Equity in Resident Crowdsourcing: Measuring Under-reporting without Ground Truth Data

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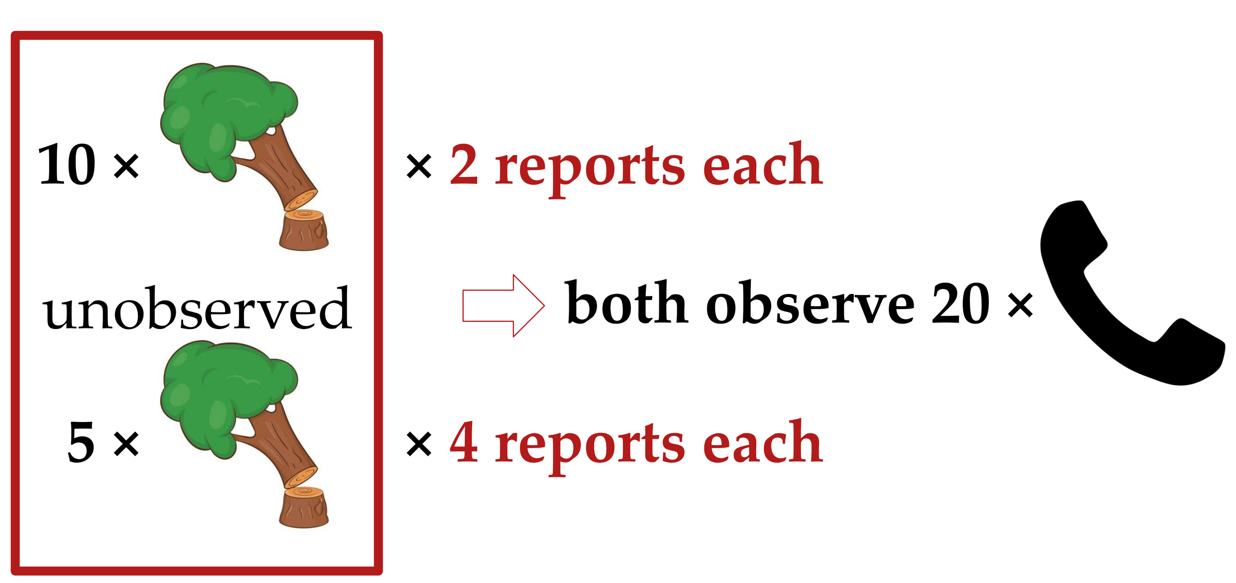
BACKGROUND

- ❏ Resident crowdsourcing systems
  - ❏ 311 systems, in North America
  - ❏ help cities learn about conditions: potholes, bedbugs, powerlines… …and in our problem, **trees**!

- ❏ Historic equity concerns in reporting
  - ❏ technological disparities, awareness
- ❏ Hard to measure under-reporting
  - ❏ observed **reports** governed by both **incidents & reporting behavior**
  - ❏ want to estimate **under-reporting**
  - ❏ **no ground-truth about incidents**



