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Statistical multiscale methods for signal detection and related problems

In statistical signal and anomaly detection problems, an optimal method may depend on – the usually unknown – scale of a signal or size of an anomaly. Moreover, in many situations relevant scales might vary throughout a sample. Often these issues can be tackled by employing multiscale methods, that is, instead of choosing a scale prior to data analysis, a variety of scales is incorporated simultaneously. In this talk, we will discuss the application of multiscale methods to image segmentation and mode hunting and we will discuss the connection to matched filtering. All these examples will be formulated as multiple testing problems and therefore we will have to deal with multiplicity effects. In order to obtain a valid simultaneous procedure we will correct for multiplicity in a strong and uniform way and it will be crucial to understand the number of effective, independent tests performed throughout the procedure. Perhaps surprisingly, asymptotically, the multiscale approach does not add to this number, compared to a single scale approach. As a consequence the proposed multiscale procedures can be shown to be adaptive and to perform optimally in sparse detection problems.

keywords: Alien-worlds, Alpacas, Also: Extreme value theory, Multiple testing, Signal detection, Simultaneous inference.

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