Digital proximity tracing in the COVID-19 pandemic on empirical contact networks: Controlling re-emerging outbreaks

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01 Intro Covid 19

- Over 38 millions detected cases [15]
- Overload of hospital facilities
- Strategies:
  - Lockdown
  - Quarantine of a large number of people
  - Digital contact tracing (DCT)
- Investigate how well contact tracing apps, coupled with the quarantine of identified contacts, can mitigate the spread of COVID-19 in realistics scenarios.

02 Baseline

Factors that make an infectious disease outbreak controllable

Christophe Fraser*†, Steven Riley*, Roy M. Anderson, and Neil M. Ferguson

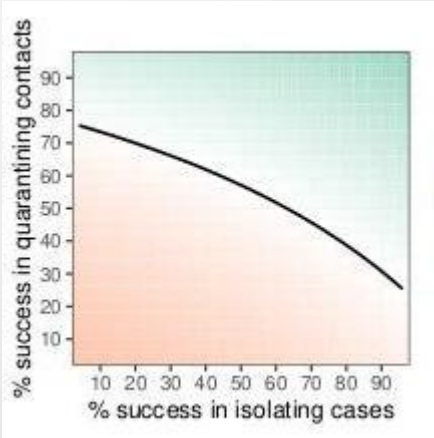
RESEARCH ARTICLE SUMMARY

CORONAVIRUS

Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing

Luca Ferretti*, Chris Wymant*, Michelle Kendall, Lele Zhao, Anel Nurtay, Lucie Abeler-Dörner, Michael Parker, David Bonsall†, Christophe Fraser†‡

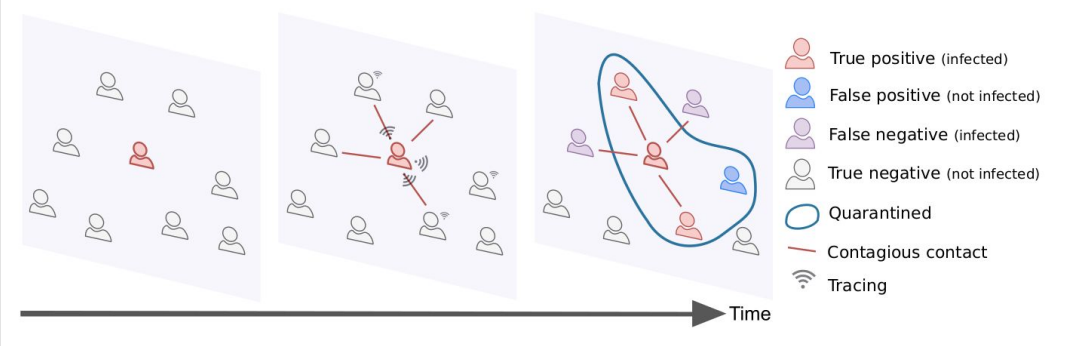
- The model:
  - Equations describing the number of infected individuals in a **homogeneously** mixed population
  - $\varepsilon I \longrightarrow$ ability to identify and isolate infected individuals
  - $\varepsilon T \longrightarrow$ ability to correctly trace and quarantine
- Assuming an exponential growth of the number of infected individuals



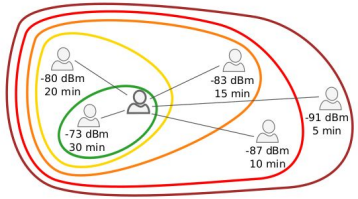
03 DCT on a real network

- General mathematical model to evaluate the evolution of an epidemic in the presence of isolation and tracing for any shape of the epidemic growth
- Evaluation of tracing efficiency on real contact data
- Dependence on real duration of exposure and on real physical proximity of contacts
- Design of appropriate policies

03 DCT on real network



ID	Signal strength threshold T_p (dBm)	Duration threshold T_d (min)	Fraction of CNS contacts
Policy 1	-73	30	2.2%
Policy 2	-80	20	7.3%
Policy 3	-83	15	13.4%
Policy 4	-87	10	25.9%
Policy 5	-91	5	56.7%



