SIGMA 2016 Conference
Abstracts

October 31–November 4, 2016

Rachid Ait-Haddou (Osaka)

Title: Convergence of dimension elevation algorithms : only a typical CAGD issue?.

Abstract: A given nested sequence of Extended Chebyshev spaces possessing Bernstein bases generates an infinite dimension elevation algorithm transforming control polygons of any given level into control polygons of the next level. This situation is the natural generalisation of the so-called degree elevation for parametric polynomial curves. Proving the possible convergence of such algorithms (in the rough sense of uniform convergence to the underlying curves) is a typical CAGD issue. In this talk, we review our recent results on this difficult question, with special focus on Müntz spaces and rational spaces. In particular we present our findings on the equivalence between convergence of a given dimension elevation algorithm and the uniform approximation of continous functions by positive operators of the Bernstein-type naturally associated with the nested sequence. Surprisingly enough, in the case of rational spaces, we show that convergence is also connected with Pólya-type theorems on positive polynomials.
Joint work with Marie-Laurence Mazure (Laboratoire Jean Kuntzmann, Grenoble Alpes University, France).

Pierre Alliez (INRIA)

Title: Low Distortion Inter-surface Mapping via Optimal Mass Transport.

Abstract: Recent advances based on entropic regularization are unleashing the power of optimal transport. In this talk I will present a novel approach for computing a homeomorphic map between two discrete surfaces. While most previous approaches compose maps over intermediate domains which result in suboptimal inter-surface mapping, we directly optimize a map by computing a mass transport plan between two surfaces. This non-linear problem, which amounts to minimizing the Dirichlet energy of both the map and its inverse, is solved using two alternating convex optimization problems in a coarse-to-fine fashion. Computational efficiency is further improved through the use of Sinkhorn iterations, modified to handle minimal regularization and unbalanced transport plans. The resulting inter-surface mapping algorithm applies to arbitrary shapes, with little to no user interaction.

Alexander I. Aptekarev (Russian Academy of Sciences)

Title: Rational approximation of the algebraic functions and functional analogs of the Diophantine approximants.

Abstract: Let f be a germ (the power series expansion) of an algebraic function at infinity. We discuss the limiting properties of the convergent of a functional continued fraction with polynomial coefficients for f (alternative name is diagonal Pade approximant or best local rational approximant). If we compare this functional continued fraction for f with the usual continued fraction (with integer coefficients) for a real number, then the degree of the polynomial coefficient is analogous to the value (magnitude) of the integer coefficient. In our joint work with M. Yattselev [1], we derived strong (or Bernshtein-Szeg?o type) asymptotics for the denominators of the convergent of the functional continued fraction for analytic function with a finite number of branch points (which are in a generic position in the complex plane). One of the applications following from this result is a sharp estimate for a strong functional analog of the Thue-Siegel-Roth theorem.

[1] A.I. Aptekarev, M.L. Yattselev, Pade approximants for functions with branch points ? strong asymptotics of Nuttall-Stahl polynomials, Acta Math., 215:2 (2015), 217 -280 (see also: arXiv:1109.0332v2 [math.CA]).

Laurent Baratchart (INRIA)

Title: Hardy-Hodge decomposition of vector fields.

Abstract: we discuss a decomposition of vector fields on hypersurfaces into harmonic gradients and divergence free components, that generalizes the classical decomposition of L p into Hardy spaces on a curve in the plane. We discuss applications to inverse potential problems and to approximation of vector fields by harmonic gradients on regular and irregular surface patches, which is a higher dimensional analog of rational approximation.

Jean-Daniel Boissonnat (INRIA)

Title: Protected triangulations.

Abstract: Good triangulations are usually characterized by the fact that their vertex set is both dense and separated, and that their simplices are thick. These conditions are not enough to guarantee the existence of Delaunay triangulations on manifolds. This has motivated the introduction of the notion of protection that appears to be central to study the stability of Delaunay triangulations. In this talk, we introduce the main properties of protected triangulations, and show how to construct such triangulations using the algorithmic Lovasz local lemma. We apply those results to two problems. We first exhibit sufficient conditions for the existence of Delaunay triangulations on Riemannian manifolds and describe an algorithm to compute such triangulations. We also show how to reconstruct a submanifold from a finite set of point P which is only known through the matrix of its pairwise distances.

