Small worlds and giant epidemics

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Summary

Key problems for models of disease spread relate to threshold, velocity of spread, final size and control. All of these depend crucially on the network structure of individual interactions.

Networks of interest range from the local extreme where interactions are only between nearest neighbours in some low dimensional space, and the infinite-dimensional 'mean-field' extreme where all interact equally with all. Intermediate cases of practical interest include 'small-world' and meta-population models.

I shall discuss the various structures of such models, their similarities and differences, and some approximations to them. The main aim is to identify what features of contact structure need to be captured when formulating a model for any specific problem of disease spread.

References

Albert, R, and Barabasi, A-L (2001) 'Statistical mechanics of complex networks', cond-mat archive 0106096.

Ball, FG, Mollison, D and Scalia-Tomba, G-P (1997) 'Epidemics in populations with two levels of mixing', *Ann. Appl. Prob.*, **7**, 46-89.

Bollobás, B (1985) *Random Graphs*, Academic Press, London.

Cox, JT, and Durrett, R (1988) 'Limit theorems for the spread of epidemics and forest fires', *Stoch Procs Applics* **30**, 171-191.

Durrett, R and Levi, SA (1994) 1The importance of being discrete (and spatial)', *Theor Pop Biol* **46**, 363-394.

Ferguson, N, Donnelly, C, and Anderson, R (2001) 'The Foot-and-Mouth epidemic in Great Britain: pattern of spread and impact of interventions', *Science*, **292**, 1155-1160.

Keeling, MJ (1999) 'The effects of local spatial structure on epidemiological invasions', *Proc R Soc Lond* **B 266**, 859-867.

Mollison, D (1972) 'The rate of spatial propagation of simple epidemics', *Proc 6th Berkeley Symp on Math Statist and Prob* **3**, 579-614.

Mollison, D (1991) 'The dependence of epidemic and population velocities on basic parameters', *Math Biosciences* **107**, 255-287.

Mollison, D (1995) 'The structure of epidemic models', in *Epidemic Models: their Structure and Relation to Data* (ed. Denis Mollison), Cambridge UP.

Newman, MEJ (2000) 'Models of the Small World: A Review', cond-mat archive 0001118.

Newman, MEJ (2002) 'Random graphs as models of networks', cond-mat archive 0202208.

Rand, DA (1999) 'Correlation equations and pair approximations for spatial ecologies', in *Advanced Ecological Theory* (ed. Jacqueline McGlade), 100-142.

Watts, DJ, and Strogatz, SH (1998) 'Collective dynamics of 'small-world' networks', *Nature*, **393**, 440-442.