Safe Blues

A Method for Estimation and Control in the Fight Against COVID-19

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Visit: safeblues.org

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SMP Pandemic Seminar Group

Regular Time: Mondays 8PM (AEST)
Zoom ID: [866342450]

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Upcoming Meetings

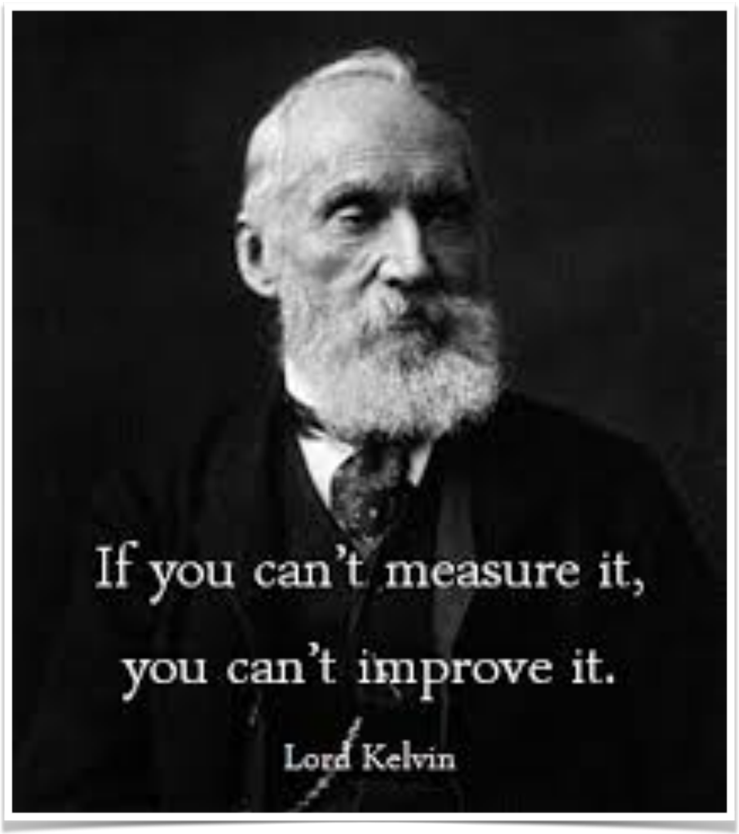
June 8

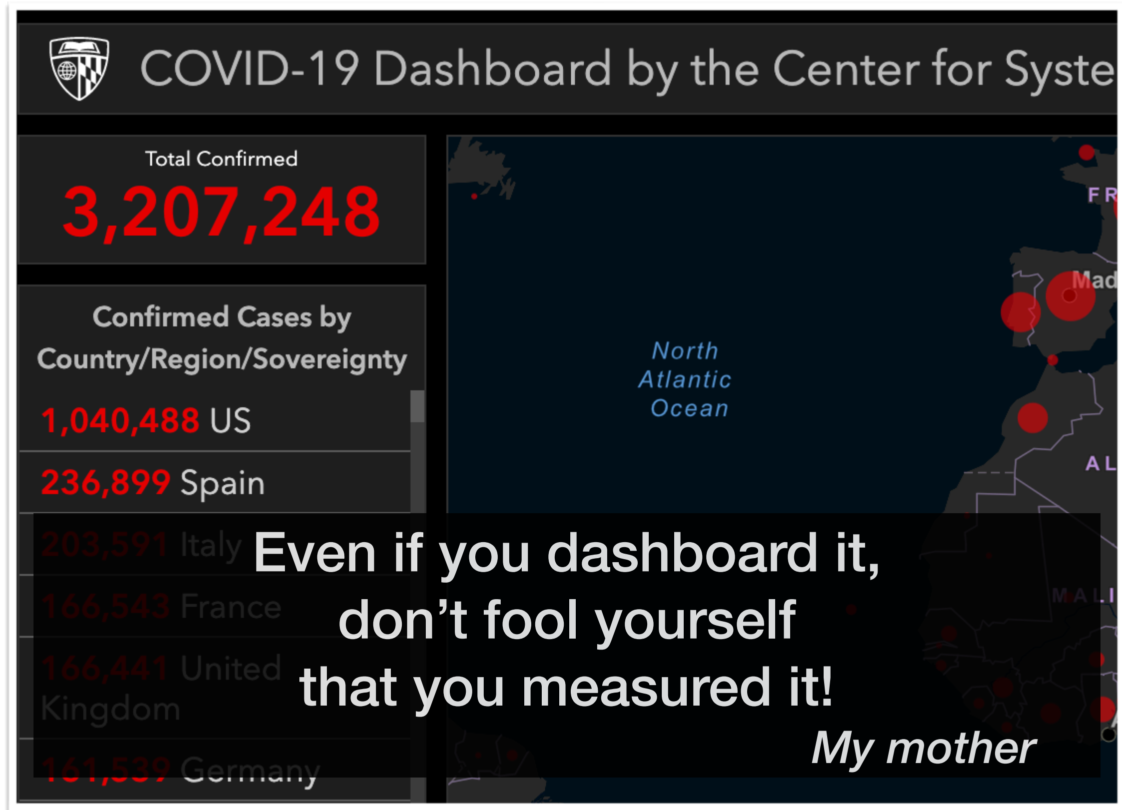
Title: Social media analysis and COVID-19

Presenter: [Lewis Mitchell]

Abstract: The COVID-19 pandemic has produced a number of areas where mathematical modelling and data science might make important contributions to the public health response. Concurrently, it has led to an unique improvement in the number of datasets (some anonymised, some not) being provided by typically-ungenerous tech companies to researchers to potentially assist with this response. This talk will explore how we are utilising a few of these datasets coming from the large social media platforms to attack COVID-related problems, including:

- Measuring social distancing and predicting risk using Facebook data
- Quantifying the 'arc' of patient experience of COVID-19 using Reddit
- Contact tracing: tracking public sentiment towards the COVIDSafe app using Twitter, and modelling app effectiveness





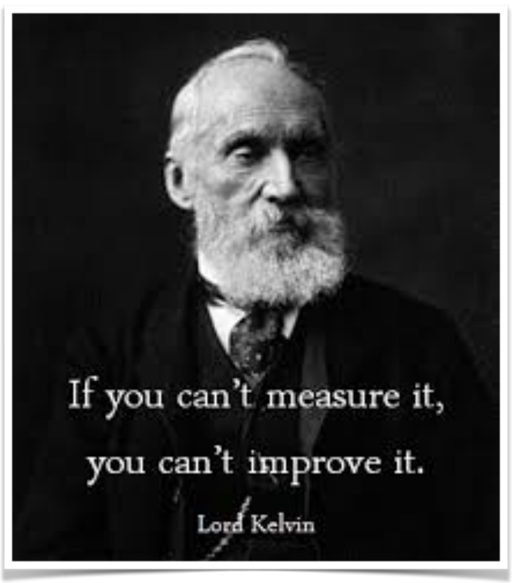
Even if you dashboard it,
don't fool yourself
that you measured it!