Lynda Bouchemakh (USTHB, Algeria)

Title: Denoising synthetic aperture radar images: Application to interferogram.

Abstract: Synthetic Aperture radar (SAR) plays an important role in Remote Sensing since they provide complementary information that provided by optical sensors. SAR data are subjected to speckle noise, which is also present in laser, ultrasound-B, and sonar imagery. This noise degrades the SAR information content and makes image interpretation , as classification, difficult. In this paper, we use a vectorial adaptive filter to despeckling the SAR images in order to remove noise from interferogram, knowing that the most interferogram filtering methods are filtering the interferogram itself, while our method is different, because of building them with filtered images.

Paul Catala (Paris-Dauphine)

Title: Low-rank SDP's for Sparse Spikes Deconvolution.

Abstract: We study sparse spikes deconvolution over the infinite-dimensional space of Radon measures. To this end, we consider total variation (TV) regularization, which extends l1-regularization techniques for discrete problems to the continuous setting of measures. We show that it is possible to numerically tackle this challenging problem by introducing (finite-dimensional) positive semi-definite relaxations, which involve moment matrices. This unleashes semidefinite programming (SDP) formulations, which benefit from powerful numerical solvers. When the target measure is atomic, we show that the moment matrices involved in the relaxation are low-rank. To exploit this computationally attractive property, we propose a Frank-Wolfe-type solver.

Antonin Chambolle (CNRS and Ecole Polytechnique)

Title: (Another) convex representation of curvature-dependent energies in 2D.

Abstract: We propose and analyse a convex relaxation of a curvature-dependent energy for 2D images or 1D contours. This is a join work with T. Pock (TU Graz)

Caroline Chaux (CNRS and I2M, Marseille)

Title: A proximal algorithm for third order tensor decomposition and application to fluorescence spectroscopy.

Abstract: We address the problem of third order nonnegative tensor factorization with penalization. More precisely, the Canonical Polyadic Decomposition (CPD) is considered. It constitutes a compact and informative model consisting of decomposing a tensor into a minimal sum of rank-one terms. This multi-linear decomposition has been widely studied in the litterature. Coupled with 3D fluorescence spectroscopy analysis, it has found numerous interesting applications in chemistry, chemometrics, data analysis for the environment, monitoring and so on.
The resulting inverse problem at hand is often hard to solve especially when the tensor rank is unknown and when data corrupted by noise and large dimensions are considered. We adopted a variational approach and the factorization problem is thus formulated under a penalized minimization problem. Indeed, a new penalized nonnegative third order CPD algorithm has been derived based on a block coordinate variable metric forward-backward method. The proposed iterative algorithm have been successfully applied not only to synthetic data (showing its efficiency, robustness and flexibility) but also on real 3D fluorescence spectroscopy data.
Joint work with Xuan Vu, Nadège Thirion-Moreau and Sylvain Maire (LSIS, Toulon).

Lénaïc Chizat (CEREMADE, Paris-Dauphine)

Title: Scaling Algorithms for Unbalanced Optimal Transport.

Abstract: There is a common structure to most optimization problems related to optimal transport (OT): a nonnegativity constraint, a linear transport cost and convex functions acting on the marginals of the transport plan. For solving the entropic regularization of these problems, we introduce a scaling algorithm which is a generalization of Sinkhorn's algorithm. This algorithm is simple and enjoys linear convergence in practice. We show how it can be used to compute unbalanced OT (i.e OT with relaxed marginal constraints), unbalanced barycenters and unbalanced gradient flows. In doing so, we also highlight the strong potential of unbalanced OT for applications.
Preprint: Scaling Algorithms for Unbalanced Transport Problems, by L. Chizat, G. Peyré, B. Schmitzer and F-X. Vialard, arXiv:1607.05816.

Karl Deckers (Laboratoire Paul Painlevé, Lille)

Title: Christoffel-Darboux-type formulae for orthonormal rational functions with arbitrary complex poles..

