THE FIELDS INSTITUTE
FOR RESEARCH IN MATHEMATICAL SCIENCES

ABSTRACTS 1.2

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High resolution spectral analysis via analytic interpolation

The culmination of research efforts in the 1980's and 1990's for high resolution techniques led to the so-called modern nonlinear methods, such as the maximum entropy, the maximum likelihood, and subspace identification techniques of MUSIC, ESPRIT and their variants. However, despite their many successes, in practical situations it is often the Fourier methods that are still the workhorse of the industry, e.g., in imaging, ultrasound, spectroscopy, etc. In fact, one may argue that for sufficiently complex spectra, variability and numerical problems render the nonlinear methods least attractive. The promised improvement in resolution is adversely affected by these problems. In this talk we will present a new class of very high resolution methods for spectral analysis. The methods are natural extentions of the classical nonlinear techniques and their theory rests on a new mathematical framework. The key idea is to use non- traditional statistics which enhance the relevance of the spectral content within any preselected interval. More specifically, a general class of input-to- state (I2S) filters is introduced, and the state-statistics are used for reconstructing the input spectrum. The frequency response of the I2S filter determines the sensitivity of spectral estimators. Maximum-entropy-like, Capon-like, MUSIC-like etc. methods are developed using state-statistics and their performance is discussed in the context of spectral line identification and SAR and ultrasound imaging. The new class of algorithms allow the frequency range to be dissected into smaller interval, thus keeping the complexity and variance of estimators to a minimum.