NightLight: Passively Mapping Nighttime Sidewalk Light Data for Improved Pedestrian Routing

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MAKEABILITY LAB

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Let’s try a quick exercise

Where would you rather walk?

A

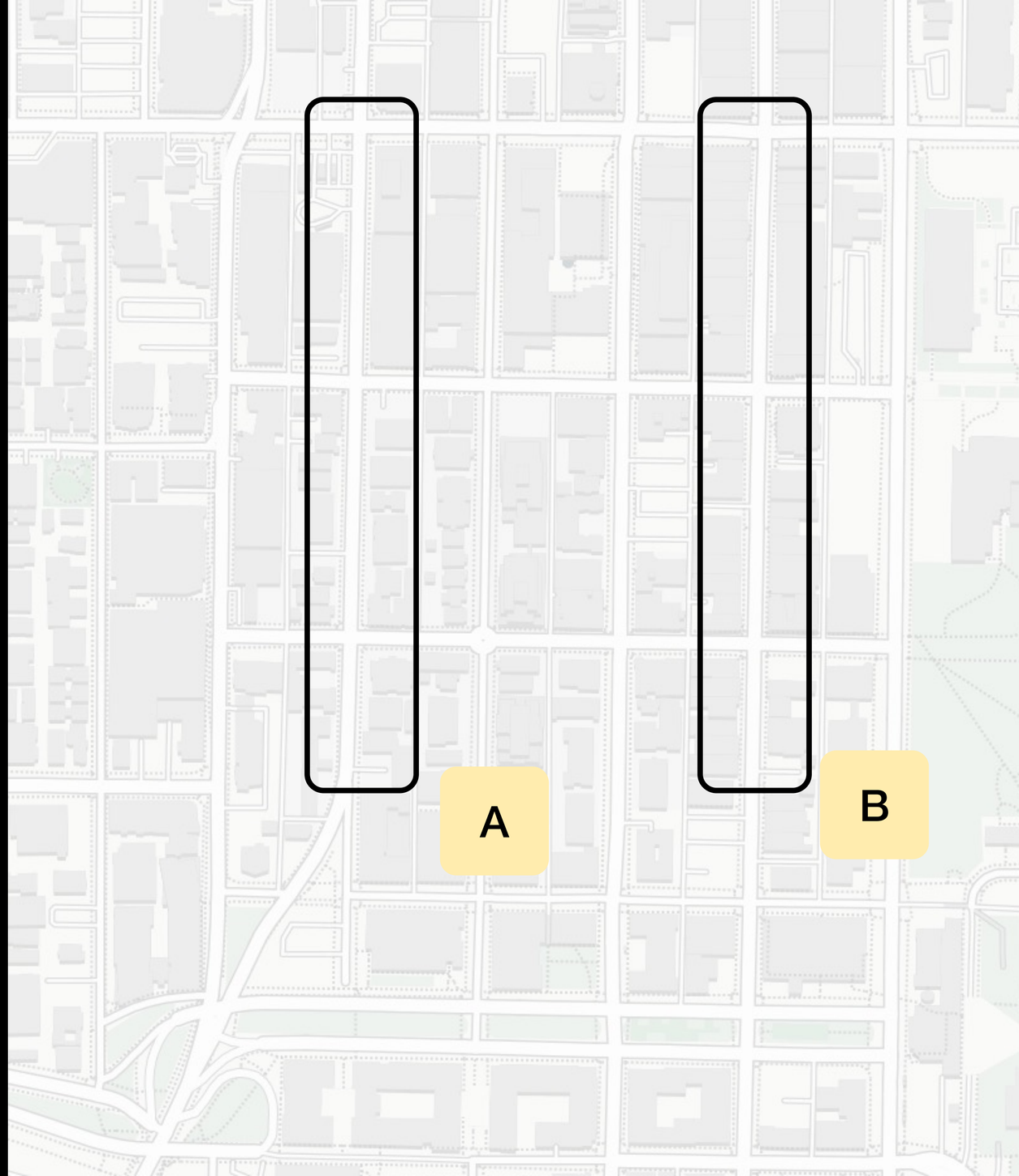
B

How about between these two?

A

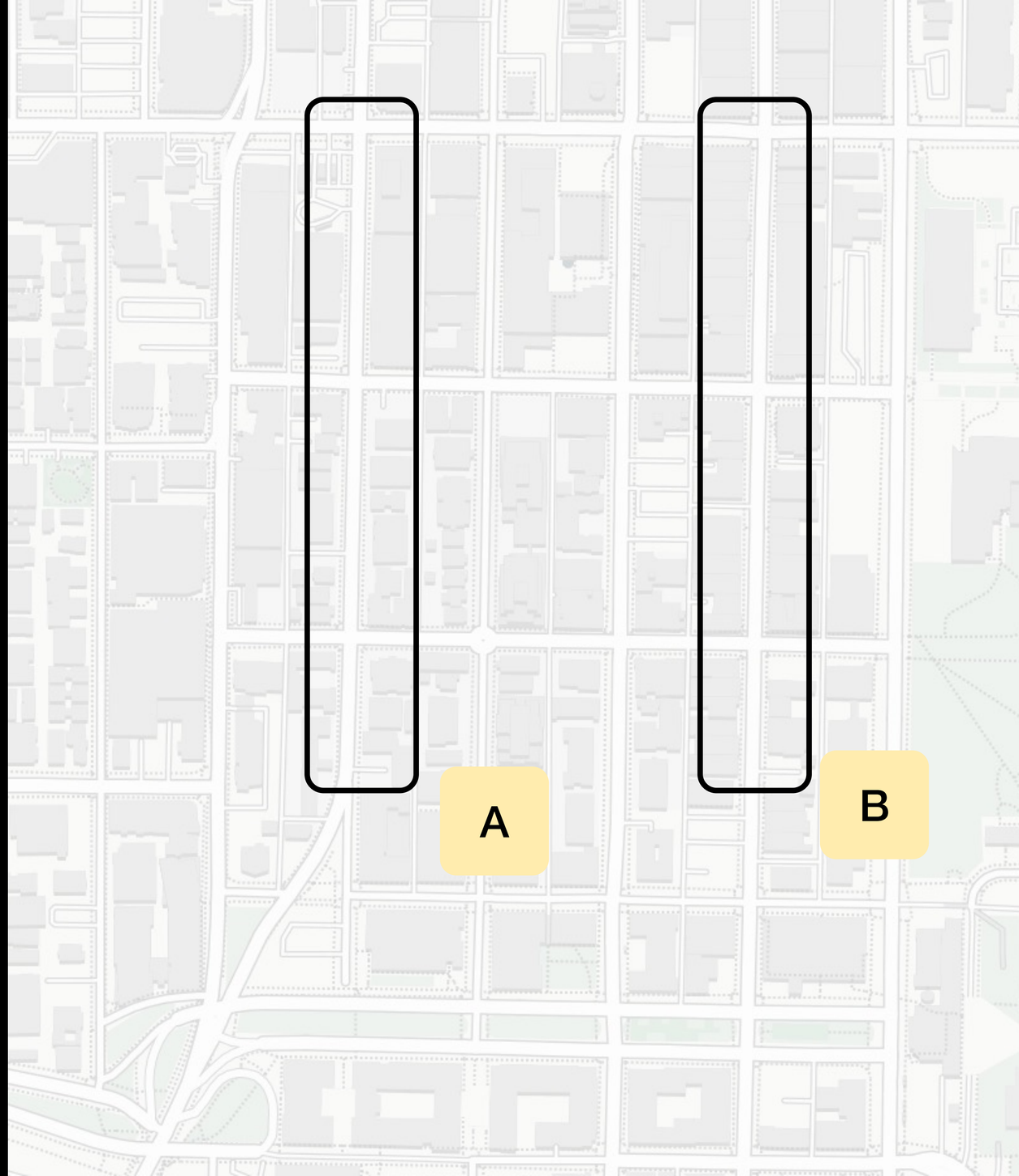
B

Now just using a map



Now just using a map

- Chances are this is a harder question.
- Information is missing from this map that could inform your route planning.
- One of these signals that's missing is lighting conditions.



