SampTA 2019

13th International conference on Sampling Theory and Applications

université de BORDEAUX

July 8-12

Monday July 8, 9.15-12.30 am

Wegener	9.15-9.25	Opening
Wegener	9.25-10.25	*Signal processing on graphs for applications in machine learning and network science* Pierre Vandergheynst Chair: Remi Gribonval
		Compressed Sensing and low-rank matrix recovery (invited session) Chair: Felix Kramer & Richard Kueng
Wegener	10.25-10.50	*Matrix Completion with Selective Sampling* Christian Parkinson, Kevin Huynh & Deanna Needell
Wegener	10.50-11.15	*Entropy Estimates on Tensor Products of Banach Spaces and Applications to Low-Rank Recovery* Kiryung Lee, Rakshith Sharma Srinivasa, Marius Junge & Justin K Romberg
Wegener	11.15-11.40	*New Algorithms and Improved Guarantees for One-Bit Compressed Sensing on Manifolds* Rayan Saab, Mark Iwen, Eric Lybrand & Aaron Nelson
Wegener	11.40-12.05	*Completion of Structured Low-Rank Matrices via Iteratively Reweighted Least Squares* Christian Kümmerle & Cláudio M. Verdun
Wegener	12.05-12.30	*Robust Recovery of Sparse Non-negative Weights from Mixtures of Positive-Semidefinite Matrices* Peter Jung

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		Gabor Analysis Chair: Volker Pohl
Edison	10.25-10.50	*Signal transmission through an unidentified channel* Dae Gwan Lee, Goetz E Pfander & Volker Pohl
Edison	10.50-11.15	*A quantitative Balian-Low theorem for subspaces* Andrei Caragea, Dae Gwan Lee, Friedrich Philipp & Felix Voigtlaender
Edison	11.15-11.40	*Time-Frequency Shift Invariance of Gabor Spaces* Friedrich Philipp, Andrei Caragea, Dae Gwan Lee & Felix Voigtlaender
Edison	11.40-12.05	*Adaptive Frames from Quilted Local Time-Frequency Systems* *Arvin Lamando* & Gino Angelo Velasco
Edison	12.05-12.30	*On the smoothness of dual windows for Gabor windows supported on* $[-1;1]$ Kamilla H. Nielsen & Jakob Lemvig

Compressed Sensing and low-rank matrix recovery

Chair: Felix Kramer & Richard Kueng

10.25-10.50: Matrix Completion with Selective Sampling

Christian Parkinson, Kevin Huynh & Deanna Needell

Abstract: Matrix completion is a classical problem in data science wherein one attempts to reconstruct a low-rank matrix while only observing some subset of the entries. Previous authors have phrased this problem as a nuclear norm minimization problem. Almost all previous work assumes no explicit structure of the matrix and uses uniform sampling to decide the observed entries. We suggest methods for selective sampling in the case where we have some knowledge about the structure of the matrix and are allowed to design the observation set.

10.50-11.15: Entropy Estimates on Tensor Products of Banach Spaces and Applications to Low-Rank Recovery

Kiryung Lee, Rakshith Sharma Srinivasa, Marius Junge & Justin K. Romberg

Abstract: Low-rank matrix models have been universally useful for numerous applications starting from classical system identification to more modern matrix completion in signal processing and statistics. The Schatten-1 norm, also known as the nuclear norm, has been used as a convex surrogate of the low-rankness since it induces a low-rank solution to inverse problems. While the Schatten-1 norm for low-rankness has a nice analogy with the ℓ^1 norm for sparsity through the singular value decomposition, other matrix norms also induce low-rankness. Particularly as one interprets a matrix as a linear operator between Banach spaces, various tensor product norms generalize the role of the Schatten-1 norm. Inspired by a recent work on the max-norm based matrix completion, we provide a unified view on a class of tensor product norms and their interlacing relations on low-rank operators. Furthermore we derive entropy estimates between the injective and projective tensor products of a family of Banach space pairs and demonstrate their applications to matrix completion and decentralized subspace sketching.

Compressed Sensing and low-rank matrix recovery

Chair: Felix Kramer & Richard Kueng

11.15-11.40: New Algorithms and Improved Guarantees for One-Bit Compressed Sensing on Manifolds

Rayan Saab, *Mark Iwen*, Eric Lybrand & Aaron Nelson

Abstract: We study the problem of approximately recovering signals on a manifold from one-bit linear measurements drawn from either a Gaussian ensemble, partial circulant ensemble, or bounded orthonormal ensemble and quantized using $\Sigma\Delta$ or distributed noise shaping schemes. We assume we are given a Geometric Multi-Resolution Analysis, which approximates the manifold, and we propose a convex optimization algorithm for signal recovery. We prove an upper bound on the recovery error which outperforms prior works that use memoryless scalar quantization, requires a simpler analysis, and extends the class of measurements beyond Gaussians. Finally, we illustrate our results with numerical experiments.

11.40-12.05: Completion of Structured Low-Rank Matrices via Iteratively Reweighted Least Squares

Christian Kümmerle & Cláudio M. Verdun

Abstract: We propose a new Iteratively Reweighted Least Squares (IRLS) algorithm for the problem of completing a low-rank matrix that is linearly structured, e.g., that possesses a Hankel, Toeplitz or block-Hankel/Toeplitz structures, which is of relevance for the harmonic retrieval or super-resolution problem. The algorithm optimizes a non- convex surrogate of the rank by minimizing well-chosen quadratic upper bounds of the smoothed surrogate. We establish a quadratic local convergence rate of the developed IRLS strategy if the linear structure is Hankel, with high probability if the provided entries of the matrix are sampled uniformly at random, and if the matrix to be completed fulfills a suitable coherence condition. Our strategy combines computational efficiency, as the dimensionality of its optimization variables scales sub-linearly in the matrix dimensions, with a favorable data efficiency, as it can be observed in experiments on hard completion tasks. In particular, our experiments show that the proposed algorithm exhibits an empirical recovery probability close to one from fewer samples than existing state-of-the-art approaches for the Hankel matrix completion task arising from the problem of spectral super-resolution of frequencies with small separation.