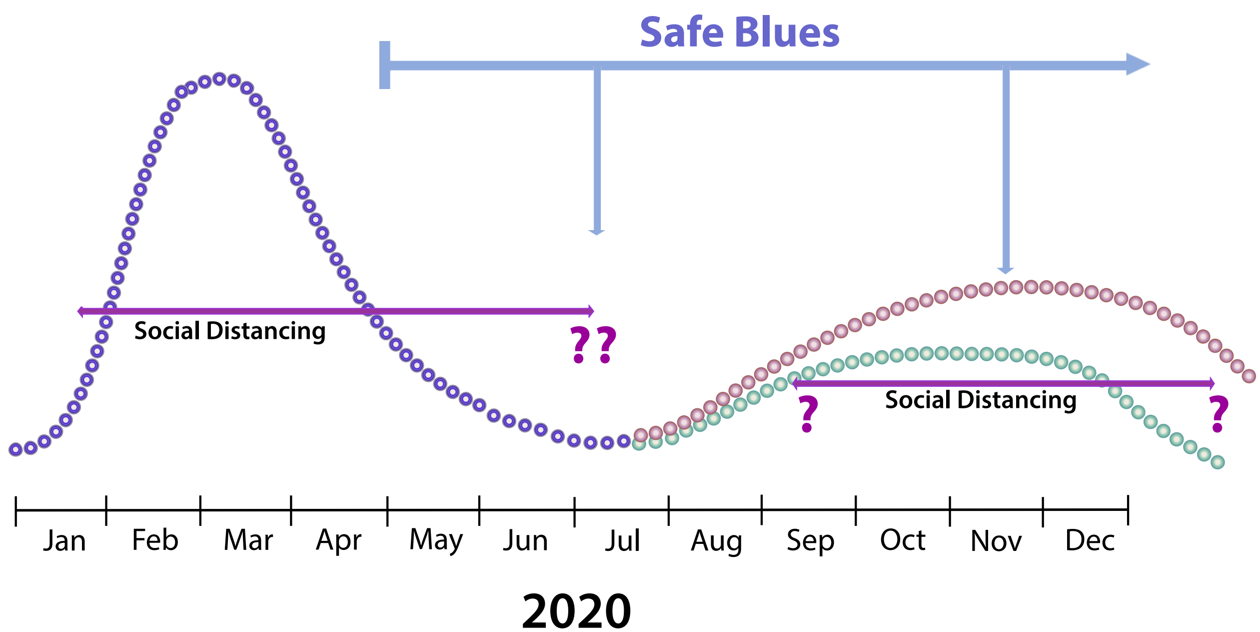
My mother

$$
\begin{tikzcd}
\text{State:} & X(t) \arrow[r, "A"] \arrow[d, "C"] & X(t+1) \arrow[r, "A"] \arrow[d, "C"] & X(t+2) \arrow[r, "A"] \arrow[d, "C"] & \cdots \\
\text{Observation:} & Y(t) \arrow[d, "?"] & Y(t+1) \arrow[d, "?"] & Y(t+2) \arrow[d, "?"] & \\
\text{Estimate:} & \hat{X}(t) \arrow[r] \arrow[d, "?"] & \hat{X}(t+1) \arrow[r] \arrow[d, "?"] & \hat{X}(t+2) \arrow[r] \arrow[d, "?"] & \cdots \\
\text{Control:} & U(t) \arrow[uuur, "B"] & U(t+1) \arrow[uuur, "B"] & U(t+2) \arrow[uuur, "B"] &
\end{tikzcd}
$$

$$X(t+1) = A\,X(t) + B\,U(t) \qquad Y(t) = C\,X(t)$$

Leaders around the world are grappling with decisions around how and when to reopen their economies.

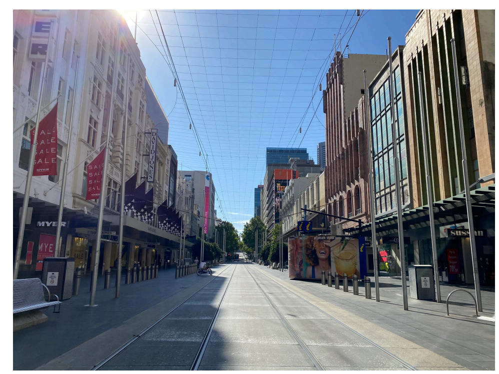




What affects the basic reproduction number?

$$R_0 = f\left(\begin{array}{c}\text{biology}\\ \text{environment}\\ \text{conduct}\\ \text{contact}\end{array}\right)$$

Social distancing level



What if you had two types of viruses?

$$R_0^1 = f^1\begin{pmatrix} \text{biology}^1 \\ \text{environment} \\ \text{conduct} \\ \text{contact} \end{pmatrix} \qquad R_0^2 = f^2\begin{pmatrix} \text{biology}^2 \\ \text{environment} \\ \text{conduct} \\ \text{contact} \end{pmatrix}$$

Social distancing level

Safe Blues is about injecting many virtual safe viruses

$$R_0^C = f^C\begin{pmatrix}\text{biology}^C\\ \text{environment}\\ \text{conduct}\\ \text{contact}\end{pmatrix}$$

