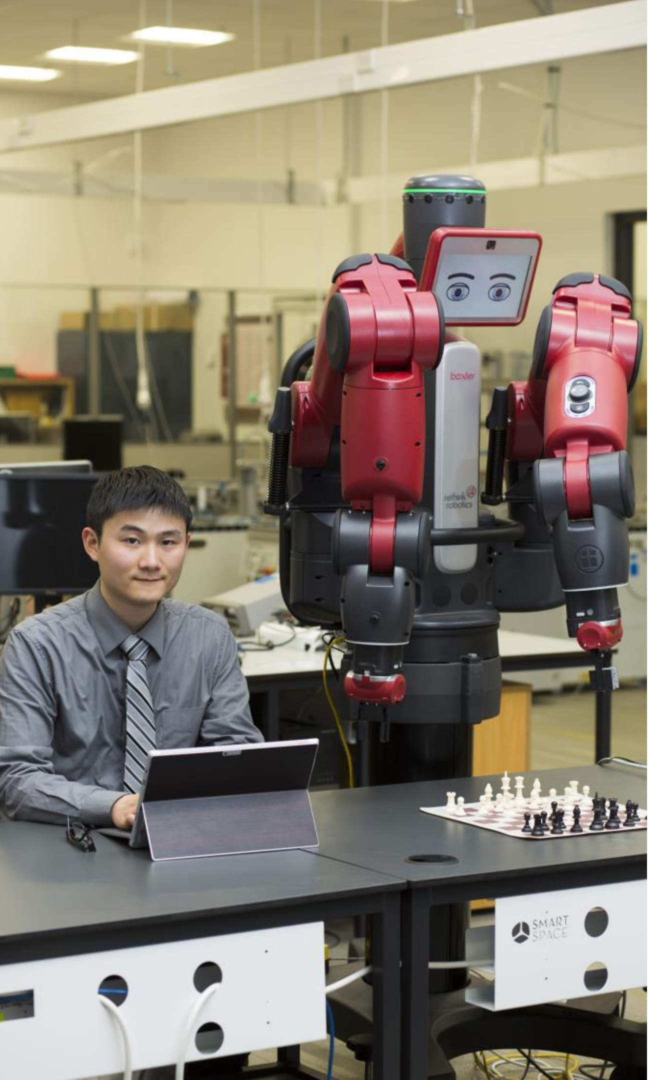
THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

KOI TŪ:
THE CENTRE FOR
INFORMED FUTURES

Digital technology for contact tracing

Koi Tū webinar presented by Dr Andrew Chen

Friday 3 July, 12pm



Dr. Andrew Chen

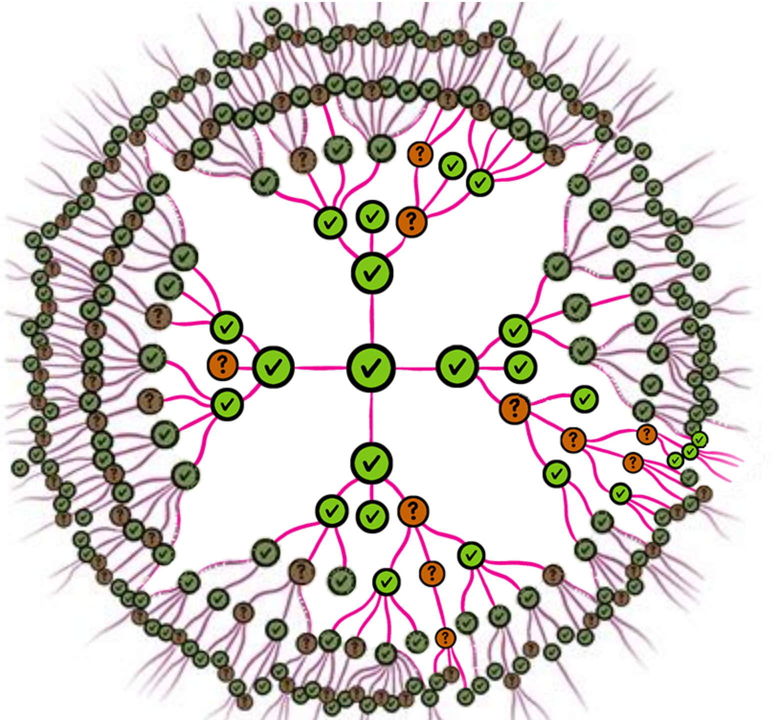
PhD in Computer Systems Engineering

- AI and Machine Learning
- Computer Vision for surveillance
- Ethics and privacy of camera surveillance

Digital Technologies and Public Policy

- Technology’s impact on societal resilience
- Analysing policy responses to COVID-19
- Analysing digital contact tracing in NZ

Contact Tracing



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Rapid identification and isolation *of new cases helps to break the chain of transmission and limit the spread of a communicable disease*

Can technology help?

