

SCIENTIFIC REPORT FOR THE RANDOM NETWORKS & ENVIRONMENTS WORKSHOP

CONTENTS

Summary	1
Description of the scientific content and discussions	2
Assessment and future impact	4
Final program of the meeting	5

SUMMARY

The Random Networks & Environments (RNE) workshop took place in Istanbul, Turkey, from July 16 – 20, 2012, with the participation of 39 people from 12 countries (Austria, Brazil, France, Germany, Hungary, Israel, Italy, Russian Federation, Switzerland, Turkey, United Kingdom, and United States), 22 of whom as invited speakers. It brought together some of the world's leading probability theorists. Please see the following website for the complete list of people:

<http://www.math.boun.edu.tr/instructors/yilmaz/RNE.html>

The workshop was organized by Atilla Yılmaz (main organizer) and Serdar Altok from the Department of Mathematics of Boğaziçi University with the help of assistants Emre Demirkaya and Levent Sağun. The venue was the Istanbul Center for Mathematical Sciences (IMBM) which is located on the campus of Boğaziçi University. Indeed, the three-story building of IMBM (with its seminar room, coffee room, offices, kitchens, guest rooms, etc.) was solely in the service of the workshop for the whole week.

The main sponsors of the event were the ESF through its RGLIS grant (to which this final report is addressed) and IMBM itself. We also gladly acknowledge the support of the Boğaziçi University Foundation (BÜVAK).

The workshop was right after the 8th World Congress in Probability and Statistics which also took place in Istanbul. This joint organization of the Institute of Mathematical Statistics and the Bernoulli Society meets every four years, and is a major worldwide event for probability and statistics, covering all its branches, and featuring the latest scientific developments in these fields. The program of the World Congress included many invited sessions highlighting topics of current research interests, several special plenary lectures presented by leading specialists, as well as a large number of contributed sessions and posters.

The RNE workshop was officially listed by the Bernoulli Society as a related event to the World Congress. During the organization phase, we were anticipating a significant overlap between the participants of the workshop and of the congress. To our surprise, only 5 of our speakers (and 11 of our participants) attended the congress the week before. In other words, the vast majority of our speakers and participants came only to the workshop.

The talks and the discussions at the workshop focused on random walks on random networks and environments, polymers, random graphs, percolation and related processes and structures. Please see the next section for details.

DESCRIPTION OF THE SCIENTIFIC CONTENT AND DISCUSSIONS

The talks and the discussions at the workshop focused on the following topics.

Percolation. As the opening talk of the workshop, Alain Sol-Sznitman presented his recent work on level-set percolation for the Gaussian free field, in which methods coming from the study of random interacements were used. These methods constituted a connection to the second talk of the workshop, delivered by Vladas Sidoravicius, which reviewed recent developments in a class of models of dependent percolation including the so-called clairvoyant scheduling problem, Lipschitz imbeddings and Poisson cylinders.

Gábor Pete gave a talk on dynamical percolation where the configuration evolves according to a continuous time Markov chain. He presented his joint work with Alan Hammond and Oded Schramm where they studied the law of the infinite cluster of the origin in critical planar percolation at so-called exceptional times when the infinite cluster does indeed exist.

Michael Damron was scheduled to give a talk titled “Geodesics and coalescence in first-passage percolation” where he was going to discuss his recent work with Jack Hanson where they develop a framework for working with distributional limits of Busemann functions and use them to prove a form of coalescence of long finite geodesics in any deterministic direction. However, due to a family emergency, he had to cancel his visit two days before the start day of the workshop.

Polymers. Timo Seppäläinen gave a talk on the exactly solvable $1 + 1$ dimensional directed polymer models that are currently known in the KPZ (Kardar-Parisi-Zhang) universality class. He discussed the expected behavior of models in the KPZ class and then some results for these exactly solvable models. This talk was followed by three more talks on polymers: (i) Firas Rassoul-Agha on variational formulas for the quenched free energy of polymers and their minimizers; (ii) Nikos Zygouras on subgaussian concentration and rates of convergence in directed polymers; and (iii) Elena Kosygina on the speed of one-dimensional random walk conditioned to hit a remote location among Bernoulli potentials. The main theme of Kosygina’s results (joint with Thomas Mountford) was ballisticity and this theme appeared in other talks as well. Let us now focus on that.

