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New Technologies and Data Systems for Pandemic Surveillance and Control

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Stanford Children's Health | Lucile Packard Children's Hospital Stanford

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Contact-tracing-quarantine technologies

Border control, pre-vaccine

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Various data streams needed to support pandemic response

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- Border control (air, cruises, land)
  - TOCC: travel history; occupation; contacts; clusters

- Public health data in central/local governments for contact, tracing and quarantine
  - Symptoms data collected in workplace and school
  - Medical records for doctor's offices and hospitals
  - Laboratory data to support medical decision making

- Data to managing healthcare capacity and assets
  - Hospitals rooms/ICU/respirators
  - Healthcare personnel
  - PPEs (e.g., masks, gloves, shields, clothing for healthcare workers)
  - Testing capacity (PCR, rapid antigen tests)

Challenges of data gathering and integration

- Various reporting needs: patients, physicians in hospital/clinic, schools, buses, health department, CDC.
  - Trust and participation
  - Timeliness
  - Interoperability of data systems: C-CDA (consolidated clinical document architecture); FHIR (fast healthcare interoperability resources)
- Interoperability
  - Information and data transfer
  - timely analysis
  - decision making
- Law and jurisdictions
  - International and interstate/interprovincial collaboration
    - trust building, need better framework to optimize global health
  - Confusing laws and jurisdiction
  - Ethical issues on use of data

MM Mello, CJ Wang, *Science.* Doi: 10.1126/science.abb9045 (2020).

Taiwan: Linked datasets for data analytics

Taiwan: Doctors alerted at point of care

Digital epidemiology with consumer technology

- New data sources:
  - cellphones (GPS); wearables (blue tooth);
  - video surveillance;
  - social media;
  - QR codes in shops;
  - Crowd sourced: internet searches and news; traffic data; symptoms self reports; pharmacy sales
- Ethical considerations:
  - unethical not to use available data;
  - ethically justifiable but ethically obligatory when disease severity is high? But how?

Google-Apple Exposure Notification (GAEN) with Bluetooth

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Pros	Cons
✓ Allows for more thorough and timely contact tracing than manual contact tracing	❑ Need early & wide-spread adoption to be effective
✓ People typically cannot recall or know everyone they have been in touch with for the last 2 weeks	❑ False alarm/ false reporting
✓ Allows gathering data they would not otherwise be able to (e.g., how long are people in contact with cases prior to getting sick)	❑ Data integration and regulatory issues

Contact-tracing app curbs the spread of COVID in England and Wales

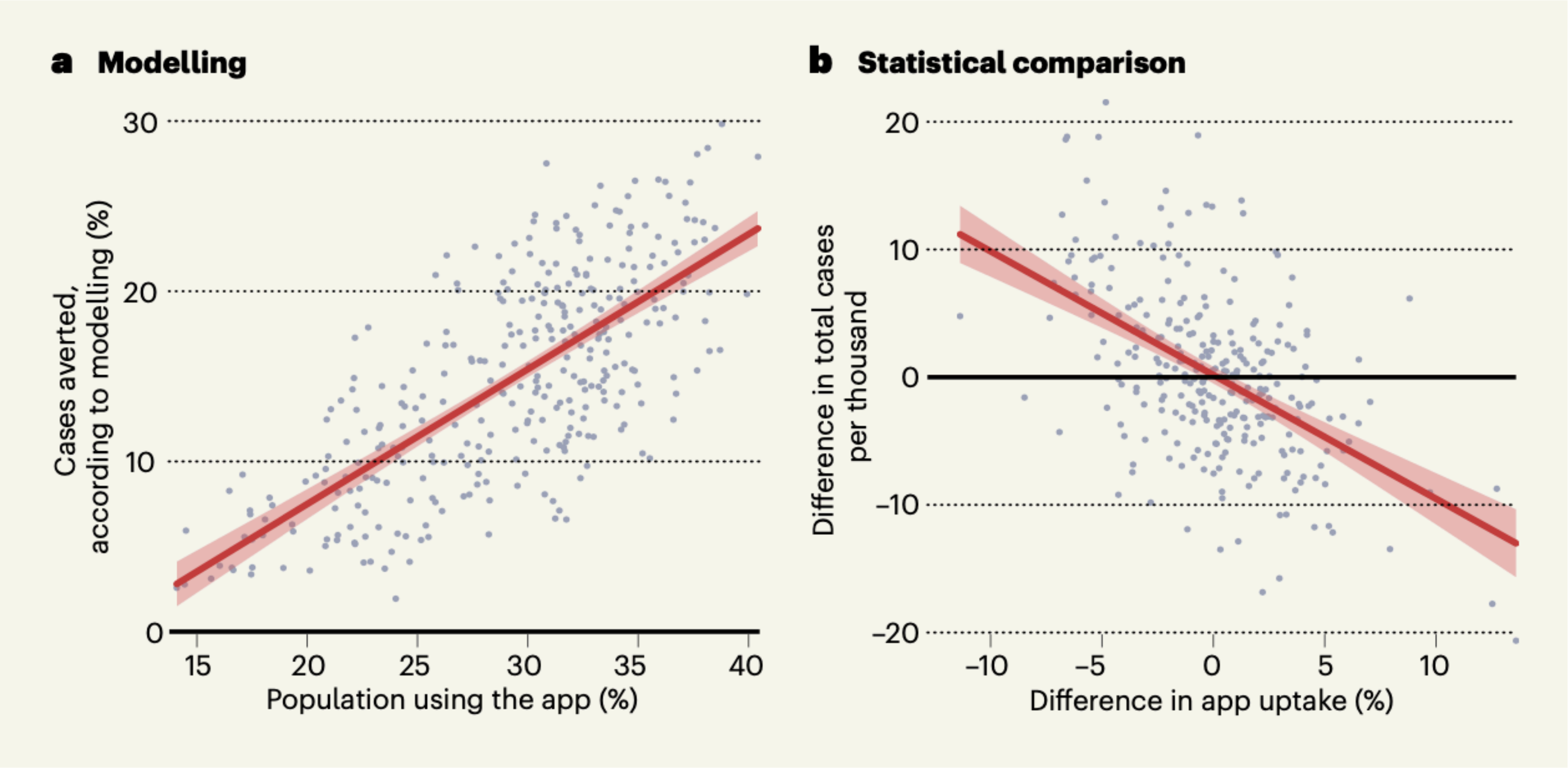
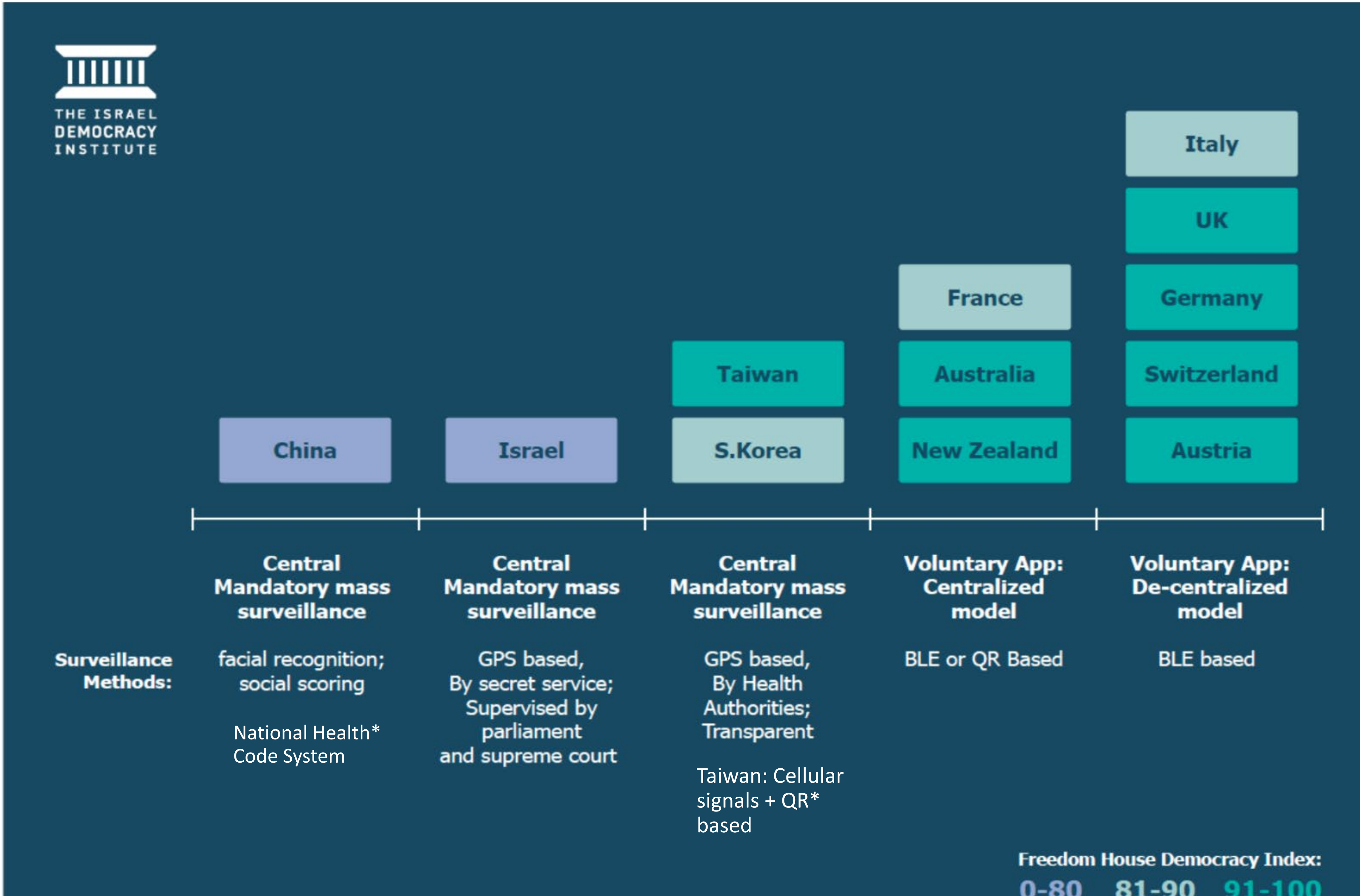


FIGURE 2: SELECT COUNTRIES' COVID-19 DIGITAL CONTACT-TRACING MODELS



Source: Tehilla Shwartz Altshuler Rachel Aridor Hershkovitz, Digital Contact Tracing And The Coronavirus: Israeli And Comparative Perspectives, Brookings Foreign Policy, August 2020

Ethical Issues Raised

- Privacy: cellphone location and text data (cellular signal vs. GPS):
  - except for use of law enforcement, data not ordinarily used for tracking down and imposing consequences
- Autonomy: Asking for permission to access personal information; informed consent
  - contact tracing through cellular records: opt in; opt out; mandatory
- Equity concerns:
  - new data source can improve representation of some populations in epidemiologic analysis with availability of smart phones.
  - disparities risk creating bias in new dataset (e.g., number of tests performed and positive test rate).
- Minimizing risk of errors:
  - scope, speed and sources.
  - need correction mechanism for mistakes.
- Accountability: transparency; potential for misappropriation of data.