Problem Definition

- Patient A tests positive for communicable disease X
- Who else could have been exposed?
  - Assuming a definition around risk (e.g. “close contact”)
  - People known to Patient A
    - Interview the Patient and ask them
  - People unknown to Patient A
    - Where was Patient A at what times?
    - Who else was there at those times?
    - What risk of exposure was there for the other people?
- Identification and Isolation required as quickly as possible
  - Taking into account other impacts and policy choices

Completeness

Speed

Adjacent Problems

- Identifying transmission chains
  - Is there community transmission?
- Detecting potential environmental or contact transmission
  - Is there aerosol spread or surface contamination in the community?
- Enforcing isolation/quarantine of positive patients (geofencing)
  - Are people where they are supposed to be?
- Detecting breaches of social/physical distancing
  - Where are crowds forming?
- Symptom tracking and risk assessment
  - How sick do people feel, who should we test?
- Keeping economies open
  - Are we confident that we can cut off transmission chains quickly enough?

Technology Options

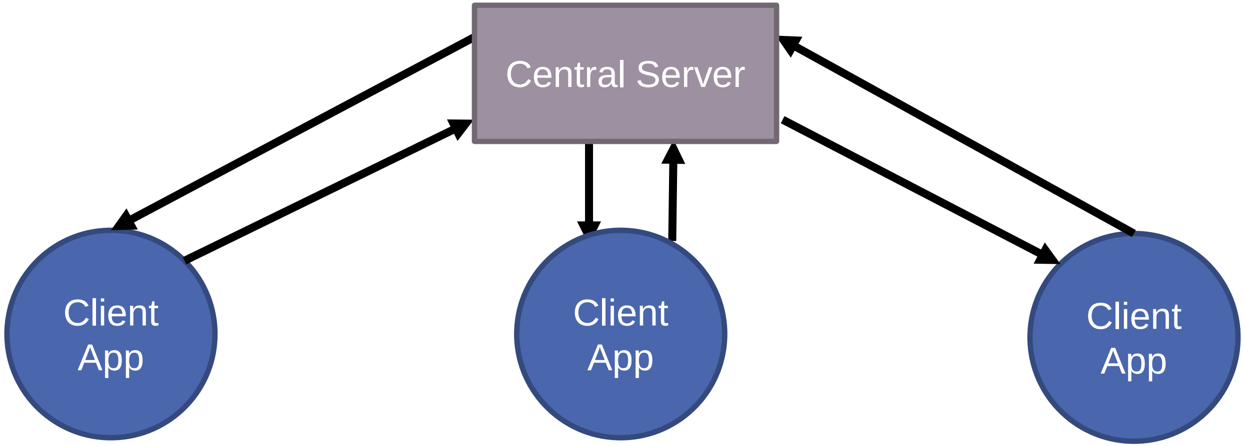
- Location Tracking
  - GPS, Wi-Fi Signals, Cell Tower Localisation [high-granularity]
    - Using signal strength, where is a person relative to a known point?
  - QR Codes, SMS (texting), Sign-in Forms [low-granularity]
    - Where and when did a person check-in at a known point?
- Proximity/Contact Detection
  - Bluetooth/BLE, IoT protocols
    - Which devices have been in proximity to a known device?
    - CMU has combined BT with ultrasonic signals to improve accuracy
- Investigative Surveillance
  - CCTV, biometrics, financial transaction data, virtual interviews
    - Mostly manual methods of determining time and place