Abstract: Consider the reproducing kernel $K_n(x,y) = \sum_{k=0}^{n-1} \varphi_k(x)\overline{\varphi_k(y)}$, where $\{\varphi_k\}_{k=0}^{n-1}$ forms an orthonormal basis for the space of rational functions with poles among $\{\alpha_1, \alpha_2, \ldots, \alpha_{n-1}\} \subset \mathbb{C}$. We then derive Christoffel-Darboux-type formulae for K_n by exploiting its relation with so-called quasi-orthogonal rational functions Q_n of the form $Q_n(x) = a_n\varphi_n(x) + b_n \left(\frac{1-x/\overline{\alpha}_{n-1}}{1-x/\alpha_n}\right) \varphi_{n-1}(x)$, where $a_n, b_n \in \mathbb{C}$. We conclude with some applications.

Bernardo de la Calle (Universidad Politécnica de Madrid)

Title: Rational interpolation of analytic functions.

Abstract: Results concerning interpolation of analytic functions by means of polynomials and rational functions with a bounded number of poles are considered. Among others, the talk deals with the zero limit distribution of the approximants, their domain and rate of convergence and the role played by their poles. We will especially focus on the interplay between the properties of the approximants and the function to be approximated and how the ones determine the others and vice versa. The talk will serve as an introduction for non-specialists.

Arnaud de Mesmay (CNRS and GIPSA-Lab)

Title: Shortest path embeddings of graphs on surfaces.

Abstract: The classical theorem of Fary states that every planar graph can be represented by an embedding in which every edge is represented by a straight line segment. We consider generalizations of Fary's theorem to surfaces equipped with Riemannian metrics. In this setting, we require that every edge is drawn as a shortest path between its two endpoints and we call an embedding with this property a shortest path embedding. The main question addressed in this talk is whether given a closed surface S, there exists a Riemannian metric for which every topologically embeddable graph admits a shortest path embedding. This question is also motivated

by various problems regarding crossing numbers on surfaces. We observe that the round metrics on the sphere and the projective plane have this property. We provide flat metrics on the torus and the Klein bottle which also have this property.
Then we show that for the unit square flat metric on the Klein bottle there exists a graph without shortest path embeddings. We show, moreover, that for large g, there exist graphs G embeddable into the orientable surface of genus g, such that with large probability a random hyperbolic metric does not admit a shortest path embedding of G, where the probability measure is proportional to the Weil-Petersson volume on moduli space. Finally, we construct a hyperbolic metric on every orientable surface S of genus g, such that every graph embeddable into S can be embedded so that every edge is a concatenation of at most O(g) shortest paths.
Based on joint work with Alfredo Hubard, Vojtech Kaluza and Martin Tancer

Quentin Denoyelle (CEREMADE, Paris-Dauphine)

Title: Support Recovery for Sparse Deconvolution of Positive Measures.

Abstract: We study sparse spikes deconvolution over the space of Radon measures on $\mathbb{R}$ or $\mathbb{T}$ when the input measure is a finite sum of positive Dirac masses using the BLASSO convex program. We focus on the recovery properties of the support and the amplitudes of the initial measure in the presence of noise as a function of the minimum separation t of the input measure (the minimum distance between two spikes). We show that when w/λ, w/t^{2N-1} and λ/t^{2N-1} are small enough (where λ is the regularization parameter, w the noise and N the number of spikes), which corresponds roughly to a sufficient signal-to-noise ratio and a noise level small enough with respect to the minimum separation, there exists a unique solution to the BLASSO program with exactly the same number of spikes as the original measure. We show that the amplitudes and positions of the spikes of the solution both converge toward those of the input measure when the noise and the regularization parameter drops to zero faster than t^{2N-1}.

Julie Digne (CNRS and LIRIS)

Title: Shape modeling based on similarity analysis.

Abstract: Most object surfaces exhibit strong local similarity defined as repetitions and variations of geometric patterns. These local properties can be inherited from the material the objects are made of or the tools used to shape them. In this talk we will describe how these local variations can be discovered and described. Using well chosen descriptors, we are able to extract and describe these data similarities. Exploiting the repetitions then allows us to revisit various surface processing tasks such as denoising, compression and shape resampling. We demonstrate the validity of our approach on several shapes such a digitized statues and mechanical objects but also on urban scenes.

