

# Digital Injustice: A Case Study of Land Use Classification using Multisource Data in Nairobi, Kenya

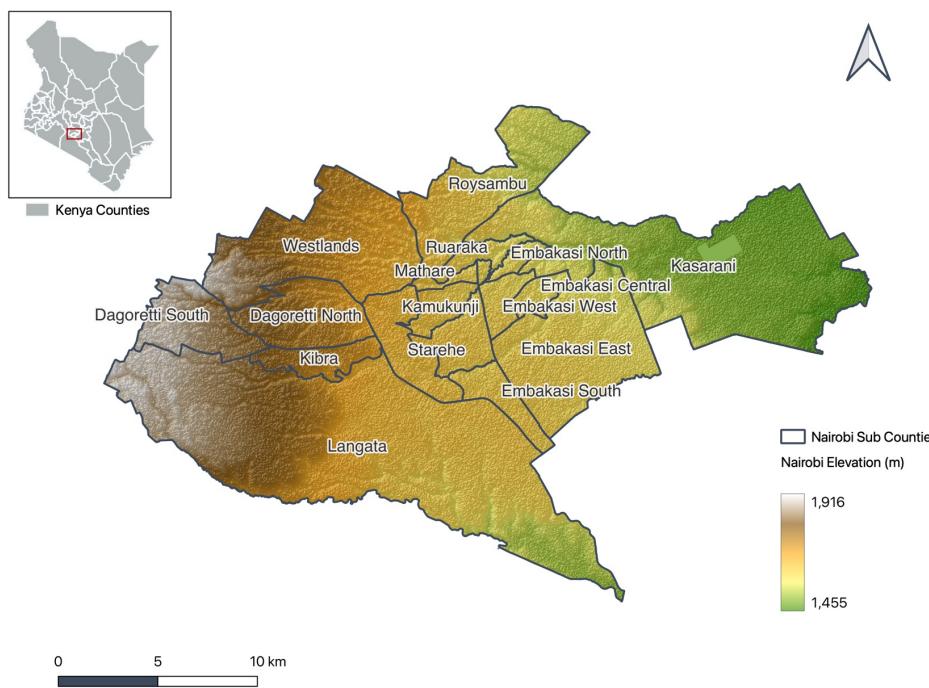
For GIScience 2023, Leeds, UK.

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# Project Aim

1. Propose a framework of using multi-source publicly available smart data for urban land use classification
2. Identify digital injustice issues in Nairobi and propose mitigation approach

