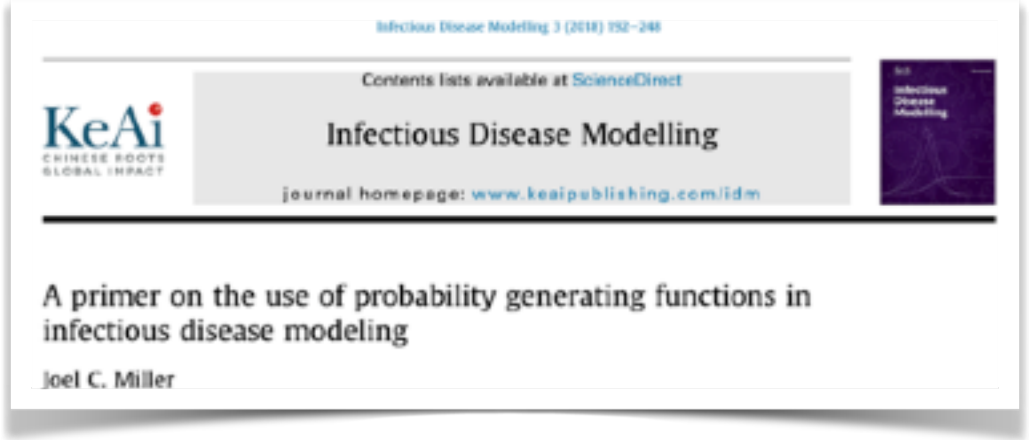
Contact network epidemiology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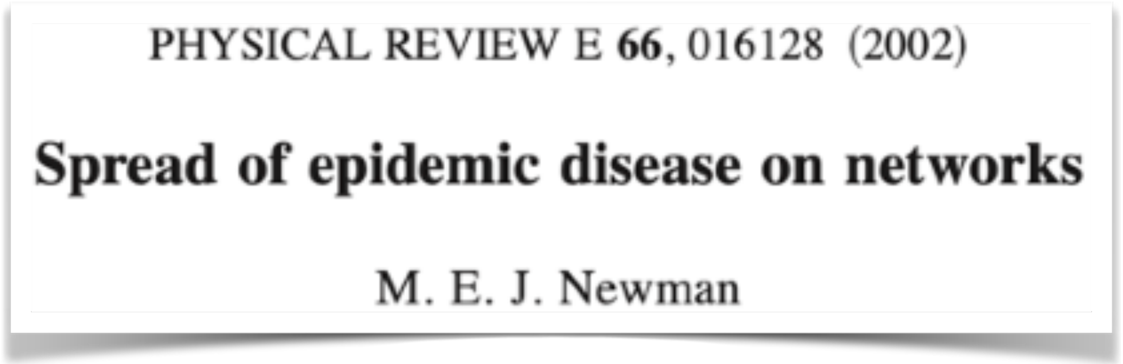
A primer on the use of probability generating functions in infectious disease modeling

Joel C. Miller


PHYSICAL REVIEW E **66**, 016128 (2002)

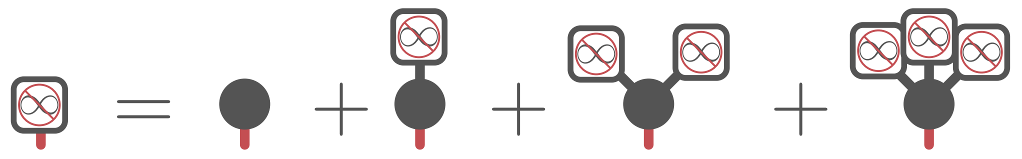
Spread of epidemic disease on networks

M. E. J. Newman

Probability generating functions (PGFs) formalism

– probability u that an outbreak eventually dies out

$$u =$$



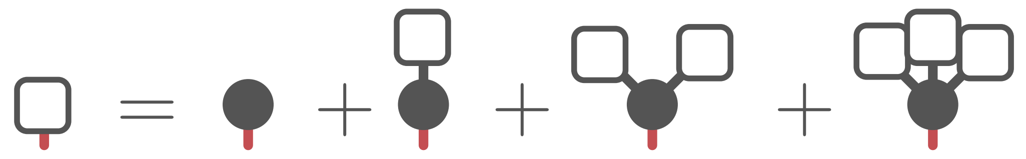
$$+ \ldots = \sum_{k \geq 0}^{\infty} \frac{(k+1)p_{k+1}}{\langle k \rangle} u^k = G_1(u)$$

– the fraction of the population infected in an epidemic wave (and the probability of such wave) is

$$R(\infty) = \sum_{k \geq 0}^{\infty} p_k (1 - u^k) = 1 - G_0(u)$$

– $H_0(x)$: PGF of the distribution of the size of outbreaks that will eventually die out