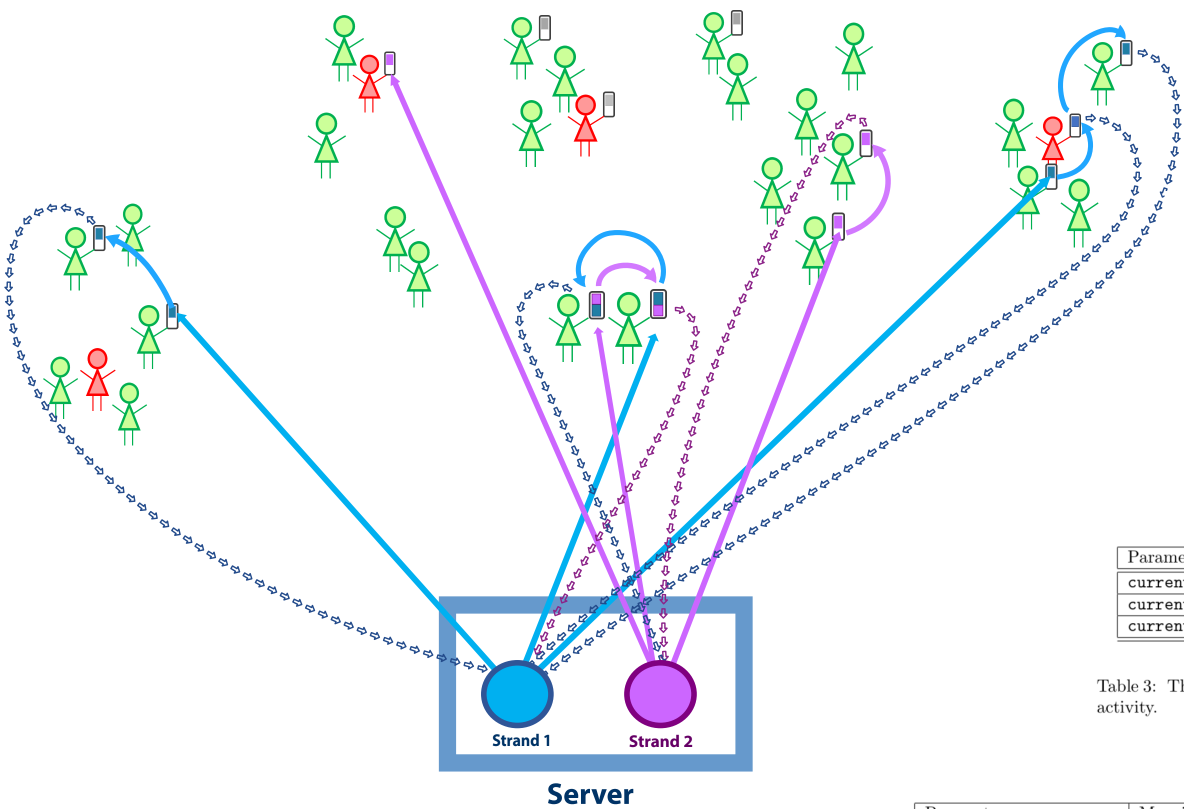
$$R_0^1 = f^1\begin{pmatrix}\text{bluetoothology}^1\\ \text{contact}\end{pmatrix}$$

$$R_0^2 = f^2\begin{pmatrix}\text{bluetoothology}^2\\ \text{contact}\end{pmatrix}$$

$$\vdots$$

$$R_0^N = f^N\begin{pmatrix}\text{bluetoothology}^N\\ \text{contact}\end{pmatrix}$$

Social distancing level



Parameter	Name	Value Type
s	`strandID`	Unique identifier.
t_{start}	`startTime`	Date and time at which the Strand begins.
t_{end}	`endTime`	Date and time at which the Strand ends.
p_0	`seedingProbability`	Seeding probability.
$I(D, \tau)$	`infectionProbabilityMap`	Mapping infection probability as distance (cm) and exposure (min).
F_I	`incubationPeriodDistribution`	The distribution of the incubation period in hours.
F_R	`infectiousPeriodDistribution`	The distribution of the infection period in hours.

Table 2: The parameters that define a single Strand.

Parameter	Meaning
`currentIncubatingStrands`	List of current Strands with state *INCUBATING* on the Host.
`currentInfectedStrands`	List of current Strands with state *INFECTED* on the Host.
`currentRemovedStrands`	List of current Strands with state *REMOVED* on the Host.

Table 3: The daily information pushed to the Database from each Host via the `PUSH-INFECTION-REPORT` activity.

Parameter	Meaning
`strandID`	The unique identifier of the Strand.
`date`	The date.
`totalHosts`	An estimate of the total number of participating Hosts.
`totalHostsSusceptible`	The estimated number of Hosts in state *SUSCEPTIBLE* for `strandID` on `date`.
`totalHostsIncubating`	The number of Hosts in state *INCUBATING* for `strandID` on `date`.
`totalHostsInfected`	The number of Hosts in state *INFECTED* for `strandID` on `date`.
`totalHostsRemoved`	The number of Hosts in state *REMOVED* for `strandID` on `date`.

