Workshop

Spreading dynamics in random environments

Berlin, July 6–8, 2026

Contents

Introduction

It is our great pleasure to welcome you to the workshop **Spreading dynamics in random environments**. We hope you enjoy illustrative talks and an interactive and inspiring exchange and networking.

Venue

The workshop will take place in presence at WIAS, Anton-Wilhelm-Amo Straße 39, 10117 Berlin.

Website

You can find further information on the web page of the workshop: https://wias-berlin.de/workshops/SDRE26/.

Organisers

Benedikt Jahnel, Jonas Köppl, Lukas Lüchtrath, Christina van de Sand

Timetable

Registration Monday 8:30–09:00
Welcome Monday 09:00–9:15

	Monday 6	Tuesday 7		Wednesday 8
9:15–10:45	Stauffer	Stauffer	9:15–10:45	Stauffer
10:45–11:30	coffee break		10:45–11:30	coffee break
11:30–12:15	Fernley	Théret	11:30–12:15	Pokalyuk
12:15–14:15	lunch break		12:15–13:00	Steenbeck
14:15–15:00	Winkelmann	Ménard		
15:00–15:45	Lengler	Schapira		
15:45–16:30	coffee break			
16:30–17:15	Gracar	Coupier		
17:15–18:00	Dai Pra	Hartung		
18:30 –21:00	Welcome reception			

Mini Course Abstract

Spread of infection among moving particles

Alexandre Stauffer
King's College London

In this mini-course, we will study models for the spread of infection in particle systems evolving in space and time, where particles move as independent simple random walks. We will review the main results known in the literature and discuss the principal technique used to prove them: multi-scale analysis. We will conclude with an overview of recent ongoing work and possible directions for future research.

Talk Abstracts

Percolation (or not!) for systems of stopped paths

David Coupier

IMT - University of Lille

Simultaneously, from all points of a homogeneous Poisson point process in $\mathbb{R}^2$, we let grow independent and identically distributed random continuum paths. Each path stops growing at time $t > 0$ if it hits the trace of the other curves realized up until time t. Such dynamic is well-defined as long as the distribution of paths has a finite second moment at each time $t > 0$. Letting the time runs until infinity so that each path reaches its stopping curve, we study the connected property (i.e. if there is percolation or not) of the graph formed by all stopped curves. This is a joint work with D. Dereudre (University of Lille) and J.-B. Gouéré (University of Tours).

Multi-type logistic branching processes with selection: frequency process and genealogy for large carrying capacities

Marta Dai Pra

University of Bielefeld

We present a model for density-dependent growth in a multi-species population. We consider two types evolving as a logistic branching process with mutation, where one of the types can have a selective advantage both in mean and variance. We first study the frequency of the disadvantageous type and show that, once the population approaches the carrying capacity, its evolution converges to a Gillespie-Wright-Fisher diffusion process. We then show that the limiting diffusion has a well defined moment dual which we interpret as the genealogical tree of a sample via constructing an ancestral selection graph. This talk is based on joint work with Julian Kern.

The contact process on a bipartite spatial network

John Fernley
University of Warwick

We study the contact process on a random bipartite connection hypergraph generated from two Poisson point processes, with mark-dependent connection thresholds. For asymmetric infection rates and asymmetric power law tail decays of the two degree distributions, we determine the dominant survival strategies in all parameter regimes and provide asymptotics for the epidemic probability up to logarithmic factors. Joint work with Christian Hirsch and Daniel Valesin.

Detection, coverage and percolation in dynamic Boolean models with random radii based on α-stable processes

Peter Gracar
University of Leeds

We consider a dynamic network in continuum time and space in which nodes, with initial locations given by a Poisson point process, move according to i.i.d. isotropic α-stable processes. Each node is additionally equipped with an i.i.d. detection radius. Inspired by corresponding results by Peres et. al. on mobile networks based on Brownian sausages with fixed width, we investigate the tail behaviour of three stopping times: The detection time of the first discovery of a designated node, the first coverage of an entire set, and the first discovery of a node by the infinite connected component of the system. Broadly speaking, we discover that the stability index as well as the random radii manifest themselves only in constants in the otherwise exponential decay rates. The proofs rest on heat-kernel bounds for the underlying Lévy processes and a detailed multiscale analysis allowing us to control the space-time correlations of the system.

The stubborn voter model

Lisa Hartung
University of Mainz

In this talk, we discuss a heterogeneous variant of the voter model in which some voters keep their opinions for a long time. We are interested in how this affects the consensus time. This is modeled through i.i.d fat-tailed average waiting times. We focus on the case where the underlying graph is a dense Erdös-Renyi graphs. Our main result is the existence of a limiting infinite voter model on the slowest updating sites. Moreover, we determine the consensus probabilities in the limit model. To prove this, we study properties of the coalescing system of random walks that forms the dual of the voter model. The talk is based on joint work with P. Hanigk, A. Klippel, C. Mönch, S. Schrempf, and R. Steiner.

Universal growth laws for spreading processes in spatial complex networks

Johannes Lengler
ETH Zurich

I will discuss a spreading process in spatial random graph models in which the transmission time of each edge is random, but with a penalty term for the degree of the two endpoints. The idea behind the model is that popular vertices have less attention for each of their neighbours. As a result, we get a rich phase diagram, where changes in the penalty term can lead to transitions between different universality classes: the growth curve can be super-exponential, exponential, polynomial, or purely geometric.

