Power Grid Frequency Increments as Indicators of Complex and Critical Dynamics in Networked Systems

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Abstract

Power grids are a good example of a human-made complex system that is vital for the functioning of many supply systems crucial to our lives. On the one hand, they generate complex frequency fluctuation signals at the micro scale, and on the other hand they represent complex network topologies at the macro scale [1,2]. A limited number of studies have been conducted to create open databases of power grid frequencies from various locations in continental Europe and to analyse them using real experimental data [3]. Nevertheless, in a very recent study, real power grid frequency data recorded from Asia, Australia, and Europe were analyzed for their non-standard characteristics, and for the first time, an open data source for these regions was created [4].

In this study, we show that the PDFs of the increments of power grid frequency data recently recorded in regions across Asia, Australia, Africa and Europe, exhibit a non-Gaussian distribution. In addition, we apply q-Gaussian fits to demonstrate that they display fat tails that are characterized by a q-Gaussian equation, a feature that is consistently identified as a typical characteristics of complex behavior. Some of the distributions that we investigate also exhibit slightly asymmetric behaviour.

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