3. International Matheon Conference on

Compressed Sensing and its Applications

December 4-8, 2017

Technische Universität Berlin

Conference Program

For more information visit us on:

www.math.tu-berlin.de/csa2017

<table>
<tr><th>Time</th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td>08:30-
08:45</td><td>Registration
from 7:30</td><td colspan="4" rowspan="2">Registration</td></tr>
<tr><td>08:45 –
09:00</td><td>Welcome Remarks</td></tr>
<tr><td>09:00 –
10:00</td><td>Ingrid Daubechies</td><td>Rob Nowak</td><td>Martin Burger</td><td>Joel Tropp</td><td>John Wright</td></tr>
<tr><td>10:00 –
10:30</td><td colspan="5">Coffee Break</td></tr>
<tr><td>10:30 –
11:05</td><td>Rima Alaifari</td><td>Rebecca Willett</td><td>Philipp Grohs</td><td>Sjoerd Dirksen</td><td>Massimo Fornasier</td></tr>
<tr><td>11:05
11:40</td><td>Yaniv Plan</td><td>Galen Reeves</td><td>Peter Maaß</td><td>Deanna Needell</td><td>Miguel Rodrigues</td></tr>
<tr><td>11:40 –
12:15</td><td>Sara van de Geer</td><td>Boaz Nadler</td><td>Yuejie Chi</td><td>Bogdan Roman</td><td>Final Remarks</td></tr>
<tr><td>12:15 –
14:00</td><td colspan="4">Lunch Break</td><td></td></tr>
<tr><td>14:00 –
15:00</td><td>René Vidal</td><td>Gabriel Peyré</td><td rowspan="5">Excursion</td><td>Joachim Ender</td><td></td></tr>
<tr><td>15:00 –
15:30</td><td colspan="2">Coffee Break</td><td>Coffee Break</td><td></td></tr>
<tr><td>15:30 –
16:05</td><td>Ivan Dokmanic</td><td rowspan="3">Poster Session
&
Coffee</td><td rowspan="3">Poster Session
&
Coffee</td><td></td></tr>
<tr><td>16:05 –
16:40</td><td>Gilad Lerman</td><td></td></tr>
<tr><td>16:40 –
17:45</td><td></td><td></td></tr>
<tr><td>19:00 –
24:00</td><td></td><td></td><td>Conference
Dinner</td><td></td><td></td></tr>
</table>

Dear Participant,

it is a pleasure to welcome you to the *3. International* MATHEON *Conference on Compressed Sensing and its Applications.* This time around, the contributions on Compressed Sensing will be accompanied by quite a few related to Deep Learning. We are particularly excited to see which synergies can be created as these two fields meet.

We would like to express our gratitude to all Plenary and Invited Speakers for accepting our invitation, as well as to all participants for visiting the Technische Universität Berlin to join this conference. We also gratefully acknowledge the support by the Deutsche Forschungsgemeinschaft (DFG), the DFG Research Center MATHEON "Mathematics for key technologies" in Berlin and the Einstein Center for Mathematics Berlin.

No conference would be possible without a team of dedicated volunteers, and we gratefully acknowledge the help of all members of the Applied Functional Analysis Group at the Technische Universität Berlin:

Tiep Dovan	Ali Hashemi	Maximilian März
Katharina Eller	Anja Hedrich	Mones Raslan
Axel Flinth	Sandra Keiper	Martin Schäfer
Ansgar Freyer	Héctor Andrade Loarca	Felix Voigtlaender
Ingo Gühring	Jan Macdonald	
Martin Genzel	Stephan Wäldchen	

If you have any questions, please feel free to come to the registration desk, which will be open each day from 8.30–9.00 (from 7:30 on monday) as well as during the coffee breaks. You may also contact any member of the organizing team, whose members are identifiable via colored name tags.

We have created a slack workspace for this conference. This will act as a discussion forum, and everyone is encouraged to join. There, we will make announcements (such as last-minute changes), and you have the opportunity to share links, ask questions, or maybe just look for people with whom to go lunch. The slack workspace can be found via `https://tinyurl.com/CSA17Slack`, or by simply scanning the QR-code at the back of the booklet. It can then be used either through any web browser, or via the slack app, which is available both for Android and Apple devices.

We now wish you an exciting conference, which we hope will bring you fruitful scientific exchange and many new contacts.

Holger Boche	Robert Calderbank	Rudolf Mathar
Giuseppe Caire	Gitta Kutyniok	Philipp Petersen

Table of Contents

Monday Plenary Talks

TBA

Ingrid Daubechies

Duke University

09:00–10:00

TBA

Scalable Sparse Subspace Clustering

René Vidal

Johns Hopkins University

14:00–15:00

Subspace clustering methods based on sparse representation theory have become very popular due to their simplicity, theoretical guarantees and empirical success. However, their applicability to large scale datasets (beyond 10K data points) has been limited due to time complexity and/or memory footprint issues. In this talk, I will present two scalable sparse subspace clustering methods. The first method addresses the scalability issue by using orthogonal matching pursuit (OMP), which is guaranteed to give a subspace-preserving affinity (i.e., there are no connections between points from different subspaces) under broad conditions (e.g., arbitrary subspaces and corrupted data). However, since OMP produces a sparse affinity, each cluster may not be well-connected, which can affect clustering performance. The second method addresses both the scalability and the connectivity issue, while maintaining the subspace-preserving property, by using elastic net (EN) regularization and an active set method. Our experiments show that both methods achieve state-of-the-art performance and can efficiently handle datasets with 500K data points.

Monday Invited Talks

Morning Session

10:30–11:05 **Phase Retrieval in Infinite Dimensions**
Rima Alaifari, ETH Zürich

In phase retrieval problems, a signal is sought to be reconstructed from only the magnitudes of a set of complex measurements. The missing information of the phase of the measurements severely obstructs the signal reconstruction.

We study this problem in the setting where the signal belongs to an infinite-dimensional Hilbert space. This problem is inherently unstable, i.e. highly sensitive to noise in the measurements. We show that in some sense this property is independent of the redundancy of the measurements. However, the instabilities observed in practice are all of a certain type. Motivated by this observation, we introduce a new paradigm for stable phase retrieval.

