Who should you be talking to?
3 lessons in interdisciplinary problem-solving

Joanna Masel

Ecology & Evolutionary Biology, University of Arizona

WeHealth PBC

3 lessons

1) Your area isn't the only one with unsolved questions

2) Find an expert in the right subsubdiscipline:

  – Good experts direct you to still more relevant experts

  – Bad experts propagate misconceptions instead

3) Math can be a common language

Contact tracing

41% of SARS-CoV-2 transmission is *before* symptoms appear (Ferretti et al. medRxiv 2020.09.04.20188516)

- Isolating the symptomatic isn't enough
- Find and quarantine contacts before they transmit to anyone else

INFECTED
NOT INFECTED
INTERVIEWED

Where have you been?

What precautions did you take?

Who have you interacted with?

From www.oneforallmo.com/contact-tracing/

For SARS-CoV-2, contact tracing must be fast

- Infected individuals could have transmitted long before the contact tracers find them
- Apps promise instant notification

Design spec for exposure notification

Get the right people to quarantine in time, and let everyone else go back to living more normally

Design spec for exposure notification

Get the right people to quarantine in time, and let everyone else go back to living more normally

- 6 feet 15 minutes from someone -2 to +9 days relative to symptom onset
- Infected

1) Your area isn't the only one with unsolved questions

Proximity in public transit

Measurement-based evaluation of Google/ Apple Exposure Notification API for proximity detection in a light-rail tram

Douglas J. Leith *, Stephen Farrell

School of Computer Science & Statistics, Trinity College Dublin, Dublin, Ireland

* doug.leith@tcd.ie

Abstract

We report on the results of a Covid-19 contact tracing app measurement study carried out on a standard design of European commuter tram. Our measurements indicate that in the tram there is little correlation between Bluetooth received signal strength and distance between handsets. We applied the detection rules used by the Italian, Swiss and German apps to our measurement data and also characterised the impact on performance of changes in the parameters used in these detection rules. We find that the Swiss and German detection rules trigger no exposure notifications on our data, while the Italian detection rule generates a true positive rate of 50% and a false positive rate of 50%. Our analysis indicates that the performance of such detection rules is similar to that of triggering notifications by randomly selecting from the participants in our experiments, regardless of proximity.
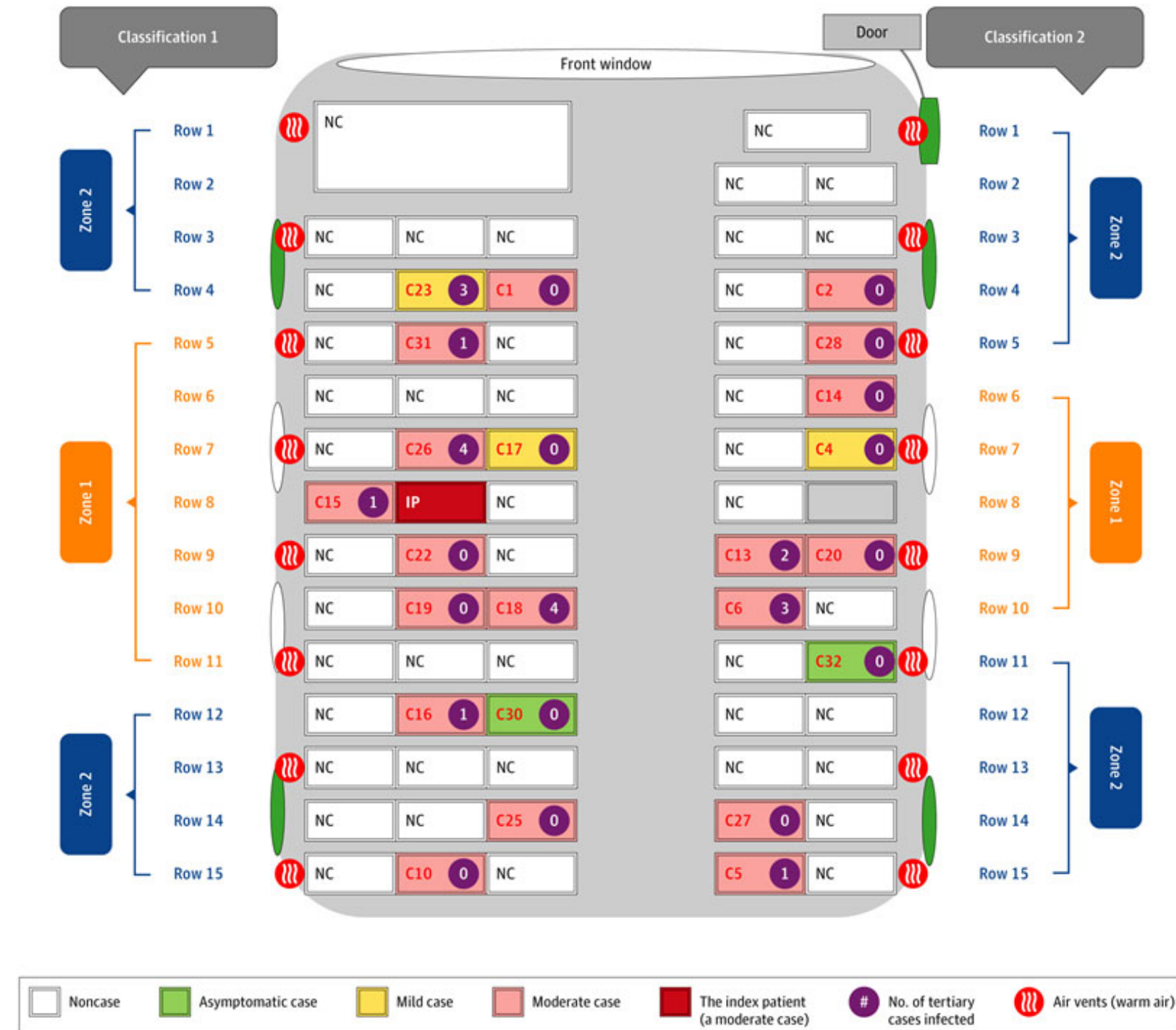
What's up with the 6 foot rule then?