Ballisticity. Apart from Kosygina, two other speakers of the workshop discussed ballisticity, albeit in different models. Hugo Duminil-Copin presented his joint work with Alan Hammond where they proved the sub-ballisticity of self-avoiding walks on \mathbb{Z}^d . He also discussed related open questions and conjectures. Noam Berger’s talk was on random walk in a random environment (RWRE). He presented their joint work with Alex Drewitz and Alejandro Ramírez where they relaxed the well-known ballisticity conditions of Sznitman from stretched exponential decay to polynomial decay. This is an important step towards proving that Sznitman’s conditions are equivalent to ballisticity.

3D Ising model. There were two talks at the workshop that were related to the 3D Ising model. The first one, by Dima Ioffe, was on the formation of facets in an equilibrium model of surface growth. He discussed an effective equilibrium model which is designed to mimic facets on the Wulff shape at low temperature. He mainly focused on the phase transitions of this model.

Fabio Toninelli gave a talk on stochastic dynamics on random tilings which correspond to the zero-temperature dynamics of the 3D nearest-neighbor Ising model. He provided almost-optimal bounds on the equilibration time of the dynamics for large sets.

Gaussian fields. The opening talk of Sznitman was not the only time when Gaussian fields were mentioned. Olivier Zindy gave a talk describing the statistics of the extremes of a discrete Gaussian field with logarithmic correlations at the level of the Gibbs measure. He outlined his recent work (joint with Louis-Pierre Arguin) proving that the joint distribution of the Gibbs weights converges in a suitable sense to that of a Poisson-Dirichlet variable. Moreover, the aforementioned talk of Toninelli referred to the Gaussian-free field when describing the behavior of height fluctuations of uniform tilings.

Random walks and the CLT. It is no surprise that random walks played a key role at this workshop. The medium of the walk varied from trees to groups, from random environments to dynamic settings, etc. For example, Wolfgang Woess gave a talk on the duality between jump processes on ultrametric spaces and random walks on trees. As another example, in his talk titled “Asymptotic direction of oriented-edge reinforced random walks”, Laurent Tournier considered a nearest-neighbor walk that chooses to cross edges randomly according to their weight and then increases by 1 the weight of the chosen (oriented) edge.

What was in fact surprising was the number of talks related specifically to the central limit theorem (CLT) for random walks. Bálint Tóth presented an alternative, weaker formulation of the so-called sector conditions of non-reversible Kipnis-Varadhan theory, from which the graded sector condition of Sethuraman-Varadhan-Yau followed in a less computational way. This was naturally a very abstract talk. On a more concrete setting, Jean-Dominique Deuschel proved a quenched invariance principle for random walk in i.i.d. balanced random environment, without any assumption of ellipticity. He used percolation ideas of the Burton-Keane type. Another CLT-related talk was delivered by Nina Gantert where she considered directed random walk on the infinite percolation cluster generated by supercritical oriented site percolation and proved an annealed central limit theorem with a regeneration approach. Via an analysis of joint renewals of two independent walks on the same cluster, she obtained furthermore a quenched central limit theorem in dimension $1 + 2$ or higher. The last CLT talk of the workshop was given by Sebastian Müller who discussed the validity of the CLT in finitely generated groups and gave answers for cocompact Fuchsian groups.

Random graphs and networks. Apart from the focus on various models of percolation, there were talks that dealt with other random graphs and networks as well. For example, Christina Goldschmidt gave a very well received talk on the scaling limit of the minimum spanning tree (MST) of the complete graph. She introduced Kruskal’s algorithm and explained how it can be connected to the Erdős-Rényi random graph in order to prove that the MST possesses a scaling limit as $n \rightarrow \infty$ in the sense of the Gromov-Hausdorff distance. Another talk on random graphs was given by Alan Hammond who discussed the random stirring model on trees and the existence of infinite cycles. Hammond’s talk was one of the three examples of dynamics on discrete structures, along with Pete’s and Toninelli’s aforementioned talks.

