Diffusive Models on Graphs and Networks

by Ernesto Estrada

I will motivate and introduce the study of diffusion on graphs. First, I will study the graph Laplacian operator and the standard diffusion equation on graphs/networks. At this point I will describe degree-biased diffusive processes on graphs and the corresponding operators. I will continue with the introduction of the d-path Laplacian operators as a way to capture non-local spatial processes on graphs. I will prove the existence of superdiffusive behavior in different dimensions with the use of diffusion equations that use Mellin-transformed d-path Laplacian operators. Finally, I will introduce a time-and-space nonlocal generalized diffusion equation on graphs. This equation uses time-fractional derivatives of the Caputo-type in combination with Mellin-transformed d-path Laplacian operators. I will prove the existence of normal, sub- and super-diffusive behavior on graphs with the use of this equation. The use of real-world examples will help the students to understand the importance of these phenomena in the real world.