Hardware

- Smartphones
  - Most have GPS, Wi-Fi, Bluetooth hardware built-in
  - 70-85% penetration in first-world countries
  - Operating system translates between software and hardware – compatibility issues
- Less-smart Cellphones
  - Celltower geolocation and SMS texting available on more phones
  - 90-95% penetration in first-world countries
  - Lower granularity with the limited technology
- Wearables
  - StayHomeSafe bracelet (Hong Kong), TraceTogether Wearable Token (Singapore)
  - CovidCard (proposed in NZ)
  - Challenges with hardware supply chains, significant capital cost

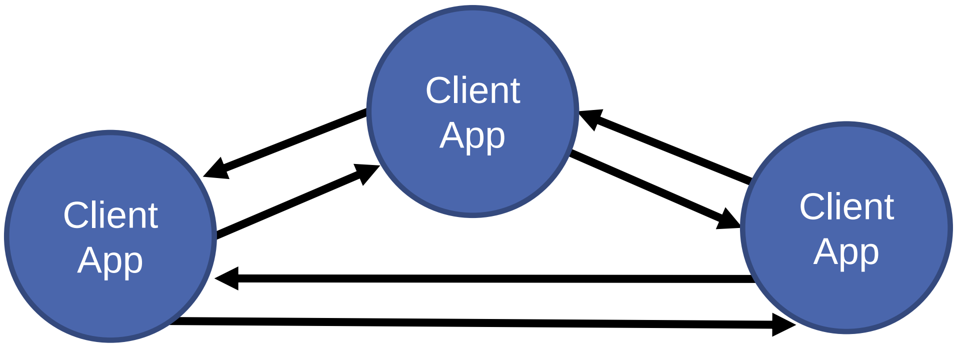
System Architectures

- Centralised
  - All devices send tracking data to a central server
  - Central server finds exposure overlaps in locations and times
  - Messages sent back out to devices or public health officials conduct calls
  - Power is concentrated with holder of central server, privacy concerns



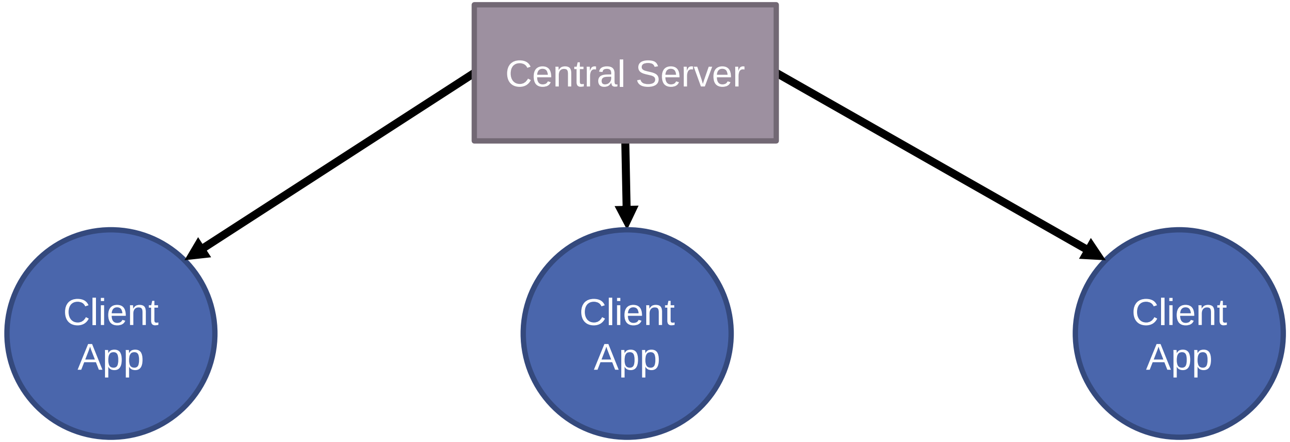
System Architectures

- Decentralised
  - All devices send messages about exposures to each other – no central server
  - Devices check for overlaps against their own logs
  - Users shown notification to contact public health officials
  - Protects privacy from govt but makes it hard to measure effectiveness