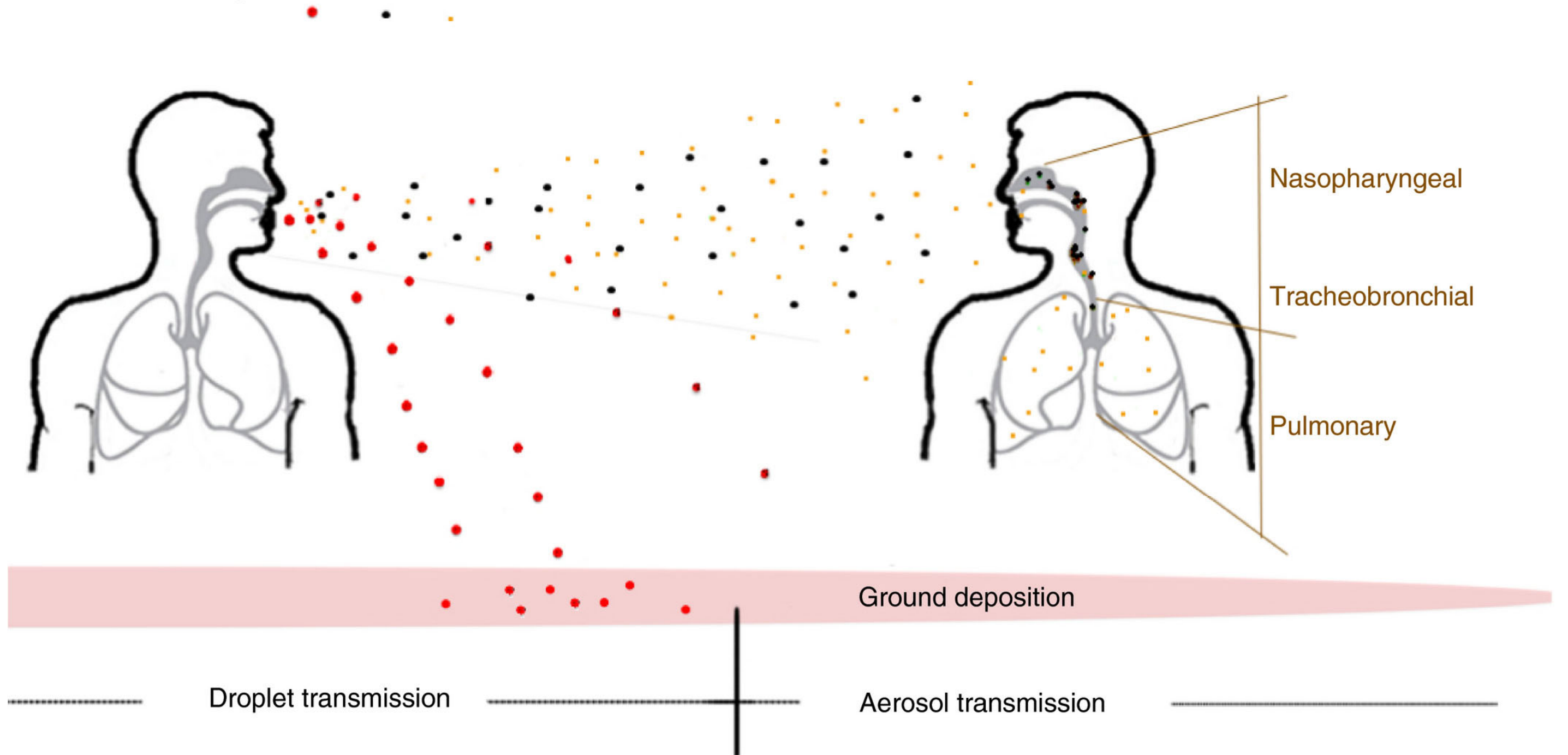2) Find an expert in the right subsubdiscipline
- Good experts direct you to still more relevant experts
- Bad experts propagate misconceptions instead

../public health/exposure science/aerosols/viral aerosols

Not ../public health/epidemiology

Particles come in a range of sizes

Where did 15 minutes come from?