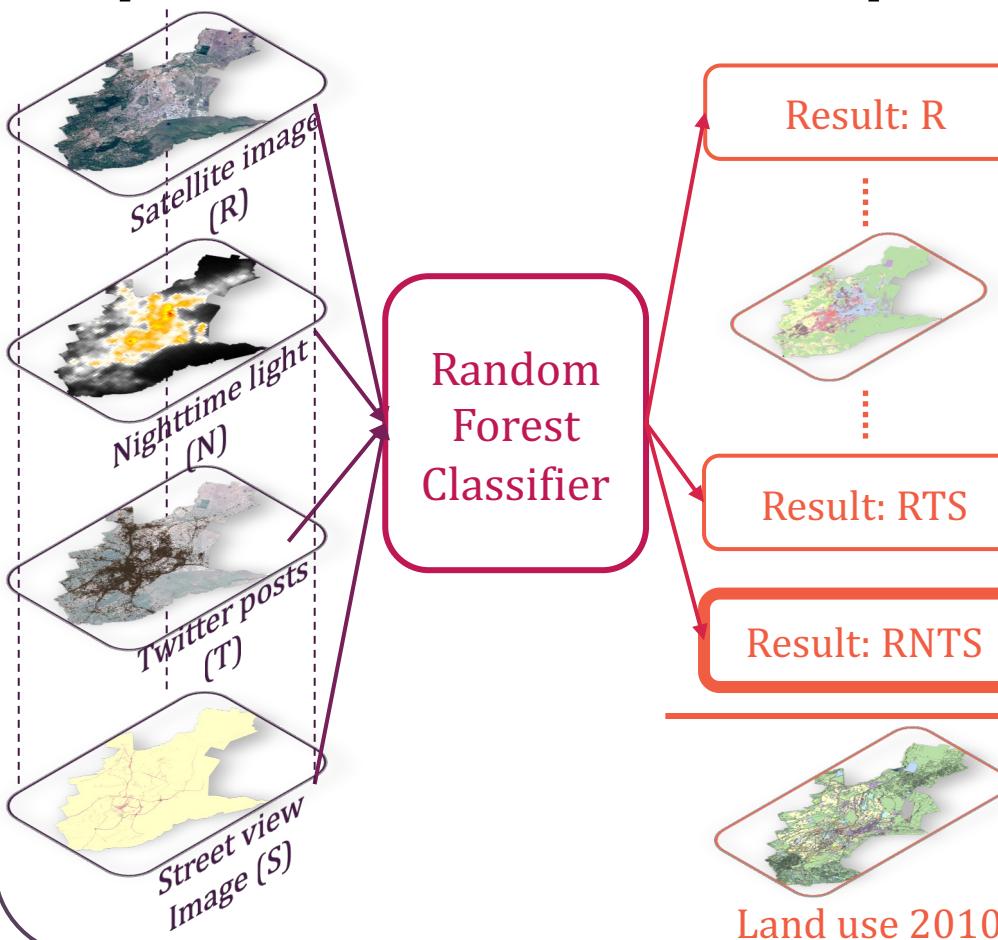


- Booming population: 4.397 million (2019)
- Growing IT service penetration of 87% (2018)
- Deprived areas accommodate more than 60% of total population while occupy less than 5% of the city extension

# Methodology

## Land use classification

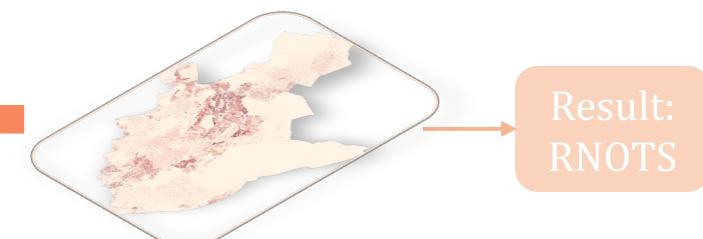
Input data      Classifier      Output



## Injustice mitigation

- Algorithm level  
Algorithm enhancement:  
Kernel Density Estimation (KDE)

- Data level  
Spatial data fusion:  
Google Open building V3 (O)  
(building footprint)



# Data Sources – Input data

## Input Data

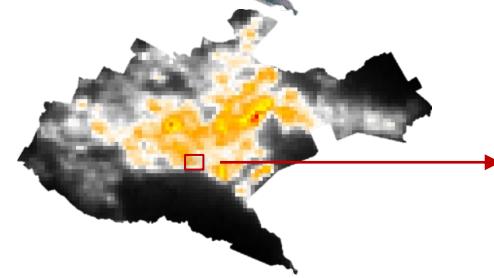
Satellite image

2022.01.01 – 2022.05.01



Nighttime light image

2022.01.01 – 2022.05.01



Social media posts  
Twitter

2019.01 – 2022.06



Twitter text

Ningekua nimewai blunt kwanza" @Gish\_\_: Nikiwa Highschool hii ndio masaa nilikuwa Na board Gari ya "

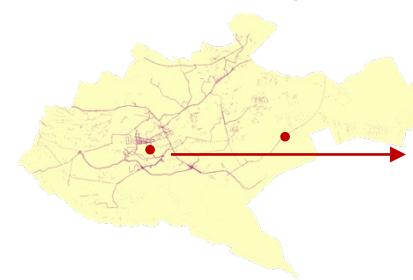
He made sure he goes in the last minutes so we have no time for replacement. Cunt

Just posted a photo @ Nairobi, Kenya https://t...

How long will this continue?

Street view image  
Mapillary

2017 – 2021



# Data Process

Cloud-free sentinel Image

Bands: Red, Green, Blue, Near Infrared , Short-wave infrared

$$\text{Normalized Difference Vegetation Index (NDVI)} = \frac{\text{NIR}-\text{Red}}{\text{NIR}+\text{Red}}$$

$$\text{Normalized Difference Water Index (NDWI)} = \frac{\text{G}-\text{NIR}}{\text{G}+\text{NIR}}$$

$$\text{Normalized Difference Built-up Index (NDBI)} = \frac{\text{SWIR}-\text{NIR}}{\text{SWIR}+\text{NIR}}$$

