

Random Geometric Graphs

Chen Avin

Random Geometric Graphs:

Random Geometric Graphs Mathew Penrose, 2003-05-01 This monograph sets out a body of mathematical theory for finite graphs with nodes placed randomly in Euclidean space and edges added to connect points that are close to each other As an alternative to classical random graph models these geometric graphs are relevant to the modelling of real world networks having spatial content arising in numerous applications such as wireless communications parallel processing classification epidemiology astronomy and the internet Aimed at graduate students and researchers in probability combinatorics statistics and theoretical computer science it covers topics such as edge and component counts vertex degrees cliques colourings connectivity giant component phenomena vertex ordering and partitioning problems It also illustrates and extends the application to geometric probability of modern techniques including Stein's method martingale methods and continuum percolation Random Geometric Graphs Mathew Penrose, 2003 Random Geometric Graphs Chen Avin, 2006 1A Bernoulli random graph a k a Erdos Renyi graph B n p is a random graph with n nodes in which each edge is chosen independently at random with an edge probability p n Efficient Broadcast on Random Geometric Graphs, 2009 A Randon Geometric Graph RGG is constructed by distributing n nodes uniformly at random in the unit square and connecting two nodes if their Euclidean distance is at most r for some prescribed r They analyze the following randomized broadcast algorithm on RGGs At the beginning there is only one informed node Then in each round each informed node chooses a neighbor uniformly at random and informs it They prove that this algorithm informs every node in the largest component of a RGG in Omicron n r rounds with high probability This holds for any value of r larger than the critical value for the emergence of a giant component In particular the result implies that the diameter of the giant component is Theta n r **Properties of Random Geometric Graphs** Sanatan Rai,2005 **Random Broadcast on Random Geometric Graphs** ,2009 In this work we consider the random broadcast time on random geometric graphs RGGs The classic random broadcast model also known as push algorithm is defined as starting with one informed node in each succeeding round every informed node chooses one of its neighbors uniformly at random and informs it We consider the random broadcast time on RGGs when with high probability i RGG is connected ii when there exists the giant component in RGG We show that the random broadcast time is bounded by Omicron n diam component where diam component is a diameter of the entire graph or the giant component for the regimes i or ii respectively In other words for both regimes we derive the broadcast time to be Theta diam G which is asymptotically optimal Random Geometric Graphs and Their Applications in Neuronal Modelling Fioralba Ajazi, 2018 Th se HEC 2018 Linear Orderings of Random Geometric Graphs ,1999 Random Geometric Graphs Tobias Müller, 2006 Structural and Algorithmic Properties of Static and Mobile Random Geometric **Graphs** Alexandre De Oliveira Stauffer, 2011 We study fundamental problems for static and mobile networks First we consider the random geometric graph model which is a well known model for static wireless networks In this model n nodes

are distributed independently and uniformly at random in the d dimensional torus of volume n and edges are added between pairs of nodes whose Euclidean distance is at most some parameter r We consider the case where r is a sufficiently large constant so that a so called giant component a connected component with Theta n nodes exists with high probability In this setting we show that the graph distance between every pair of nodes whose Euclidean distance is sufficiently large is only a constant factor larger than their Euclidean distance This result gives as a corollary that the diameter of the giant component is Theta n 1 d r Then we apply this result to analyze the performance of a broadcast algorithm known as the push algorithm In this algorithm at each discrete time step each informed node chooses a neighbor independently and uniformly at random and informs it We show that the push algorithm informs all nodes of the giant component of a random geometric graph within a number of steps that is only a constant factor larger then the diameter of the giant component In the second part of the thesis we consider a model of mobile graphs that we call mobile geometric graphs and which is an extension of the random geometric graph model to the setting where nodes are not static but are moving in space in continuous time In this model we start with a random geometric graph and let the nodes move as independent Brownian motions Then at any given time there exists an edge between every pair of nodes whose Euclidean distance at that time is at most r This model has been recently used as a model for mobile wireless networks. We study four fundamental problems in this model detection the time until a target point fixed or moving is within distance r of some node of the graph coverage the time until all points inside a finite box are detected by the graph percolation the time until a given node belongs to the giant component of the graph and broadcast the time until all nodes of the graph receive a piece of information that was initially known by a single node We obtain precise asymptotics for these quantities by combining ideas from stochastic geometry coupling and multi scale analysis Finally in the last part of the thesis we revisit the push algorithm described above and study its performance in general regular graphs Our goal is to understand the relation between the performance of the push algorithm and the vertex expansion of the graph We prove an upper bound for the runtime of this algorithm that depends on the vertex expansion of the graph and is tight up to polylogarithmic factors Then we show that there exists a substantial difference between the impact of vertex expansion and edge expansion on the performance of the push algorithm In particular we prove the existence of regular graphs which are also vertex transitive that have constant vertex expansion and for which the runtime of the push algorithm is a factor of Omega log n slower than on any regular graph with constant edge expansion

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