- Murky: some early case study of smallpox?
- Dose scales linearly over time, of course
- Another propagated misconception is the minimum infectious dose
  - Makes testable prediction that dose-response curves will curve
 - They don't

Targeting notifications to the infected

1. infectiousness of primary case
    – 10-fold variation depending on timing relative to symptom onset

2. duration of exposure
    – proportional (no magic about 15 minutes)

3. distance/BlueTooth signal
    – limited information about infection, even for known distance

3) Math can be a common language re importance of each factor

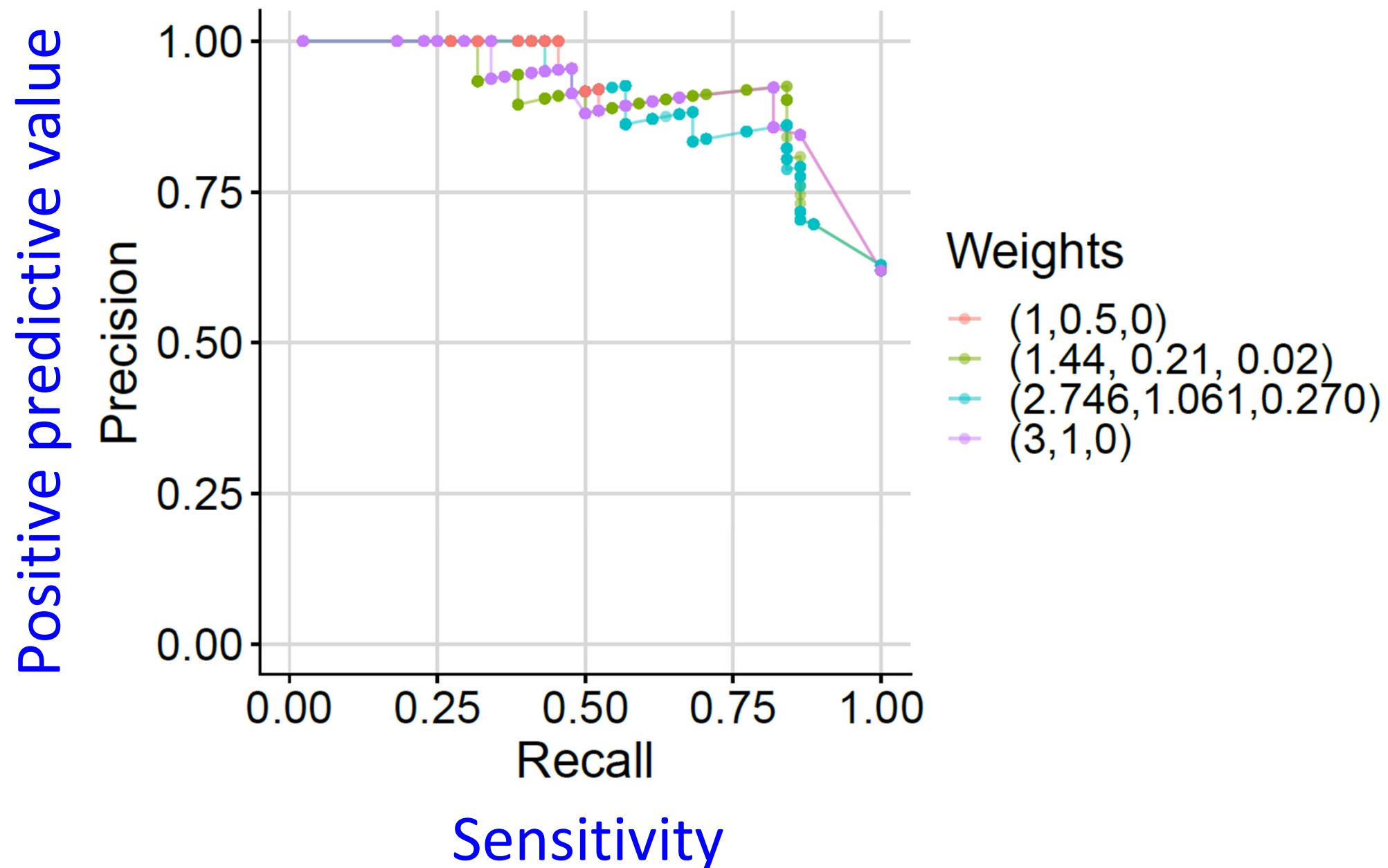# Distance is informative because of human behavior, not physics

- Natural distance when talking
- Correlation between being close and face to face interaction
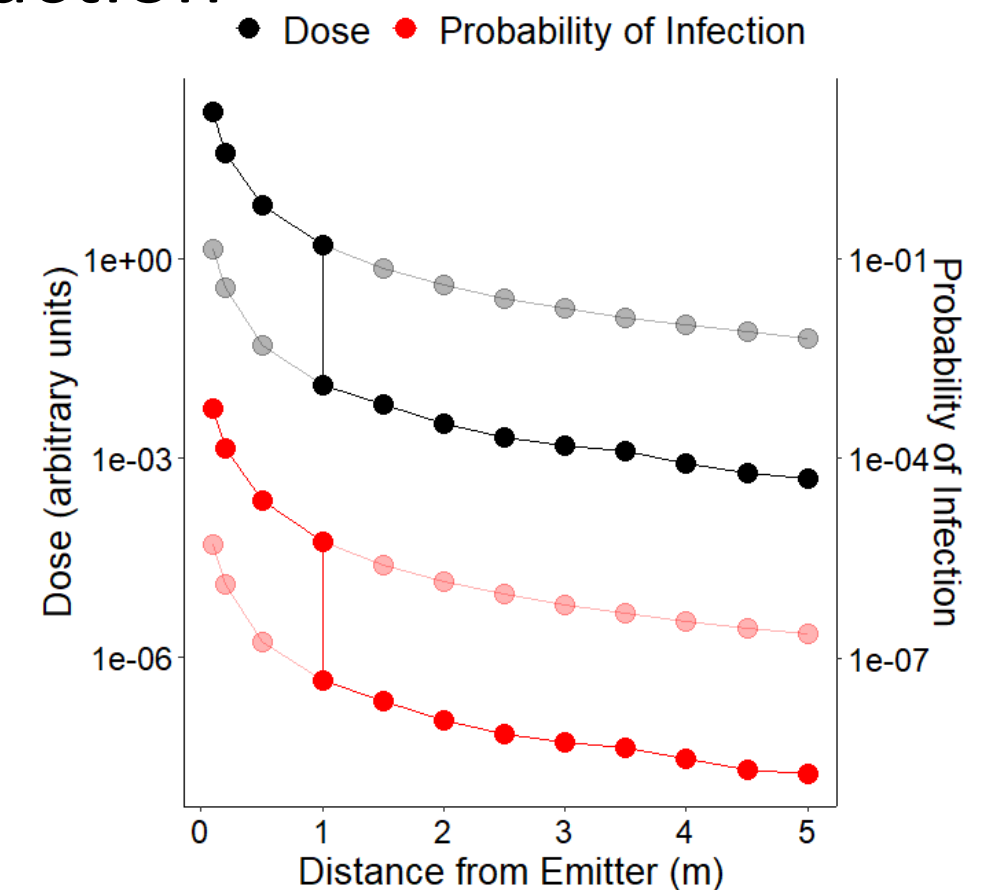
Wilson et al. (2021) "Quantifying SARS-CoV-2 infection risk within the Google/Apple exposure notification framework to inform quarantine recommendations" accepted at *Risk Analysis*, medrxiv 2020.07.17.20156539