We demonstrate that in audio processing applications this new notion of stability is natural and meaningful and that in this new setting stability can actually be achieved for certain measurement systems.

This is joint work with I. Daubechies (Duke University), P. Grohs (University of Vienna) and R. Yin (Duke University).

11:05–11:40 **Debiasing 1-step matrix completion**
Yaniv Plan, University of British Columbia

A simple and quick method for matrix completion is to fill in missing entries with zeros, take the low-rank projection of the result, and then rescale, thereby giving an estimate of all entries of the matrix. It is known that (amid noise) the estimate has near-optimal sample complexity. The ease and speed of creating this estimate makes it appealing to use as a warm start for other methods. However, a non-uniform sampling pattern can introduce bias, resulting in an unusable estimated matrix. We give a simple, data-dependent method to de-bias, which does not assume any knowledge of an underlying sampling distribution.

11:40–12:15 **Sharp estimators using ℓ_1– or other regularization methods**
Sara van de Geer, ETH Zürich

We consider a parameter of interest $\beta^0 \in \mathbb{R}^p$ that is to be estimated from random data $X_1, \dots, X_n$. Our focus is on the "high-dimensional" case where p can be much larger than n. For $b \in \mathscr{B} \subseteq \mathbb{R}^p$, let $\hat{R}_n(b)$ be a given risk function depending on the data. The set $\mathscr{B}$ is assumed to be convex. Consider for a tuning parameter

$\lambda > 0$ the minimization problem

$$\min\left\{\hat{R}_n(b) + \lambda\|b\|_1 \ : b \in \mathscr{B}\right\}$$

Let $\hat{\beta} \in \mathscr{B}$ be a solution of the KKT conditions

$$\dot{\hat{R}}_n(\hat{\beta}) + \lambda\hat{z} = 0,\ \hat{z} \in \partial\|\hat{\beta}\|_1$$

or more generally, suppose $\hat{b}$ satisfies

$$\dot{\hat{R}}_n^{\beta}(\hat{\beta} - b) + \lambda\|\hat{\beta}\|_1 - \lambda\|b\|_1 \leq 0 \quad \forall b \in \mathscr{B}.$$

Let the theoretical risk be

$$R(b) := \mathbb{E}\hat{R}_n(b), \quad b \in \mathscr{B}.$$

Let β be some "oracle", possibly $\beta = \beta_0$ or some approximation thereof. We provide conditions for high probability sharp oracle inequalities of the form

$$R(\hat{\beta}) \leq R(\beta) + \text{ error},$$

where the error depends on β via the "curvature" of R at β and the "effective sparsity" of β. The results allow for cases where $\hat{R}_n$ is not convex (but R is). Illustrations include sparse principal components and the estimation of an inverse Fisher information matrix in high dimensions. We also present some sharp oracle results for estimators based on non-differentiable but convex risk $\hat{R}_n$ such as the least absolute deviations estimator in a high-dimensional linear model. Finally, we briefly sketch the extension to sparsity inducing norms other than ℓ_1.

Afternoon Session

15.30–16.05 **Regularization by invariant multiscale statistics**
Ivan Dokmanic, University of Illinois

I will talk about a new approach to linear ill-posed inverse problems with data-driven regularization. Instead of learning a stable inverse, unrolling standard algorithms into neural nets, or learning projectors for iterative schemes, we still compute the solution as a minimizer of a regularized cost functional, albeit non-convex. Our regularizer promotes "correct" conditional statistics in some feature space. As feature transform we choose the non-linear multiscale scattering transform—a complex convolutional network which discards the phase and thus exposes spectral correlations otherwise hidden beneath the phase fluctuations.

We need scale separation in order to guarantee stability to deformations. For a given realization, the feature-space representation is linearly estimated from a reconstruction in a stable subspace and it represents the unstable part of the signal. We demonstrate that our approach stably recovers the missing spectrum in super-resolution and tomography.

16.05–16.40 **Exact Camera Location Recovery by Least Unsquared Deviations**
Gilad Lerman, University of Minnesota

We establish exact recovery for the Least Unsquared Deviations (LUD) algorithm of Ozyesil and Singer. More precisely, we show that for sufficiently many cameras with given corrupted pairwise directions, where both camera locations and pairwise directions are generated by a special probabilistic model, the LUD algorithm exactly recovers the camera locations with high probability. A similar exact recovery guarantee was established for the ShapeFit algorithm by Hand, Lee and Voroninski, but with typically less corruption. This is a joint work with Yunpeng Shi and Teng Zhang.

Tuesday Plenary Talks

Outranked: Exploiting Nonlinear Algebraic Structure in Matrix Recovery Problems

Rob Nowak

University of Wisconsin–Madison

9:00–10:00

This talk considers matrix completion in cases where columns are points on a nonlinear algebraic variety (in contrast to the commonplace linear subspace model). A special case arises when the columns come from a union of subspaces, a model that has numerous practical applications. We propose an approach to this problem based on data tensorization (i.e., products of original data) in combination with standard low-rank matrix completion methods. The key insight is that while the original data matrix may not exhibit low-rank structure, often the tensorized data matrix does. The challenge, however, is that the missing data patterns in the tensorized matrix are highly structured and far from uniformly random. We show that, under mild assumptions, the observation patterns are generic enough to enable exact recovery.

Off-the-grid Methods for Sparse Spikes Super-resolution

Gabriel Peyré

EMA, École Normale Supérieure

14:00–15:00

In this talk, I study sparse spikes super-resolution over the space of measures (as initiated for instance in [2,3]), in order to solve a wide variety of inverse problems in imaging sciences. For non-degenerate sums of Diracs, we show that, when the signal-to-noise ratio is large enough, total variation regularization of measures (which is the natural extension of the ℓ_1 norm of vectors to the setting of measures) recovers the exact same number of Diracs. We also show that both the locations and the heights of these Diracs converge toward those of the input measure when the noise drops to zero. When the measure is positive, it is known that

ℓ_1-type methods always succeed when there is no noise. We show that exact support recovery is still possible when there is noise. The signal-to-noise ratio should then scale like $1/t^{2N-1}$ where there are N spikes separated by a distance t. This reflects the intrinsic explosion of the ill-posedness of the problem [4]. Lastly, I will also discuss computational methods to solve the corresponding grid-free infinite-dimensional optimization problem. I will advocate for the use of an hybridization between a convex Frank-Wolfe algorithm (which progressively adds points to the computation grid) and a non-convex update (that moves the grid points), and show that it performs surprisingly well on deconvolution and Laplace inversion. This is joint work with Vincent Duval and Quentin Denoyelle, see [1,4] for more details.