MM Mello, CJ Wang, *Science.* Doi: 10.1126/science.abb9045 (2020).

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Detection Technologies

New advancements and applications

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Improvements in sample analysis: information, speed, convenience and population-based surveillance

Traditional

- Protein antigen tests: LFA (Later flow assays); ELIZA (Enzyme-linked Immunosorbent assays)
- Genetic materials tests: RT-PCR; NAAT (Nucleic Acid Amplification Tests); and RT-LAMP (reverse transcription loop mediated isothermal amplifications)

Information

- CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) gene editing tool,
  - target nucleic acid sequences of interest, can provide sensitivity on part to RT-PCR:
  - e.g., CARMEN, A rapid and sensitive miniaturized multiplexed CRISPR-Based diagnostic test uses microfluidic technology.
  - Pairs of droplets for analysis
  - Can test over 1,000 samples for single virus, or five samples for more than 150 viruses.
- Luminex essays: bead-based immunoassay: antibodies specific to their corresponding analyte
  - Multiple beads as detection proteins; excited by lasers to determine the bead region
  - Quantification based on magnitude of the signal

Speed

- Nanotechnology based biosensors: high sensitivity, low noise
- FET (field-effect transistor) based biosensors: speed and sensitivity comparable to PCR.
  - Conductance value after viral proteins of interest bind the FET’s graphene surface, changes surface charge distribution
  - Results in 20 minutes

Convenience

- freeze-dried synthetic biologic sensors in masks;
  - Reagents can be embedded into paper or textile – once come into contact with fluid, rehydrate and activated. Trigger a color change.

Population-based

- Wastewater surveillance
- Airborne surveillance

Using movement data to predict pandemic surges

Rich Tsui, PhD, Mark Anderson, PhD, C. Jason Wang, MD, PhD

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Study Purpose/Aim

Purpose/Aim:

To develop and deploy a new GPS-based consumer technology tool for understanding pandemic spread to informing policy decisions and preparedness

Rationale:

- Aerosol and droplets are both important modes of transmission
- The data can be viewed in focus for a particular state, city, or zip code to inform local policy.

Hypothesis:

- Venue density and dwell time (visit duration), and interaction between duration and density will have an impact on disease spread.

Method/Data

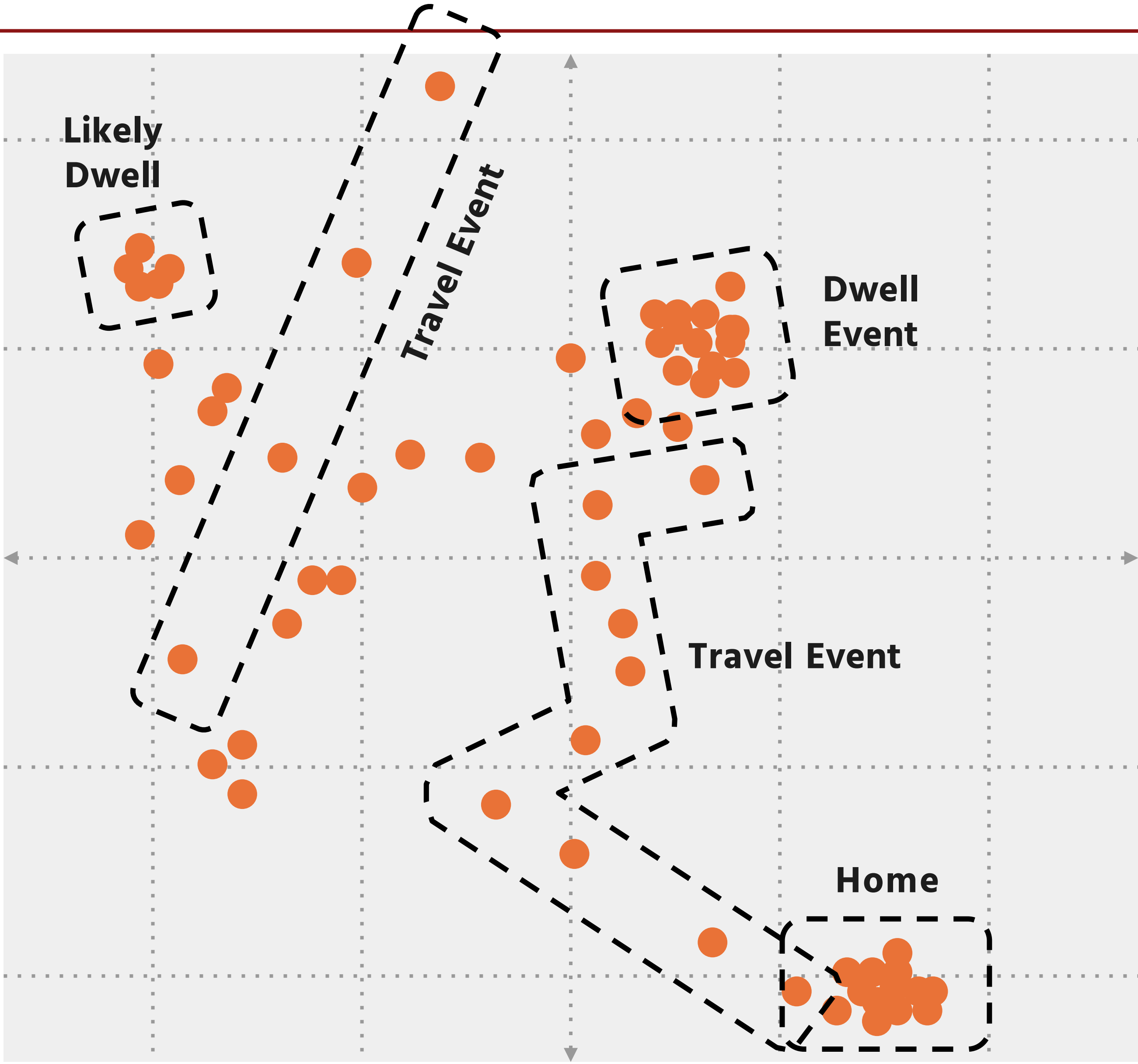
- Unacast data: Timestamped deidentified GPS-tagged location data from people's mobile apps with venue geofences, visit time and estimated visit duration, for developing model for predicting infection spread
- Full COVID-19 vaccination rates from CDC
- Confirmed COVID-19 cases from CDC
- Machine learning with automated feature selection and mathematical derivation for candidate features vs. expert ad hoc feature selection based on theory

Activity Feed: Clustering (Unacast)
Define fixed areas

Our proprietary data engine uses sophisticated algorithms to cluster pings into groups that indicate human activity.

Cluster Types

- Dwell Events
- Travel Events
- Home (recurring dwell event overnight)
- Work (recurring dwell event during the day)



Location Data Sources (Unacast)

Unacast location data is collected from a very large list of publishers/apps in the US mobile ecosystem. Unacast collects GPS data via SDKs within Mobile Apps & also through direct partnerships with Publishers & Mobile Applications. The location data is only collected & leveraged when the App is compliant with privacy regulations (i.e. CCPA, GDPR). This data is gathered, consolidated, and cleansed. All app partnerships are audited by our legal team, in order to ensure privacy compliance & proper data collection.

