Effect of Disorder Strength on Optimal Paths in Complex Networks

SAMEET SREENIVASAN, Center for Polymer Studies and Department of Physics, Boston University, Boston, MA 02215, USA, TOMER KALISKY, Minerva Center and Department of Physics Bar-Ilan University, 52900 Ramat-Gan, Israel, LIDIA A. BRAUNSTEIN, Departamento de Física, Facultad de Ciencias Exactas y Naturales Universidad Nacional de Mar del Plata Funes 3350, 7600 Mar del Plata, Argentina, SERGEY V. BULDYREV, 40 Laurel Hill Terrace, Belfer Hall, Yeshiva U, NY NY, SHLOMO HAVLIN, Minerva Center and Department of Physics Bar-Ilan University, 52900 Ramat-Gan, Israel, H. EUGENE STANLEY, Center for Polymer Studies and Department of Physics, Boston University, Boston, MA 02215, USA — We study the transition between the strong and weak disorder regimes in the scaling properties of the average optimal path $\ell_{opt}$ in a disordered ER random network and SF network. We find that for any finite value of the disorder strength control parameter $a$, there is a crossover network size $N^*(a)$ at which the transition occurs. For $N \ll N^*(a)$ the scaling behavior of $\ell_{opt}$ is in the strong disorder regime, with $\ell_{opt} \sim N^{1/3}$ for ER networks and for SF networks with $\lambda \geq 4$, and $\ell_{opt} \sim N^{(\lambda-3)/(\lambda-1)}$ for SF networks with $3 < \lambda < 4$. For $N \gg N^*(a)$ the scaling behavior is in the weak disorder regime, with $\ell_{opt} \sim \ln N$ for ER networks and SF networks with $\lambda > 3$. We proceed to derive the scaling relation between $N^*(a)$ and $a$. We find that $N^*(a) \sim a^3$ for ER networks and for SF networks with $\lambda \geq 4$, and $N^*(a) \sim a^{(\lambda-1)/(\lambda-3)}$ for SF networks with $3 < \lambda < 4$.

Sameet Sreenivasan
Center for Polymer Studies and Department of Physics Boston University, Boston, MA 02215, USA,

Date submitted: 22 Mar 2013 Electronic form version 1.4