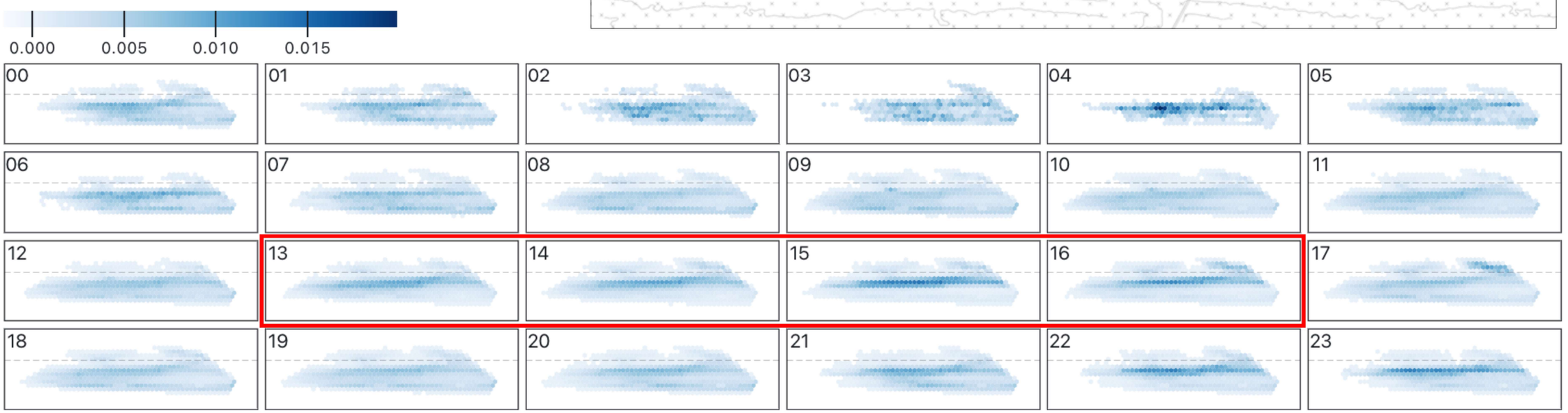
The long tail indicates that only a small % show significantly dangerous behaviour