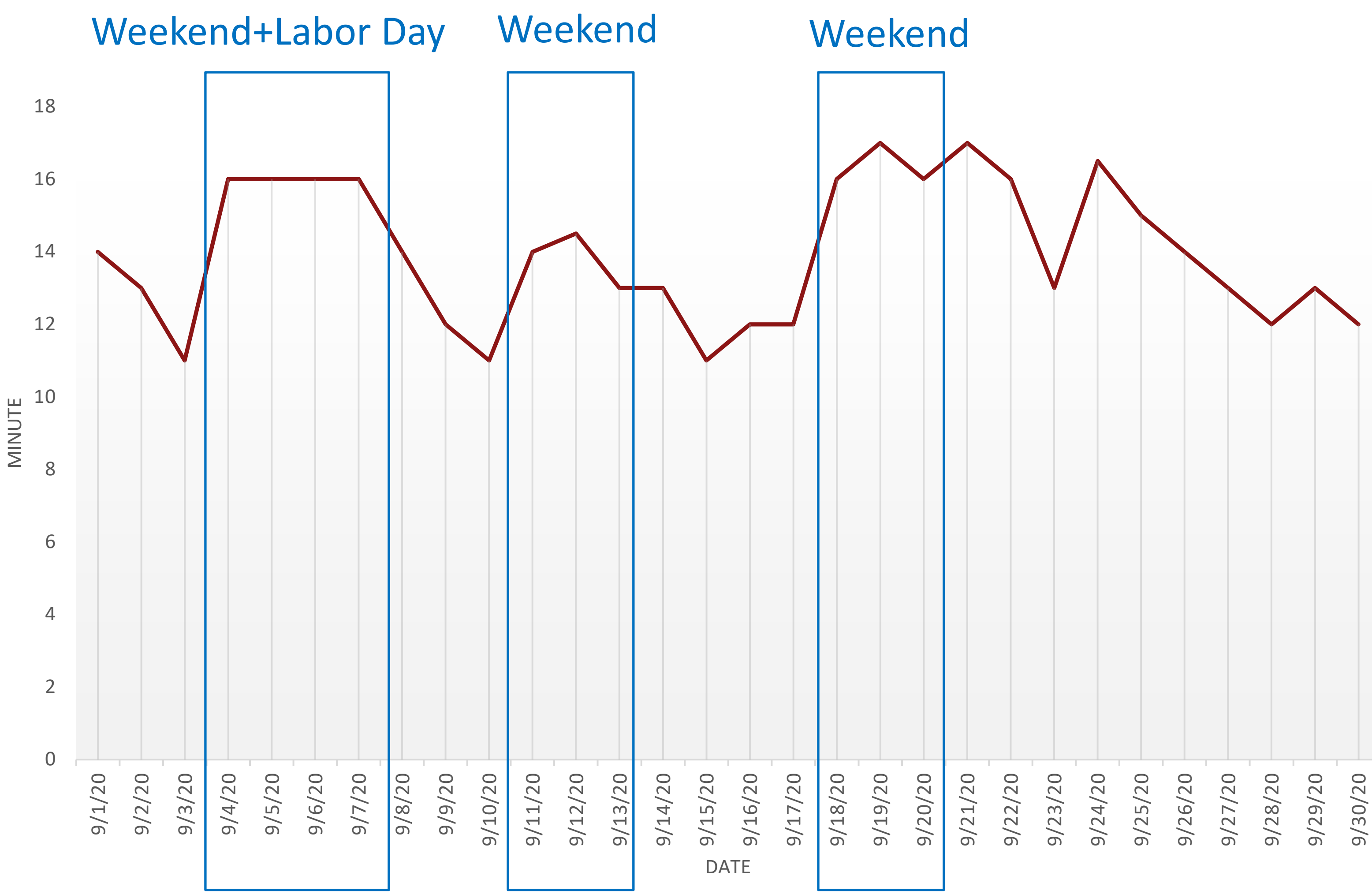
Due to confidentiality agreements, we do not divulge app name information, however we are able to provide a full overview of the Data Supply Portfolio from a category perspective. Please refer to the list on the right.

App Category Distribution:

- News/Magazines: 28%
- Social Networking: 13%
- Entertainment/Games: 12%
- Tools: 11%
- Communications: 7%
- Video Players & Editors: 7%
- Finance: 6%
- Sports: 5%
- Business: 4%
- Dating: 4%
- Lifestyle: 3%

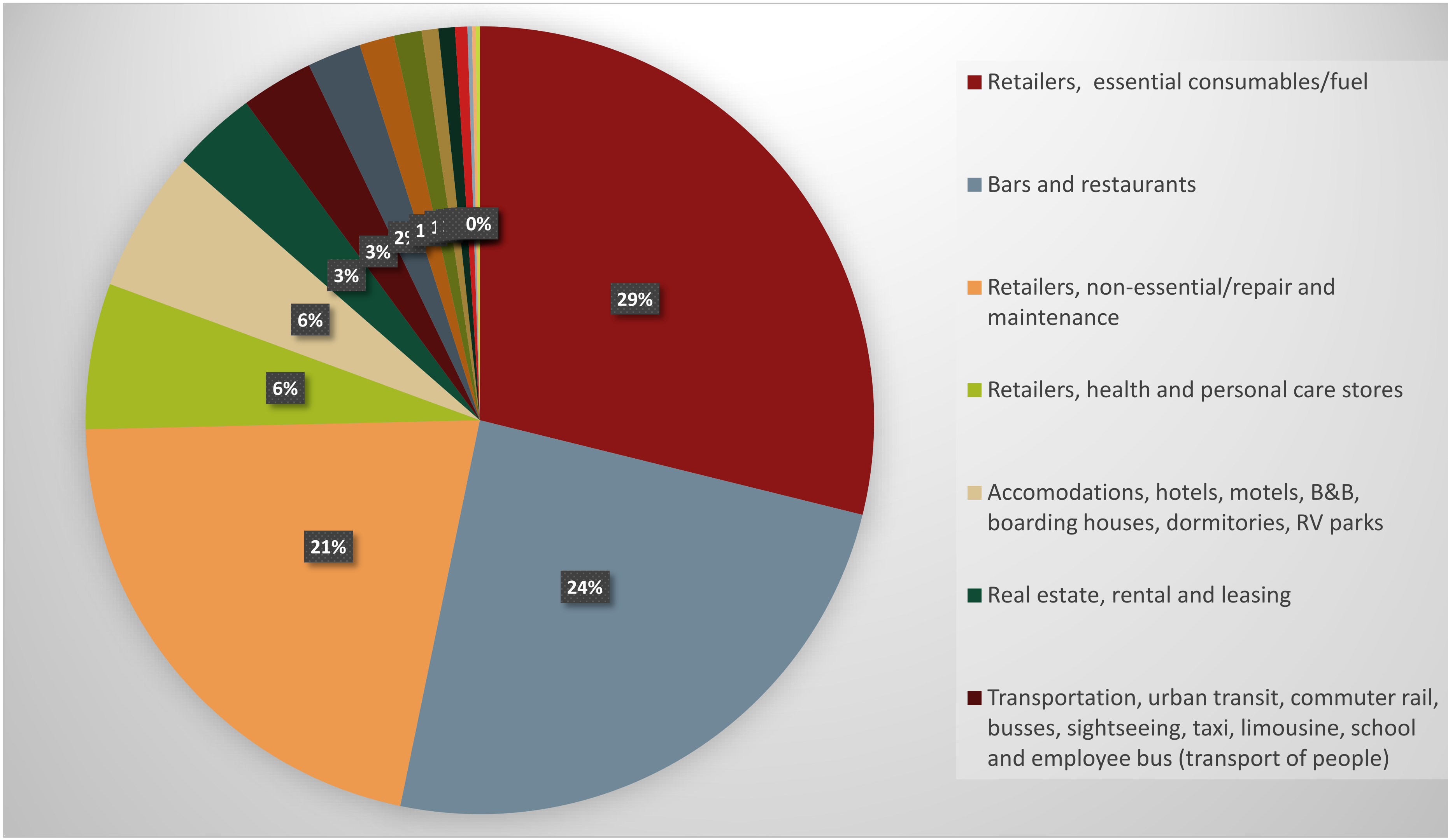
Median Restaurant Visit in Sept.*

Duration Time (D_v) in Davis City



*: calculated from daily Unacast data files with *Dwell events*.

Venue Class Distribution



Description of top 10 venue classes used

Venue Classes

Venue Classes	
Venue Class	**Brief Description**
1	Healthcare Providers
2	General Office
3	Personal Care Services
4	Dining – Full-Service
5	Dining – Limited Service
6	Fitness Centers
7	Accommodations
8	Retail – Health Products
9	Retail – Essential Consumables and Fuel
10	Retail – Other

Examples of businesses within venue classes:

3. Personal Service Venues – Hair salon, tattoo parlor, massage center, nail salon, …

4. Full service restaurant

5. Limited service restaurant

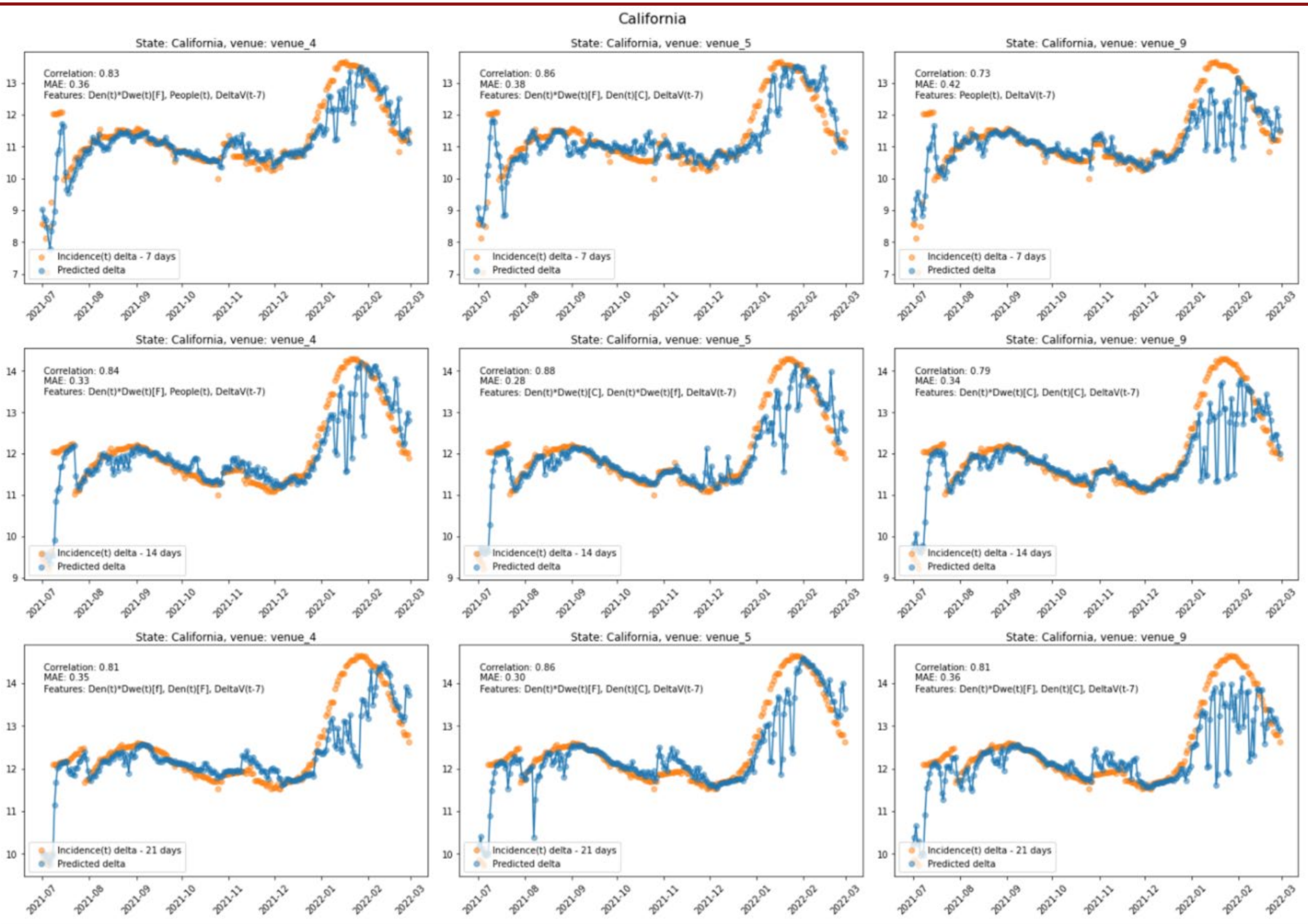
6. Fitness – Fitness centers, gyms, recreational sports centers, …

