

Preface

Since the onset of the COVID-19 pandemic in early 2020, there has been a proliferation of software packages that make inference about the current state of an infectious disease outbreak based on daily counts of disease cases. An important and widely used parameter is the instantaneous or effective reproductive number, $R(t)$, defined in Gostic et al. (2020) as follows:

“The effective reproductive number, denoted as R_e or R_t , is the expected number of new infections caused by an infectious individual in a population where some individuals may no longer be susceptible.”

Defined as such, $R(t)$ is an unobserved quantity that captures the aggregated combination of disease characteristics (e.g., infectiousness under controlled conditions, mode of transport) and extrinsic factors (e.g., lockdowns that reduce person-to-person contact).

$R(t)$ value	Interpretation
< 1	Epidemic is “shrinking” - each infected person infects on average less than one additional person
$= 1$	Epidemic is “stable” - each infected person infects on average one additional person
> 1	Epidemic is “growing” - each infected person infects on average more than one additional person

In this document we provide a theoretical comparison of the current field of methods for estimating $R(t)$, with the goal of informing user decision-making about which package to choose and in interpreting package outputs.

We limit the methods discussed here to those for estimating historical to present-day $R(t)$ values using daily case count data, where a case can be flexibly defined as an individual with a reported positive test (either through healthcare-seeking behavior, routine surveillance, or a hospital admission). Other methods not discussed here include inference of $R(t)$ exclusively from alternative data sources (e.g., genetic data,² behavioral data,³ or viral loads in wastewater⁴), or calculations from compartmental, agent-based models, or network.^{5–7} We also limit the discussion to packages in the statistical software R,⁸ which may exclude some packages in other software programs that combine many of the methodological considerations discussed below.⁹ We do not discuss any packages for now-casting or forecasting, though a number

of $R(t)$ estimation packages can be used for this purpose. The methods discussed below and references to specific R packages are current as of December 1, 2024. We attempt to harmonize the mathematical choices between each package using terminology from each.

Gostic KM, McGough L, Baskerville EB, Abbott S, Joshi K, Tedijanto C, et al. 2020. Practical considerations for measuring the effective reproductive number, R_t . PLOS Computational Biology 16:e1008409; doi:[10.1371/journal.pcbi.1008409](https://doi.org/10.1371/journal.pcbi.1008409).