Comparing forecast performance on different synthetic pandemics

Sous-titre du Rapport

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Introduction

1 The data

2 Models

[?]

2.1 SIRH model

The SIRH model is a compartemental model used in epidemiology to model the spread a pandemic. This model splits the population in different compartments which represent the health conditions of the individuals. The evolution of the pandemic is modelled by a system of differential equations.

Let S_t, I_t, R_t and H_t be the number of susceptible, infected, recovered and hospitalized individuals at time t.

The SIRH model is defined by this system of differential equations :

$$\begin{cases} \frac{dS}{dt} &= -\beta \frac{SI}{N} \\ \frac{dI}{dt} &= \beta \frac{SI}{N} - (\gamma_i + h)I \\ \frac{dR}{dt} &= \gamma_i I + \gamma_h H \\ \frac{dH}{dt} &= hI - \gamma_h H \end{cases} \tag{2.1}$$

where β is the transmission rate, γ_i is the recovery rate, γ_h is the hospitalization rate and h is the hospitalization rate. This model is useful for policymakers because of its explanatory power and its simplicity. Moreover, the parameters of the model have a physical interpretation.

2.1.1 Computing confidence intervals with delta-method

For many models, we did not have an explici way to compute the confidence interval of the prediction. We used the delta-method, which enables to output a confidence interval based on the error of estimation of the model associated with the estimation of the noise of the data.

We suppose that the number of hospitalized at day i follows the mode h_{θ^*} : $Y_i = h_{\theta^*}(i) + \epsilon_i$ where $\epsilon_i \sim \mathcal{N}(0, \sigma^2)$

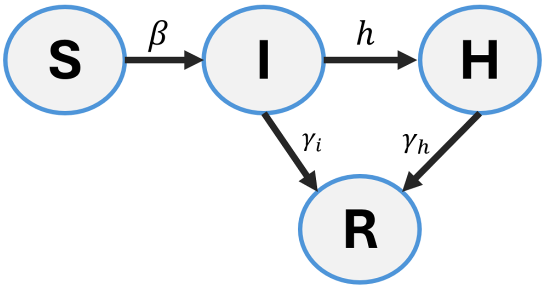

FIGURE 2.1 – Scheme of the compartments of the SIRH model

Let $h_\theta(i)$ be the prediction of the model h, with parameters θ at time i, we have : $\hat{\theta} = argmin_\theta \sum_{i=1}^{n}(Y_i - h_\theta(i))^2$ be the least-squares estimator of θ^*

if we note : $Y = \begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{pmatrix}$

and $h_\theta = \begin{pmatrix} h_\theta(1) \\ h_\theta(2) \\ \vdots \\ h_\theta(n) \end{pmatrix}$

,

we have :
$\hat{\theta} = argmin_\theta ||Y - h_\theta||^2$

We linearize around θ^* : $h_\theta(i) \simeq h_{\theta^*}(i) + (\theta - \theta^*)^T \nabla_\theta h_{\theta^*}(i)$

We have :
$\hat{\theta} = argmin_\theta ||Y - h_{\theta^*} + (\theta - \theta^*)^T \nabla_\theta h_{\theta^*}||^2$

2.1.2 Titre de la Sous-section 1

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3 Titre du Chapitre 2

3.1 Titre de la Section 2

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Figure 3.1 – Description de l'image

Conclusion

Conclusion de votre rapport...

Bibliographie

A Titre de l'Annexe

Contenu de l'annexe...