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Compressed Sensing and low-rank matrix recovery

Chair: Felix Kramer & Richard Kueng

12.05-12.30: Robust Recovery of Sparse Non-negative Weights from Mixtures of Positive-Semidefinite Matrices

Peter Jung

Abstract: We consider a model where a matrix is generated as an s-sparse linear combination of d given $n \times n$ positive-semidefinite matrices. Recovering the unknown d-dimensional and s-sparse weights from noisy observations is an important problem in various fields of signal processing and also a relevant pre-processing step in covariance estimation. We will present related recovery guarantees and focus on the case of non-negative weights. The problem is formulated as a convex program and can be solved without further tuning. Such robust, non-Bayesian and parameter-free approaches are important for applications where prior distributions and further model parameters are unknown.

We will discuss some applications in wireless communication like estimating (non-negative) pathloss coefficients and user activity using multiple antennas. Here, a small subset of s¡¡d devices indicate activity by transmitting specific length-n sequences which superimpose at each receive antenna with individual and unknown instantaneous channel coefficients. Well-known results in compressed sensing show that when using for given s and d sufficiently random sequences of length $n = O(s \,\text{polylog}(d))$ one can recover per antenna w.h.p. the channel coefficients and the activity pattern (the essential support). However, since in future even s will grow considerably the question is how to further gain from a massive number of receive antennas.

We will present some recent ideas and scaling laws in this context. In particular, using the analysis above for the rank-one case, for given n and d one can recover pathloss coefficients and activity of up to $s = n^2/\text{polylog}(d/n^2)$ devices from the empirical covariance over sufficiently many receive antennas.

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Gabor Analysis

Chair: Volker Pohl

10.25-10.50: Signal transmission through an unidentified channel

Dae Gwan Lee, Goetz E. Pfander & Volker Pohl

Abstract: We formulate and study the problem of recovering a signal x in $\mathcal{X} \subset \mathbb{C}^L$ which, after adding with a signal $c \in \mathbb{C}^L \setminus \{0\}$, is transmitted through an unknown channel H in $\mathcal{H} \subset \mathcal{L}(\mathbb{C}^L, \mathbb{C}^L)$. Here, $\mathcal{X}$ and $\mathcal{H}$ are a priori known and fixed while c is designed by the user. In particular, we focus on the case where $\mathcal{H}$ is generated by a subset of time-frequency shift operators on $\mathbb{C}^L$, which leads to investigation of properties of Gabor matrices.

10.50-11.15: A quantitative Balian-Low theorem for subspaces

Andrei Caragea, Dae Gwan Lee, Friedrich Philipp & Felix Voigtlaender

Abstract: We consider Gabor Riesz sequences generated by a window function with finite uncertainty product over a rational lattice in $\mathbb{R}^2$. We prove that the distance of a time-frequency shift of the window function to the Gabor space is equivalent, up to constants, to the Euclidean distance of the parameters of the time- frequency shift to the lattice. Under certain additional assumptions, these constants can be estimated. As a byproduct of the methods employed, we also obtain a strengthening of the so-called weak Balian-Low theorem.

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Gabor Analysis

Chair: Volker Pohl

11.15-11.40: Time-Frequency Shift Invariance of Gabor Spaces

Friedrich Philipp, Andrei Caragea, Dae Gwan Lee & Felix Voigtlaender

Abstract: We consider non-complete Gabor frame sequences generated by an S_0-function and a lattice Λ and prove that there is $m \in \mathbb{N}$ such that all time-frequency shifts leaving the corresponding Gabor space invariant have their parameters in $\frac{1}{\Lambda}$. We also investigate time-frequency shift invariance under duality aspects.

11.40-12.05: Adaptive Frames from Quilted Local Time-Frequency Systems

Arvin Lamando & Gino Angelo Velasco

Abstract:
A family of regions that cover the time-frequency plane is considered, and from each region, (possibly irregular) sampling points are taken, thereby generating local time-frequency systems for each component region. This results to "local patches" of Gabor systems which are then put together. In this work, we will be looking at different conditions in which the resulting quilted system, as well as its projection onto subspaces of eigenfunctions of time-frequency localization operators, is to exhibit a frame property.

12.05-12.30: On the smoothness of dual windows for Gabor windows supported on $[-1;1]$

Kamilla H. Nielsen & Jakob Lemvig

Abstract: We study Gabor frames of the form $\{e^{2\pi i b m \cdot} g(\cdot - ak)\}_{m,k\in\mathbb{Z}}$ generated by windows $g \in C^n(\mathbb{R})$, $n \in \mathbb{Z}_{\geq 0} \cup \{\infty\}$, that are (only) non-zero on an open interval of length $L > 0$ with translation parameter $a = L/2$ and modulation parameter $b \in (0, 2/L)$. We review a recent explicit construction of all dual windows with sufficiently short support by the two authors [J. Lemvig, K. H. Nielsen, Gabor windows supported on $[-1, 1]$ and construction of compactly supported dual windows with optimal frequency localization, preprint]. We then show that the obtainable smoothness index m in $C^m(\mathbb{R})$ of dual windows depends on the location of singularities of g, e.g., on the location of points x_0, where $g^{(m)}(x_0)$ fails to be continuous for $m > n$. Our proof yields an explicit construction procedure of smooth dual windows once the singularities of g avoid the specified locations.