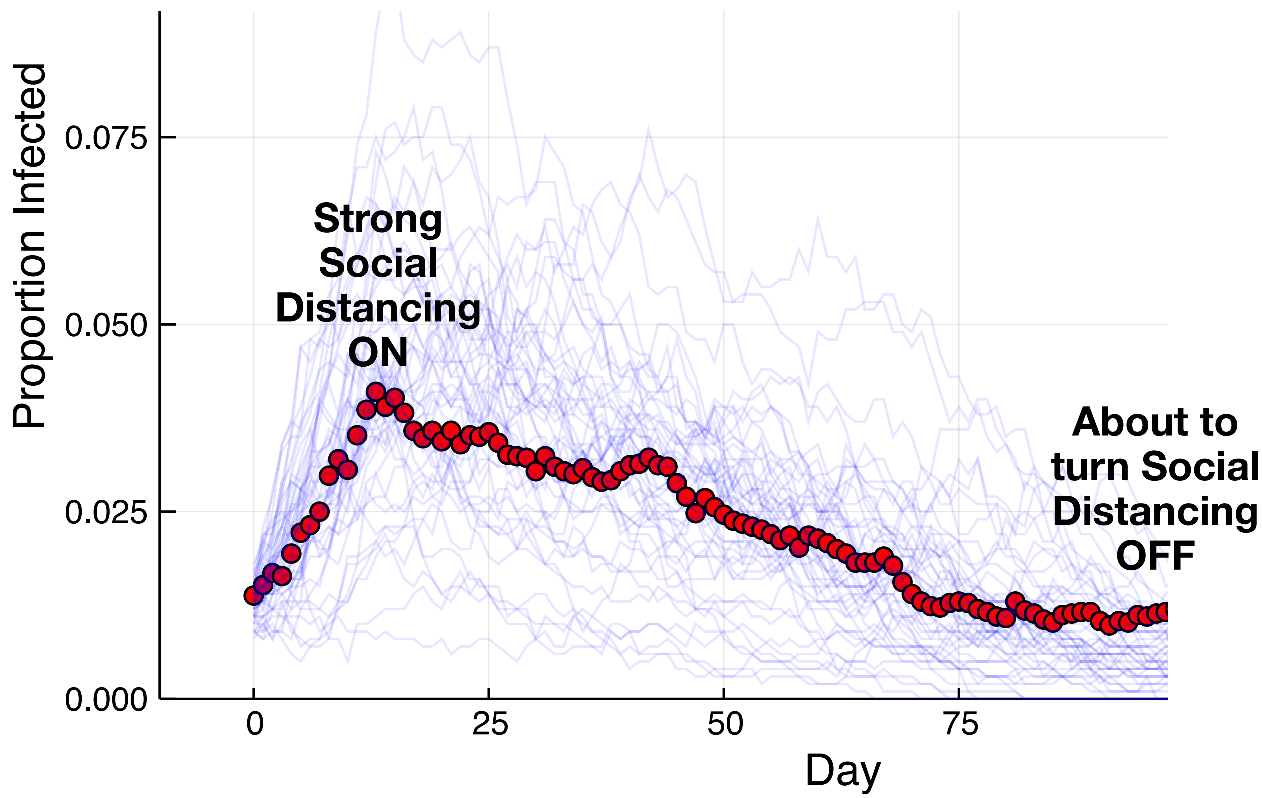
Table 4: Aggregate information publically available via the Database.

Safe Blues is not Contact Tracing

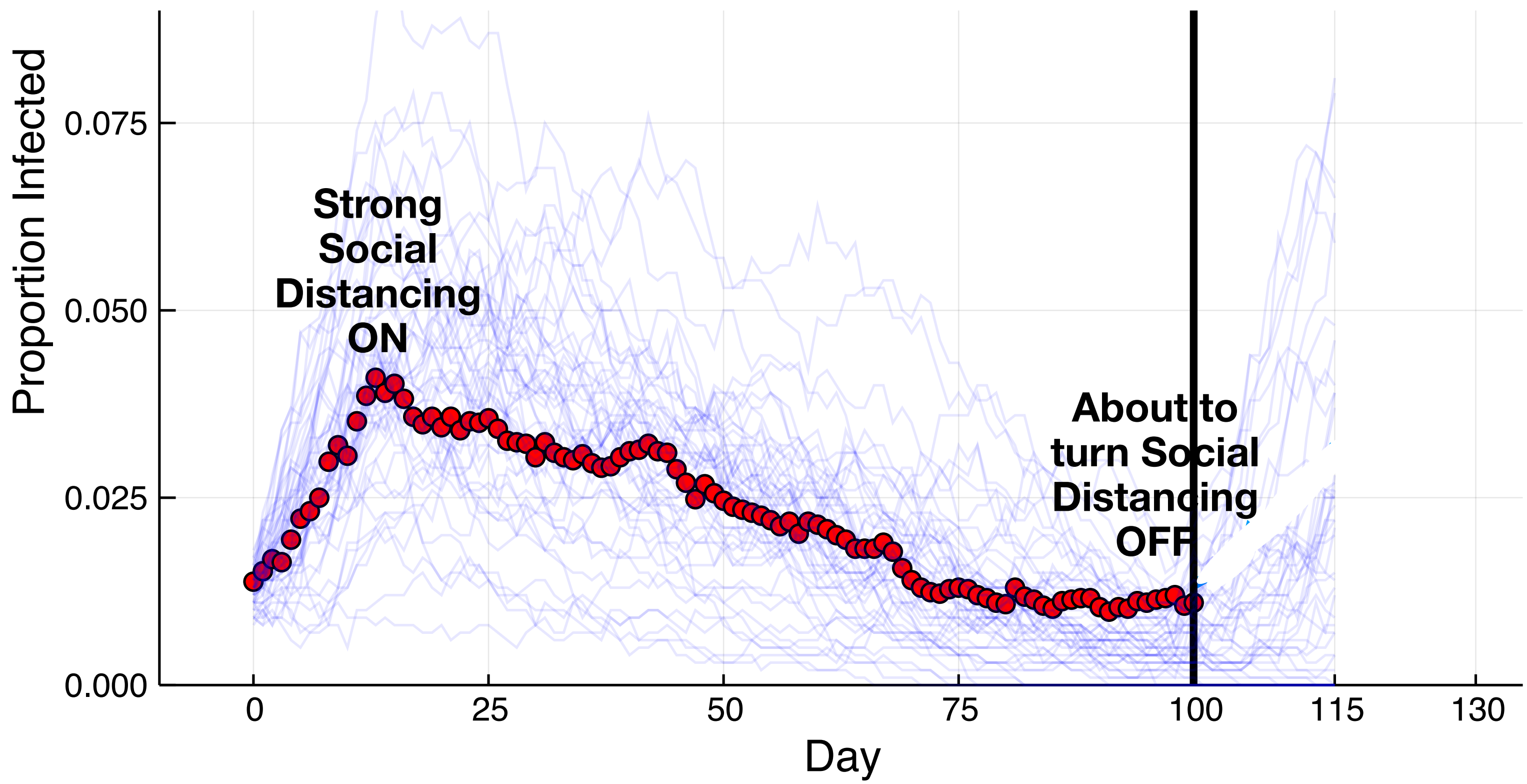
Country	App Name and reference	Source Code	Comments
Australia	CovidSafe [19]	Not released	A clone of TraceTogether [29]
Czech Republic	eRouska [20]	[21]	
Germany	ITO [22]	N/A	Only on Android at this time
India	Aarogyasetu App [23]	N/A	Also uses GPS
Israel	Hamagen [24]	[25]	Also uses GPS
North Macedonia	StopKorona! [26]	N/A	
Poland	ProteGO! [27]	[28]	Not available at this time
Singapore	TraceTogether [29]	OpenTrace [30]	BlueTrace specification at [1]

Table 1: Current contact-tracing apps that use Bluetooth.

