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A Geometrical Method for High Dimensional On-line Process Monitoring

I will review recent work where we take an extrinsic manifold fitting point of view, contrary to a manifold learning (i.e., embedding) approach, to develop an on-line monitoring scheme with a simple geometric interpretation which requires neither decorrelation of process dynamics nor dimensionality reduction. The new monitoring framework for online or “phase II” SPC monitors deviations from the reconstructed manifold using a novel univariate (scalar) distribution-free control chart. The average run length performance of the new method is compared to manifold learning methods that first embed the data into a lower-dimensional space before monitoring the embedded observations via explicit out of sample extensions. The manifold fitting SPC method has a provable controllable Type I error probability and, contrary to manifold learning SPC methods, it can operate in a high-dimensional regime where the ambient dimension exceeds the number of “phase I” in-control observations. An application to image data will be presented as well directions for further research.

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