An introduction to fractional calculus

Fractional differential equations have recently made a renaissance, mainly driven by scientists in Physics, Finance, and Hydrology, as they can be derived via stochastic limit theorems and hence provide robust and parsimonious models predicting power-law tails. This is because fractional derivatives derive from sums of random movements with power law probability tails, for which the usual central limit theorem is replaced by its heavy tail analogue. In this talk we give an introduction to fractional differential equations involving mathematical topics ranging from scaling limits of random walks to fractional powers of linear operators on a Banach space. We also give several motivational examples to the theory, including contaminant transport in subsurface hydrology, human travel patterns and spreading of invasive species.