References

[1] V. Duval, G. Peyré, *Exact Support Recovery for Sparse Spikes Deconvolution*, Foundation of Computational Mathematics, **15(5)**, pp. 1315–1355, 2015.

[2] E. J. Candès and C. Fernandez-Granda. *Towards a mathematical theory of super-resolution.* Communications on Pure and Applied Mathematics, **67(6)**, pp. 906-956, 2013.

[3] K. Bredies and H.K. Pikkarainen. *Inverse problems in spaces of measures.* ESAIM: Control, Optimisation and Calculus of Variations, **19**, pp. 190-218, 2013.

[4] Q. Denoyelle, V. Duval, G. Peyré. *Support Recovery for Sparse Deconvolution of Positive Measures*, to appear in Journal of Fourier Analysis and Applications, 2017.

Tuesday Invited Talks

Morning Session

10:30–11:05 **Graph Total Variation for Inverse Problems with Highly Correlated Designs**
Rebecca Willett, University of Wisconsin-Madison

Sparse high-dimensional linear regression and inverse problems have received substantial attention over the past two decades. Much of this work assumes that explanatory variables are only mildly correlated. However, in modern applications ranging from functional MRI to genome-wide association studies, we observe highly correlated explanatory variables and associated design matrices that do not exhibit key properties (such as the restricted eigenvalue condition). In this talk, I will describe novel methods for robust sparse linear regression in these settings. Using side information about the strength of correlations among explanatory variables, we form a graph with edge weights corresponding to pairwise correlations. This graph is used to define a graph total variation regularizer that promotes similar weights for correlated explanatory variables. I will show how the graph structure encapsulated by this regularizer interacts with correlated design matrices to yield provably accurate estimates. The proposed approach outperforms standard methods in a variety of experiments on simulated and real fMRI data.

This is joint work with Yuan Li and Garvesh Raskutti.

11:05–11.40 **Additivity of Information in Multilayer Networks via Additive Gaussian Noise Transforms**
Galen Reeves, Duke University

Multilayer (or deep) networks are powerful probabilistic models based on multiple stages of a linear transform followed by a non-linear (possibly random) function. In general, the linear transforms are defined by matrices and the non-linear functions are defined by information channels. These models have gained great popularity due to their ability to characterize complex probabilistic relationships arising in a wide variety of inference problems. In this talk, we will describe a new method for analyzing the fundamental limits of statistical inference in settings where the model is known. The validity of our method can be established in a number of settings and is conjectured to hold more generally. A key assumption made throughout is that the matrices are drawn randomly from orthogonally invariant distributions.

Our method yields explicit formulas for 1) the mutual information; 2) the minimum mean-squared error (MMSE); 3) the existence and locations of certain phase-transitions with respect to the problem parameters; and 4) the stationary points for the state evolution of approximate message passing algorithms. When applied to the special case of models with multivariate Gaussian channels our method is rigorous and has close connections to free probability theory for random matrices. When applied to the general case of non-Gaussian channels, our method provides a simple alternative to the replica method from statistical physics. A key observation is that the combined effects of the individual components in the model (namely the matrices and the channels) are additive when viewed in a certain transform domain.

11:40–12:15 **Detecting Sparse Structures in Data in Sub-Linear Time: A group testing approach**
Boaz Nadler, Weizmann Institute of Science

In several applications, large amounts of data are collected and need to be processed extremely fast, say in real-time. Under such constraints, it may thus not even be possible to process all of the data, or individually test many different hypotheses about it. This raises the following general question:

What is the tradeoff between statistical performance and computational constraints? In particular, can interesting and relevant structures be found in sub-linear time and what are fundamental bounds in doing so? In this talk, I'll present partial answers to these questions for two specific problems: (i) detecting long edges from large and very noisy images, and (ii) finding sparse representations of high dimensional signals;

We cast both problems as multiple hypothesis questions and develop extremely fast algorithms based on group testing methods, that simultaneously test several hypotheses.

For fiber detection, we show that our approach is optimal under computational budget constraints.

Afternoon Session

15.30– 17.45 **Poster Session**
The poster session will take place in the Lichthof, located on the first floor of the main building of TU Berlin.

1. Föcke, Janick (*WWU Münster)*

   Increasing Resolution in Magnetorelaxometry Imaging.

2. Schier, Peter Philipp (*UMIT Hall in Tirol)*

   Approaches to Compressed Sensing in Magnetorelaxometry Imaging

3. Badeńska, Agnieszka & Błaszczyk, Łukasz: (*Warsaw University of Technology)*

   Hypercomplex Algebras in Compressed Sensing

4. Berk, Aaron (*University of British Columbia)*

   Parameter instability regimes for Lasso programs: Choosing a LASSO is data-dependent

5. Brinkmann, Eva-Maria (*Universität Münster)*

   TBA

6. Chatalic, Antoine (*Université Rennes)*

   Large-Scale High-Dimensional Clustering with Fast Sketching

7. Chorppath, Anil Kumar (*TU Dresden)*

   TBA

8. Hage, Dunja Alexandra (*Zentrum für Sensorsysteme & Universität Siegen)*

   An ℓ_1-minimizing Kalman Filter with Aitken-Based Convergence Acceleration

9. Katzberg, Fabrice & Mertins, Alfred (*Universität zu Lübeck)*

   Compressed Sensing Based Sound-Field Recovery

10. Kümmerle, Christian (*TU München)*

    The Quotient Property and robustness of basis pursuit under weak moment assumptions

11. Limmer, Steffen (*Technische Universität Berlin)*

    Optimal Deep Neural Networks for Sparse Recovery via Laplace Techniques

12. Ottosen, Emil Solsbæk (*Aalborg University)*

    Weighted Thresholding and Nonlinear Approximation

13. Roth, Ingo (*FU Berlin)*

    Hierarchical Sparsity, Low Rank Measurements and Applications

14. Socala, Jolanta (*University of Silesia, Katowice)*

    Deterministic Generation of Compressed Sensing Matrices

15. Taghouti, Maroua (*TU Dresden)*

    Practical Joint Compressed Sensing and Network Coding in WSNs

16. Maunu, Tyler (*University of Minnesota)*

    TBA

17. Lutz Kämmerer, Daniel Potts & Toni Volkmer (*TU Chemnitz)*

    High-dimensional Approximation and Sparse FFT Using Multiple Rank-1 Lattices.