BlueTooth weights don't matter in the real world
Threshold does

- Beta test of daily life in real workplace

- Ground truth from QR code scans

Positive predictive value — Precision vs Sensitivity — Recall

Weights
- (1,0.5,0)
- (1.44, 0.21, 0.02)
- (2.746,1.061,0.270)
- (3,1,0)

3. Math can be a common language

- Not everyone in public health / biomedical science speaks it
- Often argue for "conservative" intermediate assumptions

    = treating risk inconsistently

- Final risk threshold sets conservative vs permissive

What risk should trigger quarantine?

- This is an economics question (with lots of math)
- Hard to compare lives vs. livelihoods
- Exploit fact that R(t) tends to average to 1 in the long run
- R(t) reduction achieved either by
  - selective quarantine/isolation
  - indiscriminate social distancing
  - same units: reduction in social contact per person per day

What risk should trigger quarantine?

- Optimal is to quarantine anyone who, on that day, has higher Expected(transmissions) than those not in quarantine
  - Will lead to larger number of mostly shorter quarantines
- More information on E(transmissions) means less staying home to achieve same R(t)
  - good assessment of infection risk
  - negative test results

Petrie & Masel (2020) medRxiv 2020.11.24.20238204 and another in prep.

Design spec for exposure notification

Get the right people to quarantine in time, and let everyone else go back to living more normally

Design spec for exposure notification

Get the right people to quarantine in time, and let everyone else go back to living more normally

Targeting notifications to the infected

1. infectiousness of primary case

   – 10-fold variation depending on timing relative to symptom onset

   – superspreader status (20% cases → 80% infections)

2. duration of exposure

   – proportional (no magic about 15 minutes)

3. distance/BlueTooth signal

   – limited information about infection, even for known distance

3) Math can be a common language re importance of each factor

Wilson et al. (2021) "Quantifying SARS-CoV-2 infection risk within the Google/Apple exposure notification framework to inform quarantine recommendations" accepted at *Risk Analysis*, medrxiv 2020.07.17.20156539