Walking at Nighttime

- But **walking at night** brings different consideration for different populations (i.e., women consider light and safety more).
- Without prior knowledge, route planning becomes a challenge.
- Walking is good for **physical and mental health** and **sustainability**.

How is light measured?

Measuring Light Level

Lighting conditions vary across the city

Satellite Imagery

Municipal Databases

Measuring Light Level

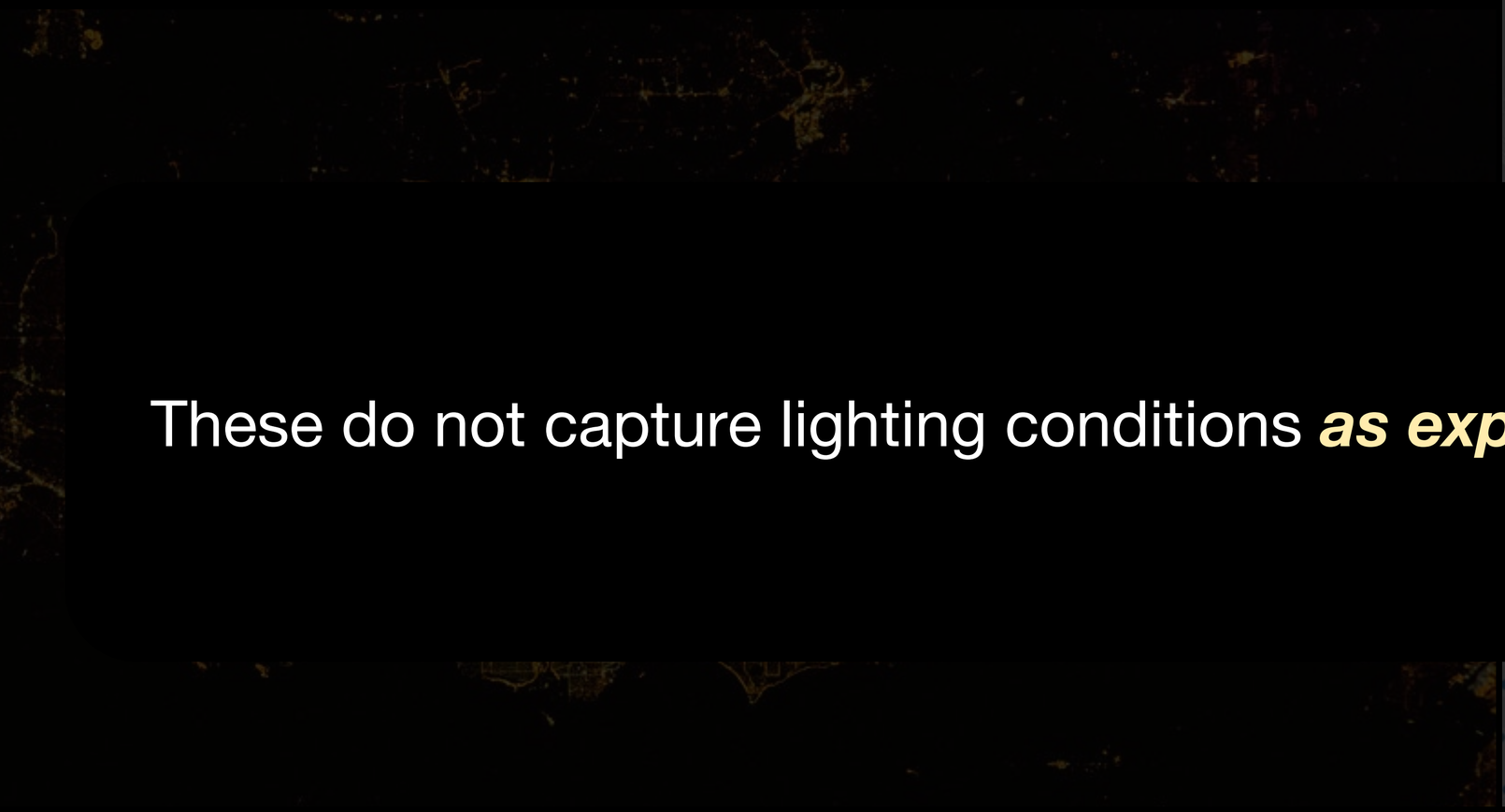
Lighting conditions vary across the city

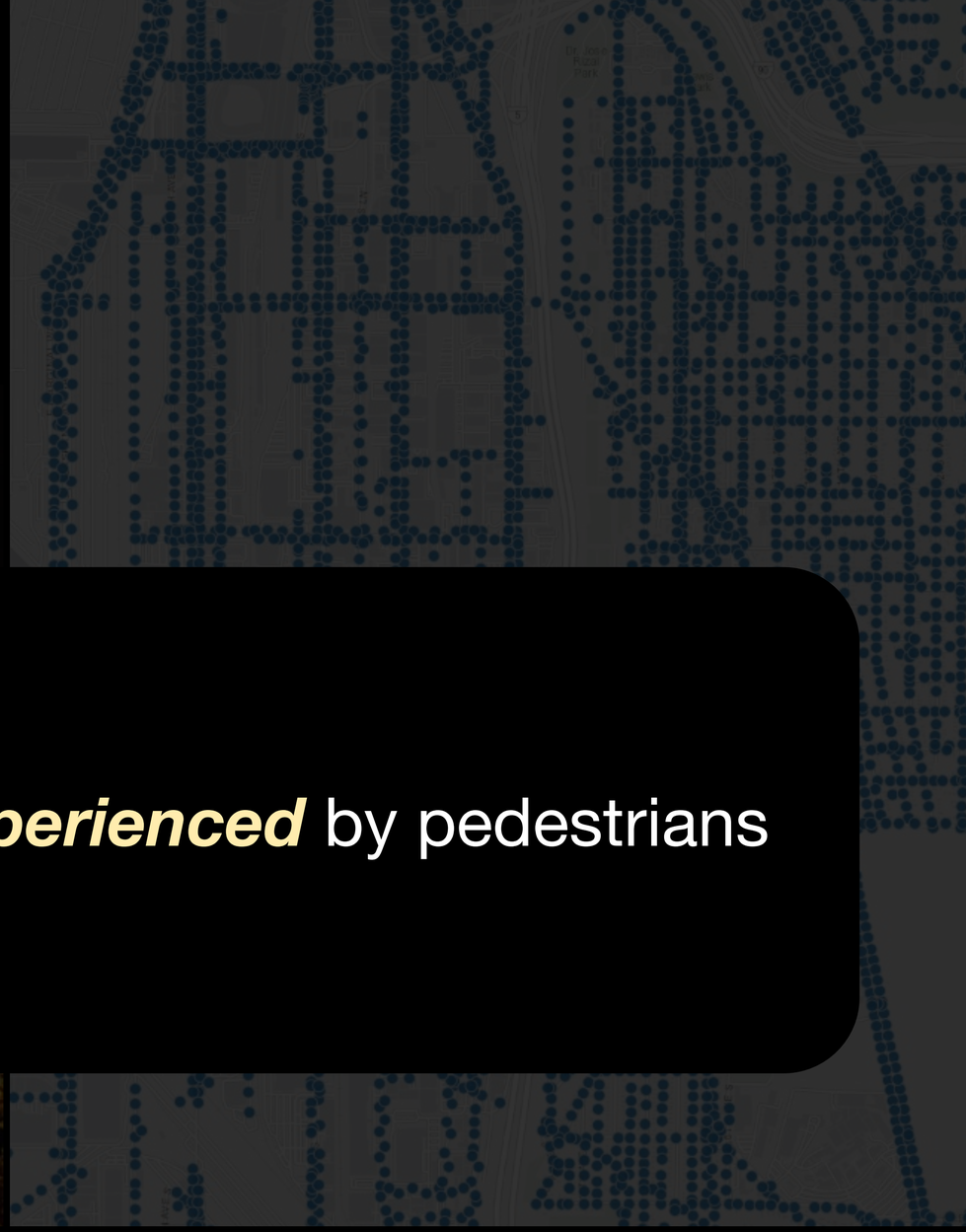
Captures real conditions but is too coarse

Only maps streetlight locations

Measuring Light Level

Lighting conditions vary across the city





These do not capture lighting conditions ***as experienced*** by pedestrians

Captures real conditions but is too coarse and hard to update

Only maps streetlight locations

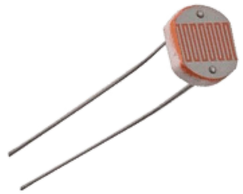
Measuring Light Level

- Manual Audits
- Handheld light meters to measure light conditions standing on the sidewalk.
- This is **expensive and time-consuming** which makes it hard to scale and keep up to date.