18. Maly, Johannes & Palzer, Lars (*Technische Universität München)*

    Distributed Compressed Sensing with One-Bit Measurements

19. Genzel, Martin (*Technische Universität Berlin)*

    Recovering Structured Data From Superimposed Non-Linear Measurements

20. März, Maximilian (*Technische Universität Berlin)*

    ℓ_1–Analysis Minimization and Generalized (Co-)Sparsity: When Does Recovery Succeed?

21. Keiper, Sandra (*Technische Universität Berlin)*

    Sparse Recovery of Finite-Valued Signals

22. Candeia Gurjao, Edmar (*Federal University of Campina Grande)*

    Analog to Information Implementation and Calibration

23. Mohammadpour, Mozhgan (*Ferdowsi University of Mahshad)*

    Multi-Channel Data Separation Using Clustering Analysis

24. Kirchhof, Jan (*TU Ilmenau)*

    Measurement Matrix Design for Compressive Sensing in Ultrasonic Non-Destructive Testing

Wednesday Plenary Talk

Compressed Tomographic Motion Sensing

Martin Burger

WWU Münster

09:00–10:00

The aim of this talk will be to discuss the reconstructing of image sequences including motion from highly undersampled tomographic measurements. We will present a joint reconstruction approach based on coupling sparsity priors for the image and motion vector fields with appropriate physical models of the motion. This allows to successfully reconstruct dynamic images with an amount of measurements comparable to a fully sampled single measurement. We discuss some questions related to modeling and analysis of the approach. Moreover we provide results on real and simulated CT measurements with different undersampling strategies. We also demonstrate that the approach can have strong benefits compared to standard reconstruction or motion estimation techniques even on weakly undersampled data in presence of noise.

Wednesday Invited Talks

Morning Session

10:30–11:05 **Stable Phase Retrieval and Spectral Clustering**
Philipp Grohs, Universität Wien

We consider the Gabor phase retrieval problem, i.e., the problem of reconstructing a signal f from the magnitudes $|V_\varphi f|$ of its Gabor transform

$$V_\varphi f(x,y) := \int_{\mathbb{R}} f(t) e^{-\pi(t-x)^2} e^{-2\pi \imath y t} dt, \quad x, y \in \mathbb{R}.$$

Such problems occur in a wide range of applications, from optical imaging of nanoscale structures to audio processing and classification.

While it is well-known that the solution of the Gabor phase retrieval problem is unique up to natural identifications, the stability of the reconstruction has remained wide open. The present paper discovers a surprising connection between phase retrieval, spectral clustering and spectral geometry. We show that the stability of the Gabor phase reconstruction is bounded by the *Cheeger constant* of the flat metric on $\mathbb{R}^2$, conformally multiplied with $|V_\varphi f|$. The Cheeger constant, in turn, plays a prominent role in the field of spectral clustering, and it precisely quantifies the 'disconnectedness' of the measurements $V_\varphi f$.

It has long been known that a disconnected support of the measurements results in an instability – our result for the first time provides a converse result in the sense that there are no other sources of instabilities.

Due to the fundamental importance of Gabor phase retrieval in coherent diffraction imaging, we also provide a new understanding of the stability properties of these imaging techniques: Contrary to most classical problems in imaging science whose regularization requires the promotion of smoothness or sparsity, the correct regularization of the phase retrieval problem promotes the 'connectedness' of the measurements in terms of bounding the Cheeger constant from below. Our work thus, for the first time, opens the door to the development of efficient regularization strategies.

This is joint work with Martin Rathmair.

11:05–11:40 **TBA**
Peter Maaß, University of Bremen

TBA

11:40–12:15 **Nonconvex Phase Retrieval with Random Gaussian Measurements**

Yuejie Chi, The Ohio State University

We report recent progresses on phase retrieval in a Gaussian measurement model, using a nonconvex strategy by applying gradient descent with a carefully chosen initialization. We show that: 1) The choice of loss functions matters, where the amplitude-based loss function allows faster convergence than the intensity-based one adopted in the Wirtinger Flow framework; 2) A much larger step-size can be used for the intensity-based loss function than originally thought, which is revealed by examining the entry-wise error of the iterates using a leave-one-out technique; and 3) a median-truncated strategy can make gradient descent robust to arbitrary outliers in a provable manner with a minimal computational overhead. Finally, if time permits, extensions to the low-rank setting will be discussed briefly. Based on joint work with collaborators that will be introduced properly during the talk.

Thursday Plenary Talks

Sketchy decisions: Low-rank Matrix Optimization with Optimal Storage

Joel Tropp

California Institute of Technology

09:00–10:00

Convex matrix optimization problems with low-rank solutions play a fundamental role in signal processing, statistics, and related disciplines. These problems are difficult to solve because of the cost of maintaining the matrix decision variable, even though the low-rank solution has few degrees of freedom. This talk presents the first algorithm that provably solves these problems using optimal storage. The algorithm produces high-quality solutions to large problem instances that, previously, were intractable.

Joint work with Volkan Cevher, Roarke Horstmeyer, Quoc Tran-Dinh, Madeleine Udell, and Alp Yurtsever.

Compressive Sensing Approaches to Inverse Synthetic Aperture Radar Imaging (ISAR)

Joachim Ender

Fraunhofer Institut für Hochfrequenztechnik und Radartechnik

14:00–15:00

ISAR is a powerful technique enabling the imaging of moving objects like airplanes, ships, satellites or cars with a ground-fixed or flying radar system. In this presentation we will give an overview on recent compressive sensing methods applied to the imaging problem. In the first part we will treat the situation of perfectly known motion parameters, while in the second part the realistic case where these are not or only roughly known and have to be estimated via autofocus algorithms.