Broadcast-only beacons (GAEN compatible) that contact tracers can use to mark superspreader sites
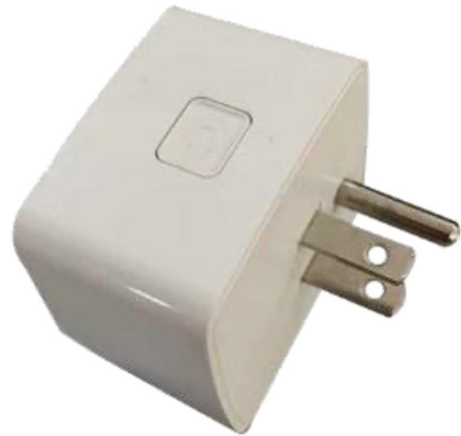
Demo
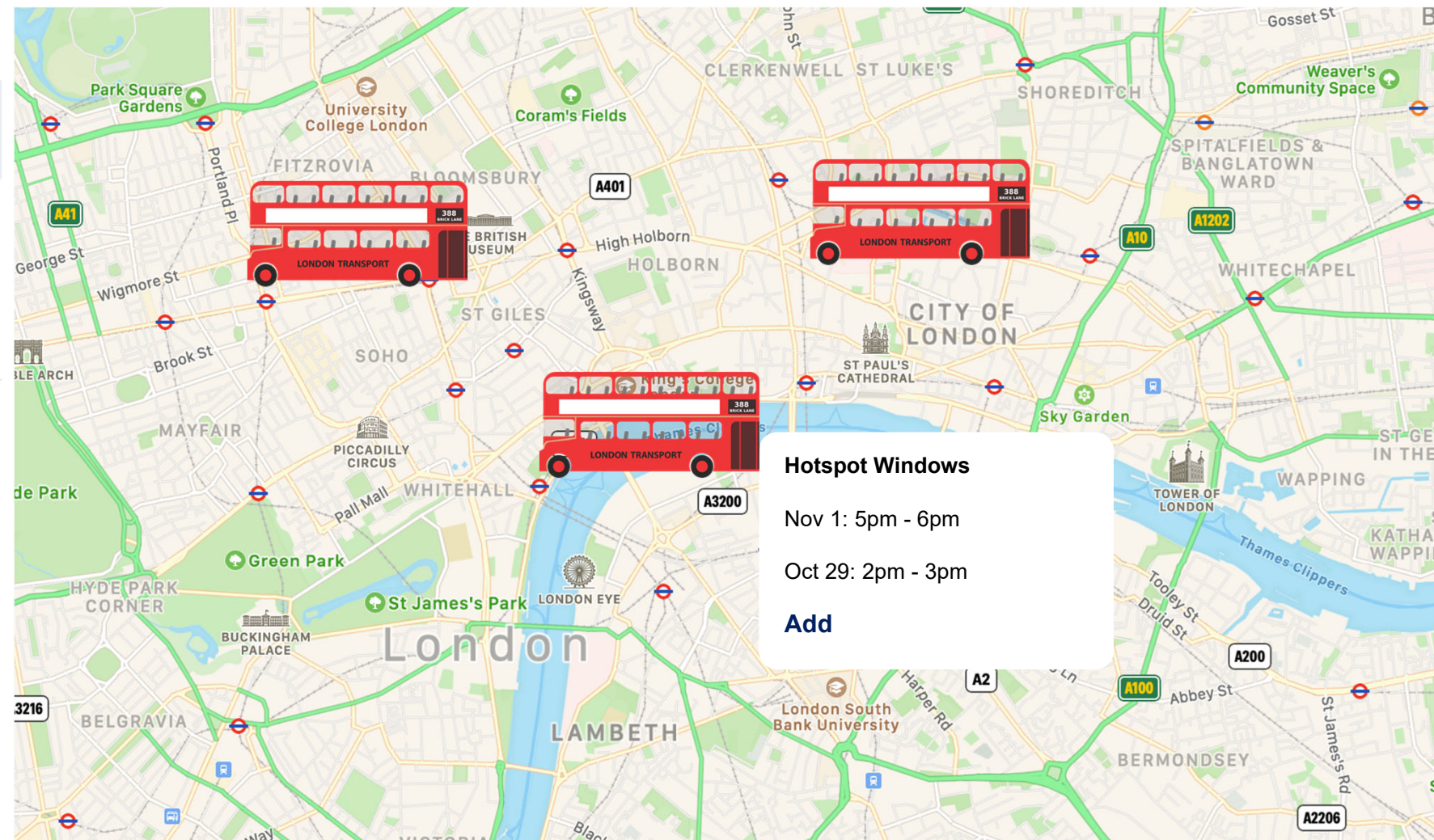
Targeting notifications to the infected

1. infectiousness of primary case
   - 10-fold variation depending on timing relative to symptom onset
   - superspreader status (20% cases → 80% infections)
2. duration of exposure
   - proportional (no magic about 15 minutes)
3. distance/BlueTooth signal
   - limited information about infection, even for known distance
   - indoors vs outdoors (estimated 20-fold risk difference)

3) Math can be a common language re importance of each factor

Wilson et al. (2021) "Quantifying SARS-CoV-2 infection risk within the Google/Apple exposure notification framework to inform quarantine recommendations" accepted at *Risk Analysis*, medrxiv 2020.07.17.20156539

Tradeoffs

Epidemiological effectiveness   vs.   Privacy/security

- Enough metadata with TEK to quantify infectiousness
- Ability to do backward contact tracing from superspreader events

- Actual threat
- Perception required to promote uptake

What is the relevant discipline to consult?

Not everyone agrees with choice

How (Not) to Fight COVID 19

Sep 3, 2020 | PETER SINGER, JOANNA MASEL

Public-health experts who adhere to rigid rules for containing the pandemic are standing in the way of new technologies that can help us develop a more flexible approach. By focusing on those with the highest risk of spreading the virus, we can inflict less harm and contain the pandemic more effectively.

MELBOURNE/TUCSON – When COVID-19 first appeared, strict quarantine requirements and short, tight lockdowns would have been a small price to pay to keep it at bay. Now that the pandemic has infected over 26 million people in 213 countries and territories, we need to find new ways to control it that are not just effective, but also efficient.

To avoid inflicting more pain than necessary, we should target stay-at-home orders as precisely as possible to those who are most likely to pose a risk to others. This requires not just tracing the contacts of those who are infected, but also distinguishing which of their contacts are most likely to have been infected.

Here, technology can help. We should combine new apps that notify people when they have been exposed to a risk of infection with new testing methods that are fast, easy, and as readily available as pregnancy tests. Contact tracing

Covid-19 Apps Are Terrible—They Didn't Have to Be

Jane Bambauer & Brian Ray*

November 2020

COVID-19 apps in the United States have been ineffective as public health tools because they are designed primarily to protect privacy. Poor design choices, effectively mandated by Google and Apple, were driven by ongoing consumer privacy and national security debates that shortsightedly rejected tracking technologies.

What helps fight Covid?