Where are they? Pedestrians

Pedestrians use both the shared path and the cycling lane

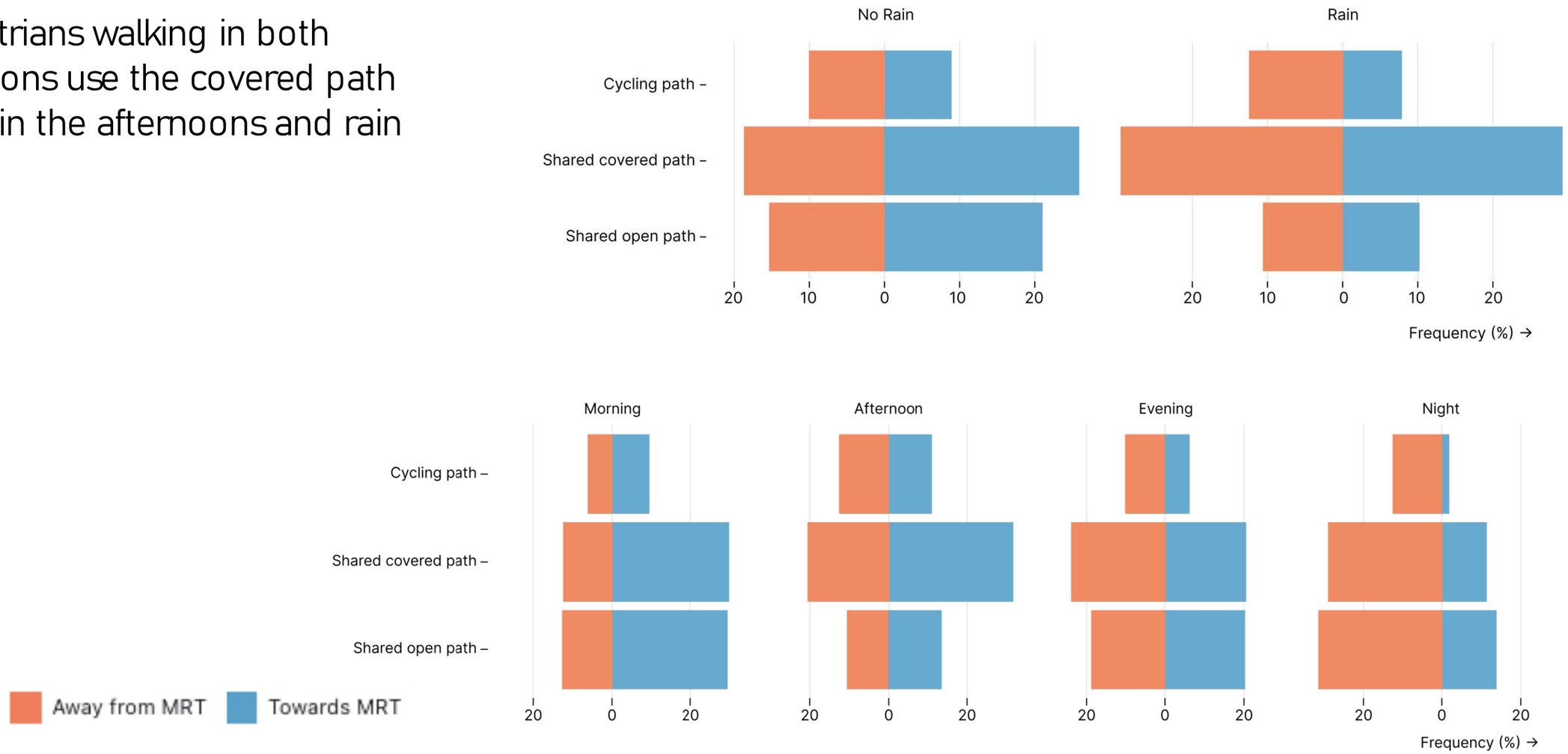
Use of covered path more prominent during afternoon





Pedestrians prefer covered path when warm/rain

Pedestrians walking in both directions use the covered path more in the afternoons and rain



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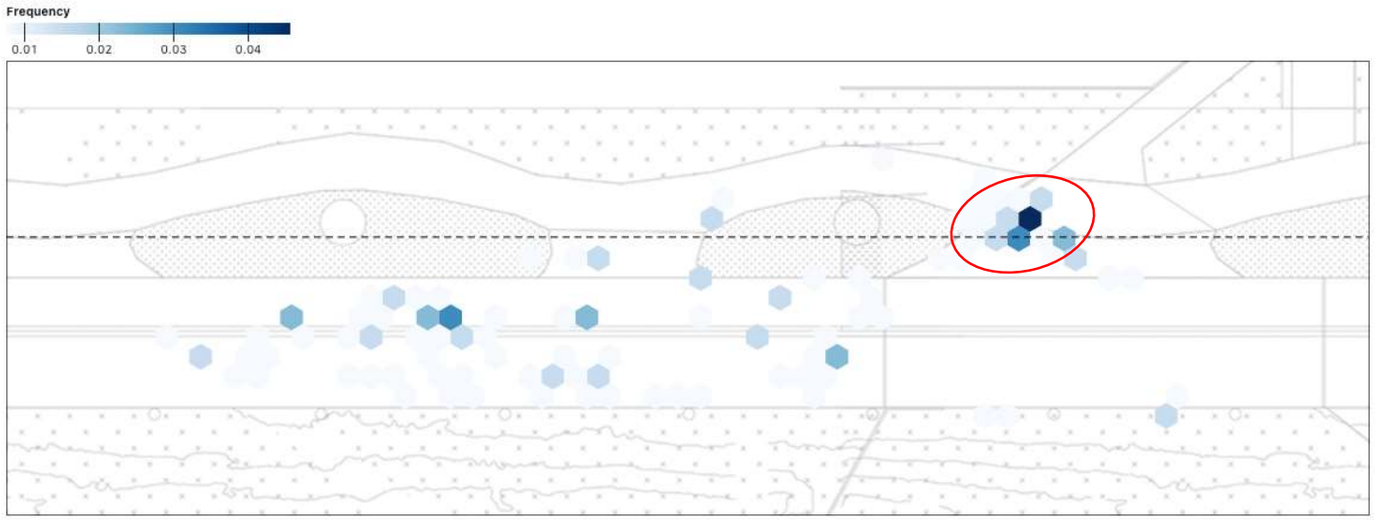
People frequently stop at the intersection of the bicycle path and linear track while waiting or socializing