Nighttime light image

VIIRS-DNB

Twitter Data

Time

Weekday

0 - 8  
Home

8 - 19  
Work

19-24  
Relax

Weekend

0 - 9  
Home

9 - 24  
Relax

Language

English

Swahili

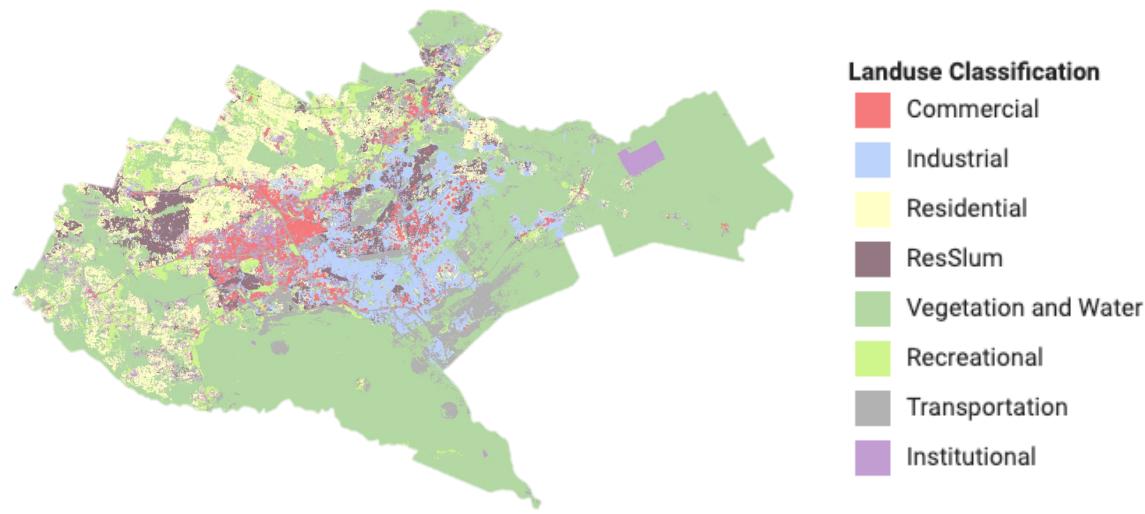