- Target notifications to the infected

Design spec:

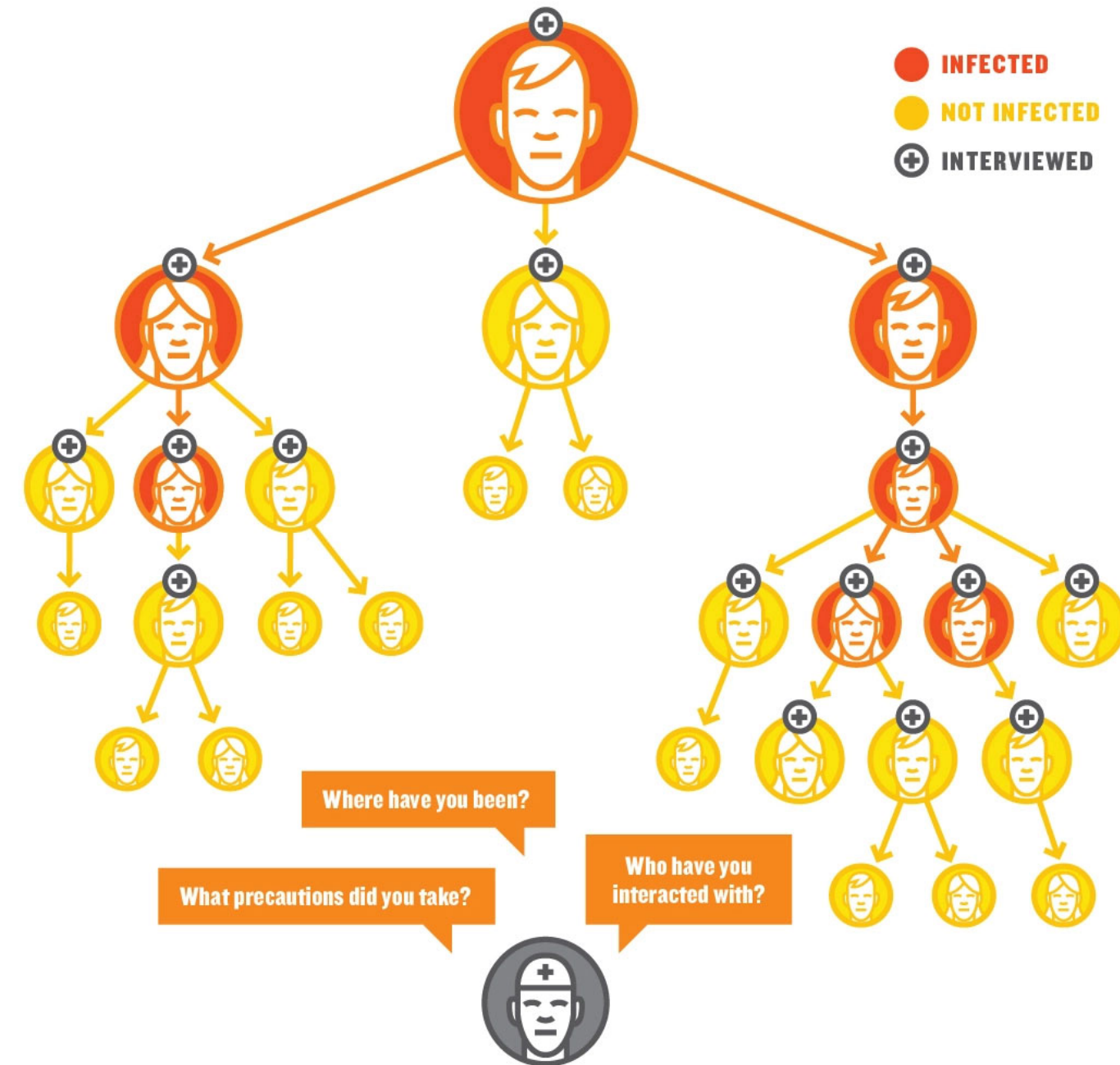Get the right people to quarantine in time, and let everyone else go back to living more normally
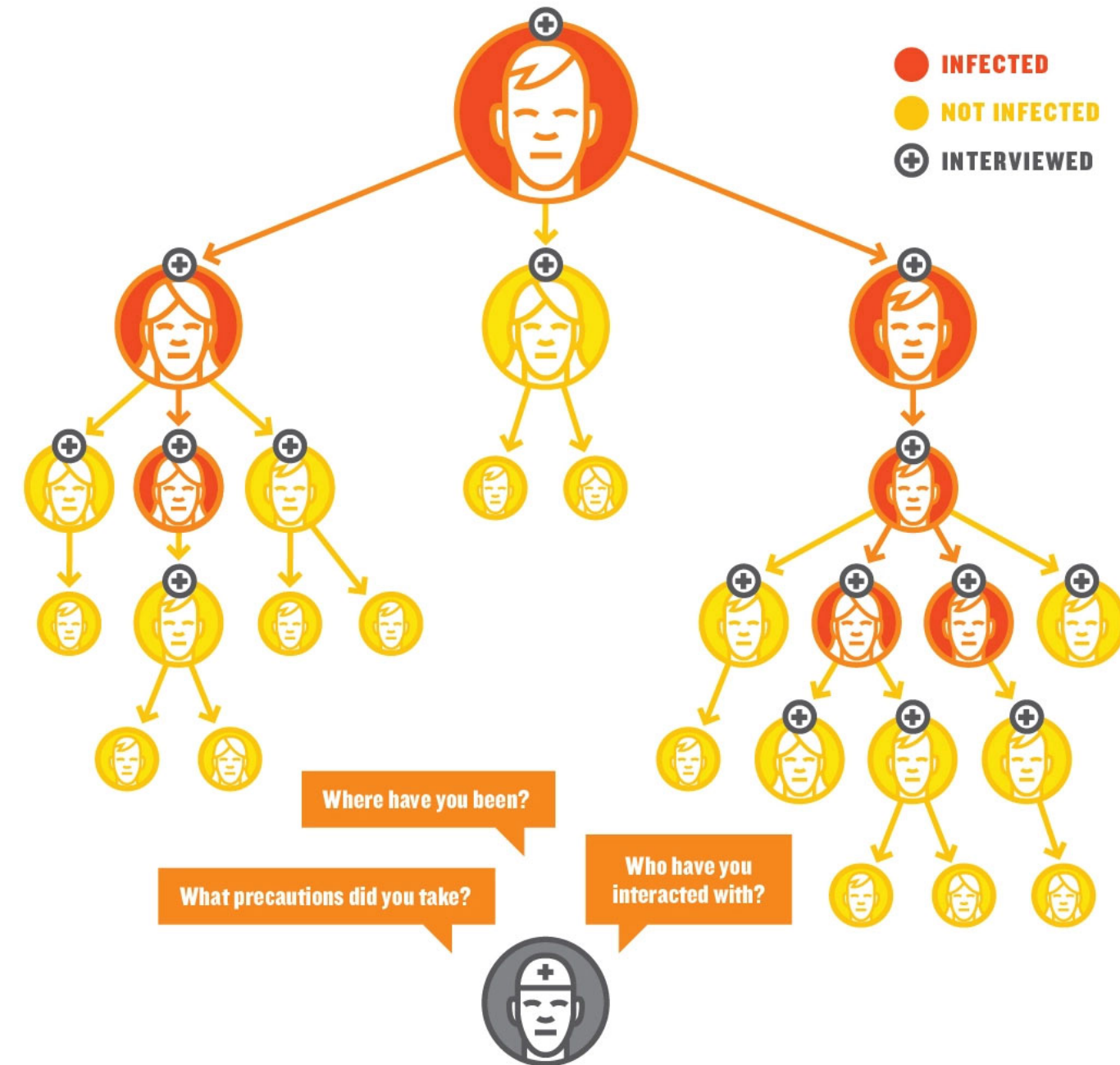
What helps fight Covid?

