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Fractional diffusion on a graph as a memory-driven diffusion

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Subdiffusion on networks can occur where overcrowding is present. It is studied through time-fractional diffusion equations, and admits an explicit solution through the Mittag-Leffler function. We give a representation of subdiffusion as a superposition of classical diffusion processes with subordination to a different timescale. Memory arises in subdiffusion, while the classical diffusion processes are Markovian.

We study the subdiffusive geometry of the network that is uncovered by the dynamics, a new metric on the graph obtained with the Communicability Distance. Fixing two vertices, the shortest paths between them are vastly different in subdiffusion and diffusion geometries. We show how memory emerges from these two different behaviours and the relation with operator-valued Volterra evolution equations.

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