Audric Drogoul (Inria)

Title: A new nonconvex variational approach for sensory neurons receptive field estimation.

Abstract: Determining the receptive field of a visual sensory neuron is crucial to characterize the re- gion of the visual field and the stimuli this neuron is sensitive to. We propose a new method [2] to estimate receptive fields by a nonconvex variational approach, thus relaxing the simplifying and unrealistic assumption of convexity made by standard approaches (see e.g. [4, 3]). The method consists of solving a relaxed discrete energy minimization problem using a proximal alternated minimizing algorithm introduced in [1]. We compare our approach with the classical spike-triggered-average technique and with a convex variational approach on simulated data, considering a typical retinal ganglion cell as ground truth. Results show a high improvement in terms of accuracy and convergence with respect to the duration of the experiment compared to the spike triggered average and the convex variational approach.
This is a joint work with G. Aubert, B. Cessac and P. Kornprobst.

[1] H. Attouch, J. Bolte, P. Redont, and A. Soubeyran Proximal alternating minimization and projection methods for nonconvex problems: An approach based on the Kurdyka-Lojasiewicz inequality, Math. Oper. Res., 35(2):438-457, 2010.
[2] A. Drogoul, G. Aubert, B. Cessac, and P. Kornprobst Estimating receptive fields via a variational approach.

Technical Report 8837, Inria, January 2016.
[3] L. Paninski Maximum likelihood estimation of cascade point-process neural encoding models, Network: Computation in Neural Systems 15(4) pp. 243-262, 2004.
[4] J.M. McFarland, Y. Cui and D.A. Butts Inferring Nonlinear Neuronal Computation Based on Physiologically Plausible Inputs, PLoS Computational Biology 9(7) pp. e1003143, 2013.

Jalal Fadili (ENSICaen)

Title: Exponential weighted aggregation for group-analysis sparse regression: risk bounds and sampling algorithms..

Abstract: In this work, we consider a high-dimensional non-parametric regression model with fixed design and i.i.d. random errors. We propose a powerful estimator by exponential weighted aggregation (EWA) with a group-analysis sparsity promoting prior on the weights. We prove that our estimator satisfies a sharp group-analysis sparse oracle inequality with a small remainder term ensuring its good theoretical performances. We also propose a forward-backward proximal Langevin Monte-Carlo algorithm to sample from the target distribution (which is not smooth nor log-concave) and derive its guarantees. In turn, this allows us to implement our estimator and validate it on some numerical experiments.

Mário A. T. Figueiredo (Instituto de Telecomunicações, Instituto Superior Tecnico, Universidade de Lisboa, Portugal)

Title: ADMM in Imaging Inverse Problems: Some History and Recent Advances.

Abstract: The alternating direction method of multipliers (ADMM) is an optimization tool of choice for several imaging inverse problems, namely due its flexibility, modularity, and efficiency. In this talk, I will begin by reviewing our earlier work on using ADMM to deal with classical problems such as deconvolution, inpainting, compressive imaging, and how we have exploited its flexibility to deal with different noise models, including Gaussian, Poissonian, and multiplicative, and with several types of regularizers (TV, frame-based analysis, synthesis, or combinations thereof). I will then describe more recent work on using ADMM for other problems, namely blind deconvolution and image segmentation, as well as very recent work where ADMM is used with plug-in learned denoisers to achieve state-of-the-art results in class-specific image deconvolution. Finally, on the theoretical front, I will describe very recent work on tackling the infamous problem of how to adjust the penalty parameter of ADMM.

Marion Foare (LAMA, Université de Savoie)

Title: Image restoration and segmentation using the Ambrosio-Tortorelli functional and discrete calculus.

