BOLD THINKERS DRIVING REAL-WORLD IMPACT

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The Implications of Utilizing Consumer Grade GPS

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Research Questions

- How do consumer grade GPS loggers compare to GIS grade loggers?
- What are sources of error in New York City?
- What should researchers consider when using GPS data?

Overview

- Global Positioning System (GPS) usage in Travel Surveys
- GPS Technology
- Methodology
- Results
- Take Aways for Consideration

GPS usage in Travel Surveys

- Surveys provide demographics, attitudes, opinion & motives
- GPS provides:
  - Spatial and temporal data
    - Acceleration & speed
  - Route path
  - Underreported trips

GPS Technology

- 31 satellites
- Distance = Rate × Time
  - Rate: How fast radio signal is received (speed of light)
  - Time: How long it takes for radio signal to arrive (signal time minus received time)
- At least 4 satellite signals for location estimate

GPS tech cont.

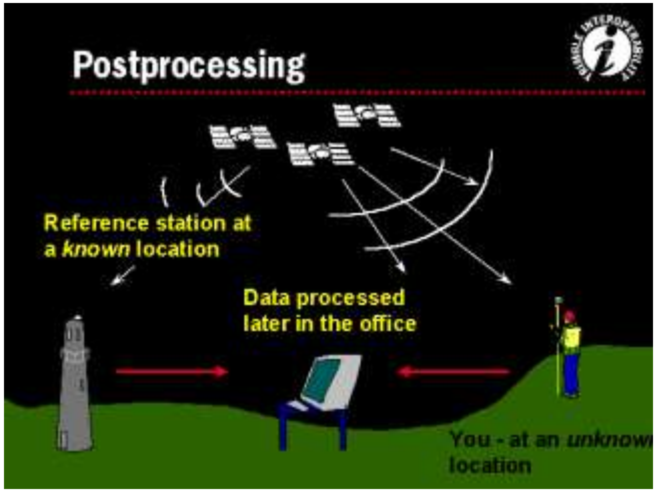
- 7.8 m at 95% confidence
  - Signal distortions
  - Residual receiver delay errors
  - Receiver noise
  - Receiver hardware/software faults
  - Multipath and receiver multipath mitigation
  - User antenna effects
  - Operator (user) error

Consumer Grade GPS

- GPS loggers
- GPS transmitters
- Smartphone applications
  - Wifi & cell phone tower assisted trilateration (AGPS)
- Low cost ($60)
- Chipsets:
  - Qualcomm (including SiRF)
  - U-blox
  - MTK

Methodology

- GIS grade equipment
  - Trimble Geo 7X Receiver
  - Zephyr Antenna
  - $10,000
- Differential Corrections (DGPS)
  - Base stations
  - Post processing (Trimble Pathfinder)

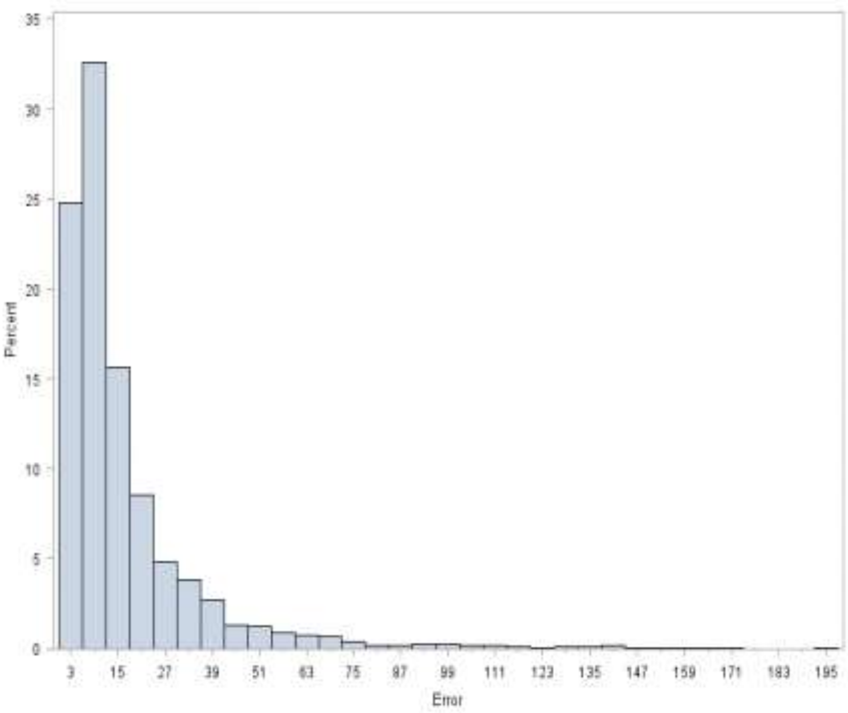


Methodology cont.