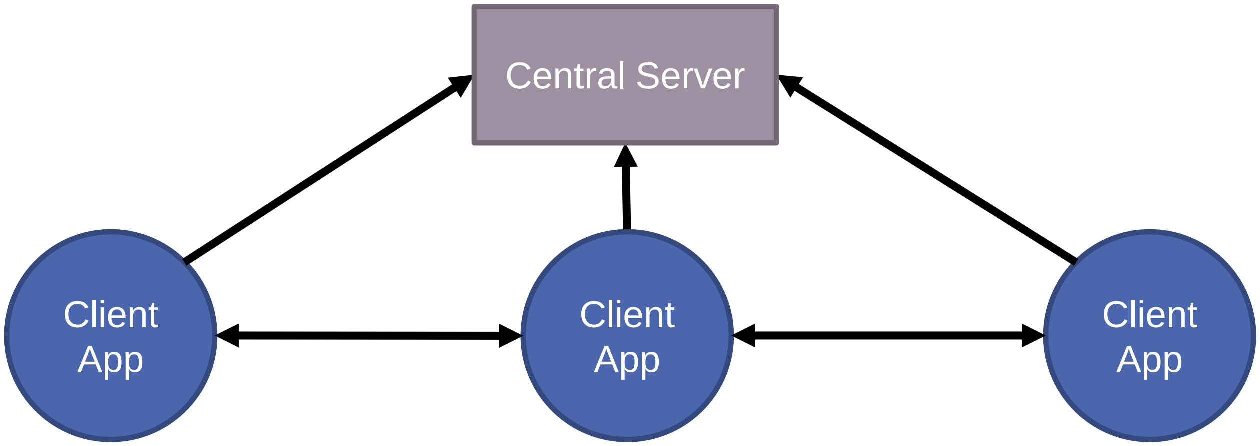
System Architectures

- Semi-centralised (publishing)
  - Central server maintains list of exposure risk locations and times (from contact tracers)
  - Devices check for overlaps between central list and their own logs
  - Users shown notification to contact public health officials
  - Can be hard to measure effectiveness, minor privacy risk in publishing exposure logs



System Architectures

- Semi-decentralised (reporting)
  - Devices keep track of their own locations and times, or interactions
  - If someone tests positive, they electronically submit their log to the central server
  - Public health officials use other methods to find people with exposure risk
  - Minimises privacy risk for healthy people, can be hard to find people with exposure risk



Privacy

- The need for privacy is a response to imperfect trust
  - Proportionality of actions depends on social license and operating conditions
- What information is being collected?
  - Names, date of birth, phone number, e-mail address, physical address, biometrics
  - Health/Symptom data
  - Location logs with timestamps
- Who gets to see that information? What purpose is the information used for?
  - Need to limit use to public health response only
  - Appropriate checks and balances / data governance and oversight processes
- When will the information be destroyed?
  - Most location logs deleted after 1-2 months
  - May keep anonymised/aggregated data for analysis/research purposes

Policy Considerations

- Voluntary vs Mandatory
  - Uptake rate can be challenging: need 40-75% of population contributing useful data
- Universalism vs Targeted
  - Deploying tech to all people, or focusing on those who are more vulnerable
- Ability to participate
  - Smartphone penetration, compatibility with operating systems differs by country
  - Need to understand who might be left out (e.g. vulnerable populations at higher risk)
- Support vs Full Automation
  - Supporting manual contact tracing efforts with more information and speed?
  - Completely autonomous contact tracing without human intervention?
- Storage and Security
  - Consideration around local vs. offshore cloud data storage
  - Encryption of data in transmission and at rest, independent audits
  - Defending against bad actors e.g. scams, false positive attacks, denial of service

Case Study - Singapore

- TraceTogether
  - Smartphones exchange Bluetooth signals to record proximity
  - If someone tests positive, proximity data provided to MOH [semi-decentralised]
    - Contact tracers then call people with exposure risk to advise on next steps
  - Targeted 75% uptake rate – approx. 25% uptake two months later (voluntary)
  - Some usability challenges (particularly on iOS devices)
  - Australia's CovidSafe is based on similar technology and methods
  - Now also releasing wearable devices for vulnerable populations
- SafeEntry
  - QR-code system, all businesses required to adopt the system
  - Some venues making it compulsory to scan QR code before entry
  - Names, national identity number, mobile phone number, and check-in/out times
  - Data uploaded to cloud service [centralised]