7. Accommodations – Hotel, motel, B&B,…

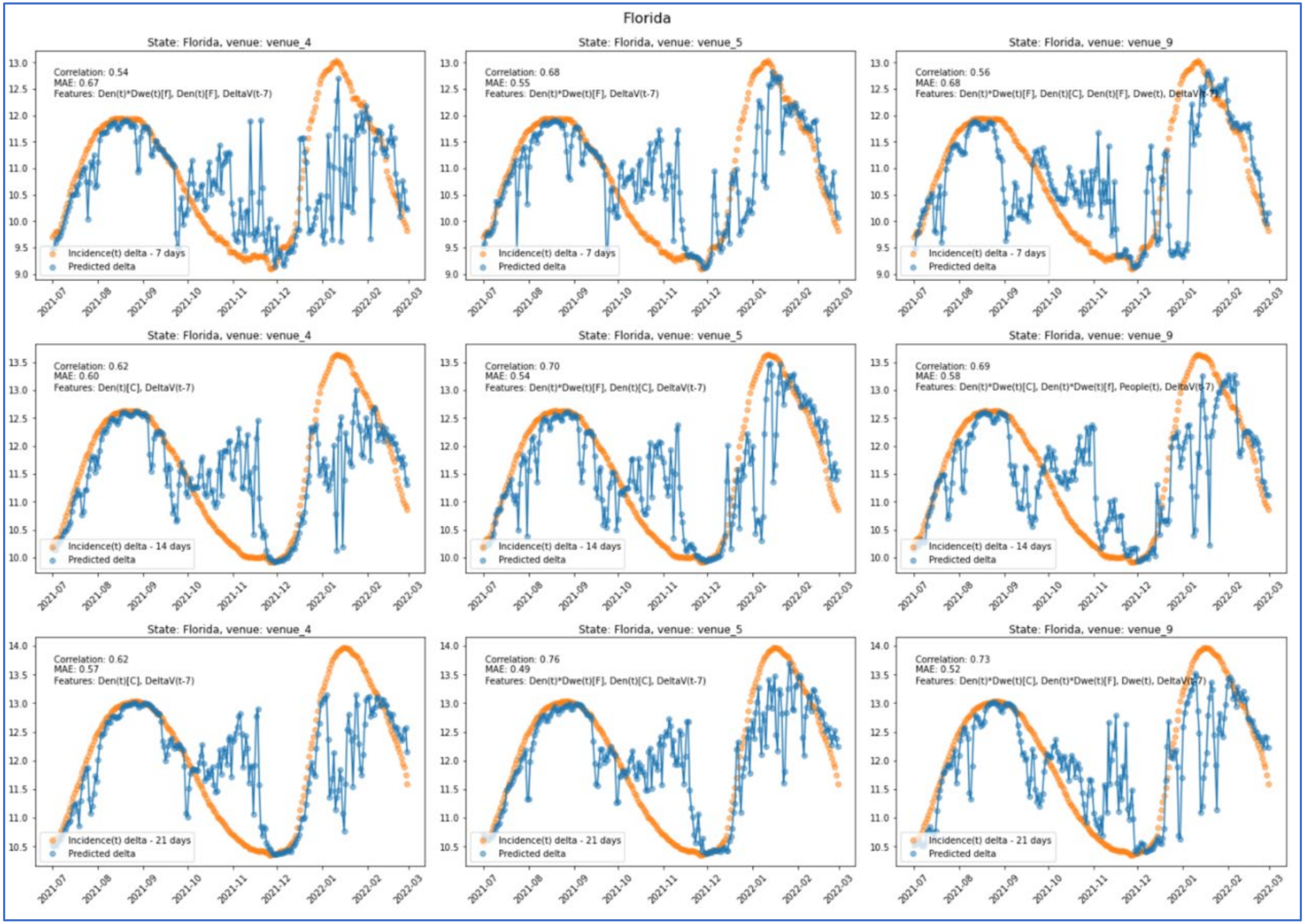
8. Health Retail – Pharmacy, health supplements, optical, …

9. Consumables (grocery) and fuel

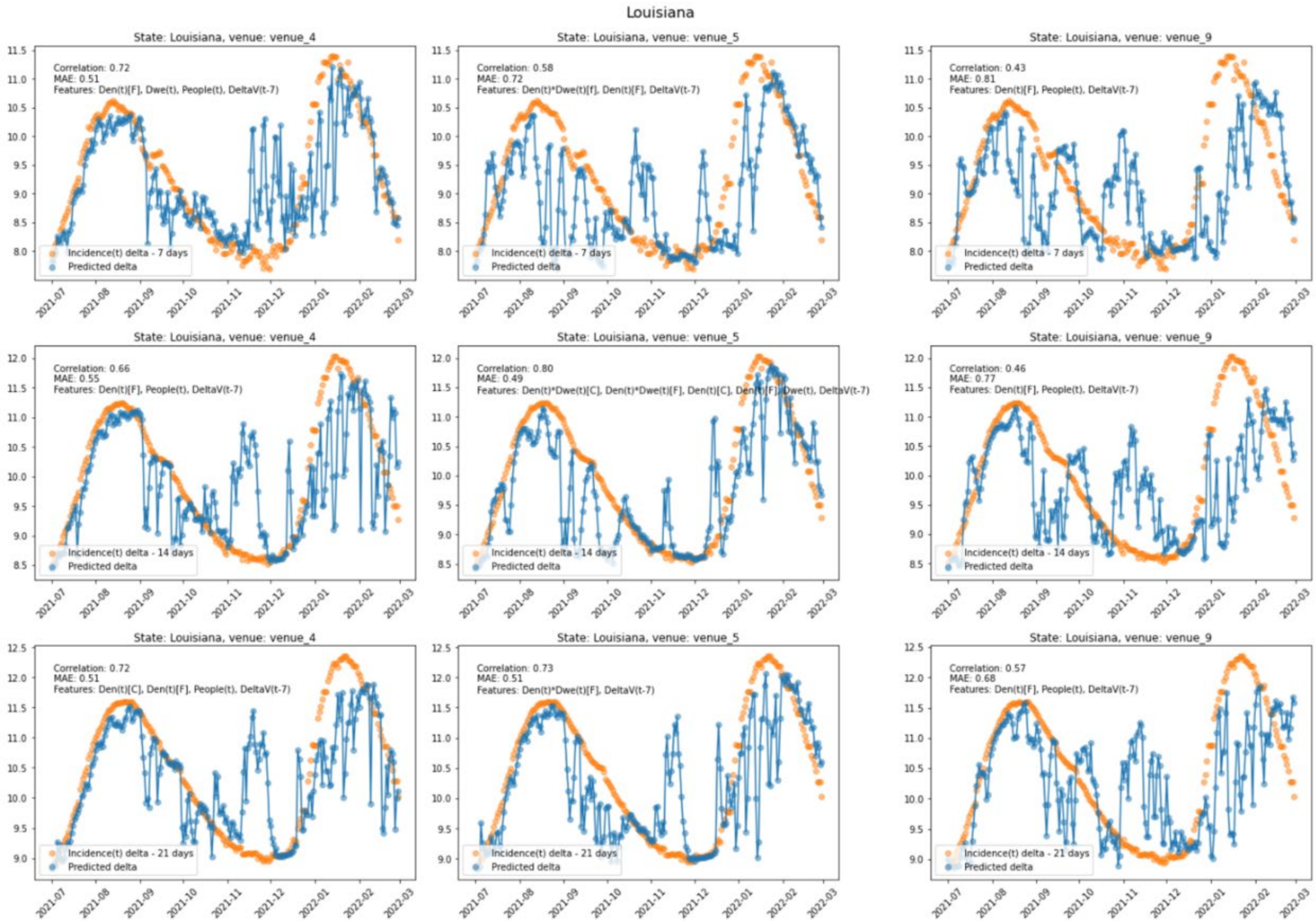
California (West, Blue):
Data-driven model with machine learning