Starting with an introduction to the ISAR principle and conventional 2D imaging, direct applications of ℓ_1-minimization will be demonstrated and discussed.

The classical approach, the polar re-formatting algorithm making use of the fast 2D-Fourier transform, can be considerably improved using a sparsity based bandwidth extension process. Sparsity with respect to a certain representation basis is a well-established and very successful tool for processing of real-valued images like photographs. However, radar signals are complex-valued, and the unknown phases related to the object points - which mostly can be modelled as independently uniformly distributed – introduce a complication to the transfer to ISAR imaging. Published methods for the estimation of these phases, applied to real radar data, will be presented and discussed. Further, two methods based on physically motivated dictionaries will be introduced. While the first method aims to classify objects, the second applies to smoothly curved objects and targets to produce synthetic ISAR images composed of estimates of elementary structures. In this approach the changing appearance of partial images during the rotation of the object is utilized.

The second part of the presentation concerns the sparsity-driven estimation of motion parameters. It is an evident idea, that sparsity maximization should be a good driver for motion retrieval since the ISAR images generated with imprecise parameters are diffuse and therefore have only a limited sparsity (a large ℓ_1-norm!). But the problem is involved. The motion is composed of the translational and a rotational component. While the first is relatively simple to handle, since the phase errors are independent on the position of the scatterers, the latter demands a deeper investigation. Nearly all published papers are treating only the first - simpler - problem. A few of these approaches will be addressed in the presentation, but also a way to solve the latter will be indicated.

Compressive sensing will be a preferred tool for a generalization to three dimensions. The change of the instantaneous imaging plane due to 3D rotations of the object will offer the possibility to get 3D information about the object or even 3D imaging. But in contrary to the two dimensional case it will not be possible to reconstruct the temporal evolution of the rotation matrix.

Thursday Invited Talks

Morning Session

10.30–11.05 **One-bit Compressed Sensing with Partial Gaussian Circulant Matrices**
Sjoerd Dirksen, RWTH Aachen

In my talk I will consider compressed sensing with quantized measurements. I will study the situation where each linear, analog measurement is quantized to a single bit in a memoryless fashion. This quantization operation can be implemented with energy-efficient hardware. Recent work has shown that if the measurements vectors are independent standard Gaussians, then it is possible to accurately reconstruct any n-dimensional s-sparse signal with a convex program using $Cs\log(n/s)$ one-bit quantized measurements. This is the optimal scaling known from 'unquantized' compressed sensing. Outside of this purely Gaussian setting, however, very little is known about one-bit compressed sensing.

In my talk I will show that if the linear measurement vectors are randomly selected rows of a Gaussian circulant matrix and a small sparsity condition is satisfied, then a reconstruction guarantee similar to the purely Gaussian case holds. This seems to be the first result on memoryless one-bit compressed sensing with structured random measurements.

Based on joint work with Hans Christian Jung and Holger Rauhut (RWTH Aachen University)

11:05–11:40 **Simple Classification from Binary Data**
Deanna Needell, University of California

Binary, or one-bit, representations of data arise naturally in many applications, and are appealing in both hardware implementations and algorithm design. In this talk, we provide a brief background to sparsity and 1-bit measurements, and then present new results on the problem of data classification from binary data that proposes a framework with low computation and resource costs. We illustrate the utility of the proposed approach through stylized and realistic numerical experiments, provide a theoretical analysis for a simple case, and discuss future directions.

11:40–12:15 **TBA**
Bogdan Roman, University of Cambridge

TBA

Afternoon Session

15:30–17:45 **Poster Session**
This poster session will take place on the first floor of the TU math building, opposite the main building at Straße des 17. Juni 136.

1. Bamberger, Stefan (*TU München*)

   Optimal Fast Johnson-Lindenstrauss Embeddings for Large Data Sets

2. Boßmann, Florian (*Fraunhofer IIS*)

   Structural Sparsity in Multiple Measurements (joint work with Nada Sissouno)

3. Cvetkovic, Nada (*FU Berlin*)

   Metric Learning for Tracking Disease Progress

4. Ghadermarzy, Navid (*University of British Columbia*)

   Near-optimal sample complexity for convex tensor completion

5. Hamad, Ahmad (*Zentrum für Sensorsysteme (ZESS)– University of Siegen*)

   TBA

6. Heredia Conde, Miguel (*Center for Sensor Systems (University of Siegen)*)

   Genetic Sparse Recovery Algorithms for Compressive Sensing

7. Keriven, Nicolas (*DMA, École Normale Supérieure, France*)

   Random Moments for Sketched Mixture Learning

8. Kliesch, Martin (*Uni Danzig*)

   Quantum Process Tomography

9. Kunsch, Robert J. (*Osnabrück University*)

   Uniform Approximation in Hilbert Spaces - Breaking the Curse with Monte Carlo Methods

10. Lopez, Oscar (*University of British Columbia*)

    Embracing Off-the-Grid Samples

11. Wagner, Christoph (*TU Ilmenau*)

    Fast and Efficient Structured Matrix Computations for Compressive Sensing Applications

12. Przelaskowski, Artur (*Warsaw University of Technology*)

    Semantic Compressed Sensing

13. Schulze, Sören (*Uni Bremen)*

Data Representation for Musical Instrument Separation

14. Sparrer, Susanne (*Uni Ulm)*

Unveiling Bias Compensation in Turbo-Based Algorithms for (Discrete) Compressed Sensing

15. Augustin, Sven (*HU Berlin)*

Application of a 0.35 Terahertz Single-Pixel Camera using Compressed Sensing

16. Dvurechensky, Pavel (*Weierstrass Institute for Applied Analysis and Stochastics)*

Adaptive Similar Triangles Method: a Stable Alternative to Sinkhorn's Algorithm for Regularized Optimal Transport