Others

Street View Image

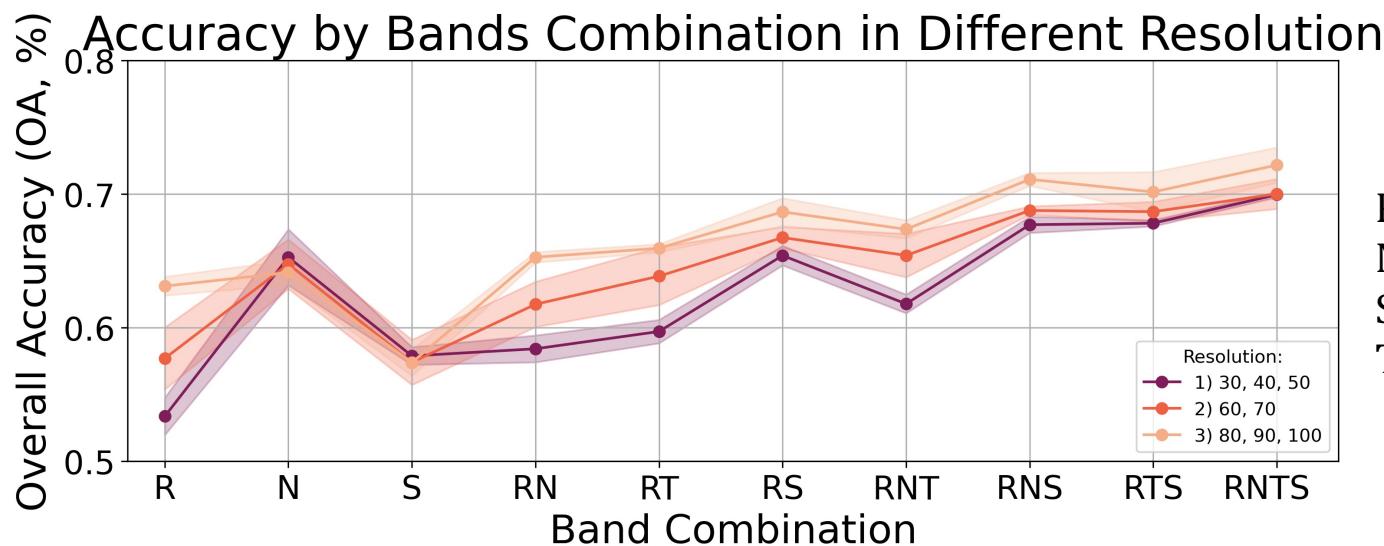
Panoramic segmentation



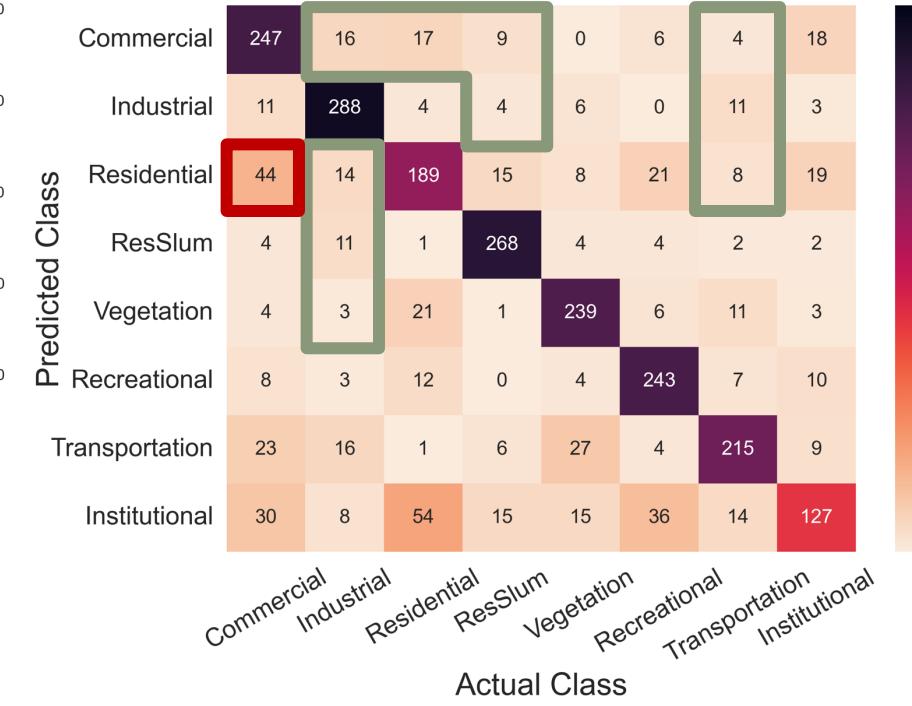
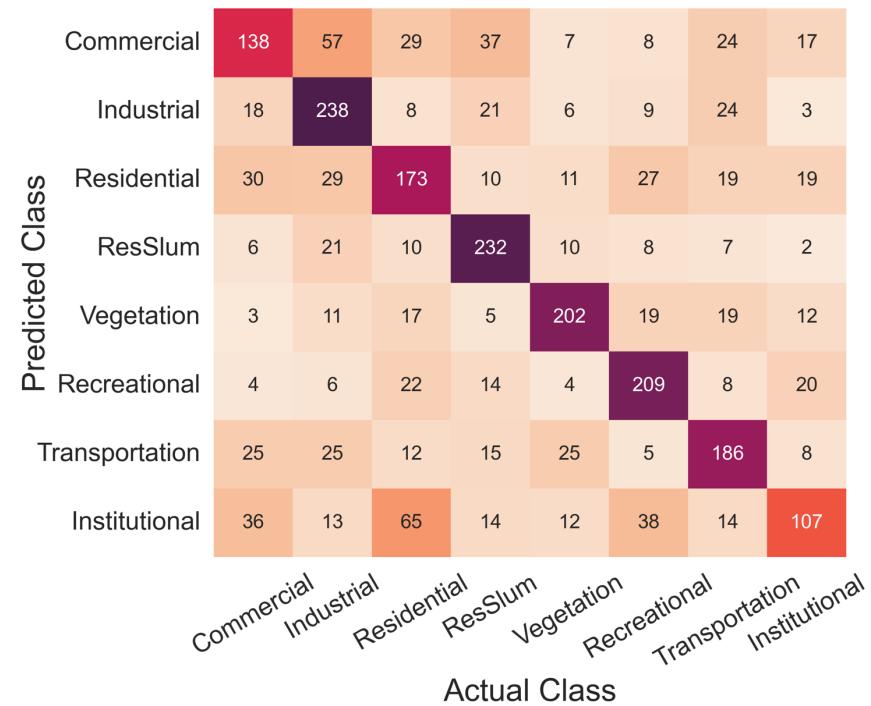
# Result – Land use classification



