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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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
\[ X(t + 1) = AX(t) + BU(t) \quad Y(t) = CX(t) \]
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?

$$R_0^1 = f^1 \left( \begin{array}{c} \text{biology}^1 \\ \text{environment} \\ \text{conduct} \\ \text{contact} \end{array} \right)$$

$$R_0^2 = f^2 \left( \begin{array}{c} \text{biology}^2 \\ \text{environment} \\ \text{conduct} \\ \text{contact} \end{array} \right)$$
Safe Blues is about injecting many virtual safe viruses.

\[
R_0^C = f^C \left( \begin{array}{c}
\text{biology}^C \\
\text{environment} \\
\text{conduct} \\
\text{contact}
\end{array} \right)
\]

\[
R_0^1 = f^1 \left( \begin{array}{c}
\text{bluetoothology}^1 \\
\text{contact}
\end{array} \right)
\]

\[
R_0^2 = f^2 \left( \begin{array}{c}
\text{bluetoothology}^2 \\
\text{contact}
\end{array} \right)
\]

\[
R_0^N = f^N \left( \begin{array}{c}
\text{bluetoothology}^N \\
\text{contact}
\end{array} \right)
\]
Table 2: The parameters that define a single Strand.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Name</th>
<th>Value Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s$</td>
<td>strandID</td>
<td>Unique identifier.</td>
</tr>
<tr>
<td>$t_{\text{start}}$</td>
<td>startTime</td>
<td>Date and time at which the Strand begins.</td>
</tr>
<tr>
<td>$t_{\text{end}}$</td>
<td>endTime</td>
<td>Date and time at which the Strand ends.</td>
</tr>
<tr>
<td>$p_0$</td>
<td>seedingProbability</td>
<td>Seeding probability.</td>
</tr>
<tr>
<td>$I(D,r)$</td>
<td>infectionProbabilityMap</td>
<td>Mapping infection probability as distance (cm) and exposure (min).</td>
</tr>
<tr>
<td>$E_l$</td>
<td>incubationPeriodDistribution</td>
<td>The distribution of the incubation period in hours.</td>
</tr>
<tr>
<td>$E_R$</td>
<td>infectiousPeriodDistribution</td>
<td>The distribution of the infection period in hours.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>currentIncubatingStrands</td>
<td>List of current Strands with state INCUBATING on the Host.</td>
</tr>
<tr>
<td>currentInfectedStrands</td>
<td>List of current Strands with state INFECTED on the Host.</td>
</tr>
<tr>
<td>currentRemovedStrands</td>
<td>List of current Strands with state REMOVED on the Host.</td>
</tr>
</tbody>
</table>

Table 4: Aggregate information publically available via the Database.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>strandID</td>
<td>The unique identifier of the Strand.</td>
</tr>
<tr>
<td>date</td>
<td>The date.</td>
</tr>
<tr>
<td>totalHosts</td>
<td>An estimate of the total number of participating Hosts.</td>
</tr>
<tr>
<td>totalHostsSusceptible</td>
<td>The estimated number of Hosts in state SUSCEPTIBLE for strandID on date.</td>
</tr>
<tr>
<td>totalHostsIncubating</td>
<td>The number of Hosts in state INCUBATING for strandID on date.</td>
</tr>
<tr>
<td>totalHostsInfected</td>
<td>The number of Hosts in state INFECTED for strandID on date.</td>
</tr>
<tr>
<td>totalHostsRemoved</td>
<td>The number of Hosts in state REMOVED for strandID on date.</td>
</tr>
</tbody>
</table>
Safe Blues is not Contact Tracing

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

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

... but can be added to such apps
Proportion Infected

Infected Projection with SafeBlues

Latest Infection Observations

Strong Social Distancing

ON

About to turn Social Distancing

OFF

Day
Proportion Infected

Day

Strong Social Distancing ON

About to turn Social Distancing OFF
The graph shows the proportion of infected individuals over time, with two different scenarios:

- **Strong Social Distancing ON**: The red dots represent the projected number of infected individuals, indicating a significant reduction in infection rates due to enhanced social distancing measures.
- **Strong Social Distancing OFF**: The blue line represents the latest infection observations, showing a higher and more fluctuating number of infected individuals compared to the projected scenario.

The graph includes a vertical line at day 100, indicating a point where the social distancing measures are about to turn off.
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.
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

\[ S' = -C\beta(p)\delta SI, \]
\[ I' = C\beta(p)\delta SI - \gamma(p)\delta I, \]
\[ R' = \gamma(p)\delta I, \]
\[ \hat{S}' = -C\beta(p)\hat{S}\hat{I}, \]
\[ \hat{I}' = C\beta(p)\hat{S}\hat{I} - \gamma(p)\hat{I}, \]
\[ \hat{R}' = \gamma(p)\hat{I}. \]
From an urgent Response Project to a Research Project…

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

Discussion....