Measuring Light Level

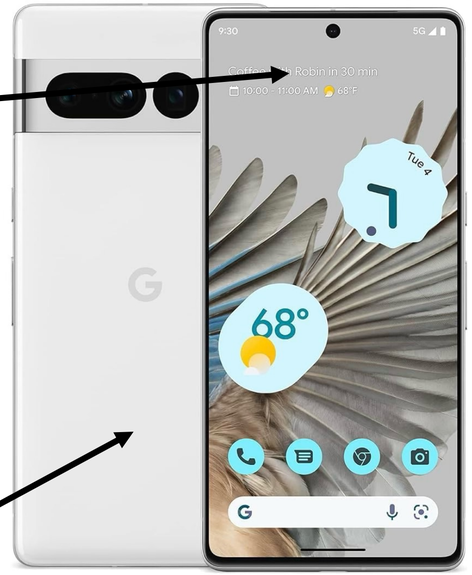
Hardware

Commercial Light Meter



Light Sensor

Processor

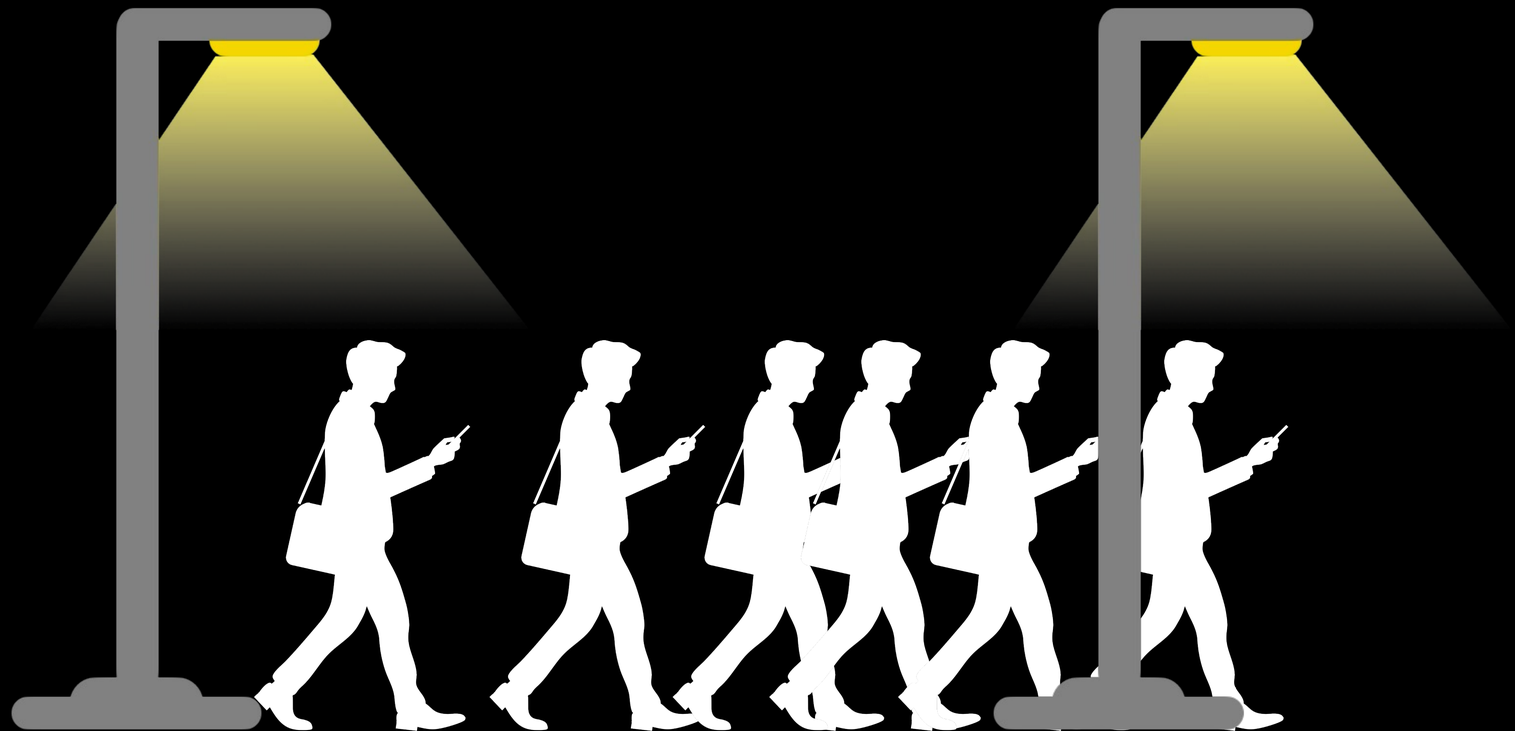


Smartphone

NightLight

Passively Crowdsourcing Light Level Data

- Many devices already out there oriented in an ideal way to capture lighting



NightLight Validation

Feasibility:

How does the ambient light sensor (ALS) in smartphones compare to commercial light meters in a lab environment?

Does this hold with real-world lighting conditions on streets?

