Mechanical Engineering Seminar

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Variation Bounding: Theory, Systems & Optimization

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Variation bounding, i.e., preventing an increase of zero-crossings or local extrema is an elementary property that we often expect from tools in signal processing, statistics, geometric modelling or approximation theory. The old and well-established theory behind this concept, however, has barely entered the respected communities and been mostly forgotten by now. In this talk, we will first review the basic concepts and characterization of this property. Subsequently, the talk will be divided into three parts to provide an overview of the research activities at our group.

In the first part, we will fill gaps in the characterization of linear variation bounding mappings and show how this can be used to characterize and verify variation bounding in system operators. Our results are applied to the open problem of upper bounding the number of over- and undershoots in a step response. In the second part, we will discuss how variation bounding provides tractability in the NP-hard problem of sparse optimization. In the third part, we will provide a new view on existing certificates based on elementary function properties, which will allow us to achieve an extension based on convex polygons. This extension is used then to provide a first characterization of systems with cyclic variation bounding properties, which we will see is a highly common property of systems considered in the study of relay feedback. In fact, we will see that cyclic variation bounding systems exhibit a monotone gain property, which is a common assumption in heuristic analysis based on harmonic balancing.