04 Dataset

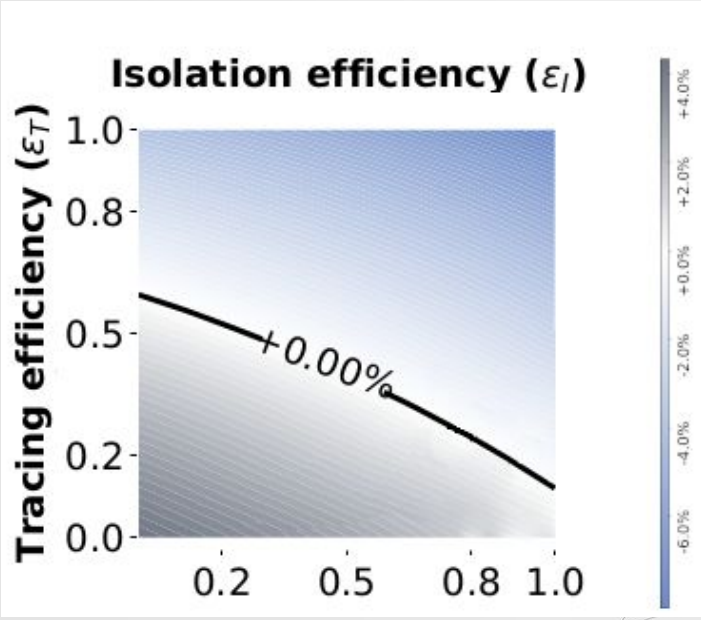
Interaction data from the Copenhagen Networks Study

Piotr Sapiezynski[1], Arkadiusz Stopczynski[1], David Dreyer Lassen[2] & Sune Lehmann[1,2*]

- Bluetooth physical proximity
- Sampling time: 5 minutes
- Four weeks public data