- Measure distance using Vincenty's formulae
- Matched on timestamp
- 4 different consumer grade devices
- 1 second intervals

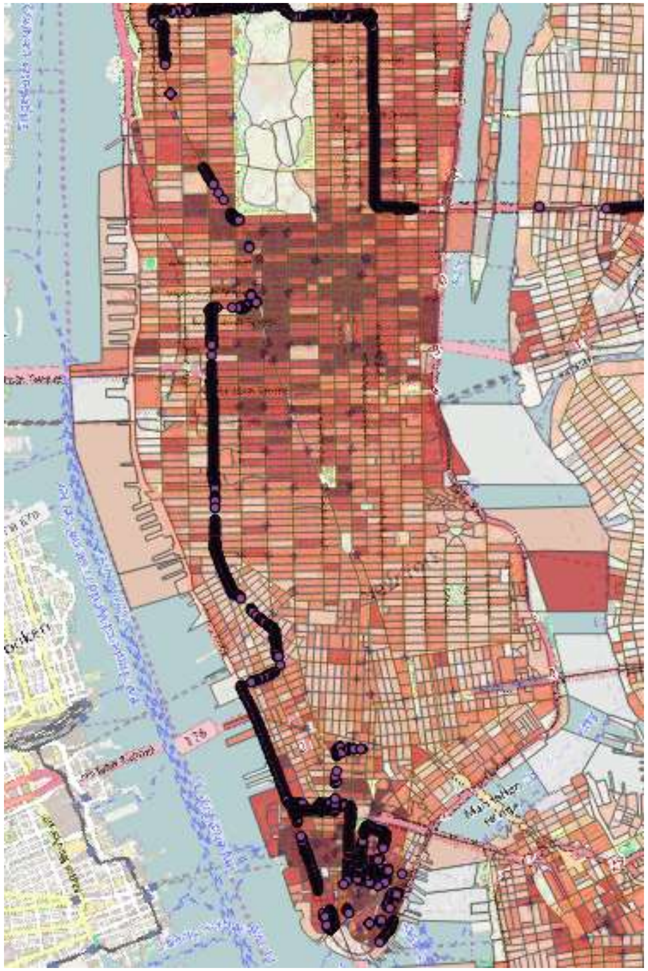
Results

Basic Statistical Measures			
Location		Variability	
Mean	16.53090	Std Deviation	19.21971
Median	10.18832	Variance	369.39707
Mode	5.16950	Range	196.94931
		Interquartile Range	13.17753