Abstract: In this work, we propose to formulate the Ambrosio-Tortorelli approximation of the Mumford-Shah functional using the full framework of Discrete Calculus, which is able to sharply represent discontinuities thanks to a more sophisticated topological framework. We present our proposed formulation, its resolution, and results on synthetic and real images. We show that we are indeed able to represent sharp discontinuities and as a result significantly better stability to noise, compared with finite difference schemes. (joined work with J.-O. Lachaud and H. Talbot)

Laurent Gajny (Institut de Biomécanique Humaine Georges Charpak - Arts et Métiers ParisTech)

Title: Accurate quasi-automatic 3D reconstruction of human body shape from biplanar X-rays using a statistical shape model.

Abstract: Personalized three-dimensional reconstruction of the human body shape is of major interest for clinical applications and biomechanical engineering. For instance, combined with 3D reconstructions of bony structures, it helps characterizing postural alignment disorders of pathological patients. Biplanar X-rays, which consists in a frontal and a lateral radiography of a patient in a desired position, is a relevant imaging modality for that purpose since it permits to obtain 3D personalized reconstructions of both body shape and bony structures within 860 times less radiation than a CT scan. Recently, we have proposed a method of 3D reconstruction of human body shape from biplanar X-rays that is accurate and that offers good reproducibility (Nérot et al., 2016).

However, since it required manual adjustment of each control point of the 3D model, this method remained time consuming (20 minutes of operator's intervention by subject). The noise, the occlusions, the superimpositions of hard and soft tissues as well as the great variety of arms and hand positions on the radiographs made the automation of such a method a challenging task.
In this work, we propose a novel quasi-automatic method of personalized 3D reconstruction of human body shape based on the adjustment of a statistical shape model. The regression scheme relies on the automatic detection of a set of predictors from few manually identified landmarks on the radiographs, image processing and L_1 spline techniques. The statistical shape model is then adjusted using the posterior shape model strategy introduced in Albrecht et al., 2013. This method enables to limit the operator's intervention to around 3 minutes, thus to reduce the initial time by 85%. A preliminary validation focuses on a comparison with the manual solution on 97 subjects and this study is presented here.

Aude Genevay (CEREMADE, Paris-Dauphine)

Title: Stochastic Optimization for Large Scale Optimal Transport.

Abstract: Optimal transport (OT) defines a powerful framework to compare probability distributions in a geometrically faithful way. However, the practical impact of OT is still limited because of its computational burden. We propose a new class of stochastic optimization algorithms to cope with large-scale problems routinely encountered in machine learning applications. These methods are able to manipulate arbitrary distributions (either discrete or continuous) by simply requiring to be able to draw samples from them, which is the typical setup in high-dimensional learning problems. This alleviates the need to discretize these densities, while giving access to provably convergent methods that output the correct distance without discretization error.
These algorithms rely on two main ideas: *(a)* the dual OT problem can be re-cast as the maximization of an expectation ; *(b)* entropic regularization of the primal OT problem results in a smooth dual optimization which can be addressed with algorithms that have a provably faster convergence.
We instantiate these ideas in three different setups: *(i)* when comparing a discrete distribution to another, we show that incremental stochastic optimization schemes can beat Sinkhorn's algorithm, the current state-of-the-art finite dimensional OT solver; *(ii)* when comparing a discrete distribution to a continuous density, a semi-discrete reformulation of the dual program is amenable to averaged stochastic gradient descent, leading to better performance than approximately solving the problem by discretization ; *(iii)* when dealing with two continuous densities, we propose a stochastic gradient descent over a reproducing kernel Hilbert space (RKHS).

Radja Kheddam (Image processing and radiation laboratory, USTHB)

Title: Bayesian Network Models for Satellite Image Classification.

Abstract: Bayesian Networks (BN) can efficiently represent complex probability distributions, and have received much attention in recent years. They have emerged as powerful data classifiers with an ability for reasoning, semantic representation and handling uncertainty. There are several BN models that have been widely used for clustering and classification. In this work, we implemented and tested some BN models to classify a multispectral remotely sensed image. The BN models considered are: Naïve Bayes (NB), Semi-Naïve Bayes (SNB), Tree Augmented Naïve Bayes (TAN), Forest Augmented Naïve Bayes (FAN), and a Bayesian network with hidden nodes (HBN). From obtained experimental results, it was shown that the studied Bayesian models gave more accurate results than those achieved by a classical Bayesian classifier, and so, they constitute a promising approach for classification task.