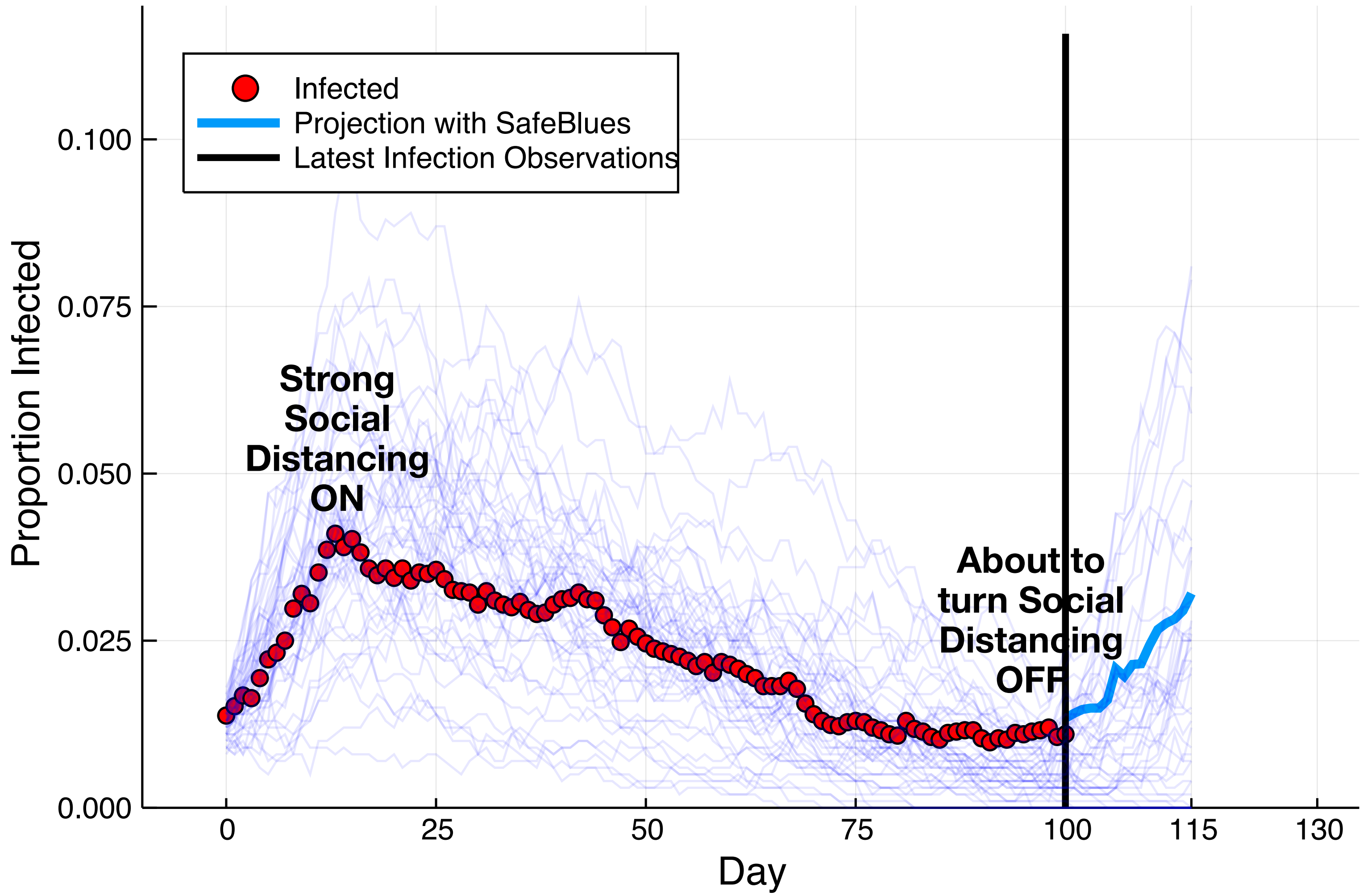
… but can be added to such apps



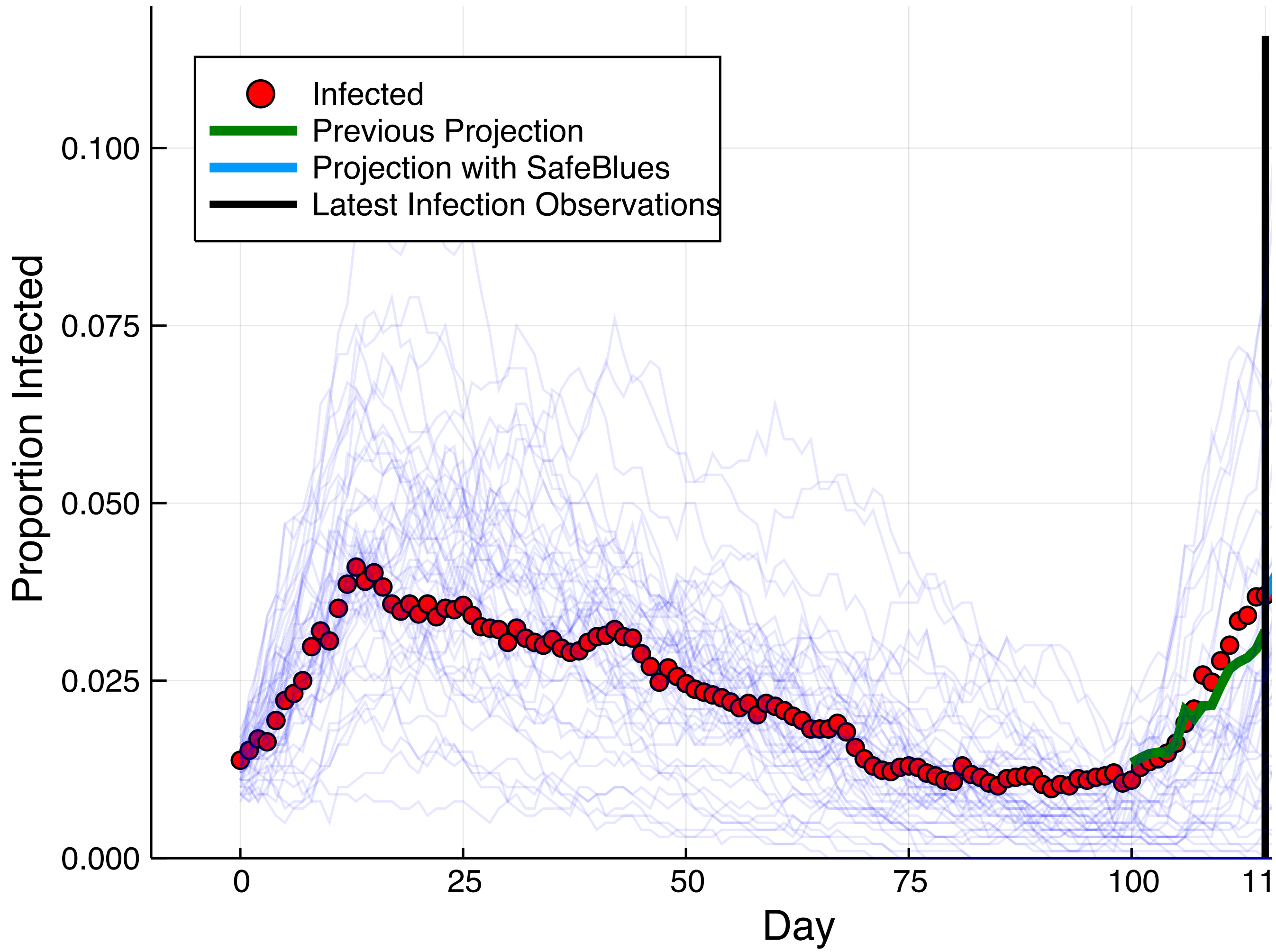
Proportion Infected
0.000
0.025
0.050
0.075
0
25
50
75
Day
Strong Social Distancing ON
