Mathematical models in outbreak response

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Background

Outbreaks: Influenza, 2009 MERS-Cov (Middle-East Respiratory Syndrome) Ebola, West Africa, DRC Zika Virus, Brazil

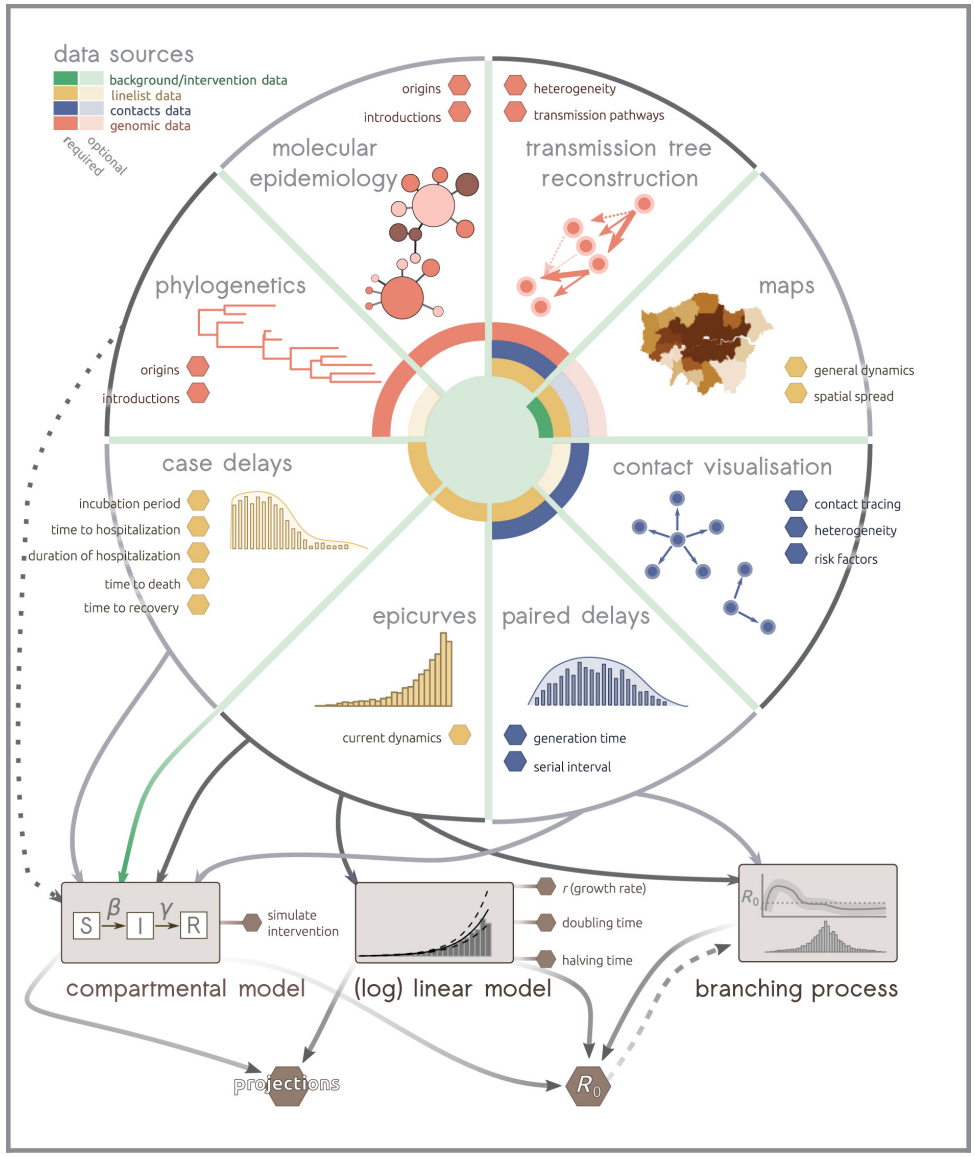
Objective/Goal

during outbreak: exploit all data inform response team in real time
in general (also non outbreak situation) allow evidence based decisions
compare/assess interventions policy evaluation (before/after in), vaccine programmes
track of WHO targets (HIV, HCV)