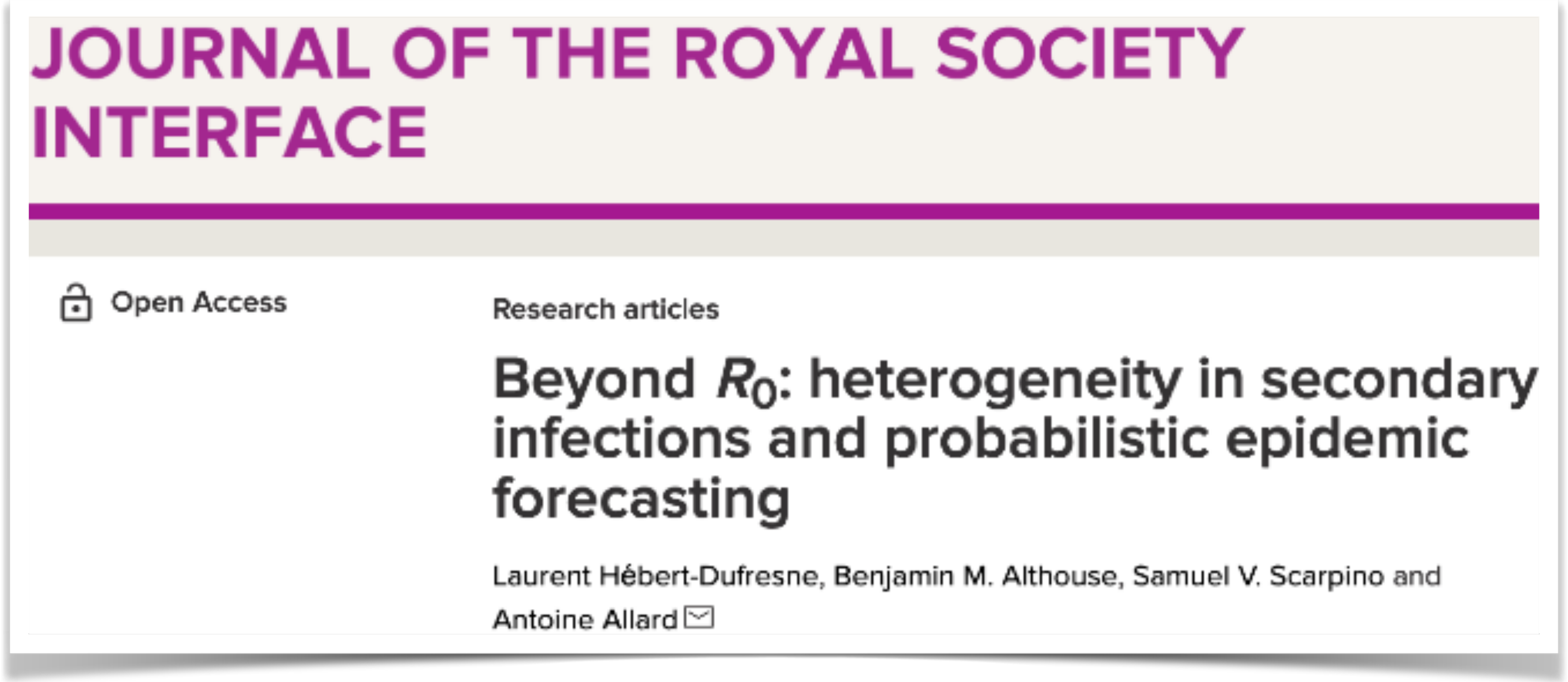
$$H_1(x) =$$



$$+ \ldots = x \sum_{k \geq 0}^{\infty} \frac{(k+1)p_{k+1}}{\langle k \rangle} \left[H_1(x)\right]^k = x G_1\big(H_1(x)\big)$$

– the distribution of the size of outbreaks that will eventually die out can be extracted from

$$H_0(x) = x G_0\big(H_1(x)\big)$$



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Research articles

Beyond R_0: heterogeneity in secondary infections and probabilistic epidemic forecasting

Laurent Hébert-Dufresne, Benjamin M. Althouse, Samuel V. Scarpino and Antoine Allard

Message #1 : the friendship paradox

- on average, your friends have more friends than you do
  - $\rightarrow$ a random individual has k friends with probability p_k
  - $\rightarrow$ however, their friends have k friends with probability $\propto kp_k$
- by spreading on a contact network, the disease naturally over-samples individuals more likely to cause a larger number of secondary infections
- ignoring this effect leads back to the mass-action assumption