Prioriteitenprogramma

Niet Lineaire Systemen

Populatiedynamica

News Letter

A newsletter for the project 'Population dynamics, including epidemiology' being part of the NWO priority program 'Nonlinear Systems'.

November 12, 1999 Visit the Home Page on: `http://www.bio.vu.nl/thb/users/nls`

This newsletter will appear once every three months during the course of the project. Its content will mainly consist of announcements of activities, such as seminars and workshops. Moreover, information about foreign visitors being in the Netherlands as part of the program will be given.

To make this newsletter as informative as possible we ask you to let us know about activities that are planned and the date visitors are coming and give lectures. Also addresses of persons (in the Netherlands or abroad) who might be interested in receiving this newsletter are welcome.

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Contents

Contributions to this newsletter were made by: Hans Metz, Bob Kooi.

1 Editorial

The URL of the home-page for the NLS Population Dynamics and Epidemiology project is: `http://www.bio.vu.nl/thb/users/nls` Activities of the programme as well as useful links are given in a Calendar. You can down-load from this home-page the **Newsletter** (4 issues per year) in PostScript and DVI format.

2 AIO-position VU Amsterdam

A four year Ph.D. position is available at the Department of Theoretical Biology, Institute for Ecological Sciences, Vrije Universiteit Amsterdam, The Netherlands on

The role of food web structures in the dynamics of ecosystems

The goal of this study, which is conducted in collaboration with the department of Animal Ecology, is to analyse the dynamics of food webs and nutrients in a series of model ecosystems of increasing complexity. The systems are spatially homogeneous, closed for mass and open for energy. We aim to quantify the activities of the system by a small number of summerizing statistics that can be measured in real world ecosystems. These statistics are used to study the relationship between complexity and stability of ecosystems. The long-term dynamic behaviour of the systems will be studied with Bifurcation Theory. Computer packages such as CONTENT and AUTO will be used for bifurcation analyses.

Candidates should hold a Ms. degree in Biology, Mathematics, Computer Science or related fields. The project description and general information about the department is available at `http://www.bio.vu.nl/thb/`

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3 Report on Workshop on Physiologically Structured Populations Lorentz Centre, Leiden

July 5-9, 1999 by Hans Metz

Starting July 5 a small one-week workshop was held at the Lorentz Center in Leiden, bringing together a number of people working on the general theory of Physiologically Structured Populations. The roots of this theory go back to the early 1980s, when a colloquium on this topic was held at the then Mathematical Centre in Amsterdam. The early developments were mainly concerned with the modelling part. A PDE formalism was used as a vehicle for communication. This led naturally to mathematical approaches centering around classical and not-so-classical semigroup theory. For a special subclass of models in addition an approach based on Volterra integral equations was available. The results of the early days are reported in J.A.J. Metz & O. Diekmann (1986) *The dynamics of physiologically structured populations*, Springer Verlag, Lecture Notes in Biomathematics 68, XII+511 p. That early work has given rise to a considerable number of applications as well as extensions. One of the most notable offspring at the mathematical end was the encompassing functional analytic approach to delay-differential equations reported in O. Diekmann, S.A. van Gils, S.M. Verduyn Lunel, H.-O. Walther (1995) *Delay Equations: Functional-, Complex-, and Nonlinear Analysis*, Springer-Verlag XI+534 p. However elegant the latter approach may be, within population dynamics it is only of use for a relatively small subclass of physiologically structured models, essentially equivalent to age based ones. This in stark contrast to the needs brought to the fore by the by now florishing industry dealing with biological applications. Since it looked as if the usual semigroup approaches, in which the semigroup is constructed from a differential generator, were leading to a dead end, a small collective of researchers have tried their hands on extending the integral equation approach, concentrating first on a proper bookkeeping of births over time from which then the population semigroup is constructed in a direct manner thus obviating the necessity to construct the semigroup from a differential generator. At the biological end all the ingredients are the same, but the mathematical end is reached through a different, less classical, route. An integral equation formalism clearly can do the job in full generality in the linear case, although the required formalism is a little daunting; see O. Diekmann, M. Gyllenberg, J.A.J. Metz & H.R. Thieme (1998) On the formulation and analysis of general deterministic structured population models I Linear theory. *J. Math. Biol.* 36: 349-388. The hunt is now on for an extension of this theory to the nonlinear case. The chosen approach is to concentrate on the environmental feedback-loop. Here the population is considered as an operator, transforming environmental inputs as functions of time into outputs to the environment, again as functions of time. The closed loop population process then is considered as a fixed point of this operator. Simple though this may sound, there are considerable technical difficulties that have to be overcome to make this scheme work, not the least of which is the impenetrability of the usual formalisms.