Joint work with Aichouche Belhadj-Aissa.

Assia Kourgli (LTIR, Faculté d'Electronique et d'Informatique, USTHB)

Title: On the retrieval of high-resolution images.

Abstract: Remote sensing is an effective tool for Earth observation, which has been widely applied in surveying land-use and land-cover classifications and monitoring their dynamic changes. With the steadily expanding demand for remote sensing images, many satellites have been launched, and thousands of high resolution satellite

images (HRSI) are acquired every day. Therefore, retrieving useful images quickly and accurately from a huge image database has become a challenge. Given its importance, this problem has been drawing the attention of people and has received a lot of attention in the literature. As high spatial resolution images are complex and differ widely in their content, even in the same category, the main issue is to find relevant features according to colour, texture and shape information describing the image contents. Indeed, due to intra-class variations and wide range of illumination and scale changes, the retrieving of high-resolution remote sensing images remains a challenging problem. During the last decade, different approaches for the retrieval of this type of images have been proposed. Most of these approaches are expressed by visual examples in order to retrieve from the database all the HRSI that are similar to the examples and achieved a satisfactory success for some types of categories. So, their efficiency depends on the choice of the set of visual features and on the choice of the similarity metric that models user perception of similarity. Approaches based on global features are more adapted to mono thematic images, whereas techniques based on key points extraction (SIFT, SURF, etc.) are more suited to multi thematic images. As these features are supposed to efficiently represent the query image, they should be adapted to all kind of images contained in the database. However, if the image to recognize is somewhat or very structured, a shape feature will be somewhat or very effective. While if the image is composed of a single texture, a parameter reflecting the texture of the image will reveal more efficient. So until recently, most of state-of-the-art techniques dedicated to high resolution satellite images retrieval made use of feature extraction algorithms (local or global) that extract interesting parts of an image that are then used along with traditional machine learning algorithms. However, HRSI retrieval requires a high-level semantic description, which is not adopted by traditional low-level representations or mid-level representations such as bag of visual word (BOVW). With the emergence of deep learning inspired by the structure of the visual system, the gaps in traditional machine learning techniques has been addressed because deep learning is an end-to-end feature learning method (e.g., from an image to semantic label). Deep convolutional neural networks (CNNs), deep belief networks (DBN), auto-encoders (AE) not only allow to perform classification, but they can also learn to extract features directly from raw images. However, CNNs have an intrinsic limitation, i.e., the complicated pre-training process to adjust parameters. Besides, the models have to be trained by using a large set of labelled data. Tests show that retrieval performance depends on three criteria: image nature, feature representation (low-level, mid-level, semantic) and retrieval schemas (one query, n query). In fact, results of any retrieval scheme depend mainly on the combination: image nature + feature representation.

Daniel Kressner (EPFL)

Title: Perturbation and fast recompression of low-rank tensors.

Abstract: The Tucker format allows to represent a tensor containing, e.g., multidimensional data approximately in a highly compressed fashion and has gained quite some popularity in signal processing, data analysis, and scientific computing. A major advantage is that the compression in this format can be performed via singular value decompositions of the matricizations corresponding to the different modes of the tensor. In this talk, we address two aspects of theoretical and practical importance. First, the singular values determining the compressibility may differ widely for the different modes, influencing the choice of the compression scheme. Until recently, very little was known on feasible configurations for these singular values. We show that, generically and locally, any configuration is possible and derive a method for constructing the corresponding tensor. In the second part of the talk, we develop a new algorithm for recompression in the Tucker format. This algorithm is based on a novel rank-1 variant of randomized algorithms for low-rank approximations and considerably reduces the computational complexity in several practically important situations.
This talk is based on joint work with Wolfgang Hackbusch, Lana Perisa, and Andre Uschmajew.

Arno Kuijlaars (Katholieke Universiteit Leuven, Belgium)

Title: Products of random matrices: explicit formulas and asymptotics.

