Centro de Matemática
Departamento de Matemática

Meeting on Branching Processes & Applications

15 - 17 April 2009

Minho University, Campus de Gualtar, Braga

The theory of branching processes has long been used to model the evolution of populations whose members live, reproduce and die independently of each other. It is a very active and rich area of research that has developed from very simple models to more complex models with an increasing realism. Currently, branching processes play a very important role in models of genetics, molecular biology, ecology and evolutionary theory. Applications in physics and computer science are also well known.

The main purposes of the meeting are to introduce the audience to the fundamental results of the mathematical theory of branching processes and to present concrete examples where the theory is being used to solve important problems arising in the areas referred above.

There will be seminars and introductory courses given by experts in the field. The meeting is suitable both for mathematicians, with an interest in the applications, and for a biological audience. No prior knowledge of branching processes is assumed.

Welcome!

Programme

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<tr><th></th><th>Wednesday, 15 April</th><th>Thursday, 16 April</th><th>Friday, 17 April</th></tr>
<tr><td>10:00 - 10:50</td><td>Patsy Haccou</td><td>Conceição Serra</td><td>Peter Jagers</td></tr>
<tr><td>10:50 - 11:15</td><td colspan="3">Cofee break</td></tr>
<tr><td>11:15 - 12:00</td><td>Vladimir Vatutin</td><td rowspan="2">Serik Sagitov</td><td rowspan="2">Vladimir Vatutin</td></tr>
<tr><td>12:15- 13:00</td><td>Atiyo Ghosh</td></tr>
<tr><td>13:00 - 15:00</td><td colspan="3">Lunch</td></tr>
<tr><td>15:00 - 15:45</td><td rowspan="2">Serik Sagitov</td><td rowspan="2">Peter Jagers</td><td rowspan="2"></td></tr>
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Obs.: Wednesday and Thursday morning sessions will take place at room B.4009 of the Mathematics Department (seminar room). Thursday afternoon and Friday morning sessions will be held at "Anfiteatro" of Chemistry Department.

Organized by CMAT-Centro de Matemática: **http://www.cmat.uminho.pt**

If you wish to attend the meeting please send an email to mcserra@math.uminho.pt

Seminars

Modeling biological invasions

Patsy Haccou
Institute of Biology, Leiden University, The Netherlands
Wednesday, 10:00-10:50

Invasions play a big role in many biological contexts. Since in most cases initial numbers of invaders are small, branching processes provide a good way to model and study such processes. This provides new biological insights, e.g. in evolutionary theory, and practical tools for preventing success of unwanted invaders. I will provide an introduction to modeling biological invasion processes and give some examples of applications.

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Branching Processes, Hazard Rates and Introgression

Atiyo Ghosh
Institute of Biology, Leiden University, The Netherlands
Wednesday, 12:15 - 13:00

Introgression is the process whereby a specified gene from one population can become permanently incorporated into the genome of another population. Since the advent of genetically modified genes, it has become a matter of interest to quantify the rate at which introgression occurs. Introgression is a process influenced by many stochastic elements, and since initial populations of an invading gene are small, it is possible for stochastic fluctuations to drive such genes to extinction, motivating a stochastic approach. This talk describes the development of a measure of the risk of introgression given that it has not occurred before - the hazard rate. The hazard rate is derived from multi-type Galton Watson process, and allows for a measure of risk of introgression while taking its inherent stochasticit y into account.

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Multitype Bienaymé- Galton-Watson processes escaping extinction

Maria Conceição Serra
Mathematics Department, Minho University, Portugal
Thursday, 10:00 - 10:50

In the framework of multitype Bienaymé-Galton-Watson (BGW) process, the event that the daughter's type differs from the mother's type can be viewed as a mutation event. Assuming that mutations are rare, we study a situation where all types except one produce on average less than one offspring. We establish a neat asymptotic structure for the BGW process escaping extinction due to a sequence of mutations toward the supercritical type.
Our asymptotic analysis is performed by letting mutation probabilities tend to 0. The limit process, conditional on escaping extinction, is another BGW process with an enriched set of types permitting to distinguish a stem lineage of particles that leads toward the escape event. The stem lineage can be described by a simple Markov chain on the set of particle types. The total time to escape becomes a sum of a random number of independent geometrically distributed times spent at intermediate types. This is joint work with Serik Sagitov.

Courses

Linear Fractional Galton-Watson Processes

Serik Sagitov
Department of Mathematical Sciences, Chalmers University of Technology, Sweden
Wednesday, 15:00 - 16:45 and Thursday 11:15 - 13:00

These lectures present an elementary introduction to the theory of Branching Processes. We consider a special class of Branching Processes, the so called linear-fractional (LF) Galton-Watson (GW) processes. In this case one can explicitly compute main characteristics of the process in terms of few key parameters defining the reproduction law.
Part 1:
LF probability generating functions
Classification of the GW-processes
The dual reproduction law
Part 2:
Decomposition of a supercritical GW-process
Transition probabilities in the LF case
Limit theorems in the subcritical, critical, and supercritical cases

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General Branching Processes

Peter Jagers
Department of Mathematical Sciences, Chalmers University of Technology, Sweden
Thursday, 15:00 - 16:45 and Friday 10:00 - 10:50

From the simple Galton-Watson structure, where there is no real time, only generations, and only a single type of individuals, branching process theory has evolved into general processes where time structure is realistic (individuals can have arbitrarily distributed life spans, and give birth at arbitrary ages) and a multitude of types of individuals can appear. I shall describe the structure and the results about such general branching processes, stressing basic properties and results rather than technical proofs.

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Branching Processes in Random Environment

Vladimir Vatutin
Department of Discrete Mathematics, Steklov Mathematical Institute, Russia
Wednesday, 11:15 - 12:00 and Friday 11:15 - 13:00

The course will be splitted in three lectures:
Lecture 0 - Branching Processes: Extinction of Populations.
Lecture 1 - Inhomogeneous branching processes with geometric offspring distributions: probability of survival and limit theorems.
Lecture 2 - Branching processes in random environment with geometric offspring distributions:
i) classification.
ii) probability of survival and limit theorems for subcritical critical and supercritical processes under the quenched approach.
iii) probability of survival and limit theorem for the critical case under the annealed approach.