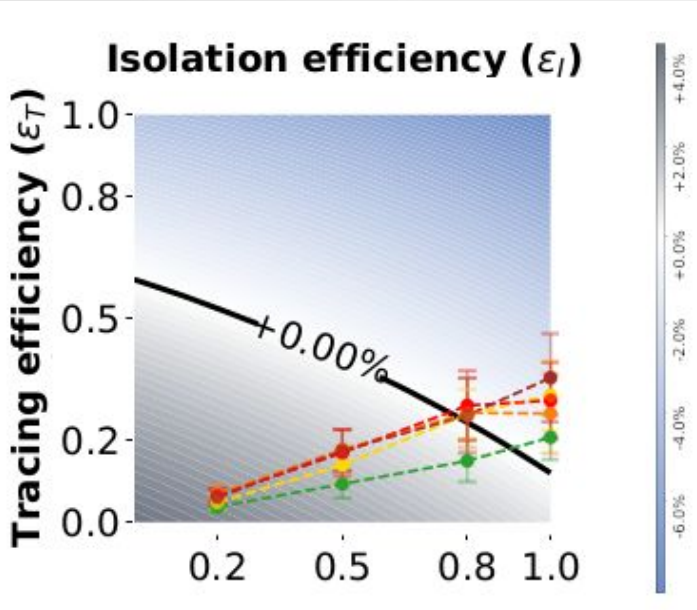
04 Results

EFFECTIVENESS



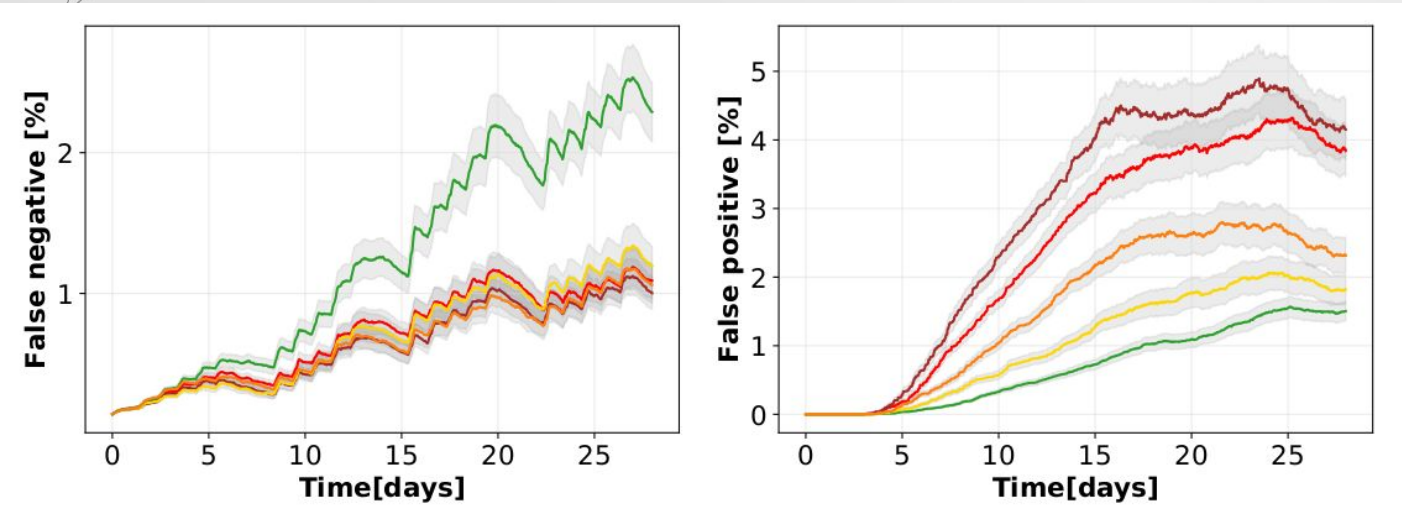
04 Results

EFFECTIVENESS



04 Results

COST