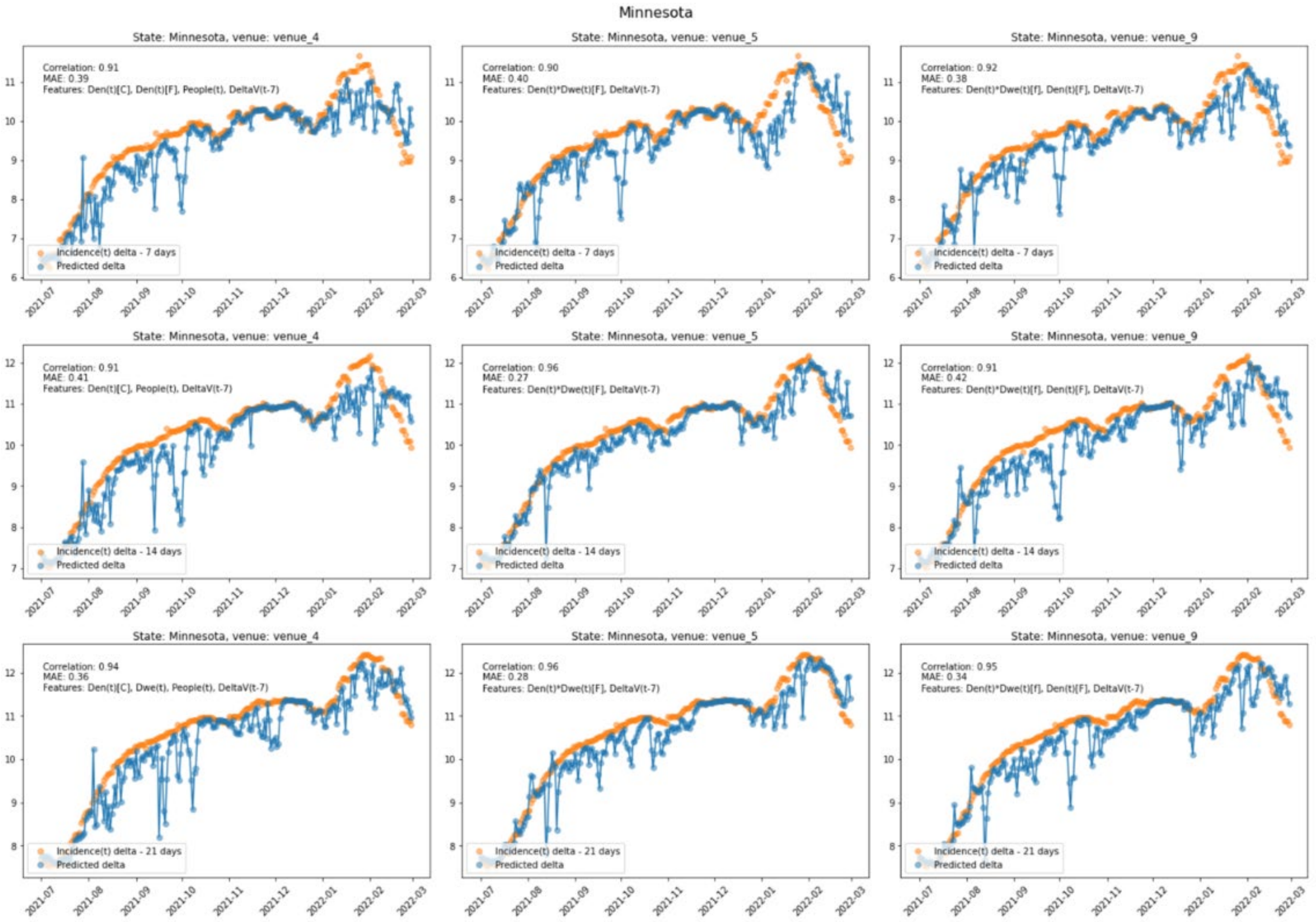
Florida (South East, Purple)
Data-driven model with machine learning



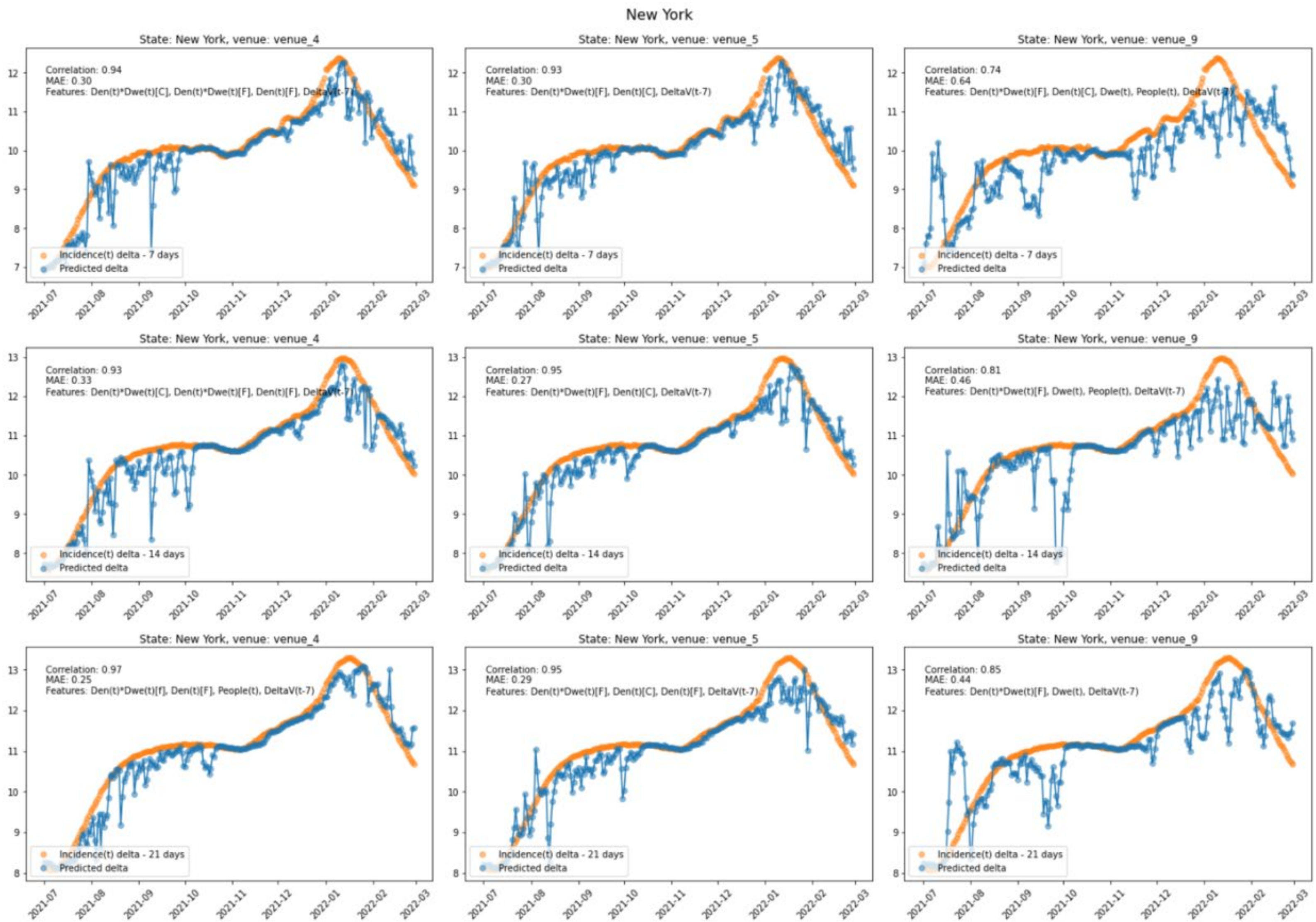
Louisiana (South, Red)
Data-driven model with machine learning



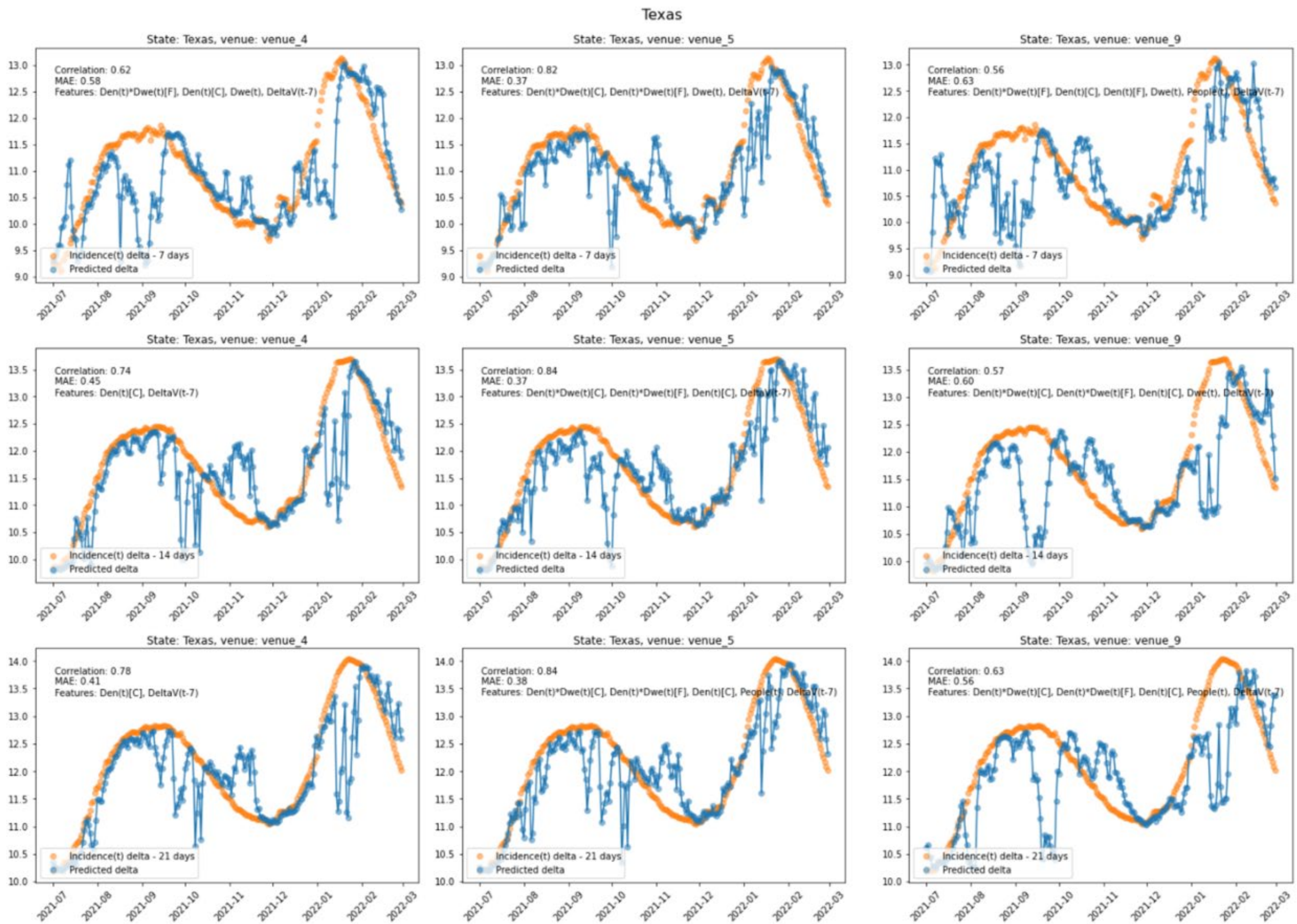
Minnesota (Mid West, Purple)
Data-driven model with machine learning