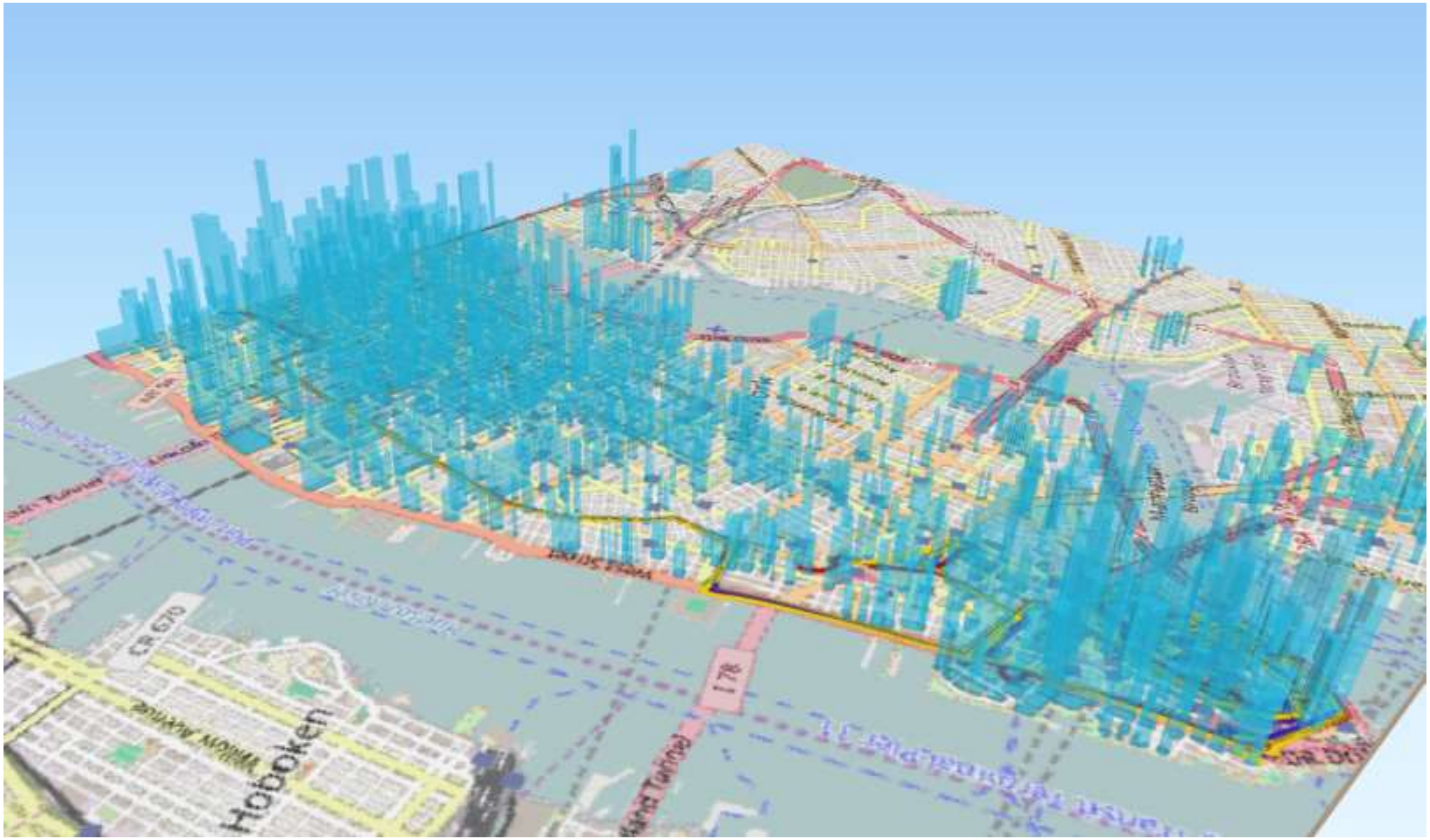


Errors

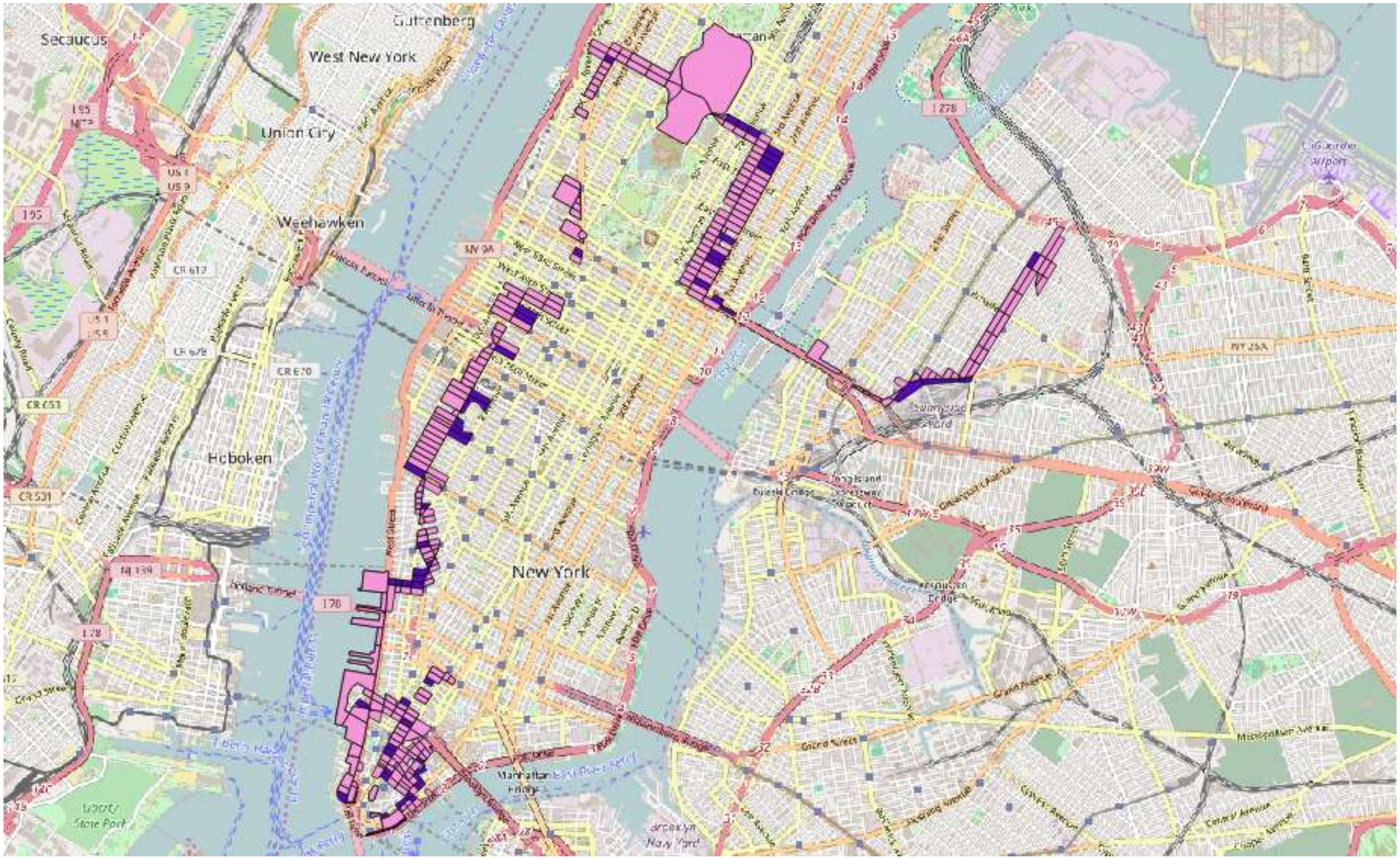
- Building height correlated with error
- Multipath error (Canyons)
- Error across all devices
  - Including GIS grade devices
- Block error



Building Heights



Block Error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I 78

Similar Research

Quantifying Distance Overestimation From Global Positioning System in Urban Spaces

Stephen J. Mooney, MS, Daniel M. Sheehan, MA, Garazi Zulaika, MPH, Andrew G. Rundle, DrPH, Kevin McGill, Melika R. Behrooz, and Gina Schellenbaum Lovasi, PhD, MPH

Objectives. To investigate accuracy of distance measures computed from Global Positioning System (GPS) points in New York City.

Methods. We performed structured walks along urban streets carrying Globalsat DG-100 GPS Data Logger devices in highest and lowest quartiles of building height and tree canopy cover. We used ArcGIS version 10.1 to select walks and compute the straight-line distance (Geographic Information System–measured) and sum of distances between consecutive GPS waypoints (GPS-measured) for each walk.

Results. GPS distance overestimates were associated with building height (median overestimate = 97% for high vs 14% for low building height) and to a lesser extent tree canopy (43% for high vs 28% for low tree canopy).

Conclusions. Algorithms using distances between successive GPS points to infer speed or travel mode may misclassify trips differentially by context. Researchers studying urban spaces may prefer alternative mode identification techniques. (*Am J Public Health.* 2016;106:651–653. doi:10.2105/AJPH.2015.303036)