- Target notifications to the infected
- Notify them faster

Design spec:

Get the right people to quarantine in time, and let everyone else go back to living more normally

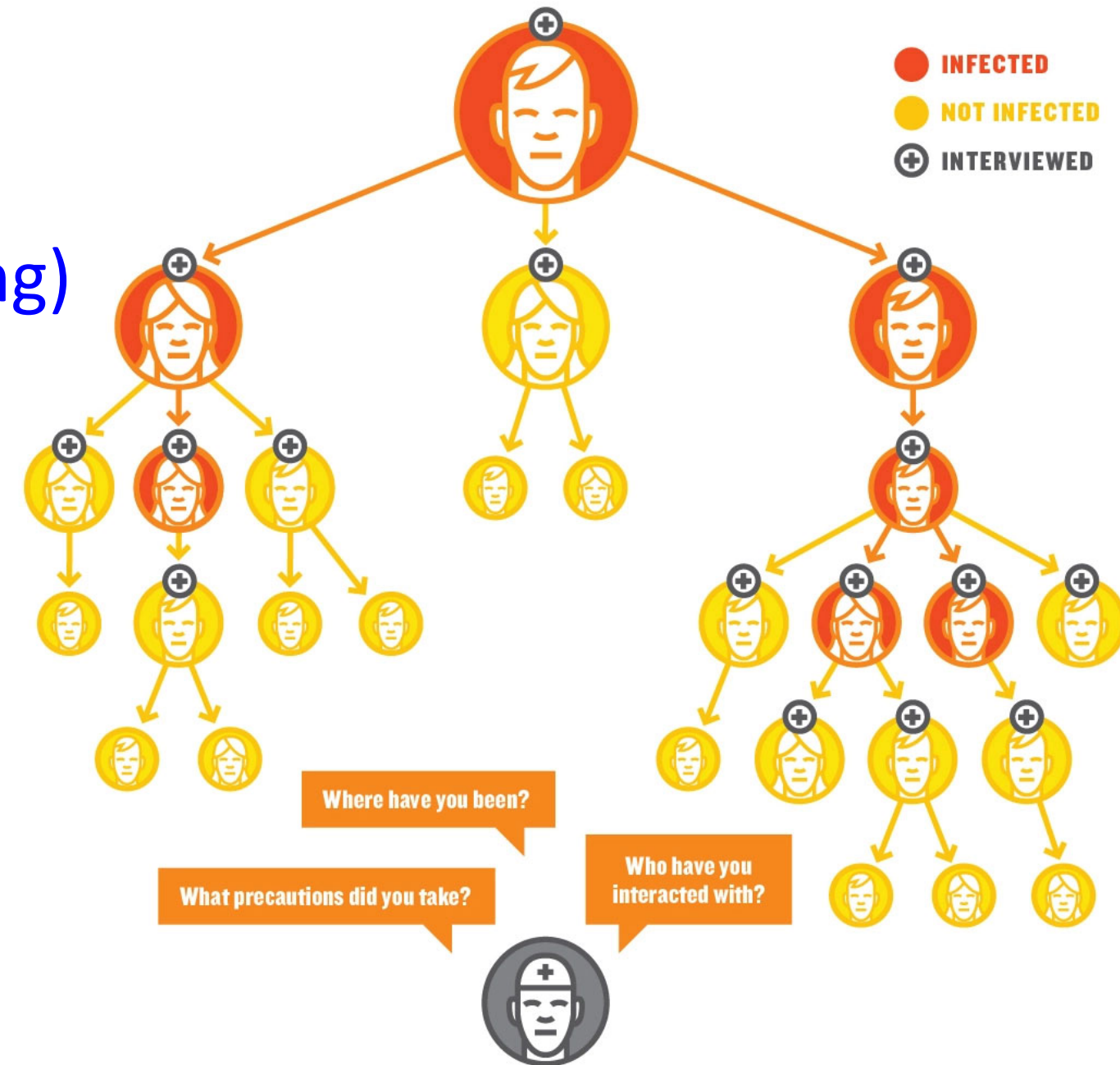# What helps fight Covid?