New York (North East, Blue)
Data-driven model with machine learning



Texas (South, Red)
Data-driven model with machine learning

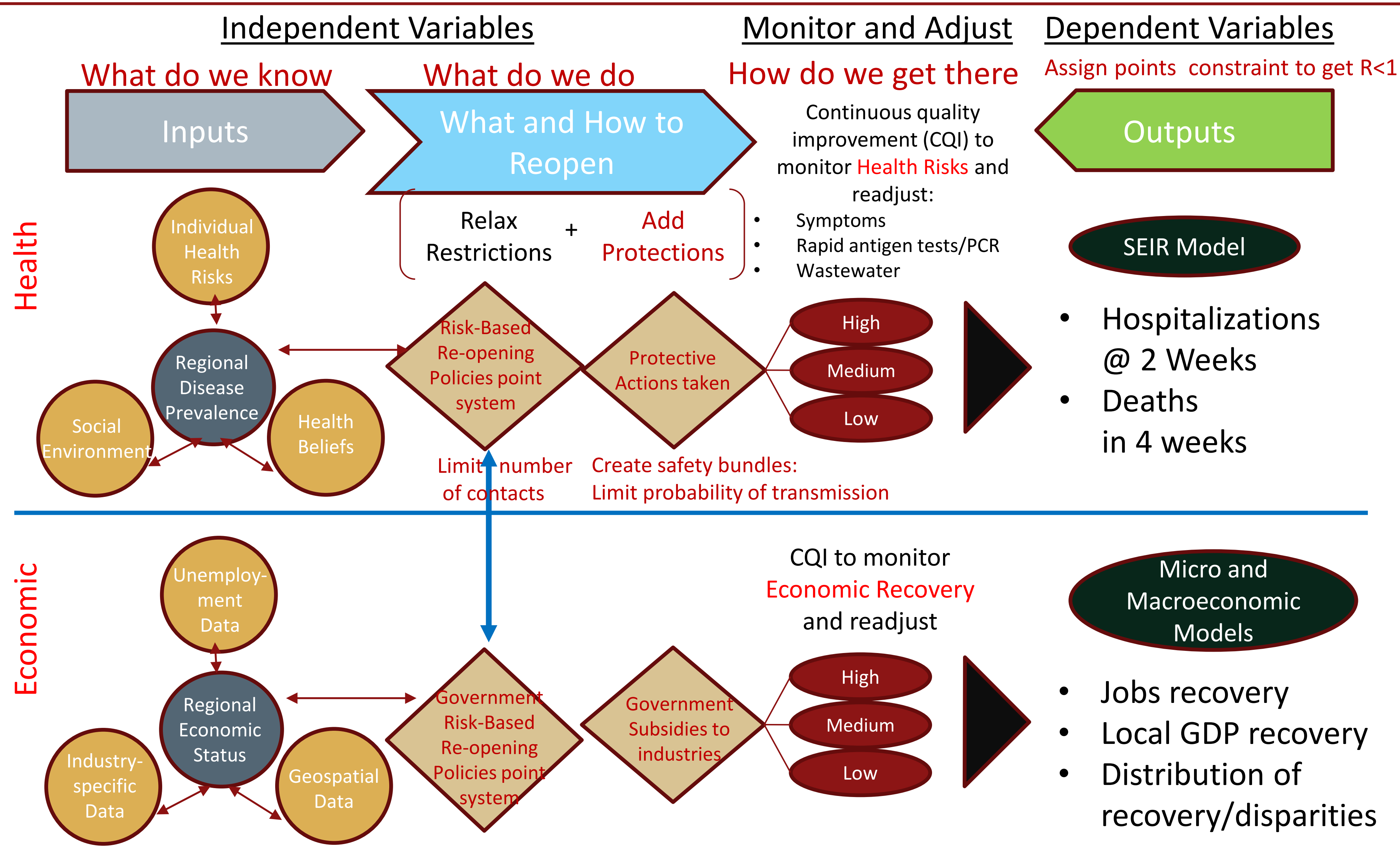


Policy Implications

- Venue-based risk assessment can inform policy interventions and strategies for reopening
  - Can be used to predict future surges 3 weeks ahead of time (compared to waste- water 1 week)
  - Allow hospital systems to prepare needed resources (beds, respirators, people)
  - Inform which venues should temporally close or be kept open.
  - Define allowable density level (point system to keep Rt <1)

- Limitations:
  - Unknown masking rate in the states studied, although residents of blue states (Democratic leaning) were more likely to have mask-wearing orders.
  - Unknown interaction between vaccination and self-protective actions (masking, hand washing, social distancing)
  - Unknown if GPS movement data would work in tall, large buildings in dense cities
  - Indoor vs. outdoor distinction (many restaurants have outdoors in warm climates)

Considerations for Reopening Society
Lives and Livelihoods



Thank you!

Traditional SEIR Model does not account for Repeated Infections from variants and waning vaccine protection over time as seen in COVID-19

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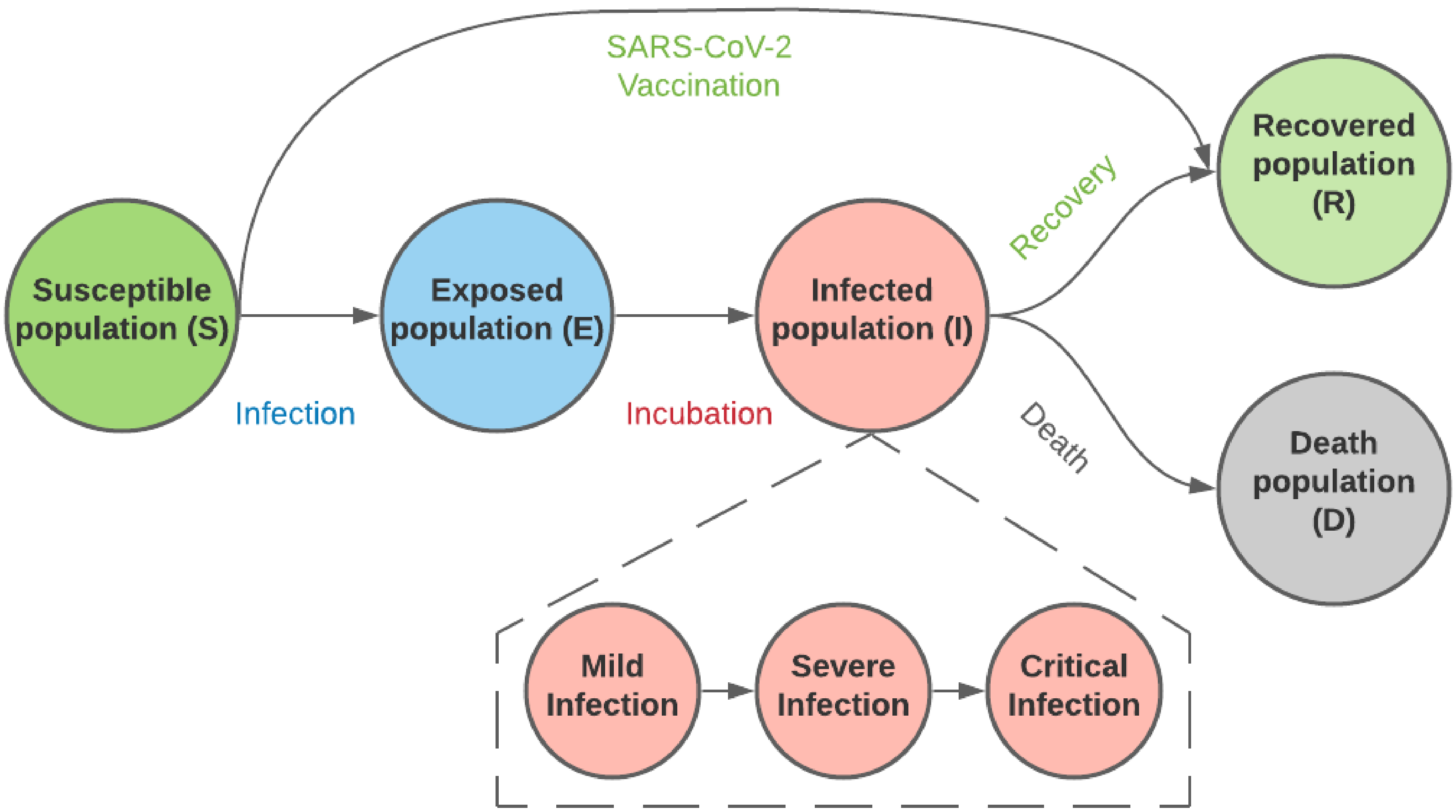

https://alhill.shinyapps.io/COVID19seir/

Comparison on methods of digital contact tracing in different countries

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FIGURE 1: SUMMARY OF THE COMPARISON BETWEEN ISRAEL AND OTHER COUNTRIES

Country	Freedom House Global Freedom Score	Legislation for epidemics (excluding special laws or orders triggered by the COVID-19 pandemic)	Privacy legislation	Technology
China	10, not free			Centralized mandatory mass surveillance, facial recognition, and social scoring
Israel	76, free	Public Health Ordinance, 1940	Protection of Privacy Law, 5741-1981	Centralized mandatory mass surveillance GPS-based, by the GSS; oversight by the Knesset and Supreme Court

Source: Tehilla Shwartz Altshuler Rachel Aridor Hershkovitz, Digital Contact Tracing And The Coronavirus: Israeli And Comparative Perspectives, Brookings Foreign Policy, August 2020

Country	Freedom House Global Freedom Score	Legislation for epidemics (excluding special laws or orders triggered by the COVID-19 pandemic)	Privacy legislation	Technology
Taiwan	93, free	Communication Disease Control Act 2004	Personal Data Protection Act 1995	Centralized, transparent, civilian-run (by health authorities) but mandatory mass surveillance; GPS-based [Cellular signal**]
South Korea	83, free	Infection Disease Control and Prevention Act amended in 2015 following the Middle East Respiratory Syndrome (MERS) outbreak	Personal Information Protection Act 2016, the Act of the Promotion of Information and Communication Network Utilization and Information Protection 2016	Centralized, transparent, civilian-run (by health authorities), but mandatory mass surveillance GPS-based; cross-checking of data from the immigration authorities, airlines, credit card companies, and surveillance cameras in public areas

