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Systematic inference of the long-range dependence and heavy-tail distribution parameters of ARFIMA models

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Long-Range Dependence (LRD) and heavy-tailed distributions are ubiquitous in natural and socio-economic data. Such data can be self-similar whereby both LRD and heavy-tailed distributions contribute to the self-similarity as measured by the Hurst exponent. Some methods widely used in the physical sciences separately estimate these two parameters, which can lead to estimation bias. Those which do simultaneous estimation are based on frequentist methods such as Whittle's approximate maximum likelihood estimator. Here we present a new and systematic Bayesian framework for the simultaneous inference of the LRD and heavy-tailed distribution parameters of a parametric ARFIMA model with non-Gaussian innovations. As innovations we use the alpha-stable and t-distributions which have power law tails. Our algorithm also provides parameter uncertainty estimates. We test our algorithm using synthetic data, and also data from the Geostationary Operational Environmental Satellite system (GOES) solar X-ray time series. These tests show that our algorithm is able to accurately and robustly estimate the LRD and heavy-tailed distribution parameters.

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