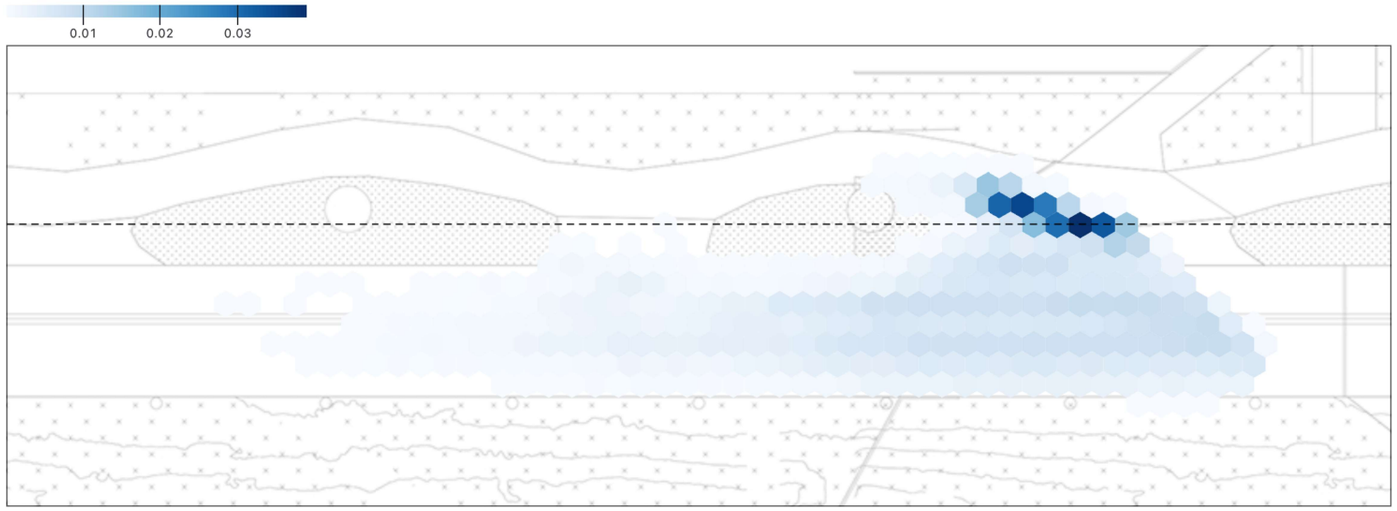


proportion of people > 60 seconds speed < 0.2 m/s

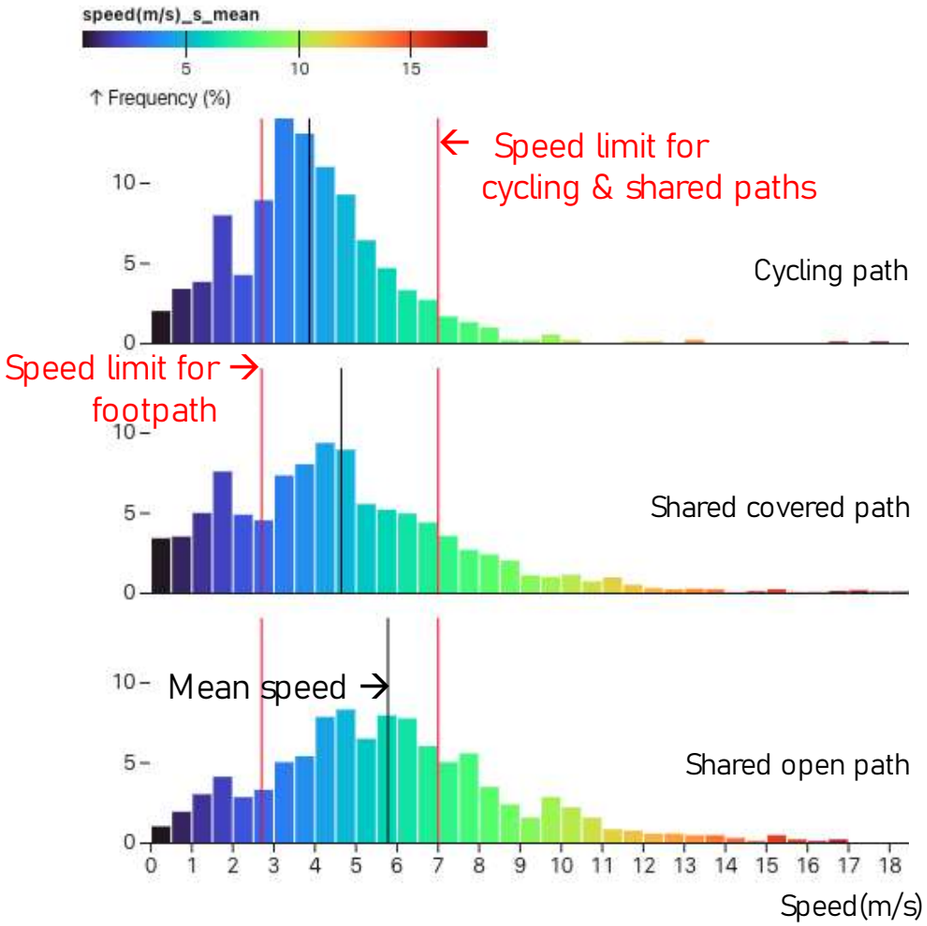