About to turn Social Distancing OFF



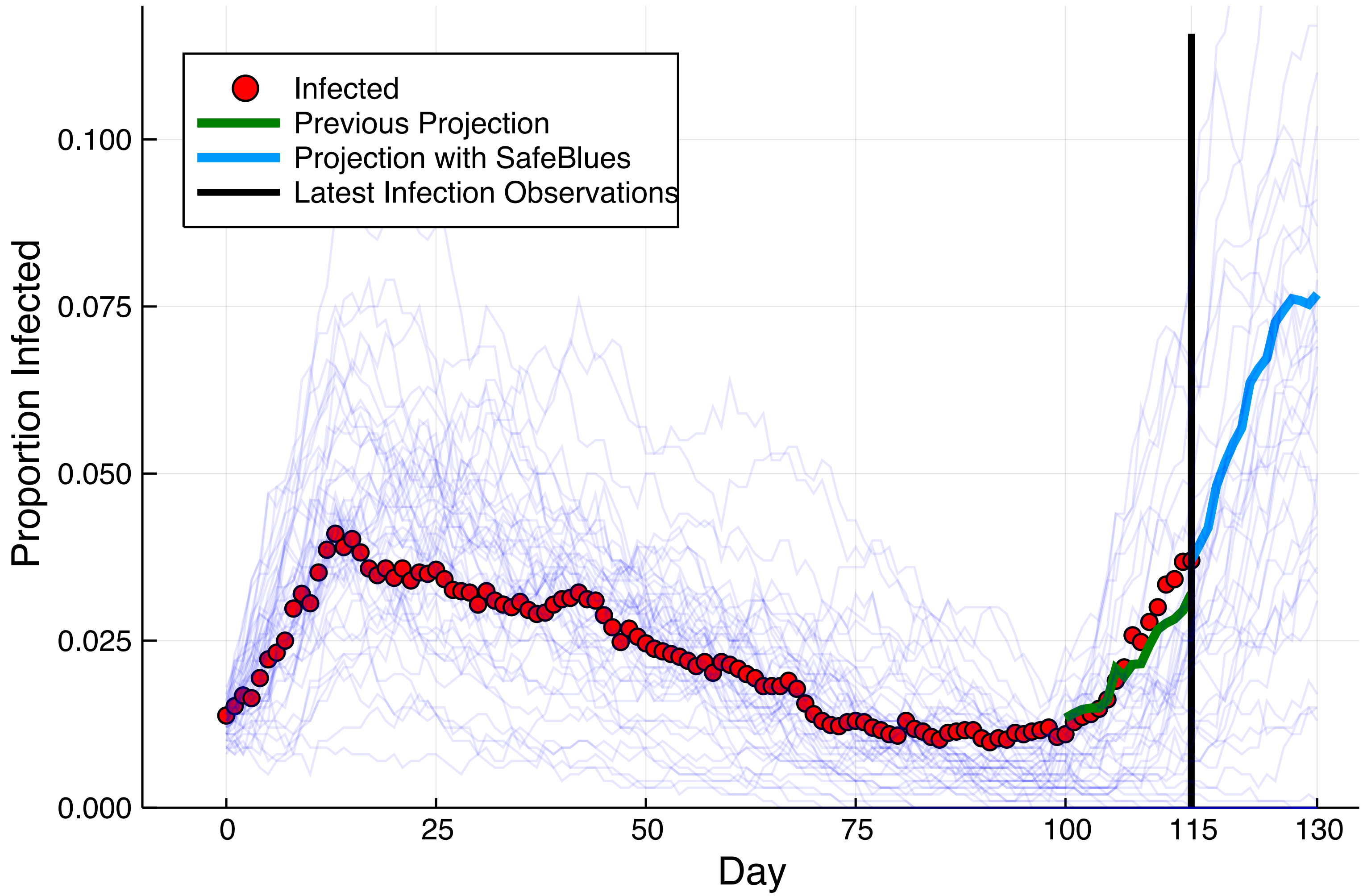
Proportion Infected
0.075
0.050
0.025
0.000
0
25
50
75
100
115
130
Day
Strong
Social
Distancing
ON
About to
turn Social
Distancing
OFF



