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**PREDAVANJE**

# Sampling, Sparsity, and Inverse Problems

Joint work with T.Blu (CUHK), Y.Lu (Harvard), Y.Barbotin, I.Dokmanic, M.Kolundzija, M.Martinez-Camara, J.Ranieri (EPFL)

## Sala 25, Paviljon Rašović (u dvorištu), subota, 22.09.2012, 10:45


**Abstract:**
Sampling is a central topic in signal processing, communications, and in all fields where the world is analog and computation is digital. The question is simple: When does a countable set of measurements allow a perfect and stable representation of a class of signals? This allows the reconstruction of the analog world, or interpolation. A related problem is when these measurements allow to solve inverse problems accurately, like source localization.

Classic results concern bandlimited functions and shift-invariant subspaces, and use linear approximation. Recently, non-linear methods have appeared, based on parametric methods and/or convex relaxation, which allow a broader class of sampling results. We review sampling of finite rate of innovation (FRI) signals, which are non-bandlimited continuous-time signals with a finite parametric representation. This leads to sharp results on sampling and reconstruction of such sparse continuous-time signals. We then explore performance bounds on retrieving sparse continuous-time signals buried in noise. While this is a classic estimation problem, we show sharper lower bounds for simple cases, indicating (i) there is a phase transition and (ii) current algorithms are close to the bounds. This leads to notions of resolution or resolvability. We then turn our attention to sampling problems where physics plays a central role. After all, many sensed signals are the solution of some PDE. In these cases, continuous-time or continuous-space modeling can be advantageous, be it to reduce the number of sensors and/or the sampling rate.

First, we consider the wave equation, and review the fact that wave fields are essentially bandlimited in space-time domain. This can be used for critical sampling of acquisition or rendering of wave fields. We also show an acoustic source localization problem, where wideband frequency probing and finite element modeling show interesting localization power. Then, in a diffusion equation scenario, source localization using a sensor network can be addressed with a parametric approach, indicating trade-offs between spatial and temporal sampling densities. This can be used in air pollution monitoring and temperature sensing. In all these problems, the computational tools like FRI or CS come in handy when the modeling and the conditioning is adequate. Last but not least, the proof of the pudding is in experiments and/or real data sets.


Predavač


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**Presenter's bio:**
**Martin Vetterli** received the Dipl. El.-Ing. degree from Eidgenössische Technische Hochschule (ETH), Zurich, in 1981, the Master of Science degree from Stanford University in 1982, and the Doctorat ès Sciences degree from the Ecole Polytechnique Fédérale, Lausanne, in 1986. He was an Associate Professor in Electrical Engineering at Columbia University in New York, and in 1993, he became an Associate and then Full Professor at theDepartment of Electrical Engineering and Computer Sciences at the University of California at Berkeley. In 1995, he joined the EPFL as a Full Professor. From 2004 to 2011 he was Vice President of EPFL and since March 2011, he is the Dean of the School of Computer and Communications Sciences. As of January 1st, 2013 he will lead the Swiss National Science Foundation.
He works in the areas of electrical engineering, computer sciences and applied mathematics covering wavelet theory and applications, image and video compression, self-organized communications systems and sensor networks, as well as fast algorithms, and has led to about 150 journals papers. He is the co-author of three textbooks: "Wavelets and Subband Coding" (with J. Kovacevic, Prentice-Hall, 1995), "Signal Processing for Communications", (with P. Prandoni, CRC Press, 2008) and the forthcoming book "Fourier and Wavelet Signal Processing" (with J. Kovacevic and V. Goyal, 2012). His research resulted also in about two dozen patents that led to technology transfers to high-tech companies and the creation of several start-ups. His work won him numerous prizes. He is a Fellow of IEEE, of ACM and EURASIP, was a member of the Swiss Council on Science and Technology (2000-2004), and is an ISI highly cited researcher in engineering.

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