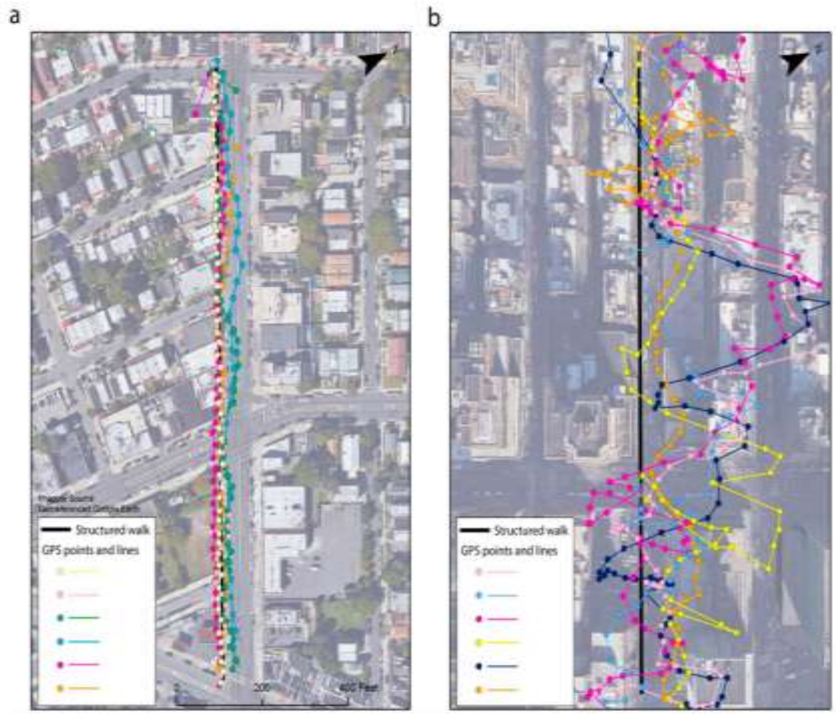
Global Positioning System (GPS) monitoring to study physical activity and mobility[1,2] has spawned 2 threads of meth-

WorldCom Corp, New Taipei City, Taiwan), devices that had previously been started and had acquired a signal from at least 1

in 80 trip records. One device failed to record on 2 walks, which were discarded from analysis.

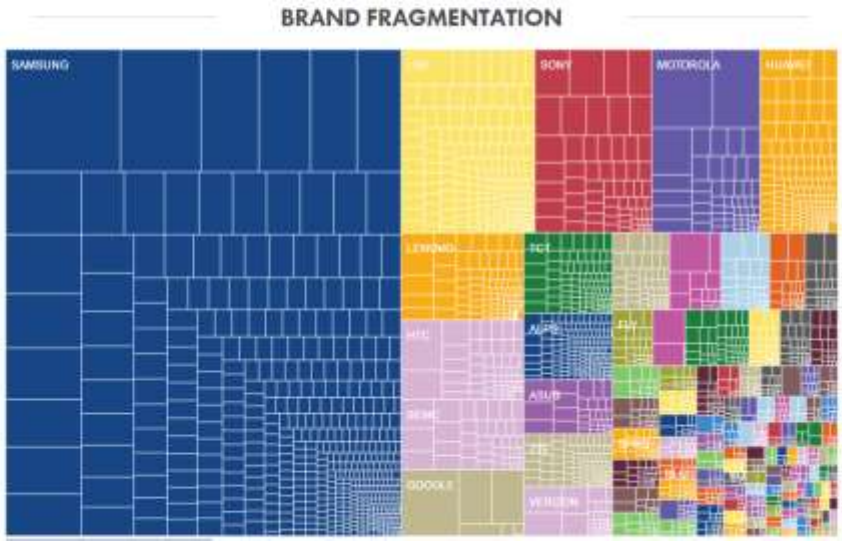
Next, we explored the effect of tree canopy cover on the basis of data gathered by lidar scan.[16] We planned walks adjacent to census blocks in the highest quartile (n = 10) and lowest quartile (n = 10) of tree canopy cover in New York City. Two research assistants carrying 3 DG-100 devices performed each walk once, resulting in 60 trip records.

We used ArcGIS version 10.1 (ESRI, Redlands, CA) to select walks and to compute the straight-line distance (GIS-measured) and sum of distances between consecutive GPS waypoints (GPS-measured) for each walk. We used R for Windows version 2.15.3 (R Foundation for Statistical Computing, Vienna, Austria) for statistical analyses.



Implications

- High resolution geography, higher error rate
  - Rooftop or block geography unstable
- Impacts prompted recall and diary matching
- Error not randomly distributed
- More devices, more variance
- Misclassify mode of travel



Conclusion

- Lat/long is an estimate
- Measures of certainty:
  - Number of satellites
  - Accelerometer
  - Confidence
- Limited hardware solutions
  - Bluetooth beacons

Thank You

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