Other. Even though almost all of the talks at the workshop focused on these central topics, there were a few others with different flavor. Leonardo Rolla considered a single-server system with service stations in each point of the circle and presented his recent proof (joint work with V. Sidoravicius) of a conjecture on the stability of the so-called greedy algorithm. Finally, as the closing talk of the workshop, Adam Timar presented various allocation schemes for the Poisson point process in Euclidean space, among them one with an optimal tail, which is his recent construction with R. Marko.

ASSESSMENT AND FUTURE IMPACT

There is no doubt that probability theory is becoming increasingly important not only as a branch of pure mathematics, but also for its applications to various disciplines such as physics, biology, economics, finance, engineering, and computer science. The Random Networks & Environments (RNE) workshop brought together some of the leading actors in this exciting field. The results in the workshop reflected the two main perspectives and their ramifications: (i) random walks on deterministic as well as random environments; and (ii) static and dynamic properties of random structures. The emphasis was towards models coming from (or motivated by) physics, and, to some extent, computer science. Engineering connections were represented only by one speaker (Rolla). As far as we can tell, none of the talks or discussions had direct applications to biology or finance.

From a purely mathematical point of view, the talks at the workshop covered some of the most exciting and cutting-edge developments in terms of techniques and implications. For example: directed polymers in the KPZ universality class, the subballistic nature of self-avoiding walk, scaling limits of the minimum spanning tree, CLT for nonreversible chains such as RWRE, various deep questions about percolation, just to name a few.

The RNE workshop was a meeting mostly of European probabilists, but there were also speakers and participants from the United States and from Israel. There were junior (i.e., recent PhDs) as well as senior people among the speakers. The workshop gave all of them an opportunity to learn about each other's latest work and interact freely without the usual space-time constraints of larger-scale events.

Probability theory is currently not as widely studied in Turkey as some other branches of mathematics such as algebra, geometry, and PDEs. As two young faculty members (Atilla Yılmaz and Serdar Altok) who have recently moved to Istanbul from the U.S., we are trying to change this picture by forming a probability theory group at Boğaziçi University. We believe that the Random Networks & Environments (RNE) workshop was a significant step towards our goal since it enabled us to bring our students and colleagues in contact with many world-class probabilists.

The venue of the workshop, Istanbul Center for Mathematical Sciences (IMBM), was founded in 2007. Even though it hosted various national and international conferences and workshops as well as leading mathematicians as invited guests during its first five years of existence, IMBM is still relatively unknown in the international mathematics community. However, we believe that it has the potential to change this picture. During and after the RNE workshop, the feedback we got from the participants was uniformly very positive. IMBM is a peaceful and charming place with all the necessary infrastructure for carrying out mathematical research as well as hosting meetings, with the bonus of being located in one of the most exciting cities of the world. It is our sincere hope that events such as the Random Networks & Environments (RNE) workshop will increase the publicity of IMBM and eventually make it a more active member in the circle of mathematics centers in Europe. This will of course have a tremendous impact on mathematics research in Turkey and in the nearby countries.

FINAL PROGRAM OF THE MEETING

Monday, July 16.

- 08:45 - 10:00 Shuttle bus from Richmond Hotel to IMBM
10:00 - 10:30 Registration & Welcome
10:30 - 11:20 Talk 1: “Level-set percolation for the Gaussian free field” by Alain-Sol Sznitman
11:20 - 11:40 Break (coffee & tea)
11:40 - 12:30 Talk 2: “Coordinate percolation” by Vladas Sidoravicius
12:30 - 14:00 Lunch at the Faculty Club (Kennedy Lodge)
14:00 - 14:50 Talk 3: “Local time for dynamical percolation, and the Incipient Infinite Cluster” by Gábor Pete
15:00 - 15:50 Talk 4: “Asymptotic direction of oriented-edge reinforced random walks” by Laurent Tournier
15:50 - 16:10 Break (coffee & tea)
16:10 - 17:00 Talk 5: “Stability of the greedy algorithm on the circle” by Leonardo Rolla
17:30 - 18:30 Reception at the Alumni Club (BÜMED)
18:30 - 20:30 Dinner at the Alumni Club (BÜMED)
20:40 - 21:30 Shuttle bus from the Alumni Club to Richmond Hotel

Tuesday, July 17.

