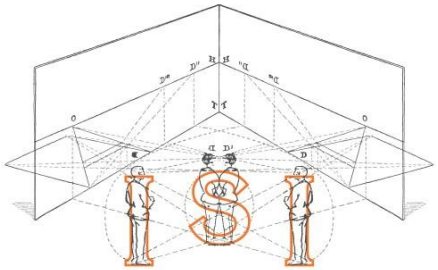


ISI Foundation

periscope

Estimating household contact matrices structure from easily collectable metadata

Lorenzo Dall'Amico

20/10/2022

Complex systems for the most vulnerable

et al: Jackie Kleynhans, Laetitia Gauvin , Michele Tizzoni, Mvuyo Makhasi , Nicole Wolter, Brigitte Language, Ryan G. Wagner, Cheryl Cohen, Stefano Tempia, Ciro Cattuto

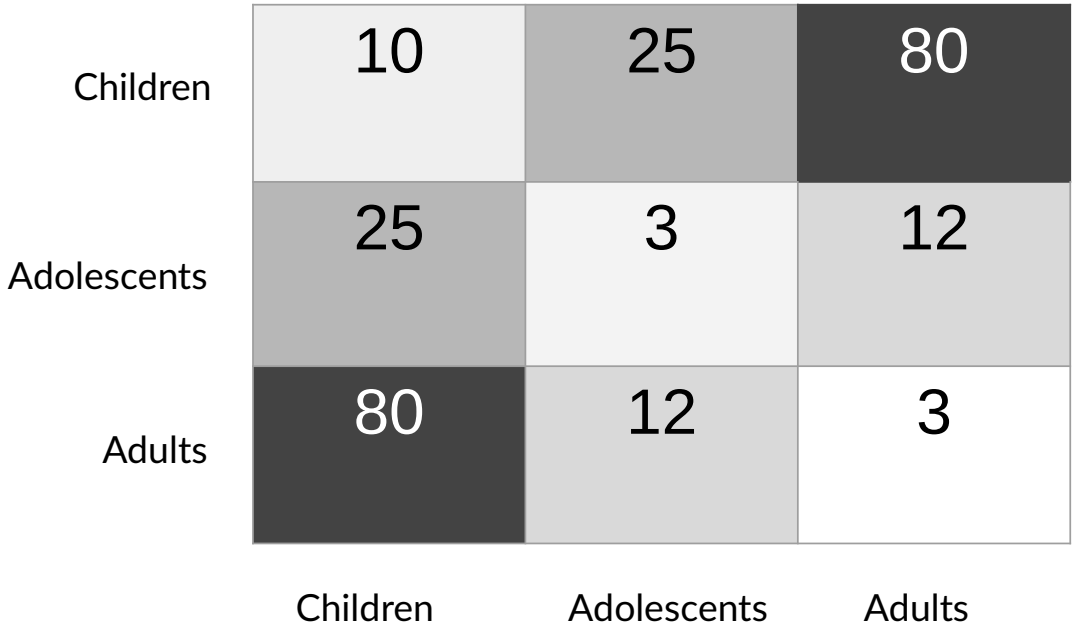
1. Introduction

- **Contact matrices**
  The measured quantity
- **Proximity sensors**
  The measuring instrument
- **PHIRST-C**
  The experiment
- **Extracting valuable information**
  What did we learn?

Contact matrix structure

Account for differences in:

- Interaction rates
- Medical conditions
- Demographic size

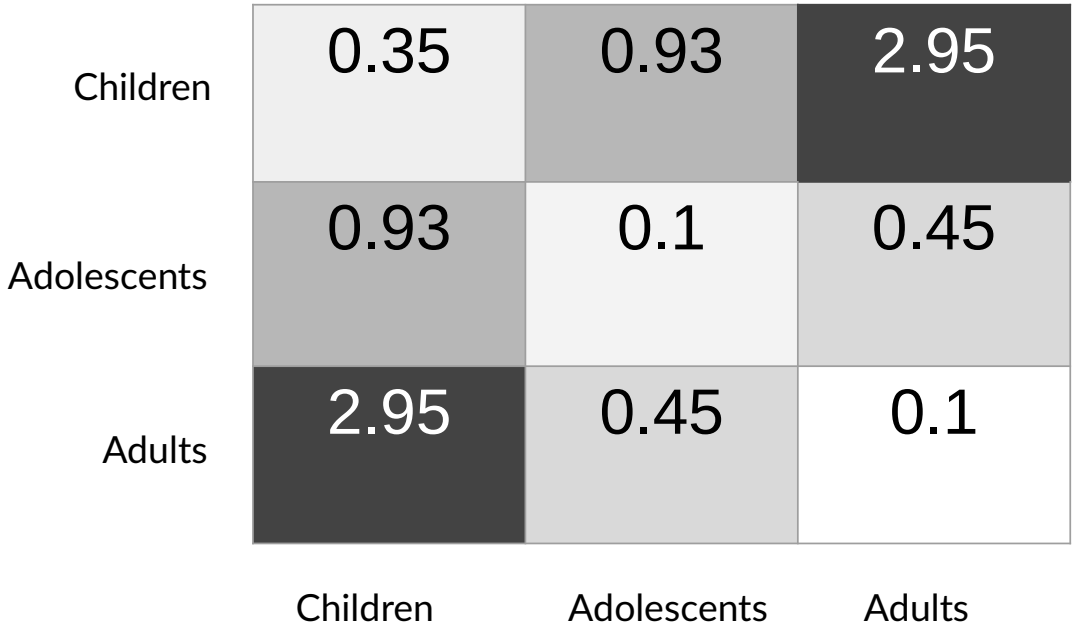


Contact matrix structure

Account for differences in:

- Interaction rates
- Medical conditions
- Demographic size

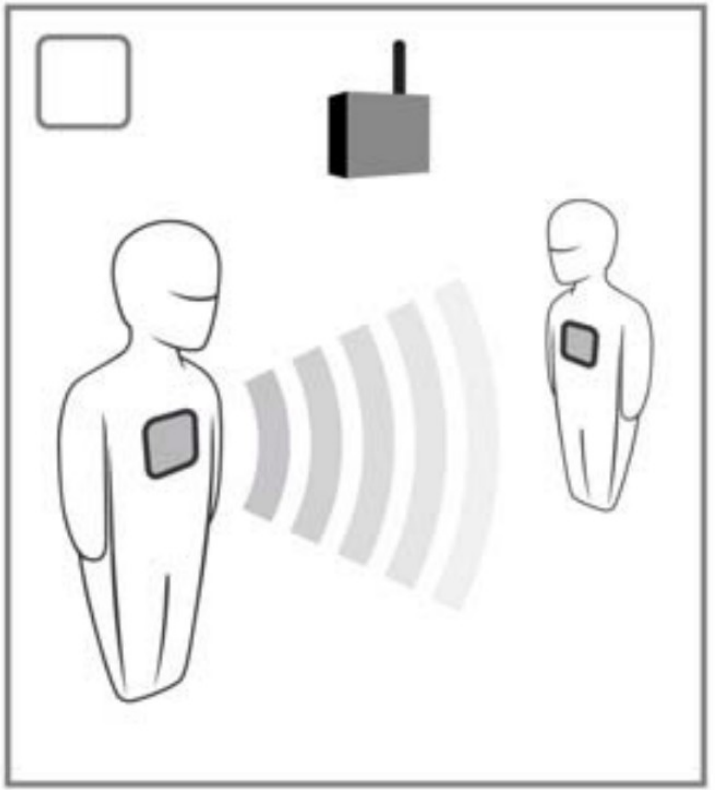
structure: we look at relative numbers



Proximity sensors

- Wearable device (SocioPatterns)
- Record proximity interaction (~ 2m)
- High spatio-temporal resolution
- Written consent from all participants

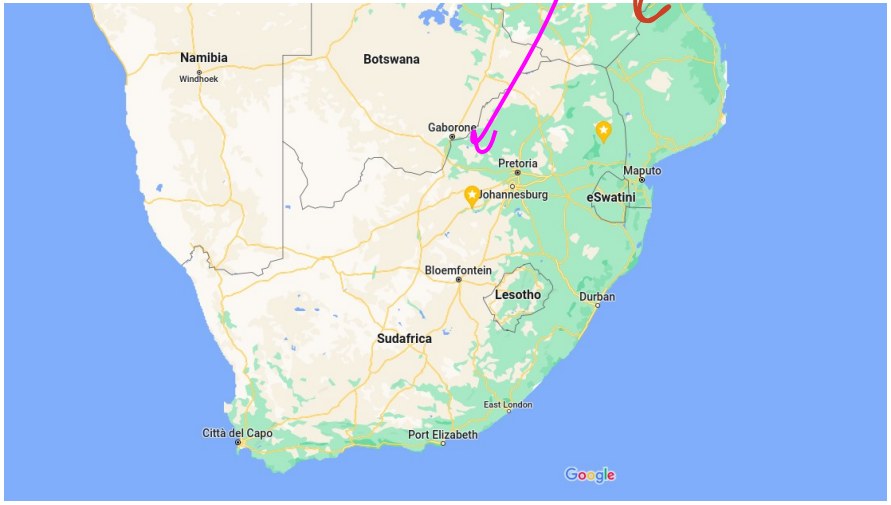
Calculate contact matrices from very accurate proximity measurement