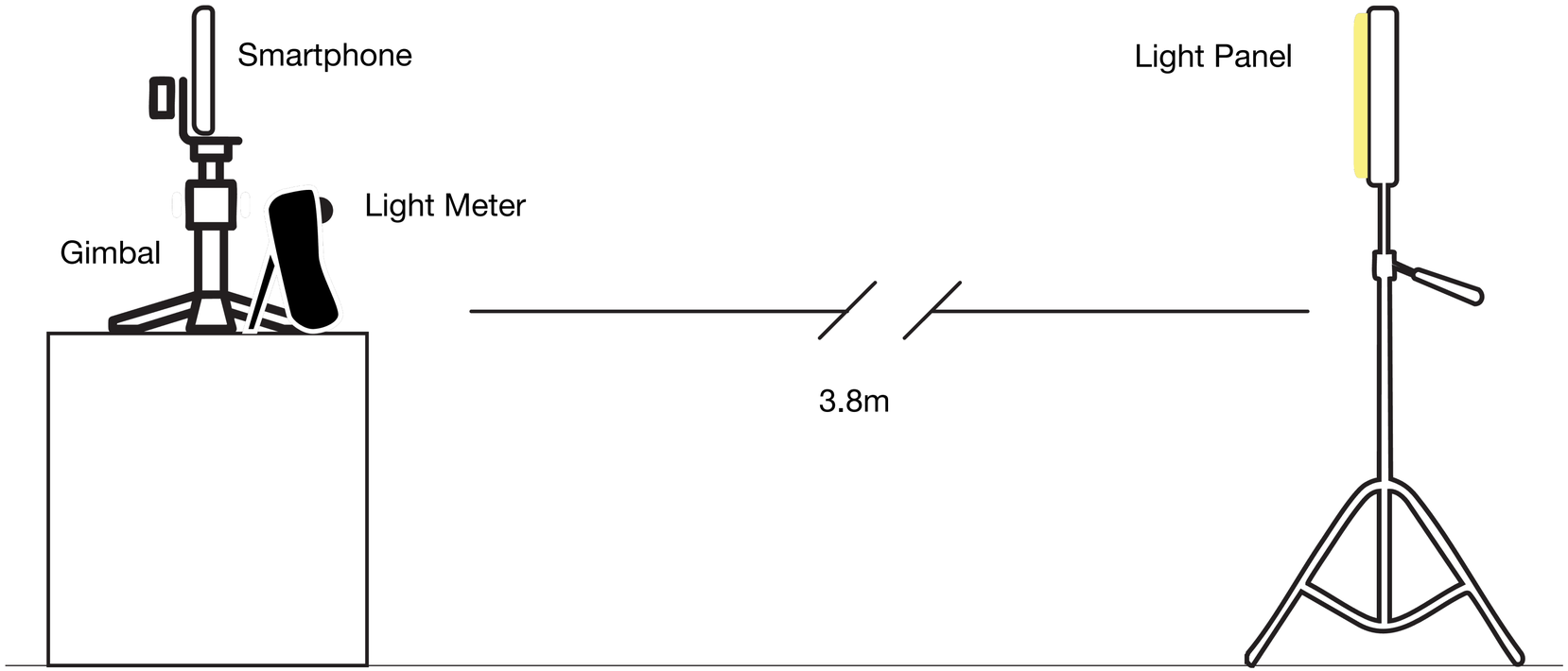
Utility

- Can we use NightLight to map lighting conditions across neighborhoods?
- How do people use NightLight data to plan their nighttime walking routes?

Feasibility

In-lab Validation

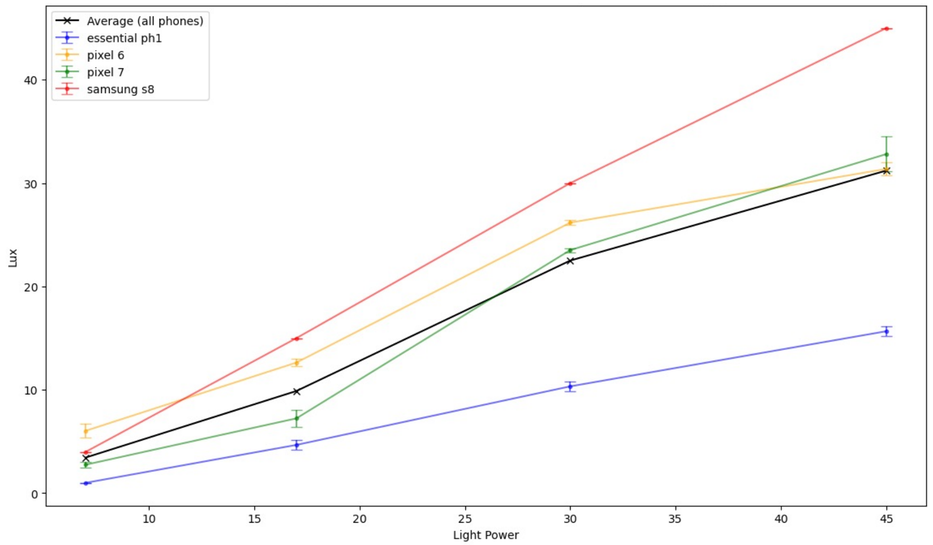
- 4 Phones
- Controlled sweep using gimbal



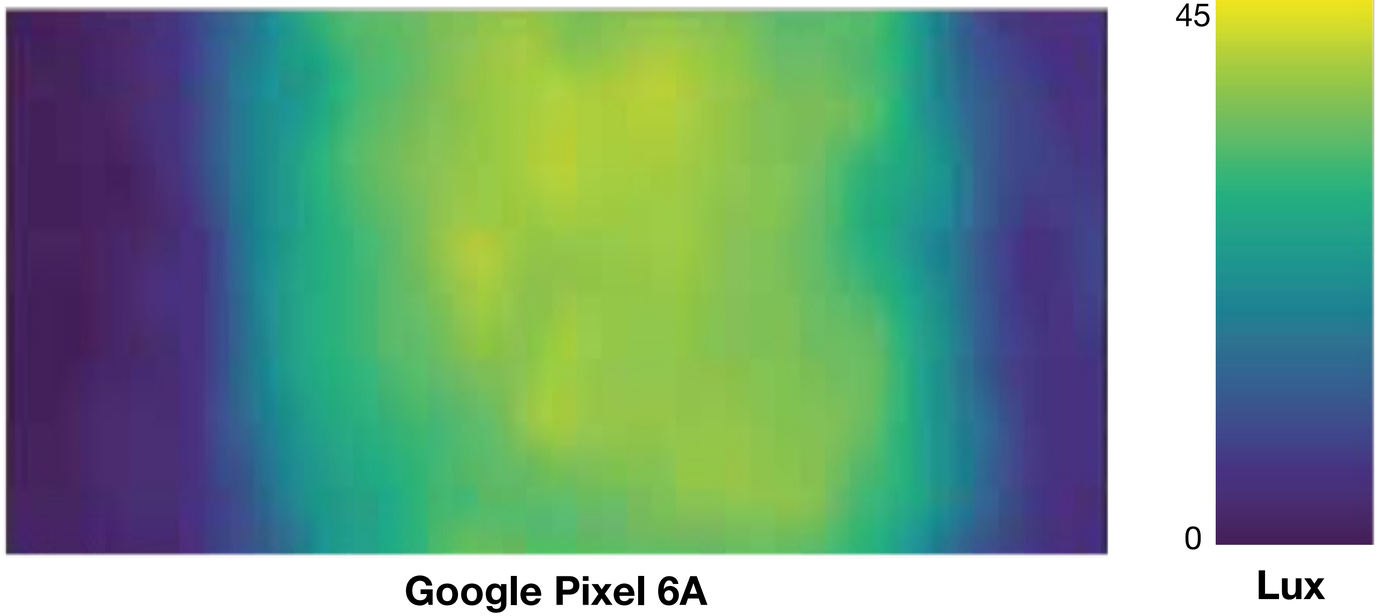
Feasibility

In-Lab Validation

Readings Across Light Intensities



Heatmap of Lux Readings



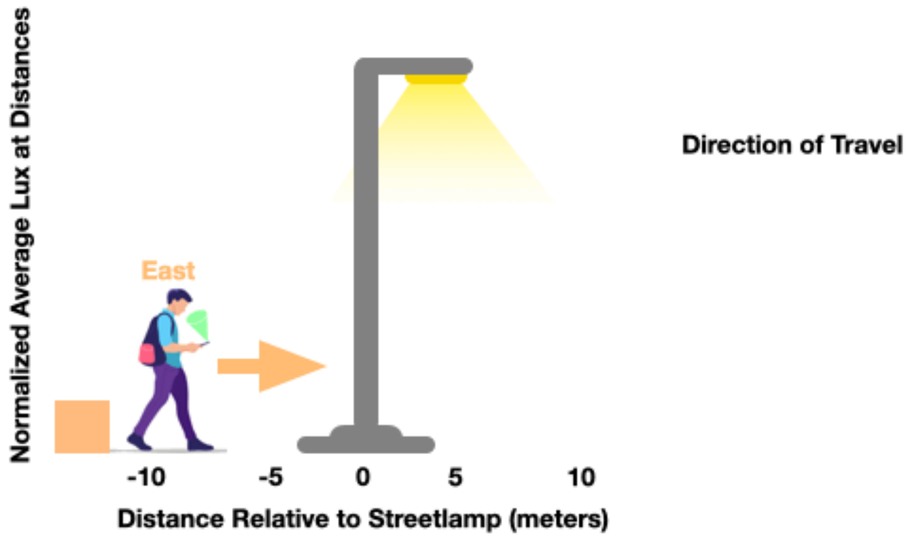
Google Pixel 6A

- On aggregate phones perform comparably to commercial light meter
- Orientation impacts light readings