Belief propagation and optimal matching

Laurent Ménard
University Paris Nanterre

We consider the maximum weight matching problem on sparse random graph models, specifically Erdös-Rényi and configuration graphs equipped with i.i.d. edge weights. This talk aims to rigorously illustrate the interplay between three fundamental concepts in probabilistic combinatorial optimization: Aldous' objective method, the cavity method, and belief propagation. By exploiting the locally tree-like structure of the graphs, we can analyze belief propagation not merely as an algorithmic message-passing protocol, but as a system of Recursive Distributional Equations (RDEs). This provides a mathematically rigorous foundation for the cavity method, a heuristic originally developed in statistical mechanics. In turn, the objective method allows us to show how local distributional limits translate into global combinatorial optimality. Based on joint works with Enriquez, Liu and Perchet.

Optimal long-run control of endemic infections: bangbang threshold policies in a stochastic SIS model

Cornelia Pokalyuk
University of Lübeck

We study long-run optimal intervention strategies for endemic infections in a stochastic susceptibleinfectedsusceptible (SIS) model. The proportion of infected individuals evolves as a diffusion process with random fluctuations, while a control variable $\zeta \in [0, \zeta_{max}]$ represents the intensity of public health interventions that reduce transmission. The objective is to minimize the long-run average societal cost, balancing the burden of infection against the costs of interventions. Under a concave intervention cost structure the problem can be formulated as an ergodic stochastic control problem, whose structure implies that optimal interventions are of bangbang type, switching between no and full maximal control at a single switching threshold in the infection level. We construct candidate value functions, rigorously verify optimality in this single-threshold case, and relate the results to extinction and persistence properties of the underlying SIS dynamics in the absence of control. In our framework, the analysis provides a rigorous justification for the threshold-based intervention rules commonly used in epidemic management. This is joint work with Matthew Buckland, Sören Christensen, and Philip Le Borne.

Contact process on dynamic regular graphs

Bruno Schapira

University Lyon 1

We consider the contact process on a dynamic random d-regular graph with an edge switching mechanism. We prove that there is a sharp phase transition between fast extinction and long-time survival, as the infectivity parameter increases. Based on a joint work with Daniel Valesin.

Harmonic crystal with irregularities

Yannic Steenbeck

Technical University of Braunschweig

The Discrete Gaussian Free Field (DGFF) models a random interface separating two phases and occupies a remarkable position at the intersection of probability, statistical mechanics, and analysis. It is a Gibbs measure arising from a local interaction energy and at the same time a Gaussian process of heights on Z^d, since the corresponding Hamiltonian has a quadratic form, summing over the squares of height differences, weighted by a set of conductances. The latter fact makes many quantities of interest explicitly accessible. Our focus is on foundations of the infinite-volume theory under minimal assumptions on the (randomly drawn) conductances: existence of infinite-volume Gibbs measure, associated reversible dynamics, and surface tension (describing the free-energy cost of imposing a macroscopic slope on the interface). This is joint work with Sebastian Andres, Leonid Kolesnikov, and Martin Slowik.

Some properties of the time constant in first-passage percolation

Marie Théret

University Paris Nanterre

The first-passage percolation model, introduced on graphs in the 1950s by John Hammersley and Dominic Welsh, is a simplified model for studying propagation phenomena. A natural continuum version can be defined using a homogeneous Poisson point process χ on $\mathbb{R}^d$ as follows. Given a norm N on $\mathbb{R}^d$ (for instance, the ℓ^p norm with $p \in [1, \infty]$), let Σ denote the Boolean model obtained as the union of the unit balls (with respect to N) centered at the points of χ. Propagation is assumed to occur at unit speed outside Σ (with respect to the norm N) and at infinite speed inside Σ. This defines a random pseudo-metric T, which measures the time required for propagation between two points in space. By subadditivity, it is known that $T(0, nx) \sim n\mu(x)$ as $n \to \infty$, where $\mu(x)$ is called the time constant. Understanding the dependence of $\mu(x)$ on the parameters of the model is notoriously challenging. In joint work with Anne-Laure Basdevant (LPSM, Sorbonne Université) and Jean-Baptiste Gouéré (IDP, Université de Tours), we study the first-order asymptotic behavior of $\mu(x)$ as the intensity of the underlying Poisson process χ tends to zero, and investigate how it depends both on the norm N and on the direction of x.

Collective Variables for Spreading Dynamics on Complex Networks

Stefanie Winkelmann

Zuse Institute Berlin

Spreading processes on complex networks often exhibit emergent macroscopic behavior that can be described by suitable low-dimensional collective variables. In this talk, we discuss how such variables can be used to derive reduced models for voter-type dynamics on random and heterogeneous networks. We first present mean-field descriptions arising in large-population limits and discuss how these approximations can be adapted to structured and scale-free networks. In particular, degree-weighted coarse variables and network-dependent correction factors can substantially improve accuracy without increasing the dimension of the reduced model. Finally, we discuss how data-driven methods can identify interpretable collective variables when no closed-form reduction is available.

Lunch options

- Chupenga Burritos (3 min walk)
- Lunch Time - Italian food (3 min walk)
- Noumi - Asian food (4 min walk))
- Fontana di Trevi - Italian food (4 min walk, potentially cash only)
- Little Green Rabbit - Soups and salads (4 min walk)
- Liu Nudelhaus - Chinese Noodles (10 min walk - limited seating)
- Huong Lua - Vietnamese food (11 min walk)
- Bistro Medina - Moroccan bistro (11 min walk)
- Ishin - Japanese food (13 min walk)

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