The Nairobi City County Assembly,  
Nairobi City County Land Use Policy (2021)



# Result – Confusion matrix



**Improvement:**

- land use/ function

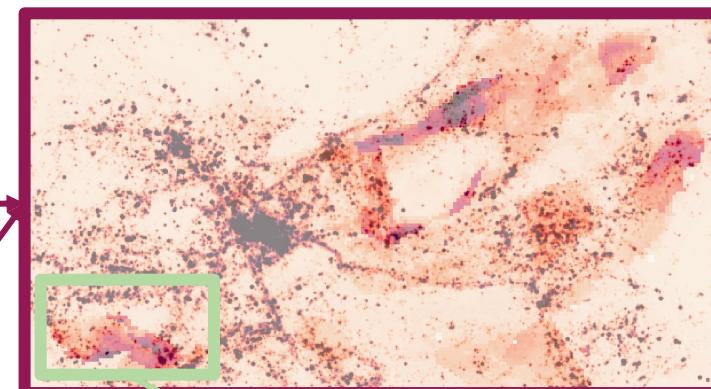
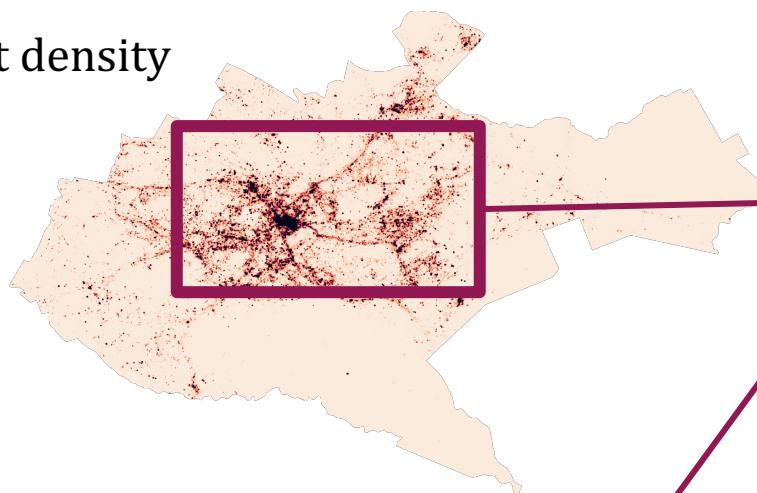
**Reason:**

- social economic features

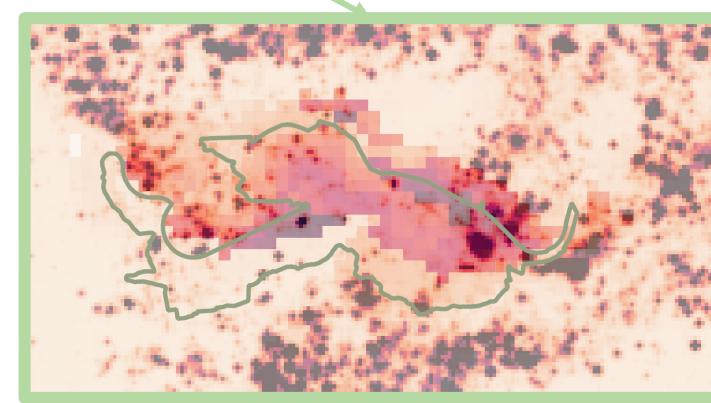
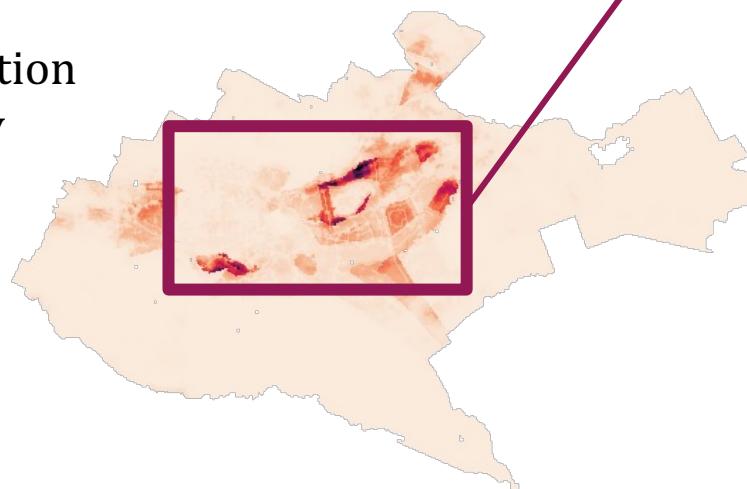
# Result – Data injustice