The Leiden workshop was the third in a series of workshops devoted to overcoming these difficulties. It was preceded by workshops in Turku (August 13-20, 1997) and Diepenveen (January 6-10, 1999) an NWO sponsored visit of M. Gyllenberg to Utrecht (one month, February 1999), and and will be followed by a next workshop in Turku (November 11-15, 1999). The attendees were Odo Diekmann (Utrecht), Mats Gyllenberg (Turku), Hiayang Huang (Beijing), Markus Kirkilionis (Heidelberg) and Hans Metz (Leiden). The main progress made this time was in the development of an efficient formalism for handling input-output semigroups in a manner compatible with both the later goal of using a contraction argument for determining the fixed point, as well as the various semigroup constructions needed to prove, for example, the principle of linearized stability. Given the results already available from previous occasions the workshop ended with a rather elated feeling: perhaps, perhaps, the end of a long road is in sight. If indeed all promises are fulfilled we shall have a framework that can deal with many of the mathematical intricacies of physiologically structured populations in one go, although necessarily on a very abstract level. Yet the framework is constructed in such a manner that in the longer run it should be possible to deal also with, for example, numerical techniques along exactly the same lines. In the end physiologically structured population models should be understood mathematically on the same level as we understand differential equation models. Of course, the developments in differential equations show that this isn't the end of the story. But at least we can then immediately get down to the nitty gritty of dealing with concrete models unhampered by the present inconclusiveness of an incomplete mathematical framework, and helped on by the then available strong tools of dynamical systems theory and bifurcation theory such as, for example, the principle of exchange of stability.

4 Report on the mini-symposium on Nonlinear Population Dynamics

This mini-symposium was part of the conference *Theory and Mathematics in Biology and Medicine* 1999 Vrije Universiteit Amsterdam, The Netherlands, June 29 - July 3, 1999.

This mini-symposium was announced in the continuation research proposal for *NLS Population dynamics and epidemics* financially supported by the NWO priority program 'Nonlinear Systems, Population dynamics, including epidemiology'. Sessions organizers were Martin Boer (VU now CPRO, Wageningen) and Markus. Kirkilonis (CWI, UU and now Heidelberg Germany). The reseach projects of Martin (Ph.D. student Dept. of Theoretical Biology VU) and Markus (post-doc with the CWI) were supported by the NLS priority program. Martin Boer is finishing his Ph.D. thesis entitled: *The dynamics of tri-trophic food chains.* Markus was involved in the development of theory and numerical bifurcation analysis of models of physiologically structured populations. To that end he wrote the computer package called BASE, a modularly designed tool for 'Bifurcation Analysis of Structured Equations.

Two invited speakers gave a rather broad introduction into the scientific field of nonlinear population dynamics. In parallel sessions oral contributions were presented. Furthermore there was a well attended poster-session.

Abstracts of the contributions of the invited speakers:

Recent trends and future perspectives in population dynamics

David Rand, University of Warwick, Mathematics Institute, Coventry CV4 7AL UK
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In this talk I propose to discuss population dynamics with a particular emphasis on recent trends and future perspectives. In the first part I will concentrate on ecology, evolutionary theory and epidemiology and my discussion will include individual-based systems, spatial ecologies, populations of structured individuals and invasion. In the second part I want to consider some examples from microbial and molecular biology such as viral systems, T-cell receptors and cell signalling. On the one hand I want to demonstrate that population dynamics is crucial to an understanding of many biological phenomena of real current interest and on the other hand I want to draw attention to the way in which new mathematical techniques can aid understanding of population dynamics.

