Estimating Covid-19 Dynamics and Clinical Detection Rate using the SEIR N-Mixture Model

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The Covid-19 pandemic highlighted the challenge of imperfect detection in disease surveillance

- Case reports undercount true infections due to asymptomatic cases and lack of access to testing
- Only the sickest got diagnosed with Covid early in the pandemic
- "We must rely on data from people who are sick enough to get themselves tested, which is a bit like trying to understand exercise trends among average Americans by surveying the participants of a marathon"

Various approaches have been developed to estimate clinical detection rates

- **Back-calculation methods** estimate the number of infections from hospitalizations and deaths
- **Seroprevalence studies** estimate the proportion of the population that has been infected by testing for antibodies
- **SEIR models** estimate the number of infections from observed cases and the distribution of the incubation period

Covid-19's incubation period requires an extension to the SIR compartment model

- **SIR model** assumes that individuals transition directly from susceptible to infectious
- **SEIR model** adds an exposed compartment to account for the incubation period
- **SEIR models** don't directly account for imperfect detection

N-mixture models account for imperfect detection and have been applied to disease

- **N-mixture models** are traditionally used in ecology to estimate the abundance of a species from counts under the imperfect detection assumption
  - American Robin
  - Oregon Slender Salamander
- Initial extensions of the **N-mixture model** allowed for survival and recruitment processes much like you would see in a compartment model