17. Shukla, Niraj Kumar (*Indian Institute of Technology Indore)*

Uncertainty Principle Associated to Finite Wavelet System

18. Stöger, Dominik (*TU München)*

Blind Demixing and Deconvolution at Near-Optimal Rate

19. Flinth, Axel & Hashemi, Ali (*Technische Universität Berlin)*

Soft Recovery in Infinite-Dimensional Compressed Sensing with Applications in Thermal Source Localization and MIMO

20. Quraishi, Sarosh (*Intel)*

TBA

Friday Plenary Talk

Nonconvex Optimization in Low-Complexity Data Modeling

John Wright

Columbia University

09:00–10:00

Nonconvex optimization plays an important role in wide range of areas of science and engineering — from learning feature representations for visual classification, to reconstructing images in biology, medicine and astronomy, to disentangling spikes from multiple neurons. The worst case theory for nonconvex optimization is dismal: in general, even guaranteeing a local minimum is NP hard. However, in these and other applications, very simple iterative methods such as gradient descent often perform surprisingly well. In this talk, I will discuss examples of nonconvex optimization problems that can be solved to global optimality using simple iterative methods, which succeed independent of initialization. These include variants of the sparse blind deconvolution problem, sparse dictionary learning problem, image recovery from certain types of phaseless measurements. These problems possess a characteristic structure, in which (i) all local minima are global, and (ii) the energy landscape does not have any "flat" saddle points. For each of the aforementioned problems, this geometric structure allows us to obtain new types of performance guarantees. I will motivate these problems from applications in imaging and computer vision, and describe how this viewpoint leads to new approaches to analyzing electron microscopy data.

Joint work with Ju Sun (Stanford), Qing Qu (Columbia), Yuqian Zhang (Columbia), Yenson Lau (Columbia) Sky Cheung, (Columbia), Abhay Pasupathy (Columbia)

Friday Invited Talks

Morning Session

10:30–11:05 **From training one neuron to training shallow neural networks**
Massimo Fornasier, TU München

TBA

11:05–11:40 **On the Generalization Properties of Deep Neural Networks**
Miguel Rodrigues, University College London

Deep neural networks (DNNs) – which consist of a series of non-linear transformations whose parameters are learned from training data – have been achieving state-of-the-art results in a wide range of applications such as computer vision, automatic speech recognition, automatic speech translation, natural language processing, and more. However, these remarkable practical successes have not been accompanied by foundational contributions that provide a rationale for the performance of this class of algorithms. This talk concentrates on the characterization of the generalization properties of deep neural network architectures. In particular, the key ingredient of our analysis is the so-called Jacobian matrix of the deep neural network that defines how distances are preserved between points at the input and output of the network. Our analysis – which applies to a wide range of network architectures – shows how the properties of the Jacobian matrix affect the generalization properties of deep neural network; it also inspires new regularization strategies for deep neural networks. Finally, our contributions also bypass some of the limitations of other characterizations of the generalization error of deep neural networks in the literature. Our insights are also supported by a number of experimental results on the MNIST, CIFAR-10, LaRED, and ImageNet datasets. This represent joint work with Jure Sokolic (UCL), Raja Giryes (TAU), and Guillermo Sapiro (Duke U.).

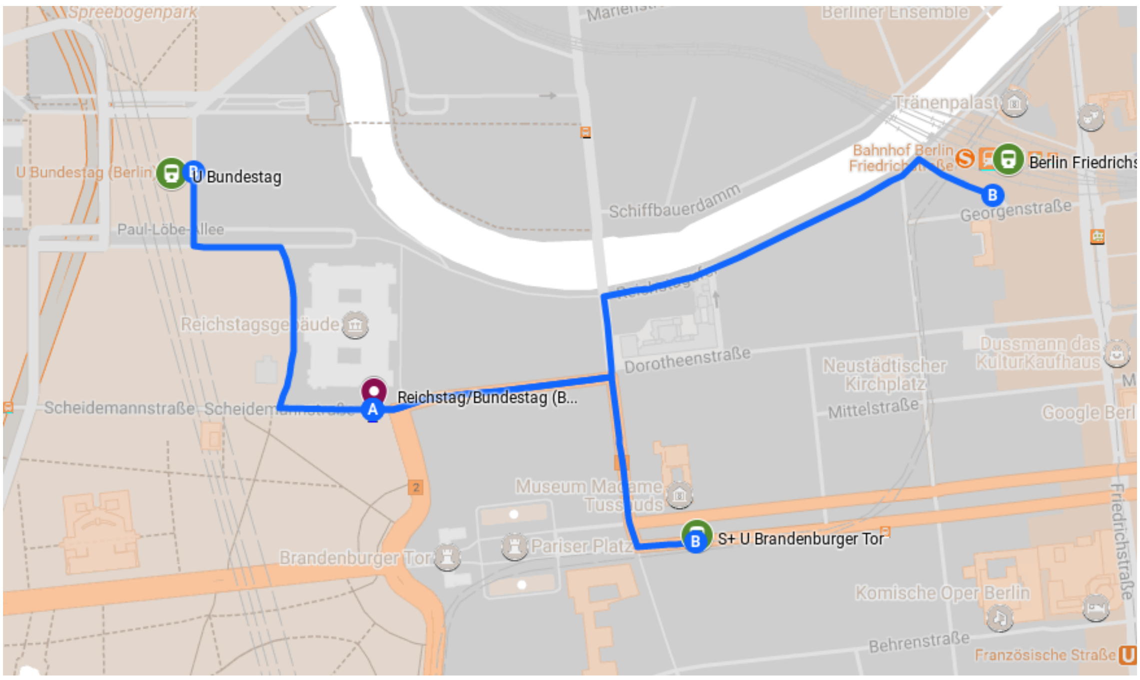
Social Events

- **Reichstagsgebäude (Bundestag, German Parliament Building)** Participate in a guided tour explaining the functions, working methods and composition of the Parliament, as well as the history and architecture of the Reichstag Building. Afterwards you will have an opportunity to visit the roof terrace and the dome, which offer spectacular views of the parliamentary and government district and Berlin's sights.

  We will meet on **Wednesday at 14:10** in front of the **TU Berlin main building** and go there by public transport (train tickets will be provided). Those who would like to go there on their own should be at the address below at 15:00. The closest public transport stations are U Bundestag, S+U Friedrichstraße and S+U Brandenburger Tor (please see also the map below).