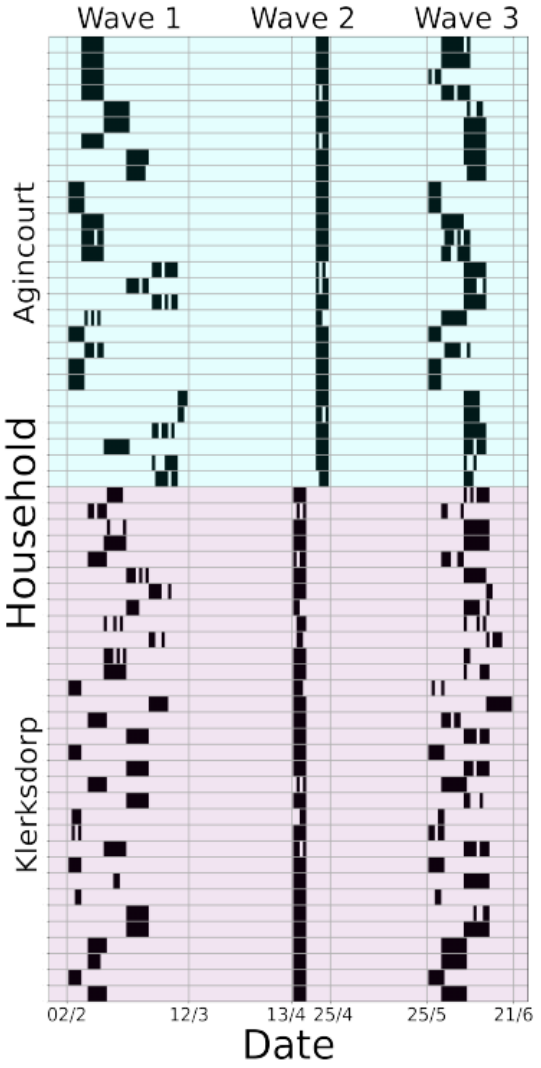


From: Cattuto *et al* “Dynamics of Person-to-Person Interactions from Distributed RFID Sensor Networks”

PHIRST-C

- Two sites: Agincourt, Klerksdorp
- > 100 households
- 3 measurement waves in 2018
- A rich metadata record



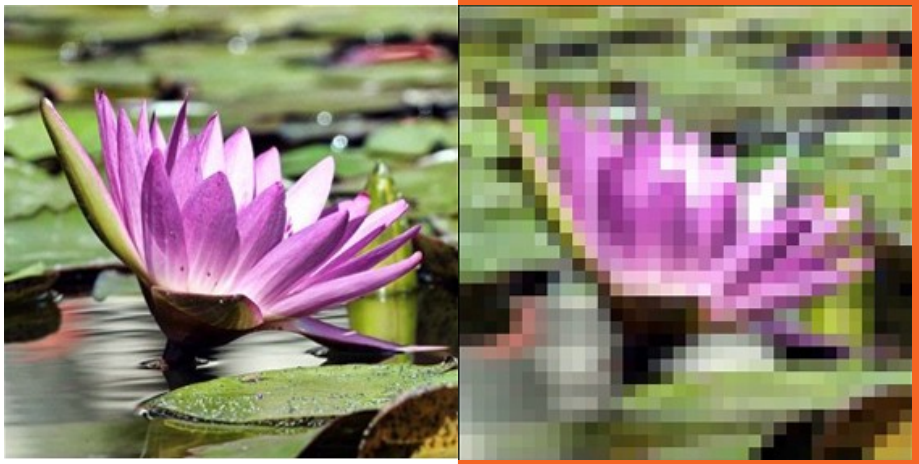


WHAT WE HAVE

- High resolution proximity measurements
- A lot of context information

WHAT WE WANT

- Simple, interpretable information
- Generalizability
- Guidance for future measurements



HOUSEHOLD INTERACTION MODEL

from a purely demographics-based model… [Fumanelli *et al*]

$$C_{ab} = T_{ab}$$

Number of contacts between age groups a and b

probability of random encounter

$$\propto n_a(n_b - \delta_{ab})$$

HOUSEHOLD INTERACTION MODEL

from a purely demographics-based model...