30m Grid Total Pixel: 792534  
Languaged Tweets: 307632  
38.82%

Tweet density

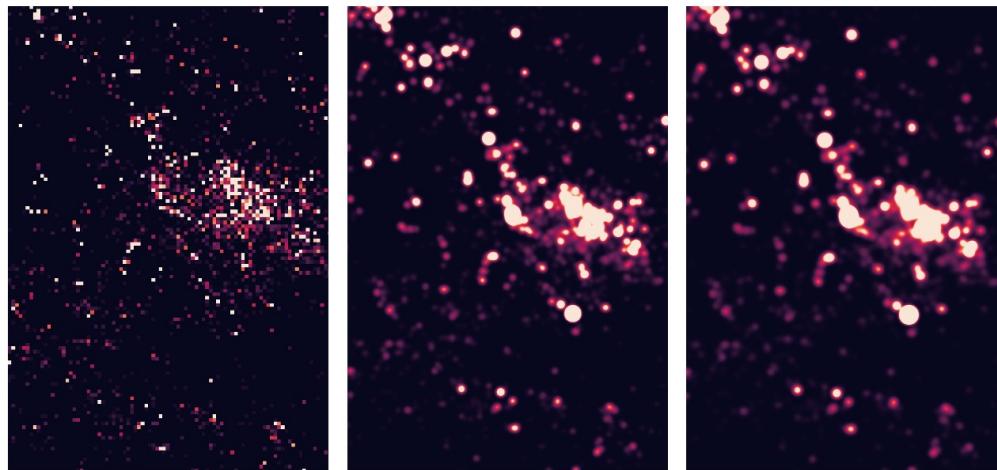
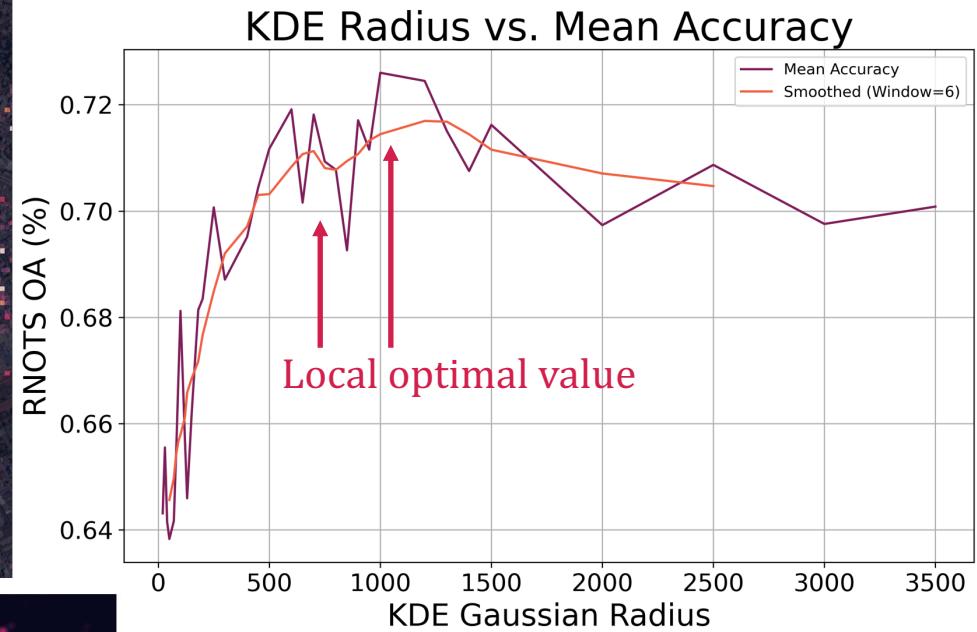


Population density



Representative?