- Target notifications to the infected
- Notify them faster
- Solicit behavior change (quarantine/testing)

Design spec:

Get the right people to quarantine in time, and let everyone else go back to living more normally

The final mile

- Messaging effectiveness
- ENX does not permit embedding of date

Exposure Details

 Back

California Department of Public Health - United States - California

Possible exposure to COVID-19 virus

CA Notify constantly exchanges anonymous keys via Bluetooth with phones of other users you are near. A person you were recently near reported that they tested positive for COVID-19. Based on the strength and duration of the signals between your phone and that person's phone, there is a good chance that you were exposed to the virus. To learn more about what you can do to protect yourself and those around you, click the link. In the meantime:
- Stay home except to get medical care and do not have visitors.
- Separate yourself from others (by at least six feet), especially those at high risk such as people who are over 65, severely overweight, or have chronic disease (like cancer, diabetes, or heart/lung disease).
- Call 911 if you have emergency warning signs such as difficulty breathing, pressure or pain in chest, bluish lips or face, new confusion, difficulty waking or staying awake, or other serious symptoms.

Continue

Community: University of Arizona

High Exposure in the past 14 days

Next steps:

Call Campus Health at (520) 621-9202 and schedule a COVID-19 test for **February 4th**.

Stay at home and self-quarantine until **February 8th** or 3 days earlier if you test negative.

Monitor for COVID-19 symptoms until **February 12th** and get tested ASAP if symptoms appear.

Register with University of Arizona's Contact Tracing team.

Diagnosis   FAQ   Share

3 lessons

1) Your area isn't the only one with unsolved questions

2) Find an expert in the right subsubdiscipline:

- Good experts direct you to still more relevant experts

- Bad experts propagate misconceptions instead

3) Math can be a common language

Let's talk, to fight this pandemic

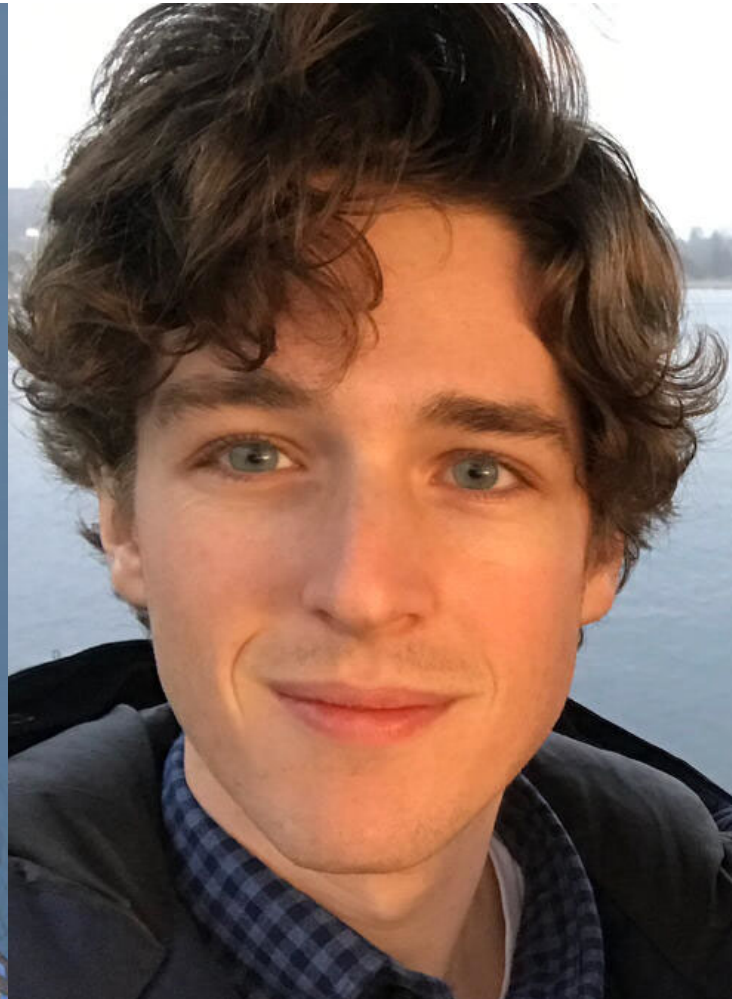Am I missing a discipline I need to know about?

Can you point me to a good expert?

Do you need help finding the right person to talk to?

Thank you!

Amanda Wilson   James Petrie   Sameer Halai

Too many others to list, at the University of Arizona, WeHealth, and elsewhere