A Model of Microbial Growth and Competition in a Plug Flow Reactor with wall growth

Hal Smith, Arizona State University, Mathematics, Tempe, AZ 85287, USA
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A mathematical model for microbial growth and competition for limiting nutrient and for limited wall attachment sites in a plug flow reactor will be presented. The model is an adaptation of a model, due to Rolf Freter for *cstr*, to examine the effect of wall attachment of bacteria in the mammalian gut on the stability of the natural microflora of the gut to invasion. We will present both analytical and numerical results which bear on such questions as 'for what gut residence times and cell doubling times can the bacteria persist?', 'how can many strains coexist in the gut?' 'when does a potential invader have a competitive edge over a resident strain?'.

All abstracts are still available on: `http://toranaga.bio.uva.nl/~aroos/`.

The oral presentations:

- Nelly Noykova, Parameter and State Sensitivity in a Five Order Model of Anaerobic Digestion in Continuous Stirred Bioreactor
- Tatiana Sazykina, An ecosystem model with the optimal feeding behavior of a predator - a pseudoequilibrium regime
- Nour Eddine Elhoussif, A deterministic size structured population model with reproduction at a specified size
- Julien Arino, Size structured models for the chemostat; comparison with experiments Vladas Skakauskas On age-sex-space-structured population dynamics model with random mating and females' pregnancy
- Idriss El Akili, Modelisation of the spatio-temporal dynamics of immune anti-tumor cytotoxic reactions
- Mark Pernarowski, Controllability of excitable cells
- Tanya Kostova, Non-periodic Oscillations in Two-Patch Systems
- Maria-Josefina Hernandez, Bifurcations and Catastrophes in Conditional Outcomes of Population Interactions
- Suzanne Touzeau, Stability of a stage-structured population model with a generalized stock-recruitment function
- Linda Rass, Exploting model similarities to describe stochastic convergence results
- Serge Chernyshenko, Mathematical Modelling of Ecological Successions: Approach on the Base of M. Eigen's Hypercycle
- Valery Kirzhner, On finiteness of the equilibria set under selection in a system of multiallele loci
- Hartmut Schwetlick, Propagation of disturbances in multidimensional nonlinear transport models
- Yoh Iwasa, Pollen-Coupling of Forest Trees, Forming Synchronized and Periodic Reproduction out of Chaos
- Jean-Luc Gouzé, Global behaviour of periodically forced loop systems: example of a class of model for algal growth
- Manmohan Singh, Predator-Prey Models with Diffusion Based on Luckinbill's Experiment with Didinium and Paramecium
- Nico Stollenwerk Testing nonlinear stochastic models on empirical algae mass time series
- Bernard Cazelles, Intermittent rarity and On-Off intermittency in population dynamics
- Sergei V. Petrovskii, The Wave of Chaos: A New Mechanism of Pattern Formation in Spatio-Temporal Population Dynamics
- Mick Roberts, A simple parasite model with complicated dynamics

Poster contributions:

- Mohamed Benkherourou, From Mechanical Characterization of Fibrin Gels To Quantification of Endothelial Cell Traction Forces
- Faina Berezovskaya, 'Travelling waves' and 'pulsing patterns' in population models with auto-taxis

- Carlos A. Braumann, Conditions for population steady-states in random environments
- Nikola Buric, Time-delay effects in a minimal model of the immune response
- Derik Castillo-Guajardo, Effect of stage-structure on stability of host-parasitoid interactions
- Michael Deakin, A Generalised Multistage Logistic Population Model
- Tiago Domingos, A General Approach to the Modelling of Trophic Chains
- Vasiliy Govorukhin, One Model of Active Migrations: Qualitative Investigation
- Michael Grinfeld, Modelling IGP and GLP in age-structured populations
- Fabrice Heiser, A Predator-Prey in a Heterogeneous Environment
- Barbara Hellriegel, Factors influencing the complex dynamics and variable composition of mixed hybridogenetic populations
- Adam Kleczkowski, Plants competition in a changing environment
- Ryusuke Kon, The Effect of Evolution to Host-Parasite Systems
- Abraham Korol, Complex Dynamics Manifested by a Multilocus Genetic System upon Cyclical Selection
- Nicholas Kositski, Self-control of Proliferation-diferentiation Proceses in Cell Population Dynamics
- Mayer Landau, Transition rules between various coexisting equilibrium states in a cardiac Non Pacemaker cel
- Pierre Magal, Evaluation of the eel flux during the migration for the reproduction
- Alexander B. Medvinsky, Fish school walks and plankton patchiness as a result of plankton- fish interactions
- Andrey Morgulis, Wave phenomena in the model of a spatially active population.
- Thorsten Mëller, Analysis of non-linear dynamical systems: estimating parameters and model selection
- Vikas Rai, On the Determinstic Description of Population Dynamics
- Akiko Satake, A Globally Coupled Map Model for Synchronized Reproduction in Beech Forests - Pollen-Coupling of Trees Creates Coherent Dynamics out of Chaos
- Pekka Vainiomäki, The Application of Ergodic Theory to Discrete Time Systems with Stochastic Perturbations
- Andrew White, Explaining the colour of power spectra in chaotic ecological models
- Sergio Furtado dos Reis, Dispersal on small spatial scales: Waves, neighborhoods of interaction and non-locality