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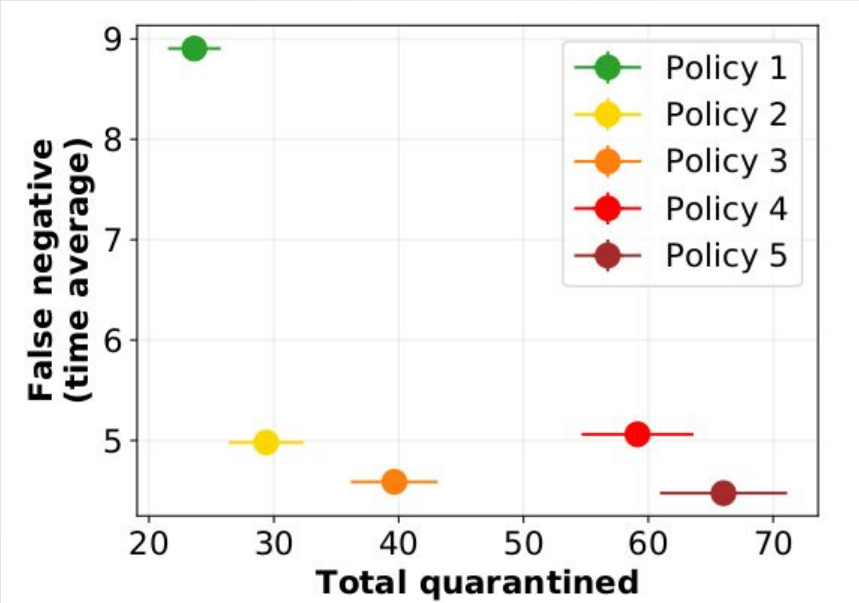
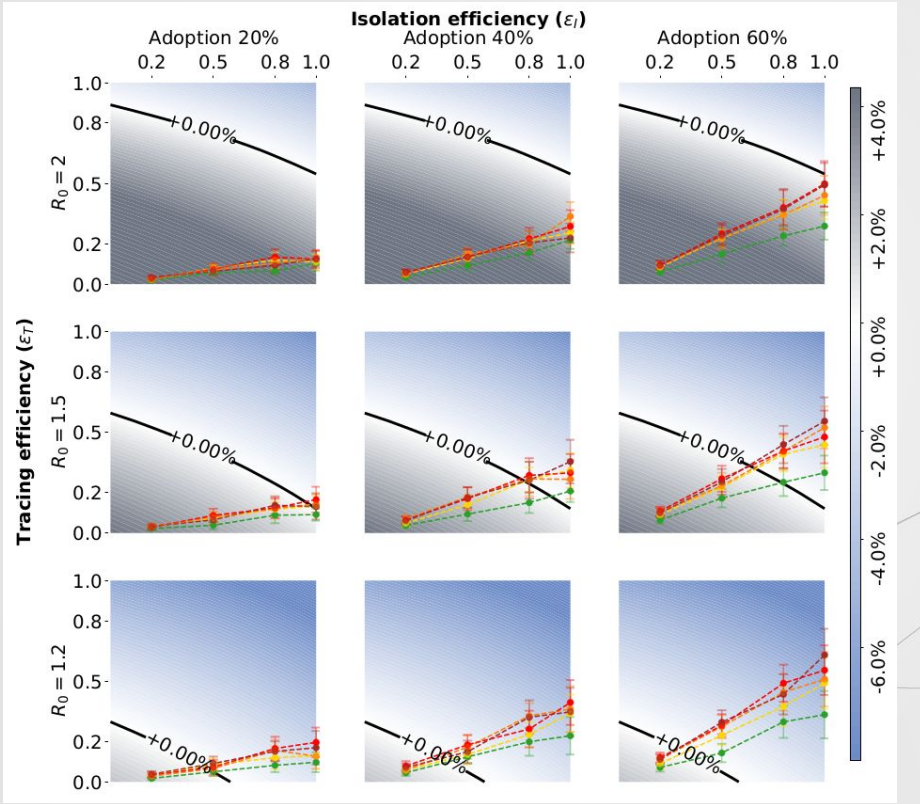
05 Policy optimization

