MATH 3820
Winter 2009
Projects

Choose one of the following papers. Suggestions of problems to consider are given, but you are free to do whatever you want. You should explain the model (avoid paraphrasing the author(s), if you become familiar enough with the model, the explanation should come naturally). Conduct some numerical simulations.. Explain how you would extend the work (you can extend if you want).

And do not hesitate to come to see me for questions, if you need help with the math, the simulations..

1. R.V. Canfield and L.E. Borgman. Some distributions of time to failure for reliability applications. Technometrics, Vol. 17, No. 2 (1975).
   This paper is perfect is you want to explore in more detail the problem of time of residence in classes.
   Modelling method used: probability.

2. J.P. Eng. A mathematical model relating cohort and period mortality. Demography, Vol. 17, No. 1 (1980).
   Modelling method used: static model.

3. R.A. Fisher. The wave of advance of advantageous genes. Annals of Eugenics, Vol. 7 (1937).
   This is an extremely well known paper of mathematical biology. Explain how the equation (1) is derived in a little more detail than is given here. Then reproduce the analysis of Fisher. Then perform numerical simulations (this should prove much easier than it was for Fisher).
   Modelling method used: partial differential equations.

4. B.J. Hammond and D.A.J. Tyrrell. A mathematical model of common-cold epidemics on Tristan de Cunha. The Journal of Hygiene, Vol. 69, No. 3 (1971).
   Modelling method used: ordinary differential equations.

5. S.B. Hsu, S.P. Hubbell and P. Waltman. A contribution to the theory of competing predators. Ecological Monographs, Vol. 48, No. 3 (1978).
   Modelling method used: ordinary differential equations.

6. Y.A. Ilinskii, B. Lipkens, T.S. Lucas, T.W. Van Doren and E.A. Zabolotskaya. Nonlinear standing waves in an acoustical resonator. Journal of the Acoustical Society of America, Vol. 104 (1998).
   Modelling method used: partial differential equations.

7. A. Inselberg. Cochlear dynamics: the evolution of a mathematical model. SIAM Review, Vol. 20, No. 2 (1978).
   Modelling method used: partial differential equations.
   For this project, see also the following two articles, on which this one is based: Inselberg and

Chadwick (1976) and Chadwick, Inselberg and Johnson (1976).

8. K. Lange and F.J. Oyarzun. The attractiveness of the Droop equations. Mathematical Biosciences, Vol. 111 (1992).
   Well known paper in the chemostat field, which establishes global properties of the Droop model, a slightly more complicated model than the one in the notes about the chemostat. Establishing global stability is not easy, as can be inferred from the analysis here. Reproduce the local analysis, and see if you can understand the global one. Do the work both in nondimensional and in dimensional form. Perform some numerical simulations.
   Modelling method used: ordinary differential equations.

9. R. Levins and D. Culver. Regional coexistence of species and competition between rare species. Proceedings of the National Academy of Sciences of the United States of America, Vol. 68, No. 6 (1971).
   Modelling method used: ordinary differential equations.

10. G.B. Markus and P.E. Converse. A dynamic simultaneous equation model of electoral choice. The American Political Science Review, Vol. 73, No. 4 (1979).
    Modelling method used: discrete-time system.

11. R.M. May. Simple mathematical models with very complicated dynamics. Nature, Vol. 261 (1976).
    This is a well known article that more or less started the whole “chaos buzz”. Reproduce the results, develop the analysis. Beware: there are some errors in this paper (for example, with figures). See if you can spot them.
    Modelling method used: discrete-time equations.

12. C.J. Mode. A mathematical model for the co-evolution of obligate parasites and their hosts. Evolution, Vol. 12, No. 2 (1958).
    A classic paper in mathematical biology. A simple model about which plenty can be done: mathematical analysis, numerical simulations, etc.
    Modelling method used: ordinary differential equations.

13. B.E. Newling. Urban growth and spatial structure: mathematical models and empirical evidence. Geographical Review, Vol. 56, No. 2 (1966).
    Describes the spread of a city and the population density. Could be used as a starting point to consider more detailed models, or could be used with more recent data.
    Modelling method used: static model.

14. C.R. Rao and A.M. Kshirsagar. A semi-Markovian model for predator-prey interactions. Biometrics, Vol. 34, No. 4 (1978).
    Modelling method used: discrete-time Markov chains.

15. D.A. Roff. The analysis of a population model demonstrating the importance of dispersal in a heterogeneous environment. Oecologia, Vol. 15, No. 3 (1974).
    Modelling method used: discrete-time systems.

16. J.A. Sherratt. Traveling wave solutions of a mathematical model for tumor encapsulation. SIAM Journal on Applied Mathematics, Vol. 60, No. 2 (1999).
    Not easy mathematically, but describes well the steps of the analysis, from how to establish the existence of travelling wave to the numerical treatment of the problem.
    Modelling method used: partial differential equations.

17. W. Siler. A competing-risk model for animal mortality. Ecology, Vol. 60, No. 4 (1979).
    The problem of time of residence in classes is investigated (with focus on mortality). Competing risks consider the different hazards that an individual is exposed to, the hazard is the derivative of the survival function.
    Modelling method used: probability.

18. J.W. Sinko and W. Streifer. A model for population reproducing by fission. Ecology, Vol. 52, No. 2 (1971).
    Modelling method used: partial differential equations.

19. M. Slatkin. Competition and regional coexistence. Ecology, Vol. 55, No. 1 (1974).
    Modelling method used: ordinary differential equations.

20. R.A.J. Taylor. A simulation model of locust migratory behaviour. The Journal of Animal Ecology, Vol. 48, No. 2 (1979).
    This paper presents a computer simulation model of locust migratory behaviour. Write a discrete-time mathematical model that could be used to run the simulations. (Simplify the problem if needed.)
    Modelling method used: computer simulations.

21. L.E. Thomas. A model for drug concentration. SIAM Review, Vol. 19, No. 4 (1977).
    Modelling method used: impulsive differential equation (ordinary differential equation with discrete-time events).

22. M.B. Usher. A matrix model for forest management. Biometrics, Vol. 25, No. 2 (1969).
    Modelling method used: discrete-time systems.

23. J. Yellin and P.A. Samuelson. A dynamical model for human population. Proceedings of the National Academy of Sciences, Vol. 71, No 7 (1974).
    This is a two sex model for a population. Go through the analysis, in particular, show how the table on page 2816 is obtained. Perform some numerical simulations.
    Modelling method used: ordinary differential equations.