Source: Tehilla Shwartz Altshuler Rachel Aridor Hershkovitz, Digital Contact Tracing And The Coronavirus: Israeli And Comparative Perspectives, Brookings Foreign Policy, August 2020

Country	Freedom House Global Freedom Score	Legislation for epidemics (excluding special laws or orders triggered by the COVID-19 pandemic)	Privacy legislation	Technology
New Zealand	97, free	Civil Defense Emergency Management Act 2002, Epidemic Preparedness Act 2006	Privacy Act 1993	Centralized voluntary app; QR code-based As part of the reopening of the economy, a new centralized but voluntary contact-tracing app based on scanning QR codes at the entrances of public places
Australia	97, free	Public Health Act 1997	The Privacy Act 1988	Voluntary app; BLE-based; centralized
France	90, free		GDPR	Voluntary app; BLE-based; centralized

Country	Freedom House Global Freedom Score	Legislation for epidemics (excluding special laws or orders triggered by the COVID-19 pandemic)	Privacy legislation	Technology
United Kingdom	94, free	Public Health (Control of Disease Act 1984), the Civil Contingencies Act 2004	The Data Protection Act 2018	Voluntary app; BLE-based; decentralized
Switzerland	96, free	Epidemics Act 2016	Data Protection Act 1992	Voluntary app; BLE-based; decentralized
Germany	94, free	Protection Against Infection Act 2000	GDPR	Voluntary app; BLE-based; decentralized
Austria	93, free	Epidemics Act 1950	GDPR	Voluntary app; BLE-based; decentralized
Italy	89, free	Consolidated Health Laws	GDPR	Voluntary app; BLE-based; decentralized

Source: Tehilla Shwartz Altshuler Rachel Aridor Hershkovitz, Digital Contact Tracing And The Coronavirus: Israeli And Comparative Perspectives, Brookings Foreign Policy, August 2020

COVID-19 Workflow

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screening → Diagnosis → Management

Symptoms & Signs
- Asymptomatic Fever
- Cough
- Shortness of Breath
- Loss of Taste/Smell
- Chills
- Headache
- Vomiting/diarrhea
- Sore throat
- Muscle pain
- Where in course of illness?
- Latency period

Sampling (Pre-analytic)
- Order
- Collection (60-75% swab collection success rate
- Route
- Transport
- Safe handling & processing

Lab Tests for virus (Analytic)
- RT PCR
- Rapid Ag

Sensitivity
Specificity
Cost
Time to reporting

Contact Tracing & Quarantine
- Triage
- Quarantine
- Insurance & payment
- +/- Hospitalization
- Retesting
- Contact Tracing*

Immunity Testing
- Ab tests IgM, IgG
- Immunity

Therapy
- Safety
- Efficacy
- Delivery Route (IV vs. oral)
- Cost of administration
- Time to market
- Cost
- Production
- Scale

Vaccine
- Develop
- Safe?
- Efficacious?
- Supply chain management
- Production capacity; fill finish
- Cold chain requirement
- Distribution channel
- Administration site and personnel
- Waning immunity
- Protection against variants

Recovery
- Infectious?
- Susceptible?
- Ct, viral load
- Long COVID PASC symptoms

SEIR model equations:

SEIR Model

Basic definitions:

- **N**: total population
- **S**: number of susceptible individuals (who have not had the infection)
- **E**: number of individuals exposed to infected people, but not developed infection yet
- **I**: number of infected individuals
- **R**: number of recovered/dead individuals

The equations for SEIR model are given by

$$\frac{dS}{dt} = -\beta S I$$

$$\frac{dE}{dt} = \beta S I - \alpha E$$

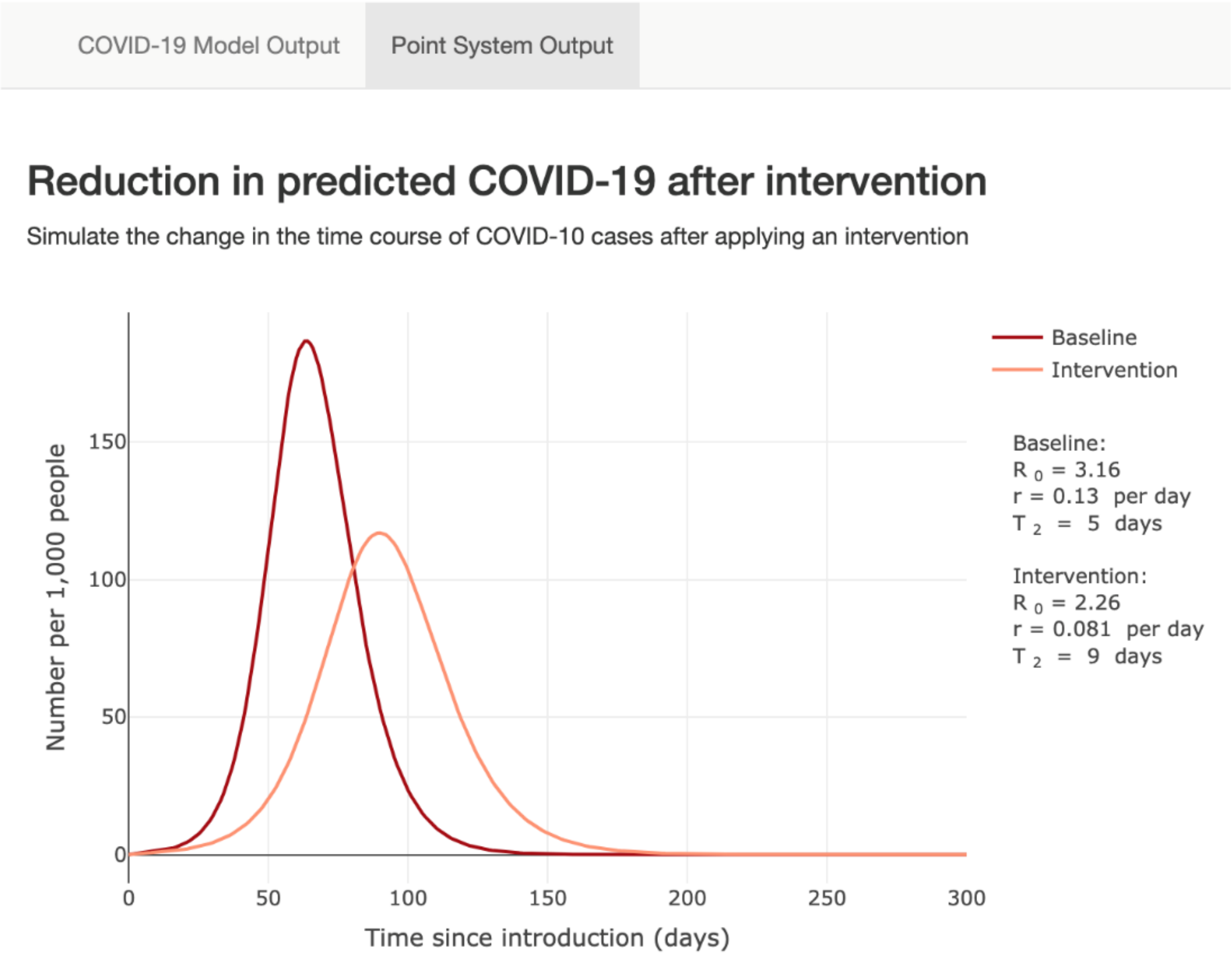
$$\frac{dI}{dt} = \alpha E - \gamma I$$

$$\frac{dR}{dt} = \gamma I$$

where

- β is the average contact rate in population, between the susceptible and infected individuals
- α is the inverse of incubation period $1/tinc$
- γ is the inverse of mean infectious period $1/tinf$

Integrating Point System into SEIR



https://tsuilab.shinyapps.io/COVID19SEIR-SocialDistance/

Tiered system for closing businesses in California since 2020

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Every county in California is assigned to a COVID-19 risk-level tier based on:

- **New cases:** the average number of new cases per day, over 7 days, per 100,000 residents
- **Positive tests:** the percentage of coronavirus tests given per day that are positive for COVID-19
- **Health Equity:** positive test rates in a county's most disadvantaged neighborhoods do not significantly lag behind the county's overall test positivity rate

Tier Level	New Cases per 100,000*	Positive Tests
Widespread PURPLE	More than 7	More than 8% testing positivity rate
Substantial RED	4 to 7	5 - 8%
Moderate ORANGE	1 to 3.9	2 - 4.9%
Minimal YELLOW	Less than 1	Less than 2%

* Case numbers are adjusted up or down based on testing volume above or below the state median.

What can open?

What's Open in Each Tier?

Widespread PURPLE	**Most indoor businesses are closed. Many can open outdoors with modifications,** for example, restaurants, places of worship, and family entertainment (mini golf). Personal care services, for example, hair and nail salons, tattoo parlors, and piercing shops, can open indoors with modifications.
Substantial RED	**Some indoor businesses are closed,** including places that serve alcohol but don't serve food. **Many can open indoors at 25% capacity** (or 100 people, whichever is fewer) for example, restaurants, places of worship, and movie theaters. Gyms can open indoors at 10% capacity. Personal care services can open indoors with modifications. Schools may re-open for full in-person instruction once a county has been in the red tier for at least 2 weeks. However, schools that have already reopened may remain open if the county moves back to the purple tier.
Moderate ORANGE	**Some indoor businesses can open with modifications.** Many can open indoors at 50% capacity (or 200 people, whichever is fewer), for example, restaurants, places of worship, and movie theaters. **Some can open indoors at 25% capacity** for example, gyms, bowling alleys, and cardrooms. Personal care services can open indoors with modifications.
Minimal YELLOW	**Most indoor businesses can open with modifications.** Some can open indoors at 50% capacity for example, restaurants, places of worship, movie theaters, gyms, cardrooms, and bars. Personal care services can open indoors with modifications.

Find which activities and businesses are open in the four tiers (PDF)

Stated Rationale for open/close – but what's the evidence?