5 Report of visit of Mick Roberts

reported by Hans Heesterbeek, Centrum voor Biometrie Wageningen.

From 27 June to 10 July, Mick Roberts (AgResearch, New Zealand) visited Hans Heesterbeek. In the first week of the visit, he attended the conference Theory and Mathematics in Biology and Medicine, where he gave a lecture in the session on Nonlinear Population Dynamics. Since the session celebrated seven years of support from NWO as part of the priority programme, it was fitting that he should give a lecture since our collaboration over the last five years has been helped substantially by the financial contributions from the programme. We have written a number of papers over recent years and this would have been much harder, if not impossible, without the support which brought Mick to the Netherlands on two occasions. He gave a lecture on a joint paper titled *A simple parasite model with complicated dynamics.*

In the second week we worked in Wageningen on a new project. This concerns a metapopulation model for possums, that includes the dynamics of tuberculosis within the possum population. It is intended that the model can be used to address specific questions on possum and tb-control from the New Zealand government. During his stay we formulated the model, after lots of discarded versions, and did some preliminary analysis. Mick left at a stage where further work could be clearly divided between us for further work in the autumn.

During his visit, Mick also spend a day at the RIVM, discussing various questions and approaches to the modelling of non-infectious diseases (chronic diseases) with experts at that institute. A good basis for collaboration and exchange of results has been created at that meeting.

6 Calendar

13-17 December 1999 and 17-21 January 2000

Mathematical methods in oceanology deterministic and stochastic approaches. Marseilles - France.

Information:
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January 5-9, 2000

Third Winter school on Population Dynamics Woudschoten, The Netherlands, January 5-9, 2000.

This will be the third edition of this event, organised by Odo Diekmann, Hans Heesterbeek, Fleur Kelpin and Bob Kooi. The previous schools in January 1996 and January 1998 each attracted more than 50 PhD-students from a broad range of countries and population biological subjects. Reports by participants about these schools can be found in the BioMathematical Newsletter 13 and BMN 17.

As in the previous editions we emphasise the word 'school' and aim to give PhD students in population biology a good understanding of the way mathematics is applied to study problems in their field as well as a thorough background in relevant deterministic and stochastic mathematical techniques. Five lecturers who will each give a series of 4 or 5 lectures. These lecture series start at an elementary level and connect to recent research topics towards the end. Basic techniques receive attention, and lecture notes accompany the presentation.

In addition we retain a successful part of the 1996 and 1998 editions in that participants team up in small groups around one or two papers of their choice from a list we provide. The papers cover the same areas as the lecture topics but go beyond the basic material. We look for stimulating and challenging papers that are allowed to be more difficult than usual, provided they have a rewarding message once you understand them. The groups then study these papers together during several periods of a few hours scattered throughout the week (the idea being that five know more than one and one learns to read more advanced papers). On Saturday one person from each group then gives a short presentation about the findings, ideas, criticism, comments etc.

The speakers are:

Fred Adler	ecology and evolution
Rob de Boer	immunology, virology
Bas Kooijman	dynamic energy budgets, ecotoxicology
Roger Nisbet	stage structured populations, numerics and applications
Horst Thieme	mathematics of physiologically structured population models

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August 23-27, 2000

Second international conference on deterministic and stochastic modeling of biointeraction

Information:

Fabio Augusto Milner	Email : `destobio@math.purdue.edu`
West Lafayette, Indiana, USA	`http://www.math.purdue.edu/~milner/DESTOBIO_2000.html`