Matrices in Action for Epidemic Models

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The spread of an infectious disease can be modeled by a dynamical system that includes important features of the disease . For disease control, the basic reproduction number R_0 is an important threshold parameter that depends on the model formulation and the parameter values estimated from data. In particular, stability of equilibria depends on the value of R_0. In ordinary differential equation systems, a method for computing R_0 as the spectral radius of the next generation matrix is derived using the theory of nonnegative and M-matrices. This is illustrated for some diseases, including influenza.
For large systems, useful bounds on R_0 are derived from matrix inequalities. Backward bifurcation and bistability are demonstrated in an epidemic model with vaccination, and compound matrices are a key tool in investigating the global behavior.