Feasibility:

On-Street Validation

Sample Street

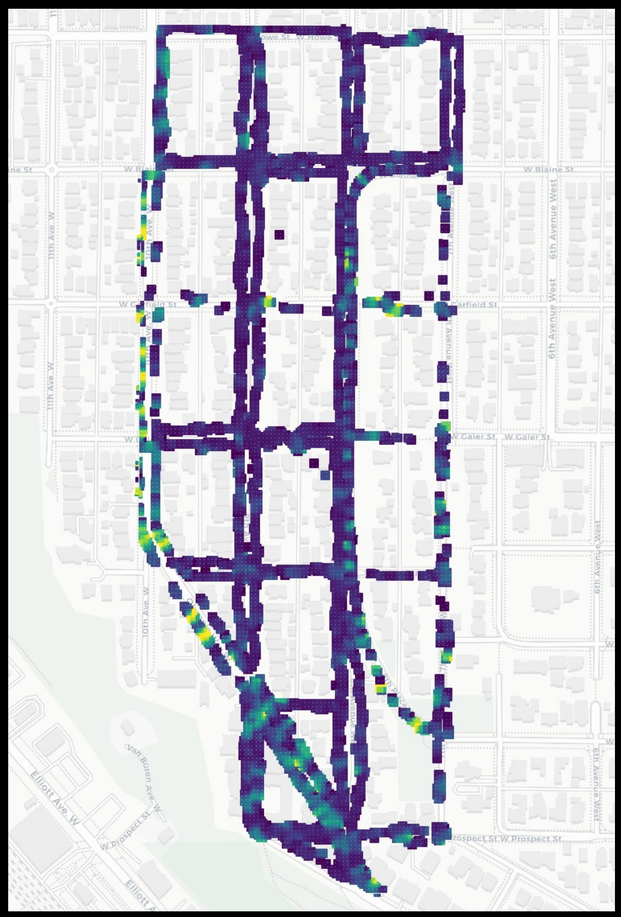


Utility: Neighborhood Data Collection

Waterfront

Gridded

Residential



Low Light

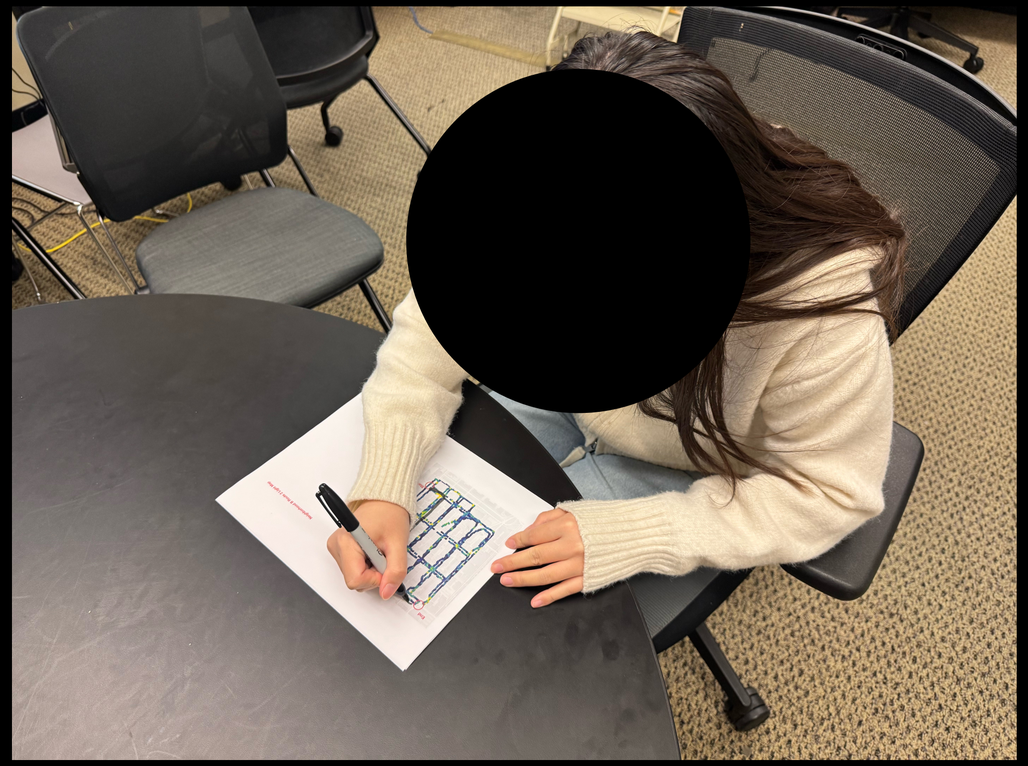
High Light

User Study

Gauging effects of light data on route planning

1. Semi-structured interview, followed by;

2. Think-aloud route planning task first without light data and then repeated with access to light data



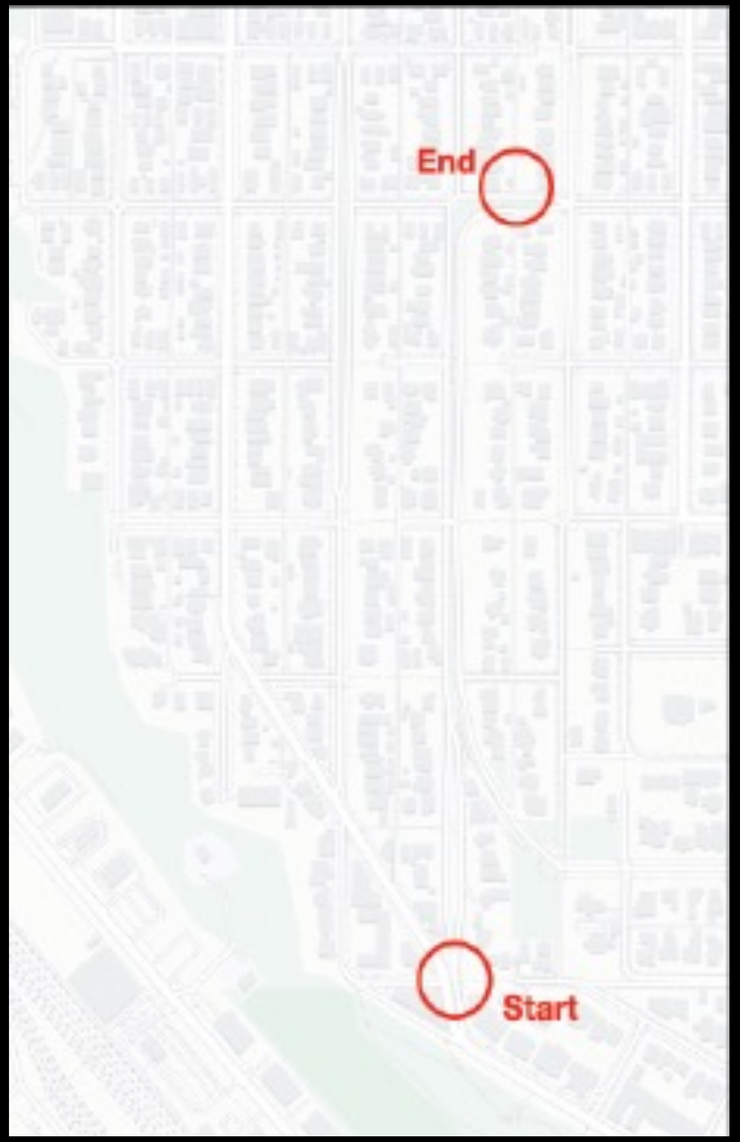
User Study

Light is already a concern

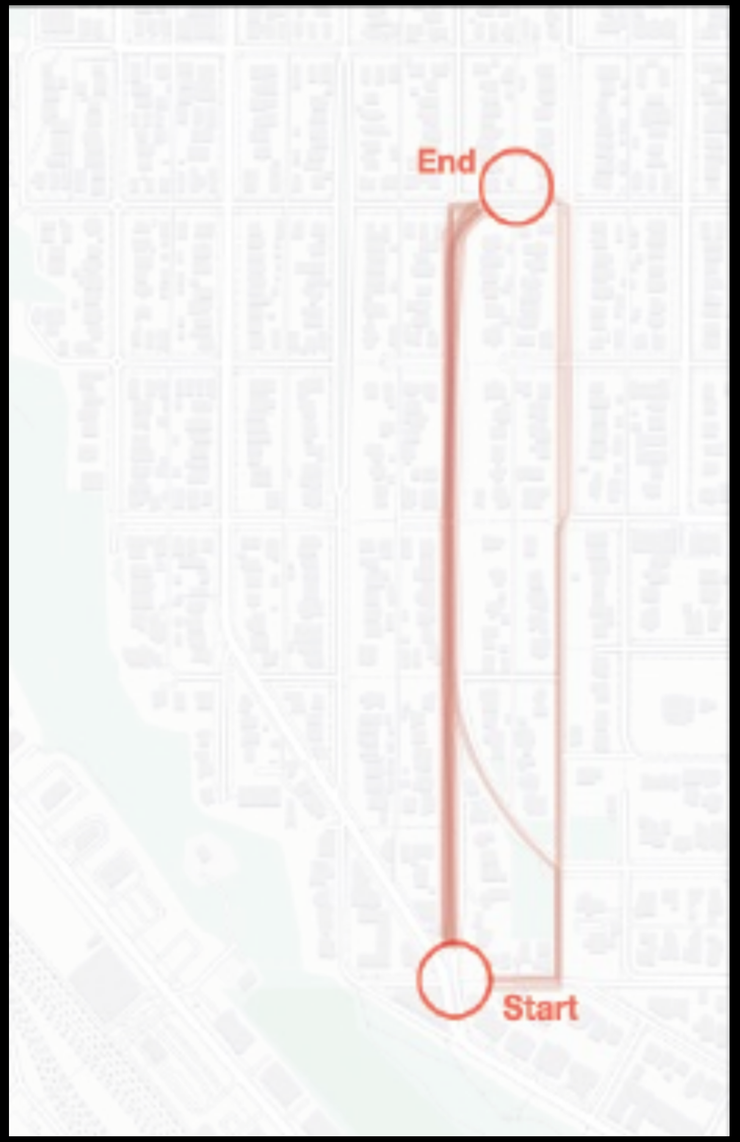
“If I had to walk at night, my primary concern is whether there is enough light”