PREVIOUS WORKS

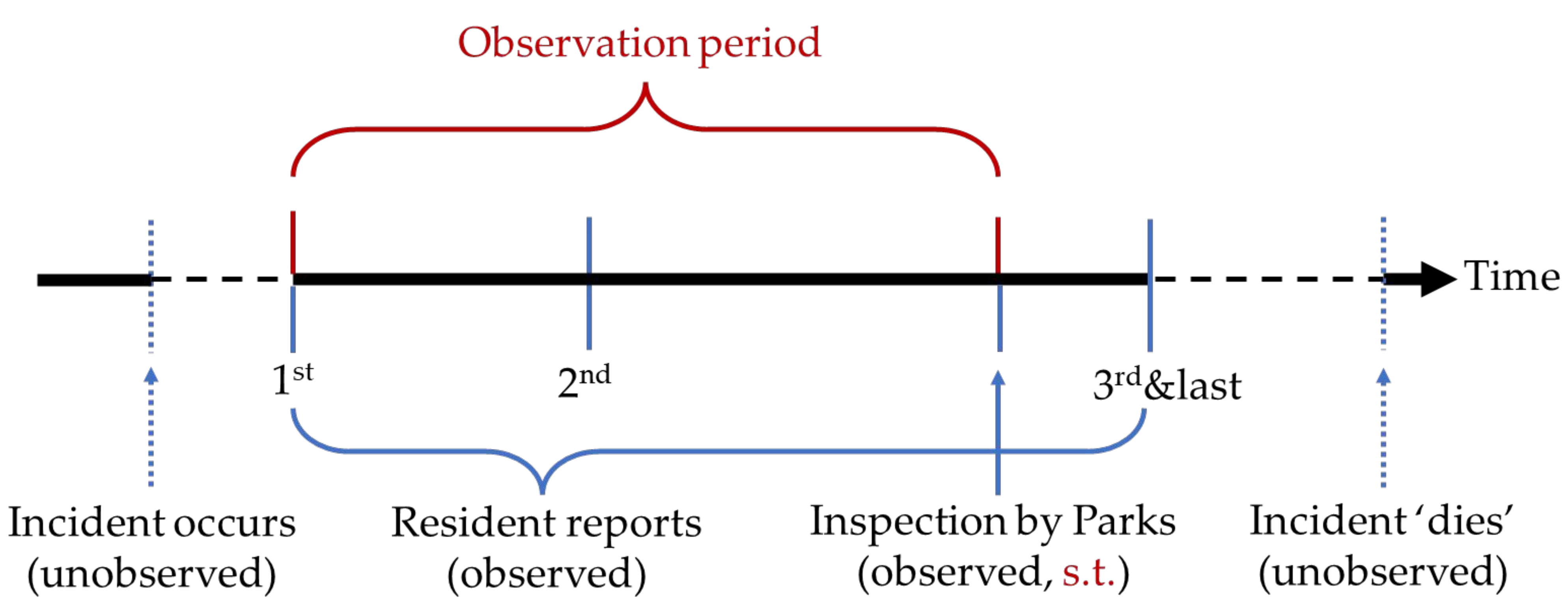
1. Assume *same incident rate*
   – likely **not true**, due to varying conditions across the city

2. Construct *proxies for reporting rate*
   – e.g. # reports/# trees
   – accuracy of results highly depend on accuracy of proxy, which **we cannot test**

MAIN RESULTS

1. Technique which leverages **duplicate reports** to estimate reporting rate without ground-truth data, with theoretical guarantee
2. Application to more than 100,000 311 reports in NYC, uncovering **substantial spatial and socio-economic disparities** in reporting

A new & general estimation technique



Model: conditional on incident happens, reports come in according to a **Poisson process** with potentially non-homogeneous rates, but incident birth and death times are unobserved

➔ difficulty: **birth and death unobserved**

Theorem(informal): an **observation period** with start & end times:

- ❏ both **contained** in the period between incident birth and death;
- ❏ both **stopping times**, independent of Poisson rate;

then estimating the reporting rate in this observation period with the **duplicate reports** ⇔ estimating the overall reporting rate

Implementation on NYC Parks data

Identifying observation period from data:

➔ start time: time of first report

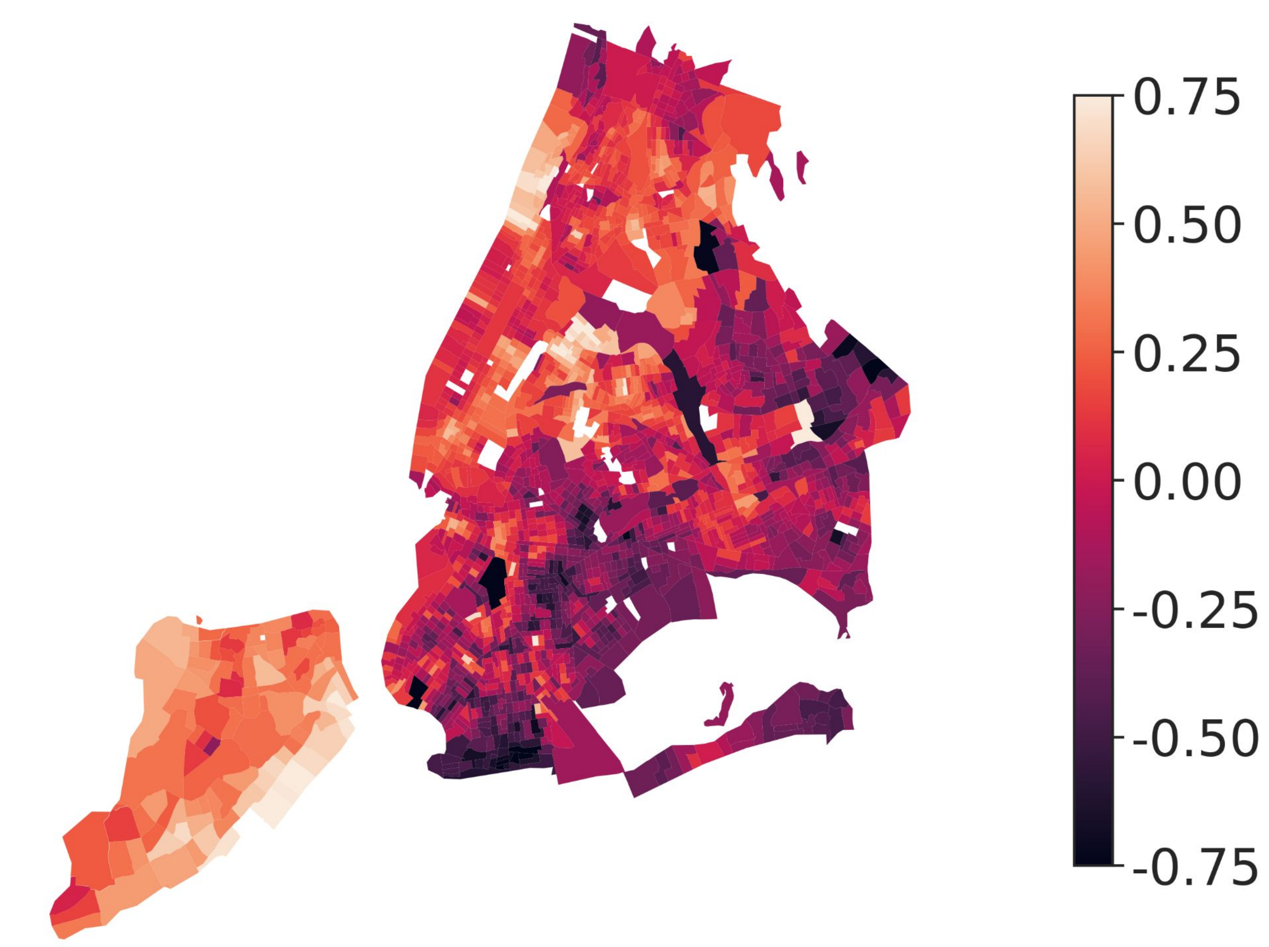
➔ end time: **min**{inspection, fixed interval (100 days) from start}

Bayesian Zero-inflated Poisson regression model for estimation

➔ covariates: incident category, inspection outcome, tree info, location, demographics of reporter

IMPLICATIONS

Fig: Census tract spatial coefficients in NYC



Even after correcting for incident category:

- ❏ substantial **spatial disparities** across census tracts
- ❏ **socio-economic disparities** across different groups

Tab: Implied reporting delay from estimated rates

Incident	Manhattan	Queens
Hazard, High risk, Poor tree	2.5 days	4.7 days
Root/Sewer/Sidewalk, Fair tree	112 days	209 days

Difference in contextualized reporting delay

➔ direct effort to push 311 system for more utilization

➔ provide foundation for downstream operations

ONGOING WORK

Deployable algorithm for inspection scheduling

➔ **efficiency**: inspect urgent incidents quickly

➔ **equity**: balance the birth-to-inspection time