  IMPORTANT: Please bring an **official photo identification**!
  (e.g. passport, national ID card, driver's license)
  Please ensure you bring the **original**, as **copies** of identification documents are **not accepted**.
  Please do **not** bring **large pieces** of luggage. For security reasons, they may not be taken into the Reichstag Building. **No storage facilities** are available on site. Small backbacks and handbags are accepted.

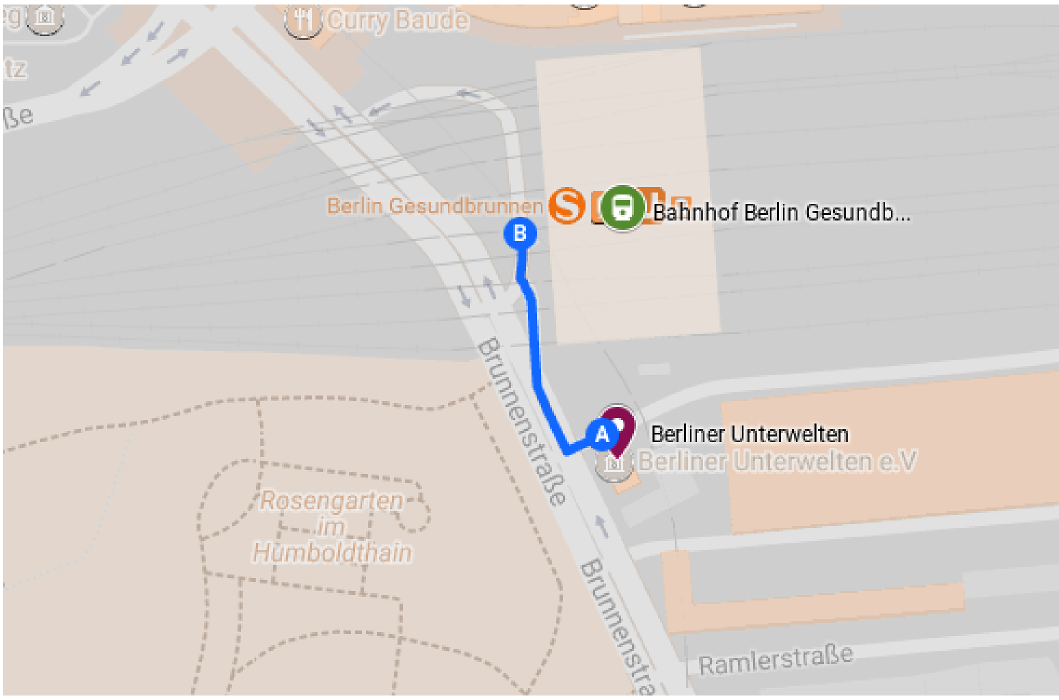
  Address: Scheidemannstraße, central entrance for visitors
  Web page: `http://www.bundestag.de/en/visittheBundestag`



- **Berlin Underworlds Museum** This tour follows the traces of the Cold War in the underground. In West Berlin, civil defense shelters were reactivated or newly built in preparation for a possible nuclear war. Particularly after the building of the Berlin Wall, the West German government and the West Berlin Senate invested millions in these projects. Some of these were built as multi-purpose structures and are currently used as underground stations, parking garages, and storage facilities. By explaining the practical preparations made to help people survive, this tour attempts to make the realities and horrors of such conflict easy to comprehend.

  We will meet on **Wednesday at 14:00** in front of the **TU Berlin main building** and use a bus to get there. Those who would like to go on their own should be at the address below at 15:00 (please see also the map below).

  Address: Brunnenstrasse 105, directly at the southern exit of the U8 station "Gesundbrunnen"
  Web page: `https://www.berliner-unterwelten.de/en.html`



After the excursions, the participants are asked to return to their hotels on their own.

Conference Dinner

The conference dinner takes place on **Wednesday at 19.00** at the **Brauhaus Lemke am Schloss, Luisenplatz 1**, located close to Schloss Charlottenburg. Dinner guests using public transport should either take the subway line U7 to Richard-Wagner-Platz, bus line 109 or M45 to Luisenplatz/Schloss Charlottenburg or bus line 309 to Schloss Charlottenburg.

Before the dinner, there is a chance to check out the traditional Christmas market in front of the Schloss Charlottenburg.

Places to Eat

This is only a selection of places close to the conference venue. See the map on the next page for locations.

Student Cafeterias / Quick Lunch: Warm dishes, sandwiches, salads, drinks etc, price range for a main dish 2 – 5 €.

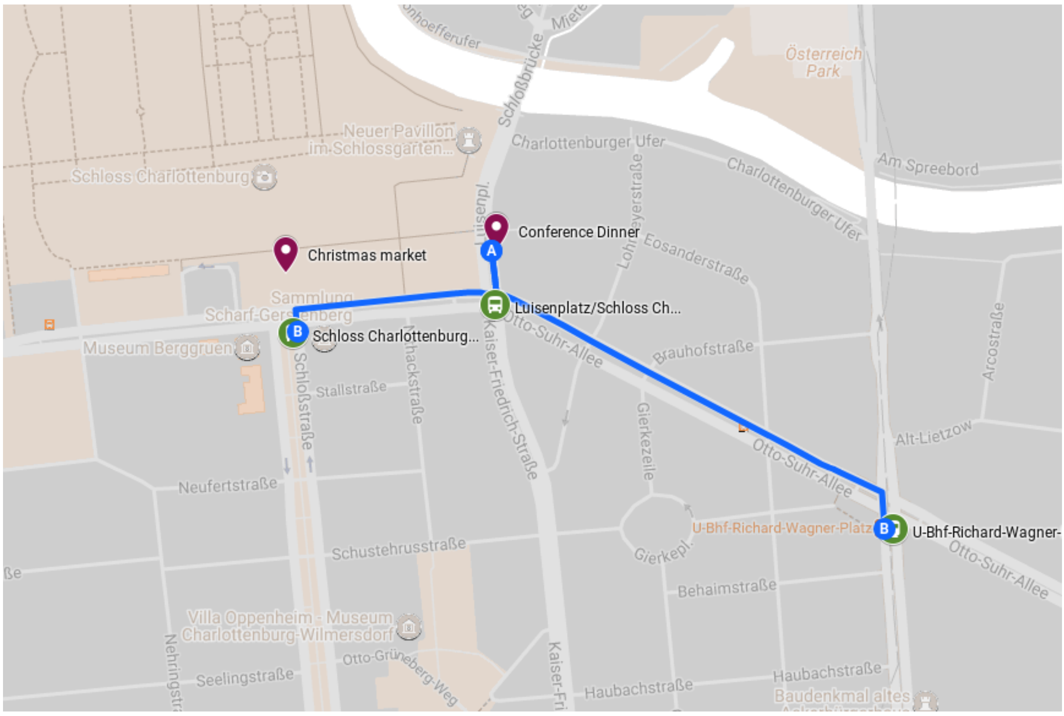
Moderately Priced Restaurants: Reasonably priced hot meals, price range for a main dish 5 – 12 €.