OPTIMIZATION



06 Robustness of the model



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THANKS

Does anyone have any questions?

https://antoniolonga.github.io/

Paper: https://www.medrxiv.org/content/10.1101/2020.05.29.20115915v2

Code: https://github.com/DigitalContactTracing/covid_code

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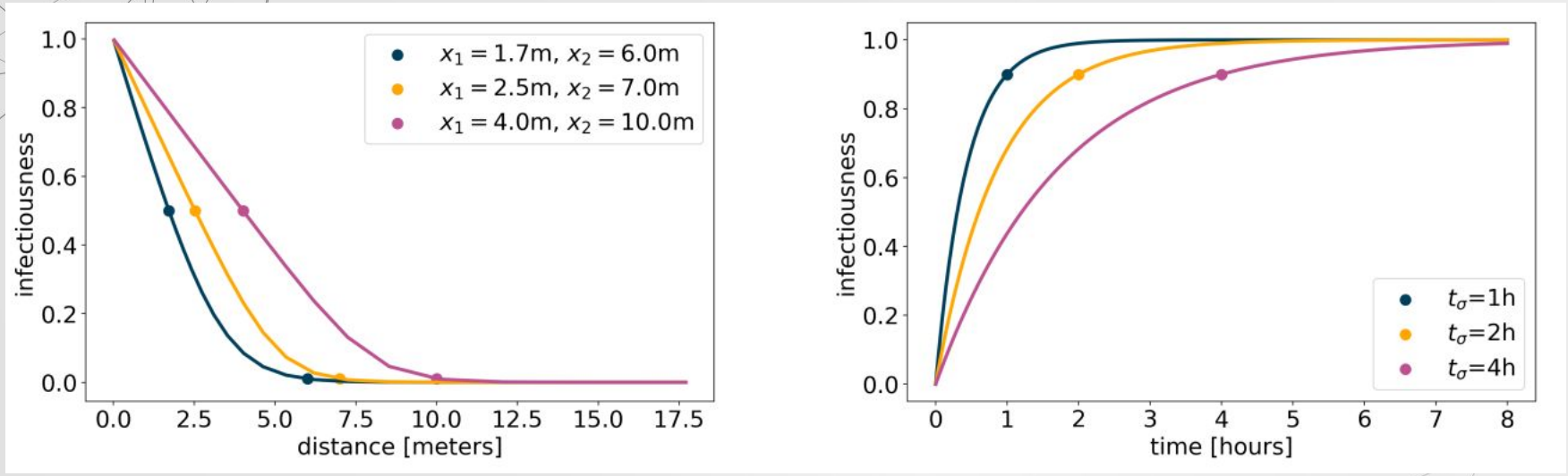
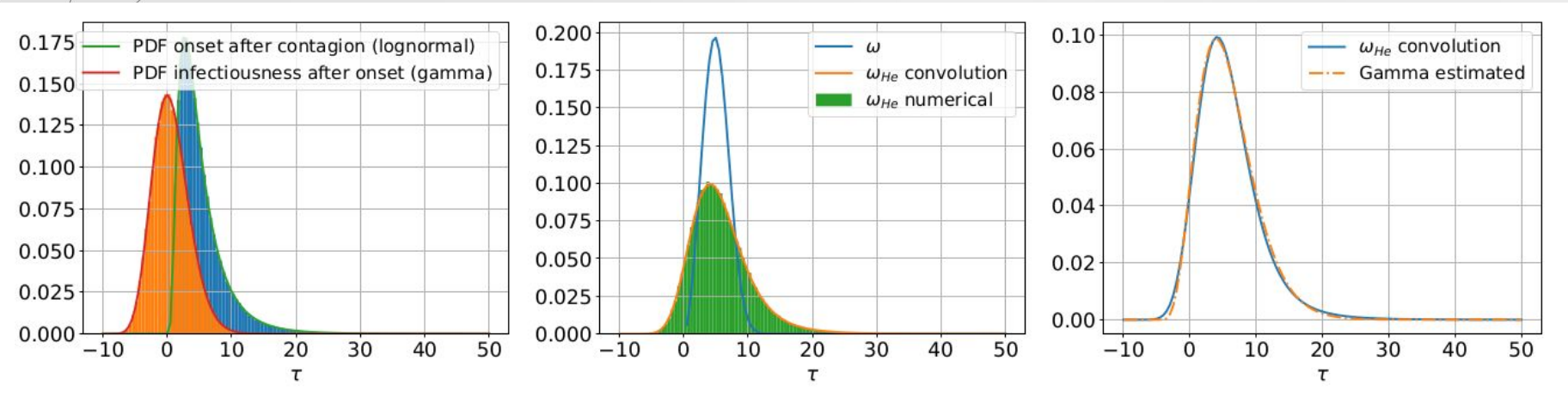
Validation of the infectiousness on the real dataset



Infectiousness as a function of distance (left panel) or duration (right panel) of the contact, for three different parameters configurations. By combining the two curves corresponding to each color we obtain R 0 = 3 in each case. The blue configuration implies an infectiousness increasing rapidly with duration but decreasing fast with distance. On the contrary, the pink curves correspond to an infectiousness that increases slowly with contact duration but has a broader spatial range. All the simulation results in the manuscript are obtained assuming the infectiousness to be ruled by the intermediate orange configuration.

Comparison with other infectiousness functions



https://www.nature.com/articles/s41591-020-0869-5
https://www.nature.com/articles/s41591-020-1016-z

Tested parameters

R0	1.2, 1.5, 2 and 3
Case reporting delay	2 and 3 days
App adoption levels	0.2, 0.4, 0.6 and 0.8
Datasets	DTU, High school and workplace
Contact tracing memory	2,10 and 15 days
% Symptomatics and % of random testing	80% symptomatics + 0% testing 60% symptomatics + 0% testing 50% symptomatics + 0% testing 80% symptomatics + 25% testing

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