Epidemic Momentum

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[A] PAPER for Epidemic Momentum by David J. D. Earn and Todd L. Parsons, i.e. Earn_EM_2025.

1 Abstract

[A] EM for Epidemic Momentum

[R] Em is “prevalence weighted by the capacity to infect in the future”, so high prevalence low infection-capacity would have a low EM and high prevalence, high infection-capacity would have a high EM?

[R] You generally, at this time in life, fear certain integrals.

[Q] What is meant by “contours of a generic first integral”? (pg. 1)

[R] Their contribution is a revision of the classical epidemic final size to incorporate prior immunity and they do this via (1) disentagling $\mathcal{R}_0$ from the population proportion that was immune prior to “disease invasion or re-emergence” and (2) inferring $\mathcal{R}_0$ and the population-with-immunity from observed data. (pg. 1)

2 Introduction

[R] It's nice to see R in SIR as Removed for "recovered and immune, isolated, deceased, or otherwise removed from the transmission process". (pg. 2)

[>] "If time is measured in units of the mean infectious period ($\tau = \gamma t$) then the only parameter is the basic reproduction number ($\mathcal{R}_0$, the expected number of infections that would be caused by a single infective individual in an otherwise fully susceptible population; an epdemic can only occur if $\mathcal{R}_0 > 1$, which we will assume)" (pg. 2)

[R] Recall that the SIR is a special case of the renewal equation.

[T] You should be able to derive the SIR from the renewal equation.

[T] Proceed through the sources and download those you find interesting.

[R] Some notes on the renewal model, from the text "state variables...are the susceptible fraction X and the force of infection F (the instantaneous risk of infection per susciptible individual)", "...allows infectiousness to vary continuously as a function of an individual's age of infection α, the amount of time that has elapsed since they were initially infected (which may include latent and or carrier periods when they were not infectious)", "...prevalence (the proportion of the population that is currently infected, whether infectious or not) is not an explicit variable." (pg. 2)

[T] Go through the paper and find terms to define.

[R] Some more notes on the renewal model: "...different models (e.g. involving multiple infection stages, hospitalization, treatment, relapse, etc.) are specified through the probability distribution $g(\alpha)$ of the intrinsic generation interval (the time difference between the moment when a focal individual was infected and the earlier time when the infector was infected)", "The renewal equation yields the SIR model if the generation interval distribution is exponential", "For any model, the incidence (the rate at which new infections occur), is $\iota = XF$ (for the special case of the SIR model, the force of infection is $F = \mathcal{R}_0 Y$)" (N.B. Y is the infected fraction or prevalence of infection). (pg. 2)

[R] The remarks of the author with respect to the force of infection better being labeled the "infective field" or "infective potential" since F does not depend on how many other susceptible individuals there are seems apt.

[>] "...hence the force must vanish for some intermediate susceptible fraction, say $\hat{x}$. Analogous to electric force, we define the epidemic force to be $(X(\tau) - \hat{x})F(\tau)$, the sign of which is determined by the epidemic charge, $X(\tau) - \hat{x}$" (pg. 2)

[U] So, the epidemic force, in English, at a unit of the mean infectious period,is the infective potential (the instantaneous risk of infection per susceptible individual) weighted by the difference between the susceptible fraction at that point and the susceptible fraction where the infective potential is 0.

[R] $\hat{x}$ is the point at which prevalence is not changing; epidemic force > 1 indicates prevalence is growing and < 1 indicates prevalence is shrinking.

[Q] “Why does $\hat{x}$ not depend on t?”

[T] Apply this paper’s results to the NHSN hospital admissions dataset for COVID-19; use `forecasttools-py`; look at the United States.

[Q] For later…why do we care about any of this?

[R] Practically speaking the estimation of the generation interval is quite difficult.

[R] (from colleague) Time-varying $\mathcal{R}_0$ intractable for now?