context agnostic

$$C_{ab} = T_{ab} u_a u_b$$

Number of contacts between age groups a and b

age-dependent interaction parameters

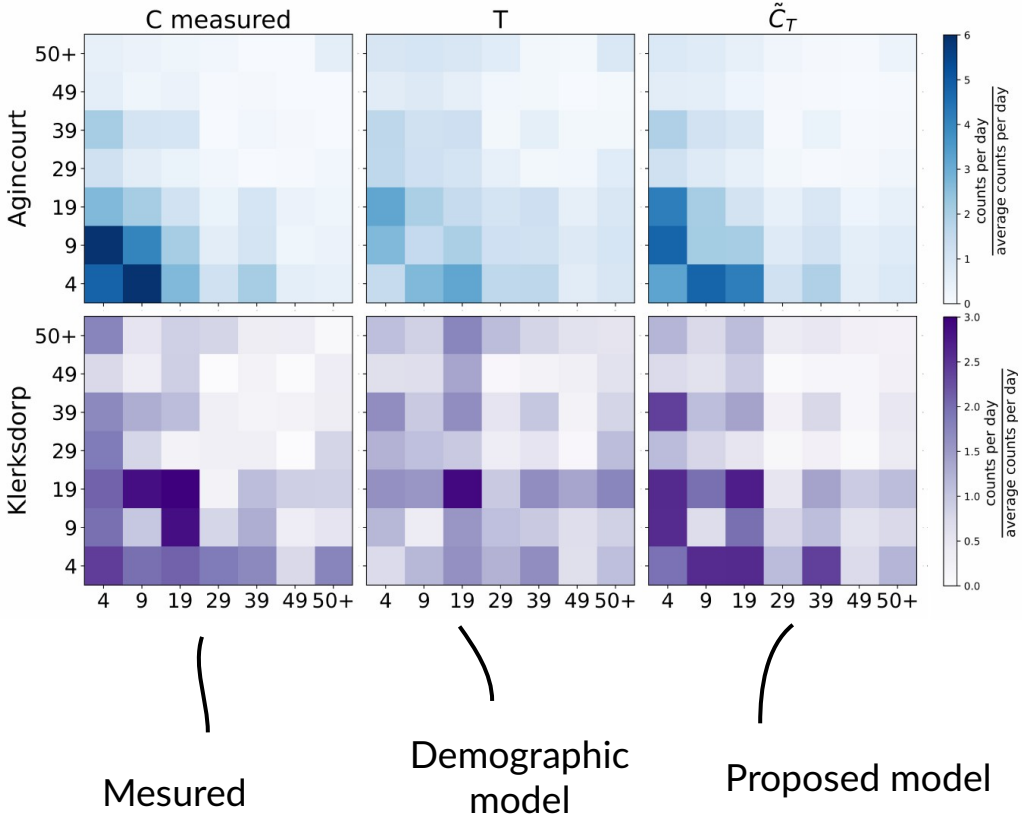
probability of random encounter

$$\propto n_a(n_b - \delta_{ab})$$

2. Main results

- **Goodness of the model**
  Tested on high resolution data
- **Model interpretability**
  Tested through metadata
- **Lighter cost for contact matrices estimation**
  Suggestion of relevant question to address