-P11

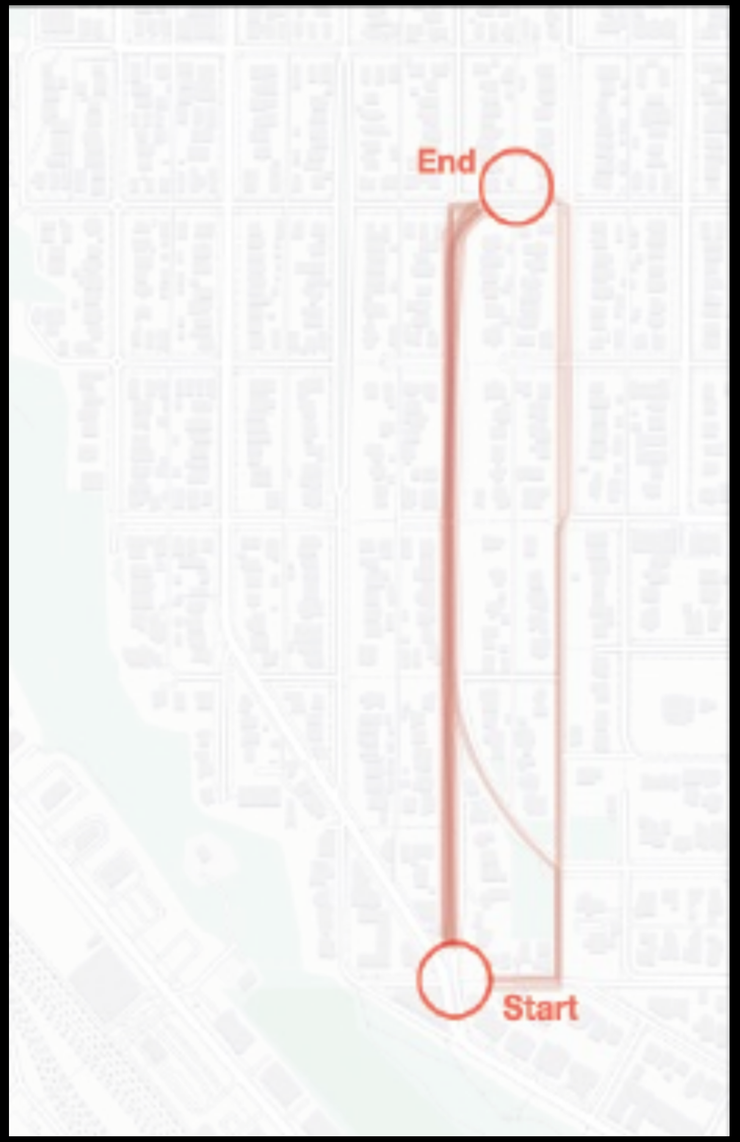
Residential Neighborhood

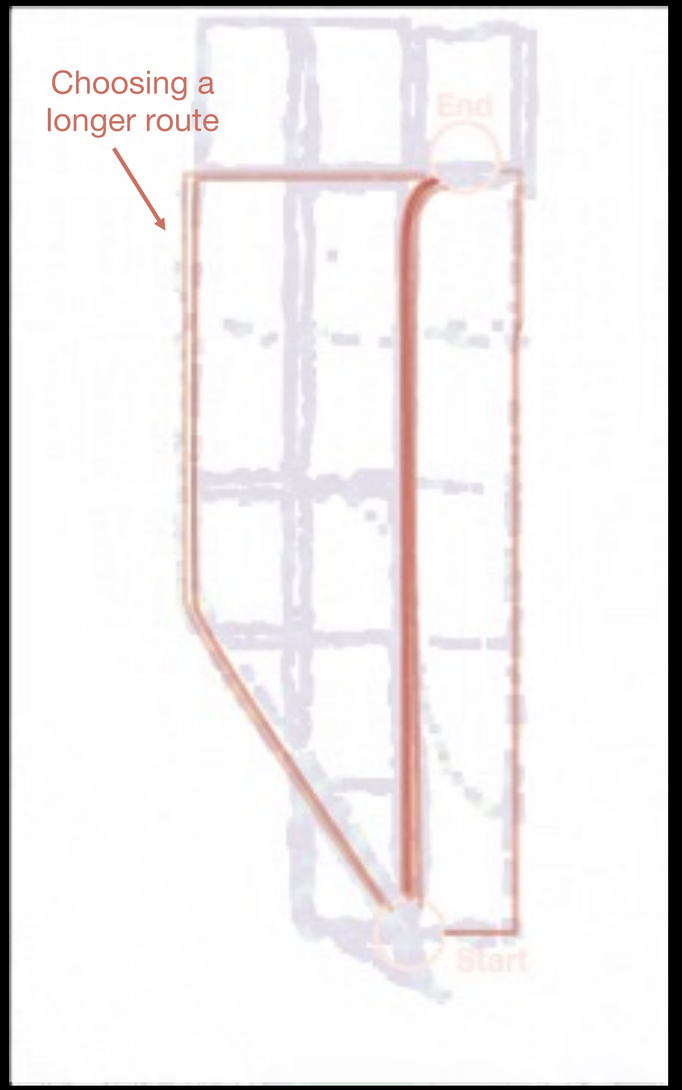


Residential Neighborhood



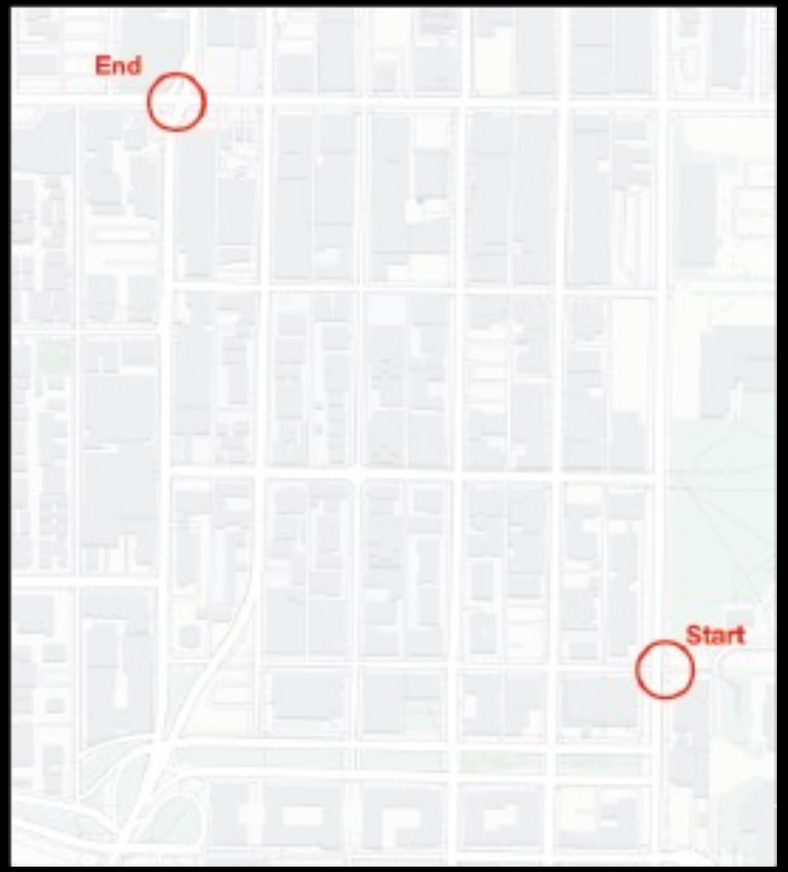
Residential Neighborhood





Gridded Neighborhood

All routes equidistant



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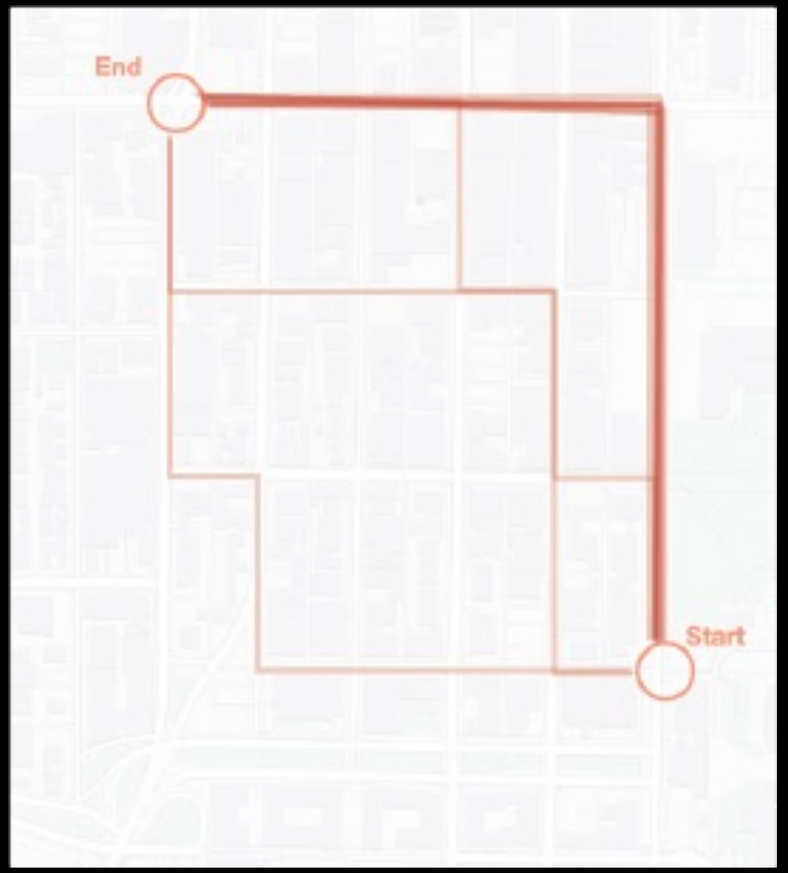

