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M. Franceschetti, R. Meester: Random Networks for Communication. From Statistical Physics to Information Systems

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Ours seems to be the age of decentralized organization. There was a time when hierarchies were dominant structures and everything, from social structures to transfer of information, had to obey their strong constraints. The explosive and widespread use of the Internet and the world wide web, has taught us that it may be worthy to change this paradigm towards a more democratic one where information is shared among all users instead of being under the control of central authorities. Making single users an active part of the evolution of the entire system has led to the spontaneous emergence of the free software, wikipedia and, hopefully, many other cooperative-based applications yet to come. The same kind of decentralized paradigm applies to modern communication systems (like the Internet), where instead of few companies controlling the whole traffic of the system, a large number of smaller communication companies agree to route third party traffic in a decentralized fashion. Of course, this both offers many advantages and at the same time poses new challenges. Systems are not externally designed anymore but self-organized and, therefore, their specific response to any given stimulus may be difficult to predict. Besides, the lack of a centralized controlling agency forces us to devise new protocols for communication able to deal with noisy and ever evolving systems.

The book by M. Franceschetti and R. Meester has been inspired by one of these decentralized communication systems: ad hoc networks. In short, an ad hoc network is a communication system made of devices which are randomly deployed in a two dimensional plane and which can communicate with others within a given range. Of course, the efficiency of such system strongly depends on the existence of paths of intermediate peers connecting two arbitrary far away such devices. One immediately recognizes here the presence of continuum percolation. This book is mainly about the global connectivity properties of random geometric graphs and the implications that disorder and decentralization have on the efficiency of the communication processes taking place on them. The style of the book is quite

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mathematical, with propositions, theorems, lemmas, and proofs of the theorems. However, unlike many mathematical texts, the authors always provide intuitive explanations and detailed discussions of the main points or tricky parts of the proofs. I am convinced that many readers (among them myself) will be thankful for this effort. The book is structured in six chapters covering three main topics, percolation properties of random geometric graphs and their different variants (Chapters 1 to 4), the information capacity of this class of networks (Chapter 5) and, finally, their navigability properties, defined as the ability to find routes in the network using only local information (Chapter 6). The chapters devoted to percolation form the main corpus of the book and provide proofs for many of the results known in the field of continuum percolation. Chapters 5 and 6 are the most novel and interesting as they treat problems specifically arising in this type of systems. In fact, one of the most challenging problems in ad hoc networks concerns the design of routing protocols able to find paths across the system without the need of having a complete knowledge of the network topology, something that may be almost impossible to achieve in certain types of networks where mobile devices create or destroy connections as they move, thus generating a highly dynamical topology. Therefore, having rigorous mathematical results that can be applied in practice will definitely boost this new kind of communication technology.

The reader, and specially physicists, should not get confused by the subtitle of the book. This is a mathematical text and all the results presented in it are rigorous mathematical results. In fact, I have not found much statistical physics in it, probably because the type of tools and arguments physicists use to use—like scaling assumptions or finite size scaling, for instance—are not mathematically rigorous. Writing a book at the frontier between different disciplines is always a difficult task but the authors accomplish it successfully. This book stands as a reference text setting the grounds for future progress involving small world topologies embedded in metric spaces—slightly touched on in the book—or the extension to non euclidean geometries. I recommend this book as a reference text to mathematicians, computer scientists, electrical engineers, and physicists interested in the field of random geometric networks and its applications to modern communication systems.