- 08:15 - 09:30 Shuttle bus from Richmond Hotel to IMBM
09:30 - 10:20 Talk 6: “Subgaussian concentration and rates of convergence in directed polymers” by Nikos Zygouras
10:30 - 11:20 Talk 7: “Exactly solvable directed polymers in the KPZ universality class” by Timo Seppäläinen
11:20 - 11:40 Break (coffee & tea)
11:40 - 12:30 Talk 8: “Variational formulas for the quenched free energy of random polymers” by Firas Rassoul-Agha
12:30 - 14:00 Lunch at the Faculty Club (Kennedy Lodge)
14:00 - 14:50 Talk 9: “On the speed of one-dimensional random walk conditioned to hit a remote location among Bernoulli potentials” by Elena Kosygina
15:00 - 15:50 Talk 10: “New ballisticity conditions for RWRE” by Noam Berger
15:50 - 16:10 Break (coffee & tea)
16:10 - 17:00 Talk 11: “Sub-ballistic self-avoiding walks” by Hugo Duminil-Copin
18:00 - 20:00 Bosphorus cruise from Bebek to Kuzguncuk
20:00 - Dinner at Ismet Baba Restaurant in Kuzguncuk

Wednesday, July 18.

- 08:15 - 09:30 Shuttle bus from Richmond Hotel to IMBM
09:30 - 10:20 Talk 12: “Formation of facets in an equilibrium model of surface growth ” by Dima Ioffe
10:30 - 11:20 Talk 13: “Discrete interfaces, random tilings and stochastic dynamics” by Fabio Toninelli
11:20 - 11:40 Break (coffee & tea)
11:40 - 12:30 Talk 14: “Poisson-Dirichlet statistics for the extremes of a log-correlated Gaussian field” by Olivier Zeitouni
12:30 - 14:00 Lunch at the Faculty Club (Kennedy Lodge)
14:00 - 14:30 Shuttle bus from IMBM to Richmond Hotel

Thursday, July 19.

- 08:15 - 09:30 Shuttle bus from Richmond Hotel to IMBM
09:30 - 10:20 Talk 15: “Relaxed sector condition” by Bálint Tóth
10:30 - 11:20 Talk 16: “A quenched invariance principle for non-elliptic random walk in i.i.d. balanced random environment” by Jean-Dominique Deuschel
11:20 - 11:40 Break (coffee & tea)
11:40 - 12:30 Talk 17: “Directed random walk on an oriented percolation cluster” by Nina Gantert
12:30 - 14:00 Lunch at the Faculty Club (Kennedy Lodge)
14:00 - 14:50 Talk 18: “On the duality between jump processes on ultrametric spaces and random walks on trees” by Wolfgang Woess
14:50 - 15:10 Break (coffee & tea)
15:10 - 16:00 Talk 19: “On limit theorems for random walks on cocompact Fuchsian groups” by Sebastian Müller
16:30 - 17:00 Shuttle bus from IMBM to Richmond Hotel

Friday, July 20.

- 08:15 - 09:30 Shuttle bus from Richmond Hotel to IMBM
09:30 - 10:20 Talk 20: “The scaling limit of the minimum spanning tree of the complete graph” by Christina Goldschmidt
10:30 - 11:20 Talk 21: “Infinite cycles in the random stirring model on trees” by Alan Hammond
11:20 - 11:40 Break (coffee & tea)
11:40 - 12:30 Talk 22: “Allocation rules for the Poisson point process” by Adam Timar
12:30 - 14:00 Lunch at the Faculty Club (Kennedy Lodge)
14:00 - 14:30 Shuttle bus from IMBM to Richmond Hotel