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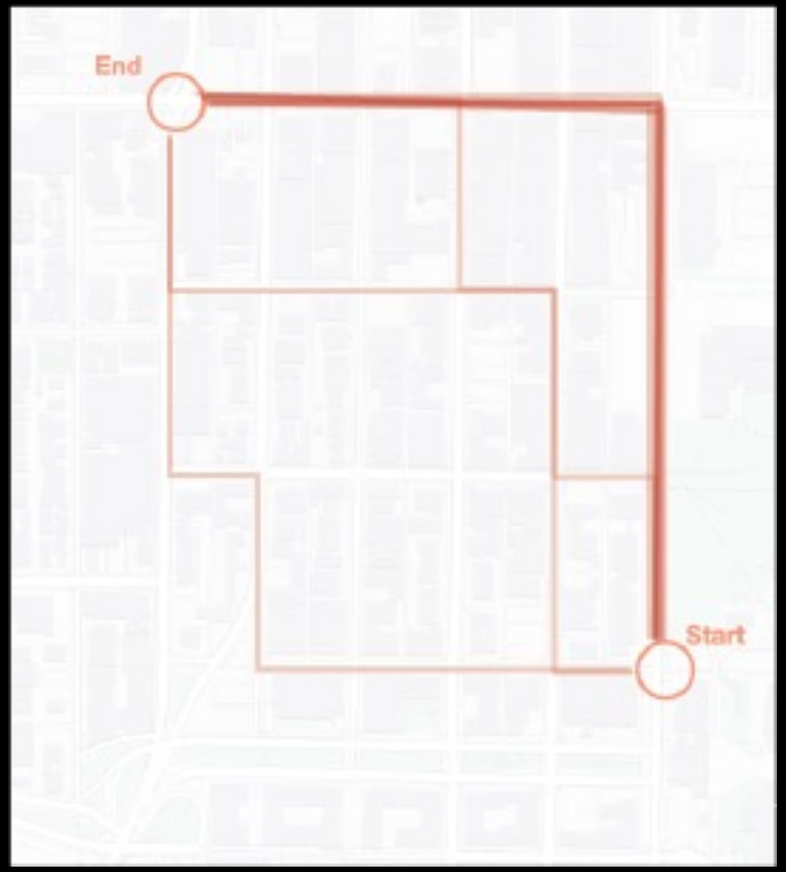
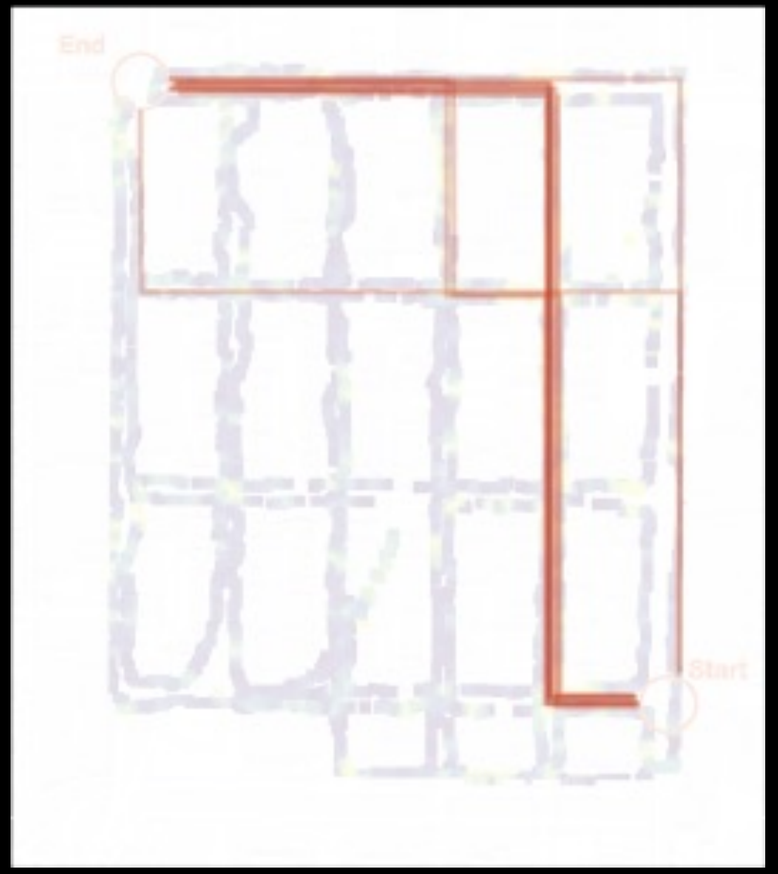
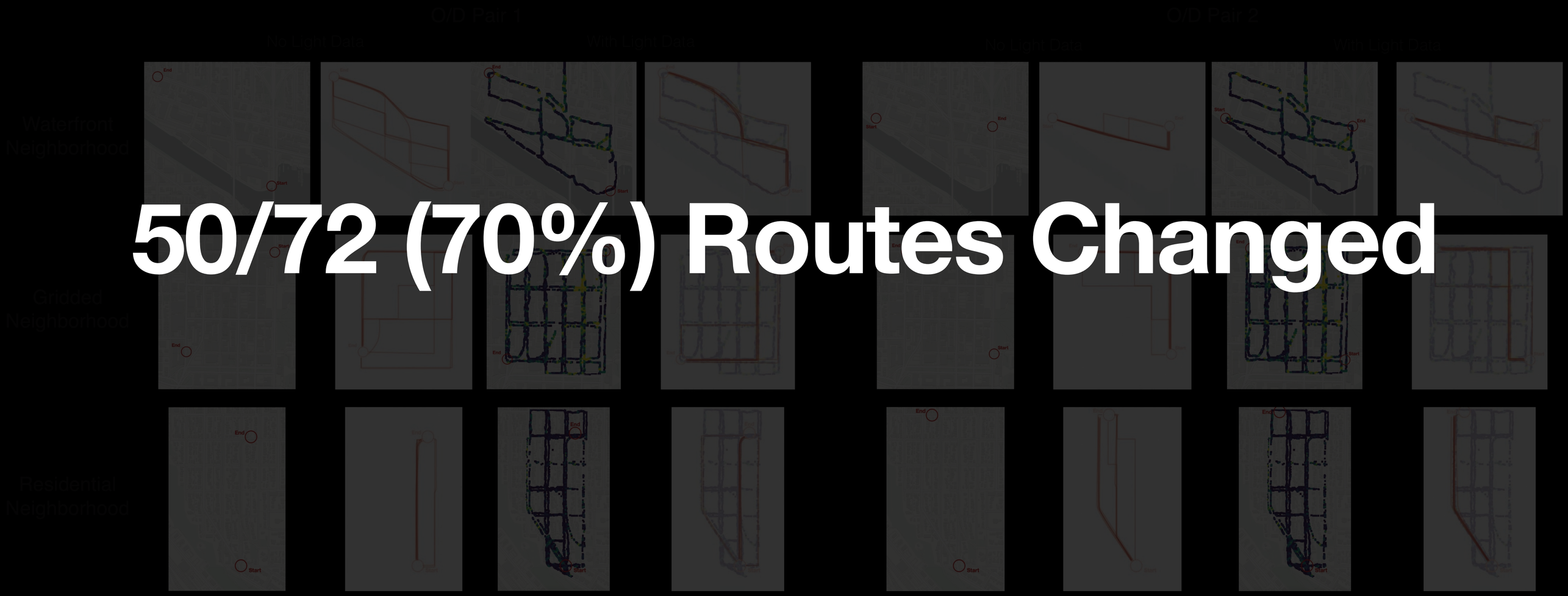
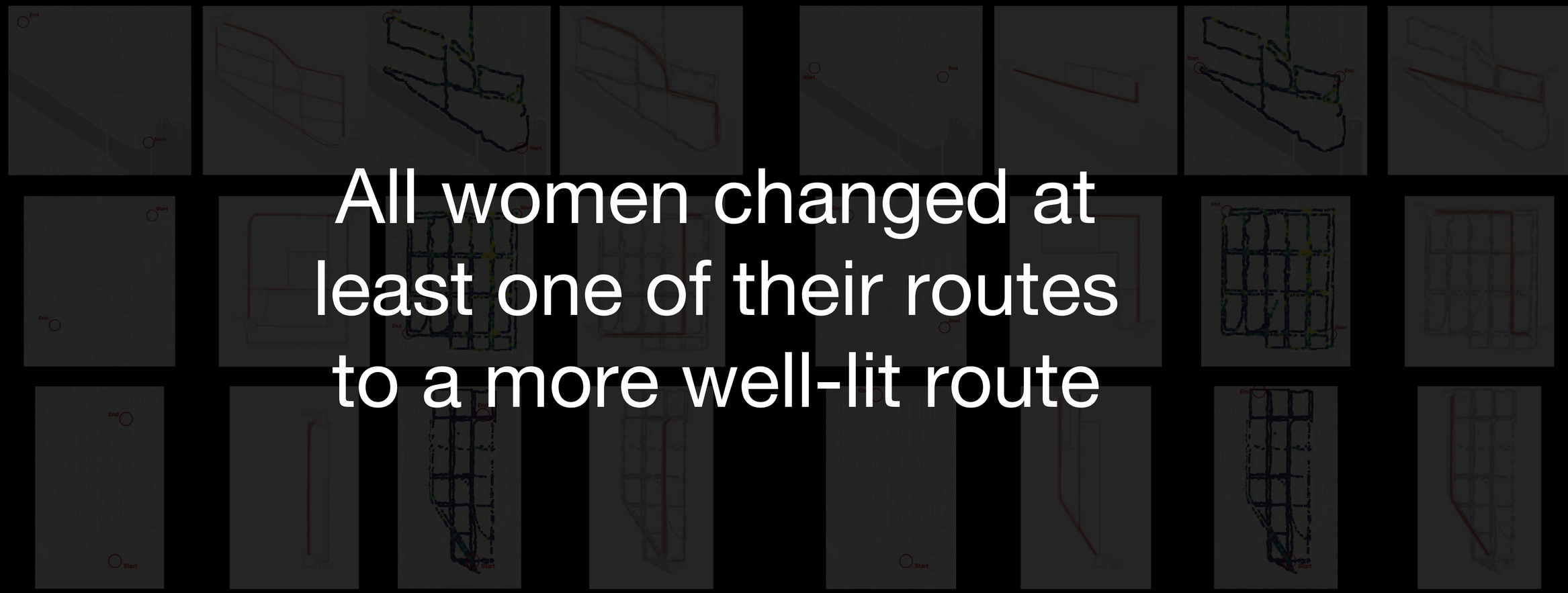




Impact of light maps on route choice



Impact of light maps on route choice



All women changed at least one of their routes to a more well-lit route

Limitations

- Limited test pool (geographic and users)
- Actual routes may differ than planned routes
- Phone operating system only allows us to get lux value

Future Work

- Large scale deployment study over time
- Build routing app that integrates light level for suggestions
- Integrate more sensor data (i.e., cameras, rear-facing ALS, etc) to improve data quality

NightLight

Conclusion

- We can leverage smartphones to passively aggregate and analyze lighting conditions
- This might have differential benefits for various populations (tourists, women, vulnerable populations)
- We can and should provide this data to help inform pedestrians on possible route choices

Thank you!

Paper

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On the job market soon!

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