Case Study – South Korea

- Contact tracers take a deep investigative approach
  - Use CCTV, credit card transactions, cellphone location tracking to find people
- CDC releases locations and times where patients have been [semi-centralised]
  - Private developers integrated the data into visual maps and apps
  - People compare maps against their own logs to self-identify exposure risk
  - Users notified if they were within 100m of where an active case was
- Popular amongst the people, but may have side effects
  - Can create perception of “high-risk areas” that people avoid
  - Released logs are “anonymous” but could have enough detail to de-anonymise
    - Logs include nationality, age, and gender of the patient
  - Privacy risk discourages people from reporting symptoms or getting tested
    - Outbreak in LGBTQ nightclub area could out people

Case Study – Poland

- Mandatory Home Quarantine app
  - Uses GPS data to monitor continuously
  - Users required to take a real-time selfie multiple times a day
  - Users have 20 mins to respond to request, facial recognition used to verify identity
  - Financial penalty for non-compliance, police visits as substitute
- Voluntary ProteGO Safe app
  - Risk assessment test to provide people with relevant health advice
  - Health journal to keep track of symptoms
  - Bluetooth proximity detection, stored on the device for two weeks [semi-decentralised]
  - Random identifiers used for communication between devices, changed every hour
  - Exposure notifications sent back out to devices [semi-centralised]

Case Study – New Zealand

- Businesses must keep contact tracing registers (with some exceptions)
  - Pen-and-paper register template released by govt
- Private developers released QR code systems [mostly centralised but not with govt]
  - Helps speed up data entry for customers and reduces “dirty pen” risks
  - Reduces privacy risks in comparison to a pen-and-paper register
- Govt released NZ COVID Tracer app
  - QR codes can be generated based on NZBN for each location
  - Data stays on the device – a “digital diary” for the individual
  - Can be electronically shared with MOH contact tracer requests [semi-decentralised]
  - Exposure notification functionality recently added [semi-centralised]
- Has created significant usability problems – shops have multiple QR codes!
  - Business obligations vs. voluntary individual efforts

Case Study – Apple/Google

- Apple/Google Exposure Notification Protocol
  - >98% of smartphones use Android/iOS - allows interoperability
    - Could allow for cross-border contact tracing
  - Bluetooth handshakes record proximity automatically, at the OS layer
    - Each govt has to develop an app to interpret signals and provide local info
  - Devices communicate with each other only [decentralised]
    - Patients are flagged as active cases, devices compare logs against their own
    - Contacts sent notification to self-isolate/test and/or call contact tracers
  - Privacy restrictions and co-ordination requirements set by Apple/Google
    - Location services (GPS, Wi-Fi, etc.) must not be used
    - Governments must only use the data for the public health response
  - Initially, a few US states and parts of Europe (Switzerland, UK, Germany) adopting it
    - Some concerns about lack of visibility for public health officials

Usability

- If it's not simple, people won't use it!
- Passive vs Active Participation
  - Signals-based tracking can happen automatically
    - Bluetooth security restrictions on iOS required app in the foreground
  - QR codes require people to pull out their phones and scan them
- Consistency and Co-ordination
  - Government solutions may compete with privately developed solutions
  - Multiple solutions can create fragmentation and confusion
- Integration
  - Any solution needs to integrate with manual contact tracing processes
  - If the data is not useful or not interrogable by contact tracers, it may be ignored
  - Augment, not replace, manual contact tracing [where manual tracing is working]

Effectiveness

- Limited evidence on the effectiveness of tech-enabled contact tracing
  - Countries with voluntary systems have limited uptake
  - Relatively few new contacts found that manual systems missed
  - Limited evidence on speed – dependency on enforcement mechanisms
  - Not much evidence on error rates in the wild, only in controlled tests
  - Need to consider recursive/cascading order effects in automated systems

  Council of Europe: "Considering the absence of evidence of their efficacy, are the promises worth the predictable societal and legal risks?"

- Operating Conditions
  - In most countries, tech developed and released as case numbers fall
  - In other countries, contact tracing already ineffective/too late as case numbers rise
  - Other interventions simultaneously in place – hard to separate effects

Tech for Contact Tracing

The theory and logic of digital contact tracing is sound
But relatively untested in the real world
Many non-technical considerations - it's complicated!

Tech solutions must be designed with public health goals first, in consultation with public health experts

Digital contact tracing for COVID-19 is a big experiment
Jurisdictions have selected many different approaches
We will have to analyse effectiveness ex post

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