# Result – Data injustice mitigation1



Origin

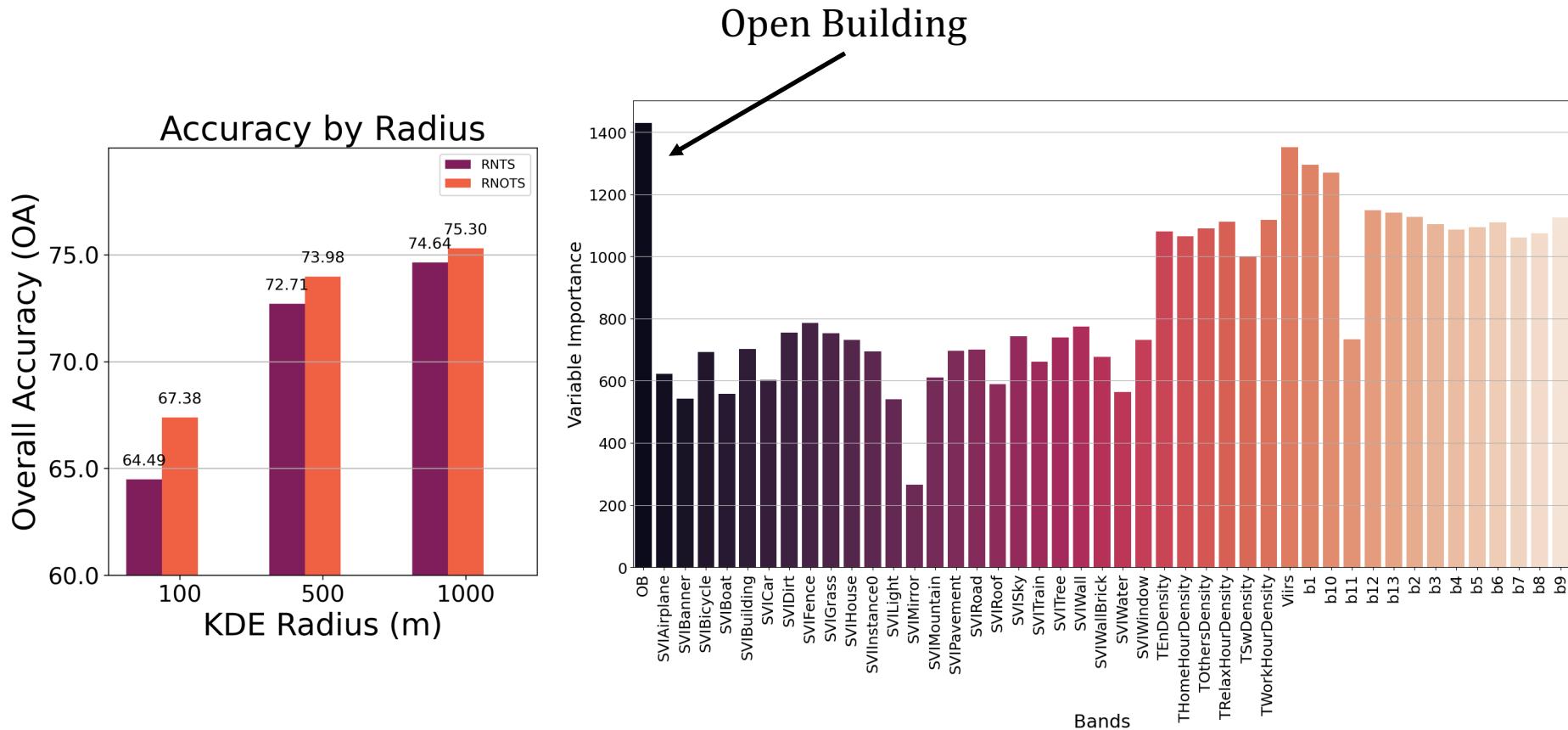
KDE

Convolution

Twitter ENG: radius 60, sigma 15

- KDE is effective as an **algorithm enhancement** approach for digital injustice mitigation

# Result – Data injustice mitigation2



Adding open building data:  
Overall accuracy & variable importance change

# Summary of Result

- Smart data (street view image and social media posts) can be used to improve land use classification
- Digital injustice mitigation :
  - Algorithm level approach - algorithm enhancement
  - **Data level approach - participatory data collection**

# Future Work

- Algorithm enhancement
- Targeted participatory data collection
  - Identify the location of digitally injustice groups (spatial overall accuracy / variable importance)
  - Community mapping

# Thank you

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