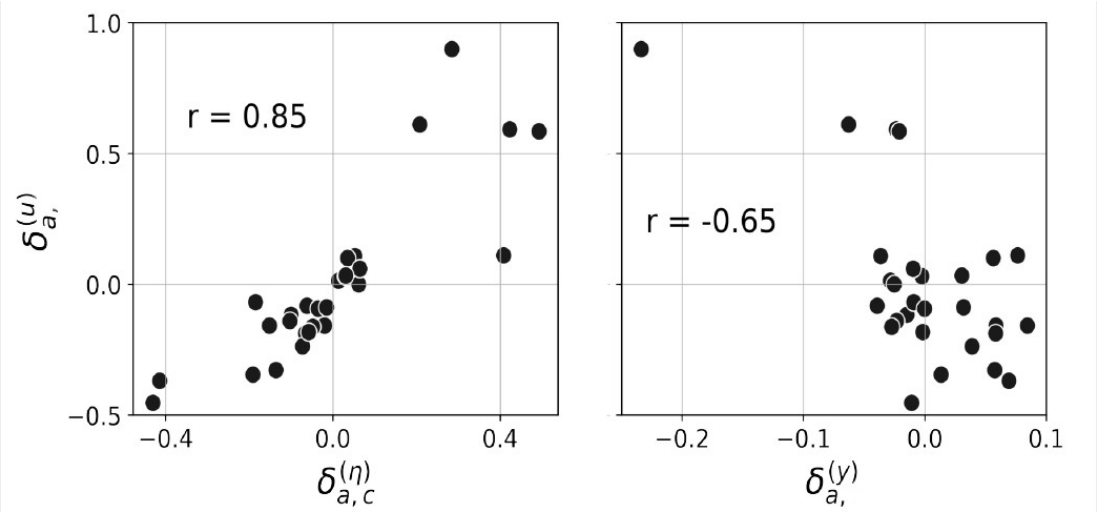
GOODNESS OF THE MODEL



	T	$\tilde{C}_T$
Agincourt	0.83	0.95
Klerksdorp	0.89	0.95

good estimation of high resolution data

INTERPRETABILITY OF THE MODEL



$\delta_a^{(x)}$: fluctuations around the age `a` average of measurement x

The activity is strongly correlated with easily collectable quantities

Total degree

Fraction of people with a main activity outside the household

- SURVEYS
  - Requires parameters for every age pairs
  - Requires an immutable age binning
  - Requires the knowledge of the interacting person's age

- DEMOGRAPHICAL MODEL
  - Can be inferred from easily available information
  - Does not capture the age-dependent component of interaction

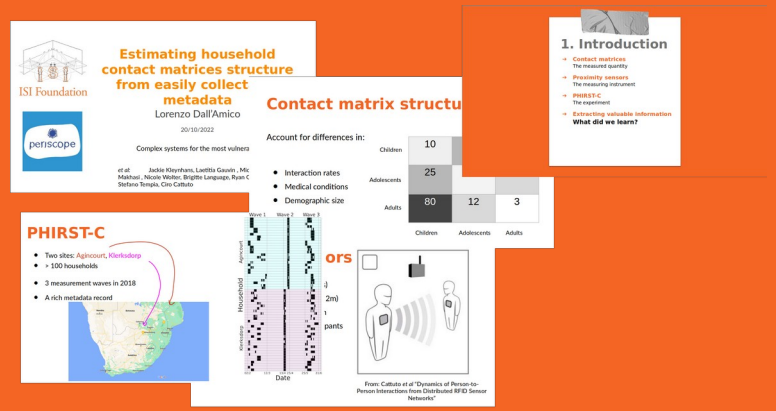
- OUR METHOD
  - Few highly interpretable parameters
  - Independent of the age binning
  - Independent of the interacting person's details
  - **Questions to quantify co-presence and activity**
  - Needs the estimate of activity parameters in different settings
  - Very accurate

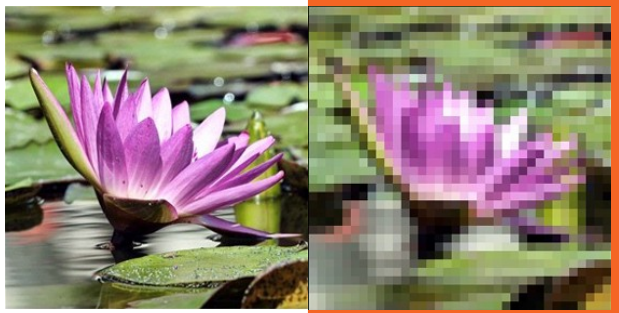
Estimating household contact matrices structure from easily collectable metadata

Lorenzo Dall'Amico[1,*], Jackie Kleynhans[2,3], Laetitia Gauvin[1], Michele Tizzoni[1,4]
Mvuyo Makhasi[2], Nicole Wolter[2,5], Brigitte Language[6], Ryan G. Wagner[7]
Cheryl Cohen[2,3], Stefano Tempia[2,3], Ciro Cattuto[1,8]

[1] ISI Foundation, Turin, 10126, Italy
[2]National Institute for Communicable Diseases of the National Health Laboratory Service, Johannesburg, South Africa
[3]School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa
[4]Department of Sociology and Social Research, University of Trento, Trento, Italy
[5]School of Pathology, University of the Witwatersrand, Johannesburg, South Africa
[6]Unit for Environmental Science and Management, Climatology Research Group,
North-West University, Potchefstroom, South Africa
[7]MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt)
[8]University of Turin, Department of Informatics, Turin, 10124, Italy
[*]Corresponding to: lorenzo.dallamico@isi.it

October 14, 2022





THANK YOU

+ Find the pre-print at: **arxiv.org/abs/2210.07034** and **ResearchSquare**

+ Find the contact matrices at: **github.com/lorenzodallamico/PHIRST_CM**

+ Visit my webpage: **lorenzodallamico.github.io**

+ Visit SocioPatterns: **www.sociopatterns.org**