**COVID-19 Research: Leo, Gareth, Andrea, Francois, George**

**Authors: Flexman et al., (2020)**

**Title: “Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe”**

**Main Themes:**

* Major Imperial study, this is where everything is based.
* The study evaluates the effects of NPI across 11 European countries. We evaluate the effect for US states + European countries + globally by type of country.
* The aim is to find if NPI are successful at reducing Rt below 1.
* The dates are from Feb 2020 – 4 May 2020. We use more days.
* The authors list the challenges that the epistemological community faces to accurately measure the reproduction number (Rt). These include different testing policies across countries; countries tend to change the test policies from period to period; not all infections are captured by the health system.
* They introduce a mechanistic Bayesian model that links the observed infections with deaths, inferring the total population infected (attack rates) as well as Rt. Our model if very straightforward and intuitive, minimum computational cost and flexible to adjust to errors.
* Infer Rt from death data.
* For each country model the number of infections, the number of death and Rt.
* The authors argue that death counts are more reliable than other alternatives, like case data.
* As fixed priors (based on past research) they use the onset-to-death distribution π, infection fatality rate (IFR), generation distribution g. Here, we can argue that our model does not have to rely on other data. Therefore, we protect it from past research bias/miscalculations.
* Overall, the model uses 8 priors and 3 functions for deaths D, infections c, and reproduction number R.
* Similar NPI have the same effect across countries. We do not presume that. We let data speak for themselves.
* They argue that their model allows for generating early warnings. By leveraging what happened in countries with earlier epidemics to inform countries with more recent epidemics. We too prove that GP models can act as an early warning system.

**Diagram

Description automatically generatedPlots & Info:** Projections of daily infections, daily deaths and Rt. Table with total population infected. Quantifying effectiveness of interventions. We haven’t done that bit, I think.

**Test: GP model, MSE for 3, 7 and 14 days via CV (May 4 max date)**

**Model:**

**Authors: Unwin et al., (2020)**

**Title: “State-level tracking of COVID-19 in the US”**

**Sources:** Flaxman (2020), Abouk (2020), Friedman (2020), Wang (2020)**,**

**Main Themes:**

* Extend the Flaxman (2020) model by changing lockdown NPI data with mobility data (Abouk, 2020), applying the model to US and comparing the results with similar SIR models (Friedman, 2020).
* Data, Feb 2020 – 1 June 2020.
* They average all the mobility data (except residential) because of collinearity.
* The model is fitted in **ALL** US states.
* Model is approximately as described in Flaxman 2020 with some differences as visualised below.
* The model infers, daily deaths, reproduction number Rt and daily cases.
* **Mobility alone is not enough to capture the evolution of transmission (p. 5). Check argument in page 7. “Our model uses mobility…”. What about the argument that mobility is more accurate than timing NPI because as we can see in the second wave mobility accurately depicts the psychological capacity of the people to adhere by the rules, while using timing NPI we assume that people synchronise in following the gov advice, which is not the case (check for example Greece mobility on first and second wave/NPI).**
* **Magnitude of the reductions in average mobility are important in determining the size of reduction Rt**
* They significantly increased the number of priors from 8 in Flaxman to 13, also they have increased the complexity of the model
* Apart from the infection fatality rate (ifr) to compute the daily deaths the model also uses the infection ascertainment ratio (iarm) for each state, which is defined as the number of reported cases divided by the true number of infections (including both symtomatic and asymptomatic infections).
* They argue that the Bayesian approach they follow is a is a significant advancement over curve-fitting models fit directly to reported cases.
* Important! For the infection fatality rate (IFR) they agree with our findings that there is no POLYMOD or any other social mixing studies for US.

**Diagram, map

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**Authors: Brauner et al., (2020)**

**Title: “The effectiveness of eight nonpharmaceutical interventions against COVID-19 in 41 countries”**

**Sources:** Flaxman (2020), Dehning (2020), Hsiangg (2020), Lai (2020), Liu (2020)

**Main Themes:**

* Extended Flaxman (2020) and other publications (Tables F.7 and F.8) in measuring the impact of each individual NPI in reducing the spread of COVID-19.
* 41 countries, with 34 European and 7 non-European.
* 22 January- 30 May 2020
* The underlying model is an extension to Flaxman’s (2020) by modelling both observed daily deaths and cases. It looks like it is similar to a newer version of Flaxman (Unwin, 2020) but they keep the NPI instead of mobility data.
* They have a very comprehensive review of COVID-19 NPI publications. Tables F.7 and F.8 at pp.57-59

**Diagram

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**Authors: Qian et al., (2020)**

**Title: “When and How to Lift the Lockdown? Global COVID-19 Scenario Analysis and Policy Assessment using Compartmental Gaussian Processes”**

**Sources:** Flaxman (2020) p.3

**Main Themes:**

* The authors are expanding Flaxman (2020) by incorporating socio-economic features alongside the NPI for each country.
* Data are from January 2020 – 8 May 2020
* Is the only paper that uses GP model.
* Is the only paper that incorporates socio-economic and demographic information for each country (36) alongside with NPI (9).
* 170 countries in total.
* The Bayesian nature of our model enables combining the rigorous mechanistic foundation of compartmental models with the data-driven (non-parameteric) nature of GPs. That is, at the early stages of the pandemic, the early fatality forecasts would be dominated by the prior mean function D(t) derived from the SEIR prior — as more data on COVID-19 fatalities are collected over time, the GP posterior will refine the SEIR forecasts based on observed patterns in the data. Because of its hybrid nature, we call our model a compartmental Gaussian process (CGP). p.5
* The authors evaluate the accuracy of the 7-day and 14-day projections issued at three stages of the pandemic: before the peak of infections (March 28), in the midst of the peak (April 11), and in the “plateauing” stage (April 25). p.7
* Diagram

  Description automatically generatedThe imperial model can be viewed as a special case of as it assumes policy effects to be fixed across all countries in its upper layer with no machine learning components to model heterogeneity, and its lower layer uses a serial interval distribution to predict short-term deaths only.
* Can then the model we use can be also considered as a special case of Flexman? Since the upper layer here is similar to the