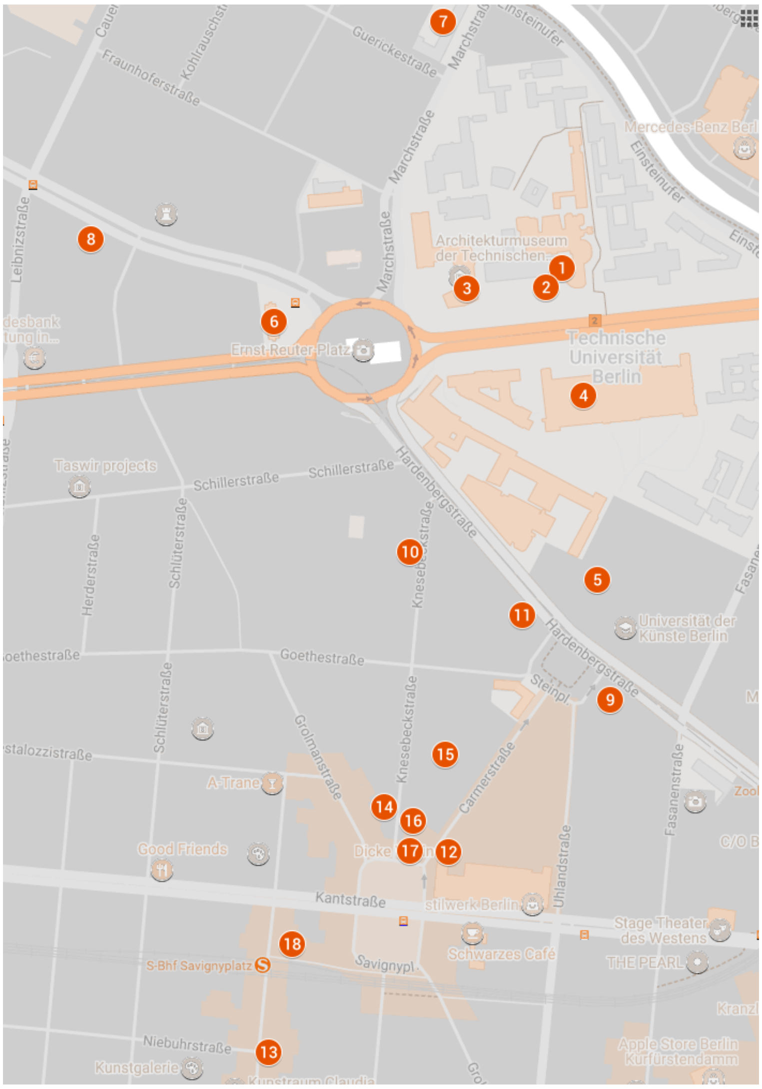
More Expensive Restaurants: More expensive meals, price range for a main dish 10+ € (normally between 10 and 20 €).

Quick Lunch		**Moderately Priced**	
1	Personalkantine TU Berlin	8	TU Long (Chinese)
2	Math Cafeteria	9	Filmbühne am Steinplatz
3	Cafeteria Architekturgebäude	10	Manjurani (Indian)
4	Cafeteria TU Hauptgebäude	11	Café Hardenberg
5	Mensa TU Hardenbergstraße	12	Dicke Wirtin (Berlin Pub)
6	Cafeteria TU Skyline	13	Café Bleibtreu
7	Mensa TU Marchstraße		

More Expensive	
14	Pratirio (Greek)
15	Buddha Republic (Indian)
16	Aida (Italian)
17	Mar y Sol (Spanish)
18	12 Apostel (Italian)

Scan this QR-code for a map with more information about the restaurants:
It can also be found via `tinyurl.com/CSA2017Map`.


Christmas market
Conference Dinner
Luisenplatz/Schloss Ch...
Schloss Charlottenburg...
U-Bhf-Richard-Wagner-
Schloss Charlottenburg
Museum Berggruen
Charlottenburger Ufer
Otto-Suhr-Allee
Schloßstraße
Kaiser-Friedrich-Straße
Neufertstraße
Schustehrusstraße
Villa Oppenheim - Museum Charlottenburg-Wilmersdorf
Seelingstraße
Haubachstraße
Behaimstraße
Brauhofstraße
Eosanderstraße
Am Spreebord
Alt-Lietzow
Arcostraße
Österreich Park
Stallstraße
Gierkezeile
Gierkepl.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Ernst-Reuter-Platz
Technische Universität Berlin
Architekturmuseum der Technischen
Universität der Künste Berlin
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Marchstraße
Einsteinufer
Fraunhoferstraße
Guerickestraße
Leibnizstraße
Schillerstraße
Goethestraße
Kantstraße
Knesebeckstraße
Carmerstraße
Fasanenstraße
Uhlandstraße
S-Bhf Savignyplatz
Savignypl.
Niebuhrstraße
Kunstgalerie
A-Trane
Good Friends
Stage Theater des Westens
Schwarzes Café
THE PEARL
stilwerk Berlin
Taswir projects
Apple Store Berlin Kurfürstendamm
Steinpl.
Grolmanstraße
Mercedes-Benz Berl

Join the slack workspace!