Infected
Projection with SafeBlues
Latest Infection Observations
Strong Social Distancing ON
About to turn Social Distancing OFF
Proportion Infected
0.100
0.075
0.050
0.025
0.000
0
25
50
75
100
115
130
Day



Infected
Previous Projection
Projection with SafeBlues
Latest Infection Observations
Proportion Infected
0.100
0.075
0.050
0.025
0.000
0
25
50
75
100
11
Day



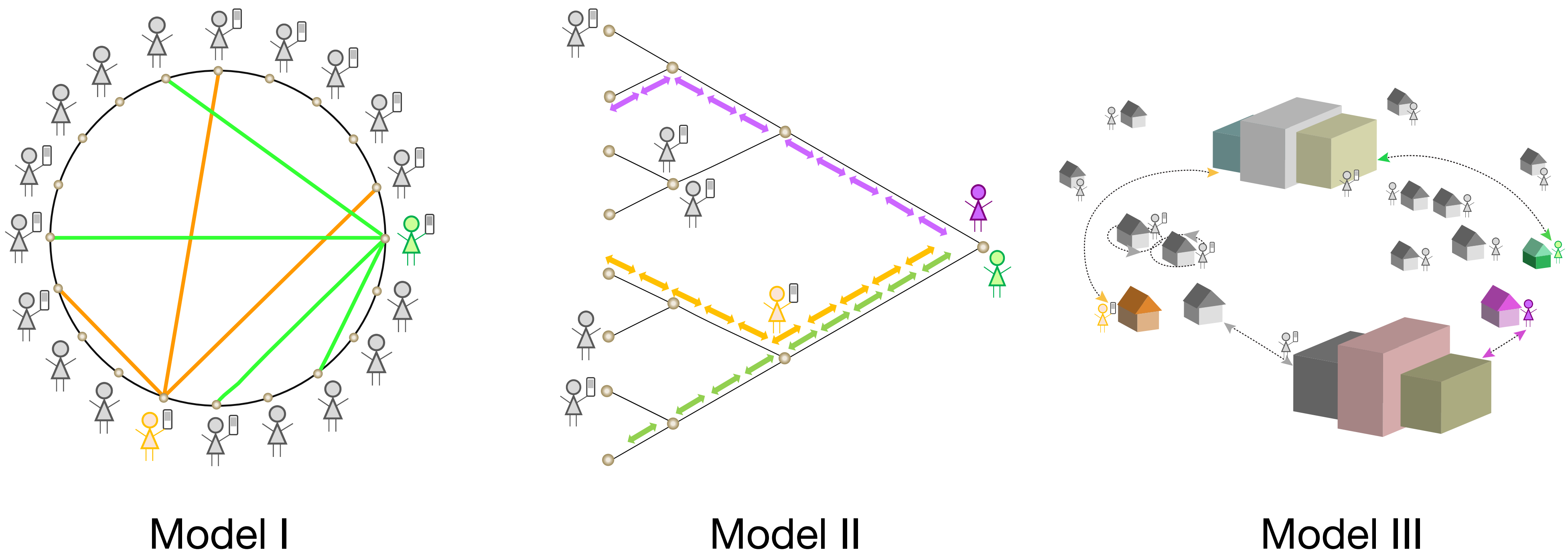
Infected
Previous Projection
Projection with SafeBlues
Latest Infection Observations
Proportion Infected
0.000
0.025
0.050
0.075
0.100
0
25
50
75
100
115
130
Day

Estimation and Control with Safe Blues

Some Goals:

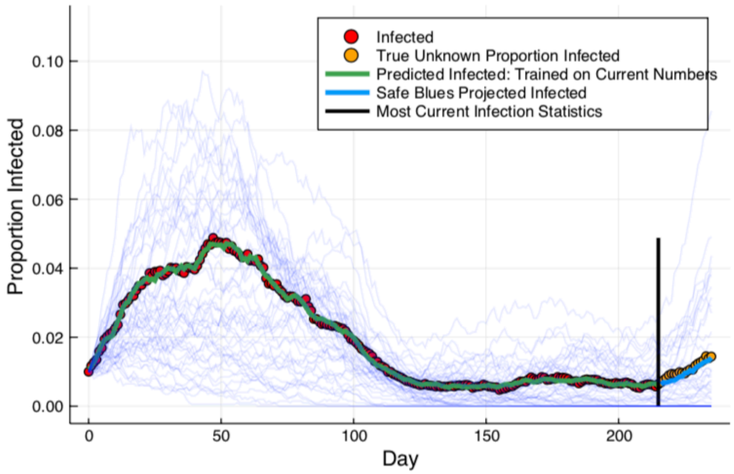
1. Early warning of a rise towards a “second wave”.
2. Understanding the effect of various social distancing regimes on $R_{\text{eff}}(t)$.
3. Designing optimal control policies for fine tuning social distancing measures towards the end game of COVID-19.
4. Projecting the course of the epidemic in the medium and long run.
5. Estimating the proportion of asymptomatic carriers of COVID-19.
6. Computing uncertainty bounds for projections.
7. Optimally choosing parameters and timing for newly created Safe Blues Strands.