Where are they? PMD

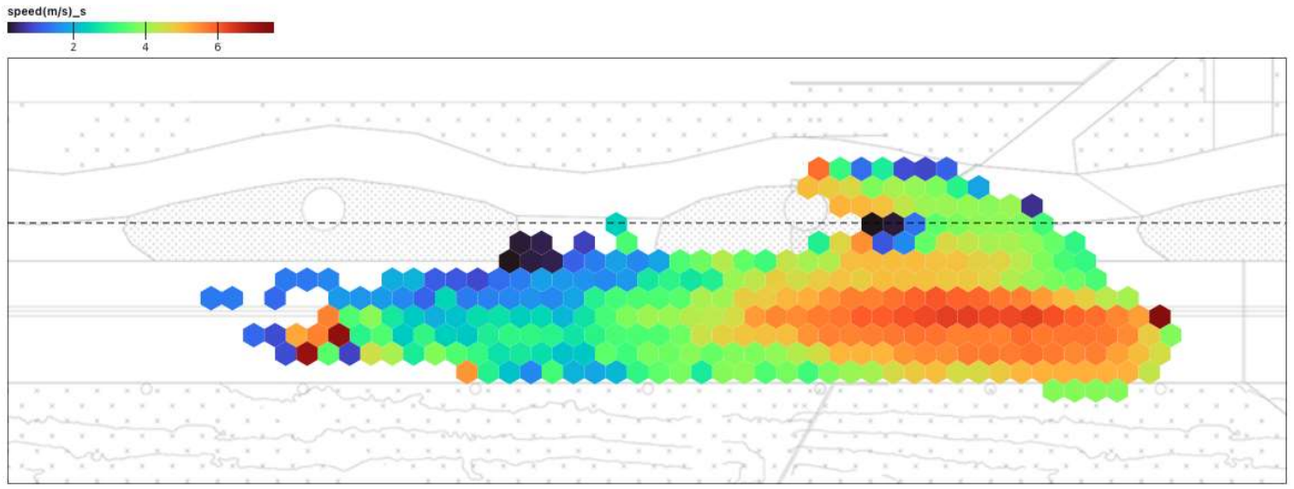
PMDs prefer the dedicated cyclist path.