Types of models

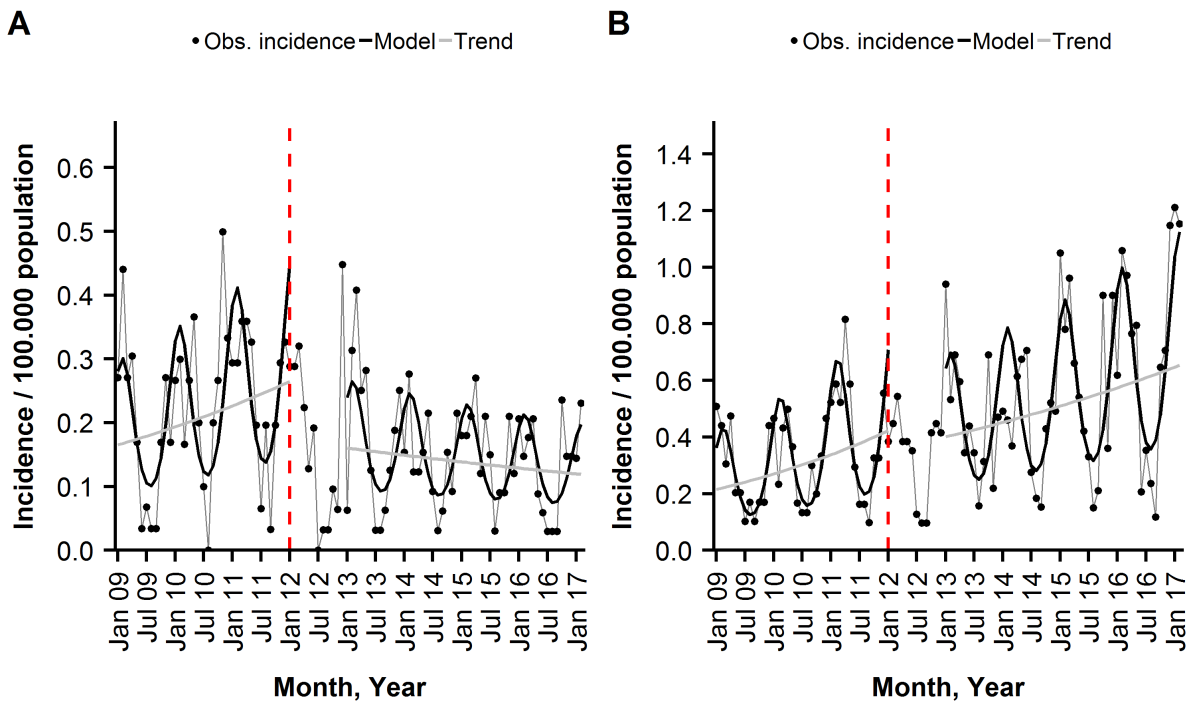
dynamic, mathematical (SIR) statistical (e.g. Poisson regression) Bayesian statistics spacial stats/models
-> visualise outcome

Example of outbreak analytics workflow.



IPD

Figure: Monthly incidence of (A) PCV10 ST-IPD and (B) non-PCV10 ex ST 6A-/19A-IPD, among the ≥50 years old, observed and modelled by a segmented negative binominal regression, Austria, January 2009-February 2017, shown are overall and seasonal trends.



Richter et al. 2019

IPD2

Model

$$\begin{aligned}\log(Y_t) &= \log(pop_t) + \beta_0 + \beta_1\, t + \beta_2\, \sin\left(\frac{2\pi t}{12}\right) \\ &\quad + \beta_3\, \cos\left(\frac{2\pi t}{12}\right) + \beta_5\, (t - t_0)^+ \\ &\quad + \mathbb{1}_{t-t_0>0}\left[\beta_4 + \beta_6\, \sin\left(\frac{2\pi t}{12}\right) + \beta_7\, \cos\left(\frac{2\pi t}{12}\right)\right]\end{aligned}$$

with

$$(x)^+ = \begin{cases} x, & \text{if } x > 0, \\ 0, & \text{otherwise.} \end{cases}$$

HIV/HCV

a

GO ??

a

Conclusion

Here comes the conclusion

Thank you!
Any questions?

References

[1] Polonsky Jonathan A. et al. "Outbreak Analytics: A Developing Data Science for Informing the Response to Emerging Pathogens". In: *Philosophical Transactions of the Royal Society B: Biological Sciences* 374.1776 (July 8, 2019), p. 20180276. DOI: 10.1098/rstb.2018.0276. URL: https://royalsocietypublishing.org/doi/10.1098/rstb.2018.0276 (visited on 06/18/2019).

[2] Lukas Richter et al. "Invasive Pneumococcal Diseases in Children and Adults before and after Introduction of the 10-Valent Pneumococcal Conjugate Vaccine into the Austrian National Immunization Program". In: *PloS One* 14.1 (2019), e0210081. ISSN: 1932-6203. DOI: 10.1371/journal.pone.0210081. pmid: 30629620.