APPLIED MATHEMATICS DIVISION

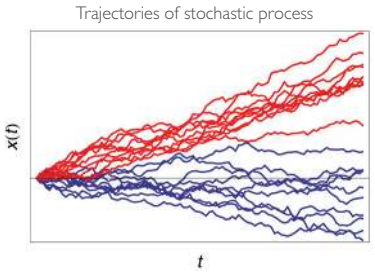
The division of Applied Mathematics at Stellenbosch University focuses on research in numerical analysis and scientific computing, computer vision and machine learning, fluid dynamics and modelling, and applied discrete mathematics. Our mission is to formulate and solve problems in all walks of life by making use of mathematical skills in an innovative way.

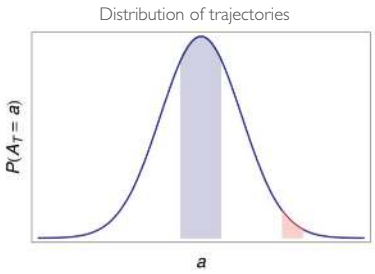
MODELS AND SIMULATIONS OF RANDOM DYNAMICAL SYSTEMS

Physicists and engineers use differential equations, such as Newton's equation, to predict and simulate the evolution of dynamical systems as varied as a ball thrown in the air, the weather system, or a spacecraft cruising to Mars. Many systems, however, are perturbed by ambient noise or other random factors as they evolve in time. In many cases, the initial conditions are also not exactly known exactly and so must be treated as a random variable.

The study of such random dynamical systems, or stochastic processes as they are called in mathematics, involves many techniques beyond differential equations coming from probability theory and statistics. Here at Stellenbosch we study many aspects of stochastic processes, including:

- Simulation of stochastic differential equations using time-discretization schemes
- Sampling of rare event occurring with very low probability but which have great impact on the behaviour of a system (e.g., defects in engineering structures, rogue waves or rare weather events)
- Evolution of stochastic process that are reset at random times to a particular state, related, for example, to the random clearing of a queue or the decimation of a population
- Modelling and simulation of physical systems perturbed by thermal noise at the microscopic level
- Financial prediction of indices (stocks, options, etc.) using machine learning techniques.



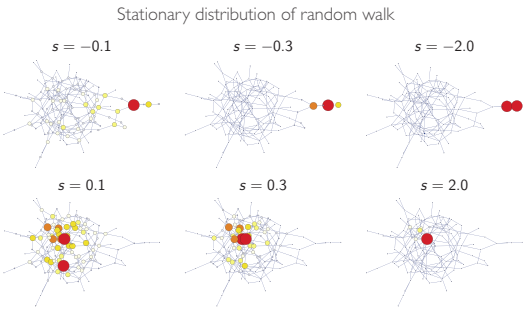


GRAPH THEORY

A graph is a mathematical representation of a network and therefore describes the relationships between different objects. In graph theory we study the structures and a variety of properties of these networks.

Projects done at Stellenbosch University includes:

- Simulation of random walks on graphs, related, for example, to the Google pagerank algorithm.
- Theoretical investigation of facility location problems
- The study of the behaviour of graph properties when network changes are observed

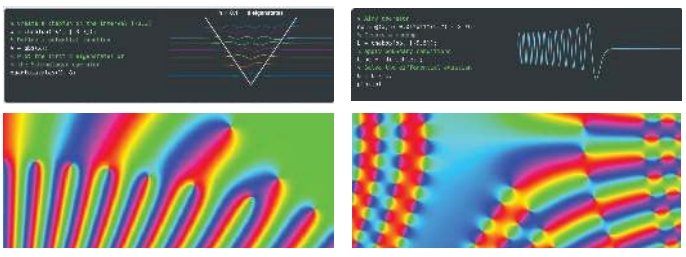


NUMERICAL ANALYSIS AND SCIENTIFIC COMPUTING

Numerical analysis is the study of computer algorithms for solving engineering and scientific problems. This involves the design of the algorithms, as well as their stable and efficient implementation on a computer.

The main focuses of the Stellenbosch Numerical Analysis group in Applied Mathematics are:

- Methods for numerical solution of differential equations (including ordinary, partial, and fractional derivatives)
- Algorithms for efficient matrix computations
- Software for the computation of special functions and fast transforms



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