More PMDs in the shared path in the evenings and night.



Faster PMD prefer the bottom half of shared path

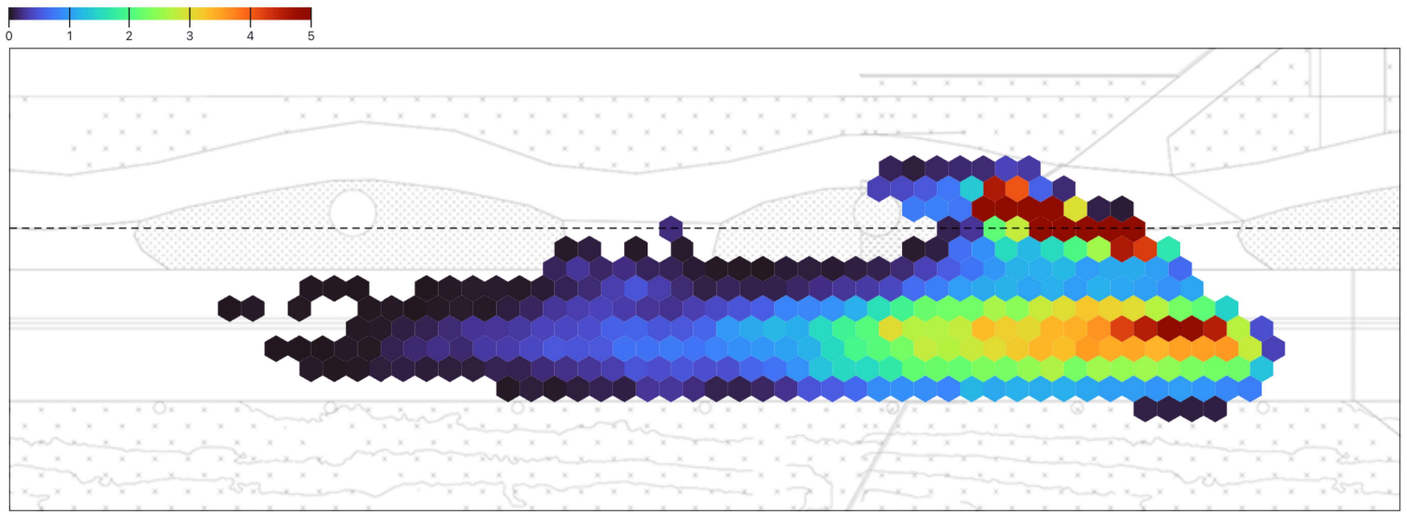


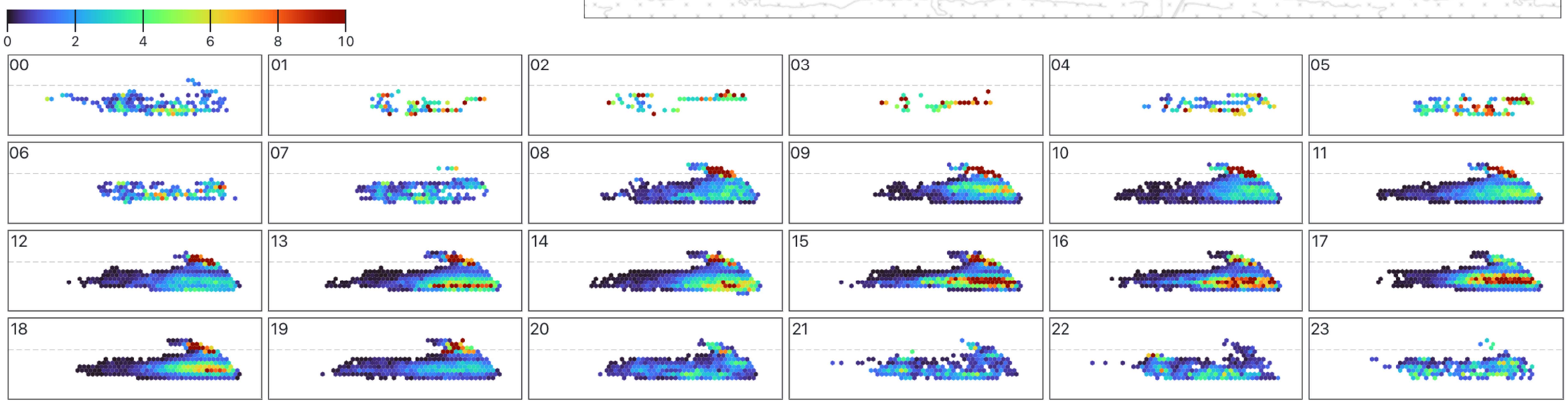


High-interaction Zones

Potential conflict zones marked by high interactions of pedestrians and PMD.

Most notably the cycling path and the centre of the shared path.





Planning Implications

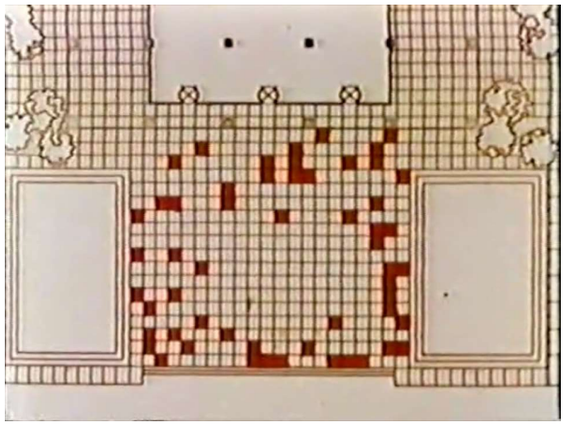
- Focus on minority dangerous PMD behaviour who travelled at extreme speeds
- Policy to reduce pedestrian activities on cycling path
- Consider how weather and time of day impacts behaviour and use patterns eg. fewer cyclists when it rains, pedestrians take cover
- Use design elements to direct behaviour eg. shelter for pedestrians and straight vs curvy paths for PMD

Conclusions

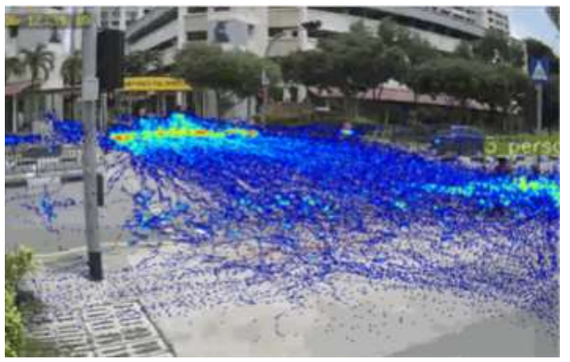
The capabilities of the approach :

- Relatively easy to cover large areas and obtain continuous data over long durations
- Can extract location and movement with higher precision
- Can analyse multiple classes of objects simultaneously
- Insights on use patterns are helpful to understand crowd distributions, hotspot areas, peak hours, and clustering patterns
- Insights on how design elements (eg., traffic lights, shades, bench, path, trees, shelters) impacts use patterns