Why Some Activities and Businesses Can Open While Others Stay Closed

- Activities and businesses that have a lower risk of spreading COVID-19 are allowed to open sooner.
- Higher-risk activities or businesses will be allowed to open when the risk is determined to be less.
- In each tier, an activity or business's operations depend on whether it has the:

Ability to Accommodate

- ☑ Mask wearing at all times while not eating and drinking
- ☑ Physical distance between individuals from different households
- ☑ Increased airflow (such as operating outdoors or opening windows and doors)

Ability to Limit

- ✘ Number of people per square foot
- ✘ Time that an individual spends at the business or activity
- ✘ Time that an individual spends in close contact with others
- ✘ People from one household mixing with other households
- ✘ Amount of physical interactions of visitors/ patrons
- ✘ Activities known to increase the spread of COVID-19 (singing, shouting, and heavy breathing)

Schools in **purple-tiered** counties cannot reopen for in-person instruction. However, schools that have already reopened may remain open if the county moves back to the purple tier. Local health departments can grant waivers for TK-6 grades, and schools can provide supervision, or instruction, and other services for small groups (16 individuals total per group). Schools may re-open for full in-person instruction once a county has been in the **red tier** for at least 2 weeks.

School Re-opening Framework (PDF)

See full Blueprint for a Safer Economy **guidance**

COVID-19 publications

- Updates

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JAMA Viewpoint: March 3, 2020

VIEWPOINT

Response to COVID-19 in Taiwan
Big Data Analytics, New Technology, and Proactive Testing

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Robert H. Brook, MD, ScD

Taiwan is 81 miles off the coast of mainland China and was expected to have the second highest number of cases of coronavirus disease 2019 (COVID-19) due to its proximity to and number of flights between China.[1] The country has 23 million citizens of which 850 000 reside in and 404 000 work in China.[2,3] In 2019, 2.71 million visitors from the mainland traveled to Taiwan.[4] As such, Taiwan has been on constant alert and ready to act on epidemics arising from China ever since the severe acute respiratory syndrome (SARS) epidemic in 2003. Given the continual spread of COVID-19 around the world, understanding the action items that were implemented quickly in Taiwan and assessing the effectiveness of these actions in preventing a large-scale epidemic may be instructive for other countries.

COVID-19 occurred just before the Lunar New Year during which time millions of Chinese and Taiwanese were expected to travel for the holidays. Taiwan quickly mobilized and instituted specific approaches for case

Recognizing the Crisis

In 2004, the year after the SARS outbreak, the Taiwan government established the National Health Command Center (NHCC). The NHCC is part of a disaster management center that focuses on large-outbreak response and acts as the operational command point for direct communications among central, regional, and local authorities. The NHCC unified a central command system that includes the Central Epidemic Command Center (CECC), the Biological Pathogen Disaster Command Center, the Counter-Bioterrorism Command Center, and the Central Medical Emergency Operations Center.[5]

On December 31, 2019, when the World Health Organization was notified of pneumonia of unknown cause in Wuhan, China, Taiwanese officials began to board planes and assess passengers on direct flights from Wuhan for fever and pneumonia symptoms before passengers could deplane. As early as January 5, 2020, notification was expanded to include any individual who

JAMA Pediatrics, August 11, 2020

Opinion

VIEWPOINT

Operational Considerations on the American Academy of Pediatrics Guidance for K-12 School Reentry

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There is general consensus among experts that K-12 schools should aim to reopen for in-person classes during the 2020-2021 school year.[1,2] Globally, children constitute a low proportion of coronavirus disease 2019 (COVID-19) cases and are far less likely than adults to experience serious illness.[3,4] Yet, prolonged school closure can exacerbate socioeconomic disparities, amplify existing educational inequalities, and aggravate food insecurity, domestic violence, and mental health disorders.[5] The American Academy of Pediatrics (AAP) recently published its guidance on K-12 school reentry.[1] However, as many school districts face budgetary constraints, schools must evaluate their options and identify measures that are particularly important and feasible for their communities.

We suggest that school districts engage key stakeholders to establish a COVID-19 task force, composed of the superintendent, members of the school board,

In terms of protective equipment, schools will need to have a steady supply of hand sanitizer for students and staff each day. In districts where families cannot afford face coverings, schools will need to provide them; they can take the form of disposable surgical masks, reusable cloth masks, or reusable face shields. Disposable masks cost between $0.50 to $1 each and can be used over the course of a day. Cloth masks should be regularly washed between uses. Face shields cost between $5 to $10 and can be used as long as they maintain their shape and remain intact. The decision of which option to adopt and stock will depend on the number of students and the school's budget. Transparent barriers placed on the sides of students' desks can further limit the spread of respiratory droplets. Costs of transparent barriers range from $100 to $200 per desk. As the AAP guidance suggests, teachers who must work closely with students with special needs or with students who are un-

Annals of Internal Medicine

How to Safely Reopen Colleges and Universities During COVID-19: Experiences From Taiwan

Shao-Yi Cheng, MD, MSc, DrPH; C. Jason Wang, MD, PhD; April Chiung-Tao Shen, PhD; and Shan-Chwen Chang, MD, PhD

Reopening colleges and universities during the coronavirus disease 2019 (COVID-19) pandemic poses a special challenge worldwide. Taiwan is one of the few countries where schools are functioning normally. To secure the safety of students and staff, the Ministry of Education in Taiwan established general guidelines for college campuses. The guidelines delineated creation of a task force at each university; school-based risk screening based on travel history, occupation, contacts, and clusters; measures on self-management of health and quarantine; general hygiene measures (including wearing masks indoors); principles on ventilation and sanitization; regulations on school assemblies; a process for reporting suspected cases; and policies on school closing and make-up classes. It also announced that a class should be suspended if 1 student or staff member in it tested positive and that a school should be closed for 14 days if it had 2 or more confirmed cases. As of 18 June 2020, there have been 7 confirmed cases in 6 Taiwanese universities since the start of the pandemic. One university was temporarily closed, adopted virtual classes, and quickly reopened after 14 days of contact tracing and quarantine of possible contacts. Taiwan's experience suggests that, under certain circumstances, safely reopening colleges and universities this fall may be feasible with a combination of strategies that include containment (access control with contact tracing and quarantine) and mitigation (hygiene, sanitation, ventilation, and social distancing) practices.

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Ethics and governance for digital disease surveillance

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The question is not whether to use new data sources but how

PERSPECTIVES IN HOSPITAL MEDICINE

How to Prevent and Manage Hospital-Based Infections During Coronavirus Outbreaks: Five Lessons from Taiwan

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During the severe acute respiratory syndrome (SARS) outbreak in 2003, Taiwan reported 346 confirmed cases and 73 deaths.[1] Of all known infections, 94% were transmitted inside hospitals. Nine major hospitals were fully or partially shut down, and many doctors and nurses quit for fear of becoming infected. The Taipei Municipal Ho-Ping Hospital was most severely affected. Its index patient, a 42-year-old undocumented hospital laundry worker who interacted with staff and patients for 6 days before being hospitalized, became a superspreader, infecting at least 20 other patients and 10 staff members.[2,3] The entire 450-bed hospital was ordered to shut down, and all 930 staff and 240 patients were quarantined within the hospital. The central government appointed the previous Minister of Health as head of the Anti-SARS Taskforce. Ultimately the hospital was evacuated; the outbreak resulted in 26 deaths.[2] Events surrounding the hospital's evacuation offer important lessons for hospitals struggling to cope with the COVID-19 pandemic, which has been caused by spread of a similar coronavirus.

LESSON 1: DIAGNOSIS

Flexibility about case definition is important, as is use of clinical criteria for diagnosis when reliable laboratory tests are not available.

Diagnosing SARS was challenging. Early symptoms such as fever and malaise were nonspecific. Polymerase chain reaction tests, although available, were unreliable especially in early stages of the disease and had a high false-negative rate. As cases of SARS increased rapidly, Taiwan began using fever alone for early detection.[6] Patients and hospital staff received temperature measurements twice daily. Despite the late start to SARS screening, the fever criterion identified many suspected patients, which ensured widespread detection and containment.

For COVID-19, symptoms such as fever, dry cough, and shortness of breath can be used as clinical criteria to triage patients for quarantine in endemic areas when reliable diagnostic tests are not readily available, but all frontline clinical staff should receive daily temperature checks and/or COVID-19 tests, if available, to protect their families and the public.

LESSON 2: COORDINATION

Ineffective coordination between central and local governments can delay response, but this can be remedied.

During the SARS outbreak, the Taipei City Government and the Taiwan central government were controlled by opposing political parties. Responses to SARS were initially impeded by political skirmishes, which hindered implementation of policies

How Community and Unity Can Help Americans Survive

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management, analytics, and AI. The center would not need to have perfected the metrics/systems to get started; it could learn and perfect its algorithms with time, experience, and data. To increase trust, the press could be part of the center so that fact-based information could be communicated directly to the public rapidly and reliably.

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COMMENTARY

Managing medication supply chains: Lessons learned from Taiwan during the COVID-19 pandemic and preparedness planning for the future

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ABSTRACT

Coronavirus disease 2019 (COVID-19) has posed unprecedented challenges for nations worldwide, among which medication shortages can cause a devastatingly negative impact on global health. Using Taiwan as an example, this report describes the sources of potential medication shortages, discusses the preparedness and contingency strategies to address medication shortages, and outlines the evidence-based recommendations on ensuring a stable medication supply and improving the quality and security of medicines.

An Impact-Oriented Approach to Epidemiological Modeling

Stanford MEDICINE

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Table 1 Considerations for Impact-Oriented COVID-19 Modeling

	Considerations	Description
1	Agility	Is the data and model providing timely information?
2	Responsiveness	Does the data and model respond to new evidence?
3	Transparency	Are the data and model's mechanisms and data sources publicly available for fact-checking and validation?
4	Usability	Can the data and model be used easily, effectively, and efficiently?
5	Accessibility	Can the data and model be understood and used by a broad audience, irrespective of scientific, technical, and other capabilities?
6	Universality	Does the data and model draw on inputs that are defined and measured consistently?
7	Adaptability	Can the model be easily modified and adapted?
8	Actionability	Are there clear calls-to-action that reflect current government policies?