Models for basic evaluation of the Safe Blues idea

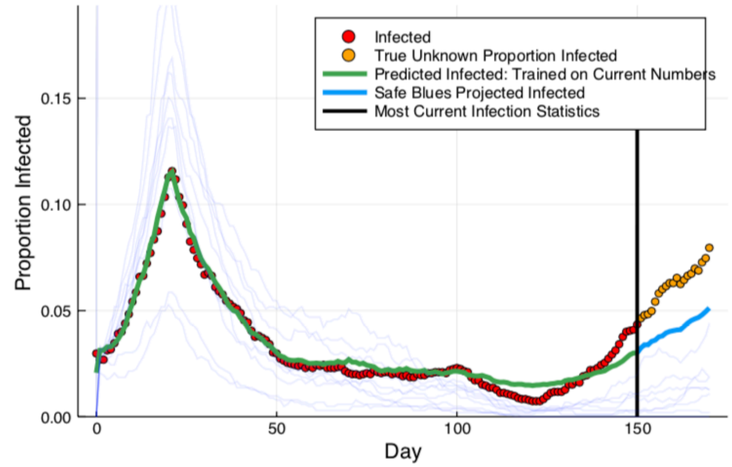


Important: Safe Blues is NOT about model fitting

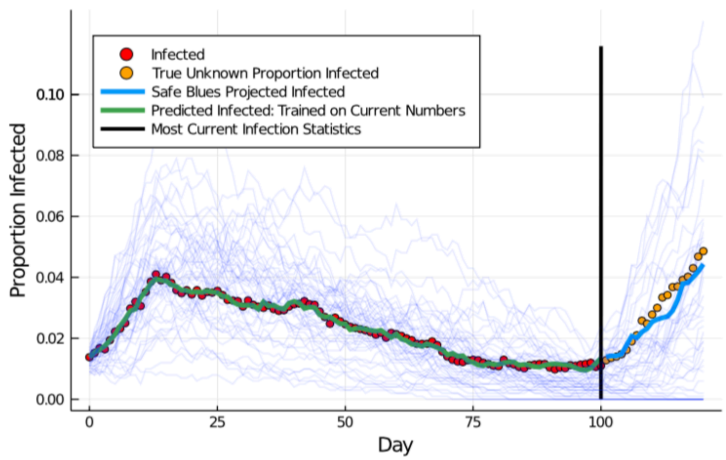
Early warning towards a second wave



(a) Model I.

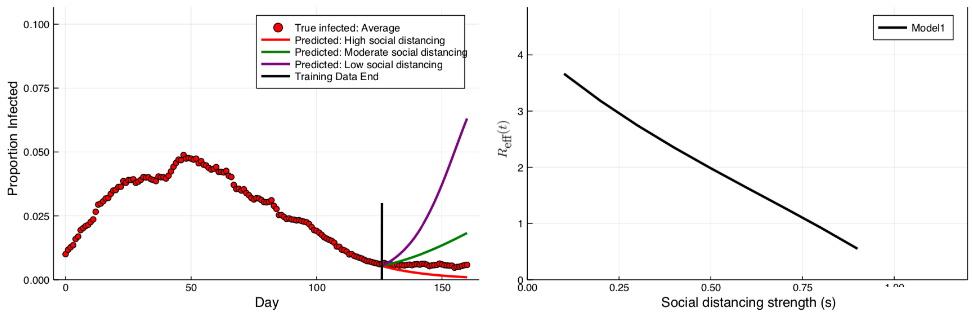


(b) Model II.

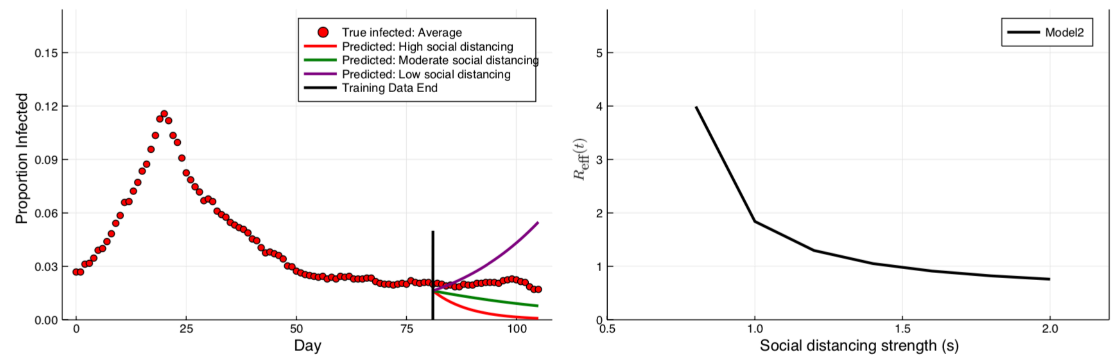


(c) Model III.

Understanding the effect of various social distancing regimes

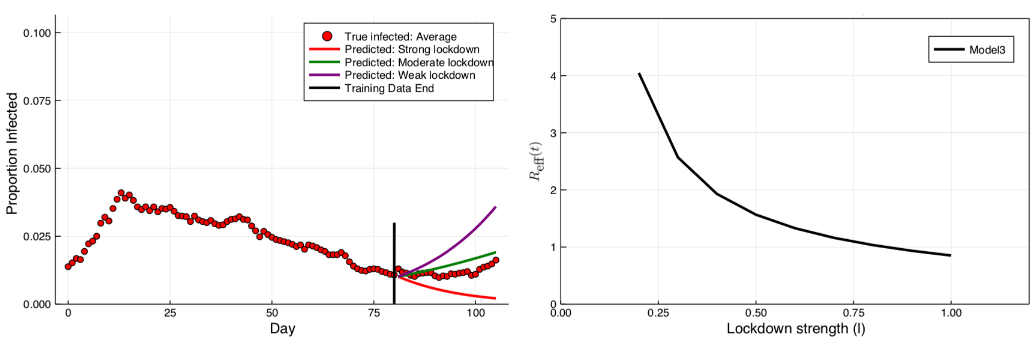


(a) Model I.



(b) Model II.

$$
\begin{aligned}
S' &= -C\beta(p)\delta S I, & \tilde{S}' &= -C\beta(p)\tilde{S}\tilde{I},\\
I' &= C\beta(p)\delta S I - \gamma(p)\delta_\gamma I, & \tilde{I}' &= C\beta(p)\tilde{S}\tilde{I} - \gamma(p)\tilde{I},\\
R' &= \gamma(p)\delta_\gamma I, & \tilde{R}' &= \gamma(p)\tilde{I}.
\end{aligned}
$$



(c) Model III.

From an urgent Response Project to a Research Project…

Working towards an Android App based on “Trace Together”…

BlueTrace
Protocol

Privacy-Preserving
Cross-Border
Contact Tracing

Read Policy Brief | Read White Paper

Where to?

Discussion….