Then



Now



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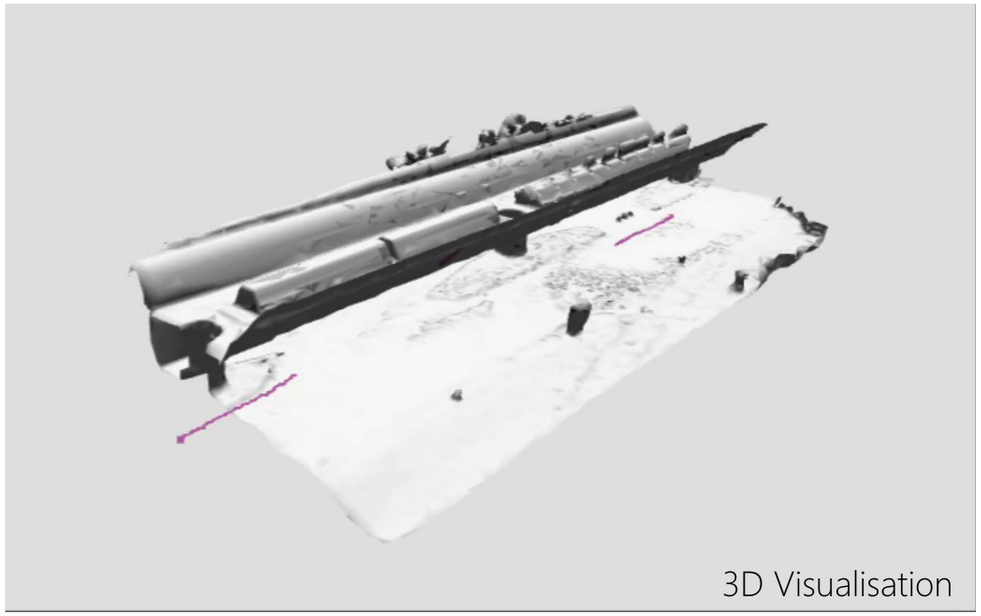
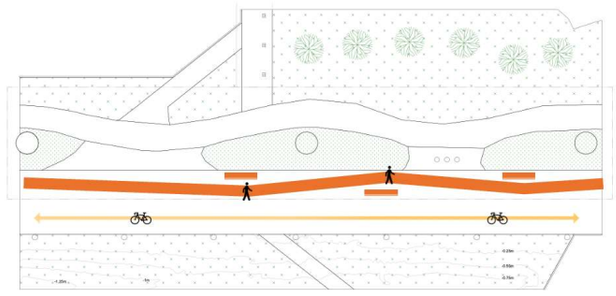
Future Work

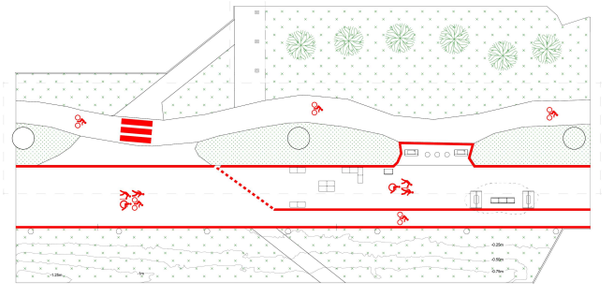
- Expanding classification to capture more urban activities and users
- Spatially integrate data from multiple sensors
- Enhance video capture by employing cameras with better sensors and higher frame rates to improve accuracy
- Expand spatiotemporal metrics and visualisation techniques for deeper insights and better communication (4D)
- Explore A/B testing for different planning scenarios using data driven site interventions to reduce conflicts and improve active mobility experience



3D Visualisation



Solution A



Solution B

Thank you!

Team

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Sam Conrad Joyce
ASD, SUTD

Ibrahim Nazim
ASD, SUTD

Meriky Lo Alexander
ASD, SUTD

Collaborators

Belinda Yuen
LKYCIC, SUTD

LEE KUAN YEW CENTRE FOR INNOVATIVE CITIES

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