Abstract: Random matrix theory has been applied succesfully in several areas of physics and engineering, such as quantum chaos and wireless communication. Of interest in these applications are the singular values of a large random matrix, which could represent a scattering matrix in quantum scattering, or a transmission matrix for a channel in wireless communication. Having several channels in series leads to the consideration of products

of random matrices.
I will report on recent progress in the understanding of eigenvalues and singular values of products of complex Gaussian random matrices. This started with the discovery Akemann et al. (2013) that there are explicit formulas for the joint distribution functions. The singular values are in fact a determinantal point process, with a correlation kernel that has a double contour integral representation. These explicit results for finite matrix dimensions were subsequently used to obtain asymptotic limits as the dimensions of the matrices tend to infinity. The most interesting phenomenon is the appearance of a new class of scaling limits near the origin.

Paola Lamberti (University of Torino)

Title: Multilevel quadratic spline quasi-interpolation and application to numerical integration.

Abstract: Quasi-interpolation operators have been studied in the literature and are extensively used in mechanics, engineering, scientific computations and many results have been recently achieved on this subject. In fact such operators have been successfully applied to numerical solution of differential equations, scattered data approximation, numerical integration, etc. The purpose of this talk is to present a kind of new quasi-interpolation schemes which are based on a multilevel technique [3,5] and on quasi-interpolation operators Qf in quadratic spline spaces on uniform type-2 triangulations [1,4]. Polynomial reproduction and approximation order are studied. The resulting operators provide better performances than Qf, also when applied to the numerical evaluation of two-dimensional integrals and compared with the corresponding cubatures given in [2].
[1] Chui, C.K., Wang, R. : On a bivariate B-spline basis., Sci. Sin. XXVII, 1129-1142 (1984)
[2] Lamberti, P. : Numerical integration based on bivariate quadratic spline quasi-interpolants on bounded domains, BIT Numer. Math. 49, 565-588 (2009)
[3] Li, C.-Y., Zhu, C.-G. : A multilevel univariate cubic spline quasi - interpolation and application to numerical integration, Mathematical Methods in the Applied Sciences, 33, 1578-1586 (2010)
[4] Sablonnière, P. : Quadratic spline quasi-interpolants on bounded domains of Rd, d = 1; 2; 3, Rend. Sem. Mat.Univ. Pol. Torino 61(3), 229-246 (2003)
[5] Wang, R., Wu, J., Zhang, X. : Numerical integration based on multilevel quartic quasi-interpolants operator, Applied Mathematics and Computation 227, 132-138 (2014)

Juliette Leblond (INRIA Sophia Antipolis, France)

Title: Inverse potential problems for elliptic PDE, with physical applications.

Abstract: We will discuss some inverse problems for Laplace-Poisson and conductivity partial differential equations (PDE) with source term in divergence form. We consider situations where incomplete (noisy) Cauchy data are given in some restricted region of the space (accessible to measurements) from which the unknown source term is to be recovered, at least partly. These issues are ill-posed inverse problems, that need first to be analysed from the mathematical point of view, next regularized, then algorithmically and computationaly solved. We will focus on boundary value problems related to data transmission or completion issues and on source recovery from boundary data, and explain other related issues like conductivity estimation. We will show how do harmonic analysis tools, function and operator theories, together with approximation techniques allow to set assumptions for well-posedness (uniqueness, smoothness, stability) and to constructively solve for these issues, and provide numerical illustrations. The above issues arise in many physical problems related to non-destructive inspection, in particular for electromagnetic phenomenon modelled by Maxwell's equations, under quasi-static assumptions. We will more specifically consider brain source estimation from electroencephalography (EEG) data [2, 3], arising in neurosciences and medical imaging, and similar issues in planetary sciences and paleomagnetism, concerning magnetization recovery from magnetic data [1].
This is from joint works with several colleagues, in particular with my co-authors below.
[1] L. Baratchart, S. Chevillard, J. Leblond, "Silent and equivalent magnetic distributions on thin plates", submitted for publication.
[2] M. Clerc, J. Leblond, J.-P. Marmorat, T. Papadopoulo, "Source localization in EEG using rational approximation on plane sections", Inverse Problems, 28, 055018, 2012.
[3] M. Clerc, J. Leblond, J.-P. Marmorat, C. Papageorgakis, "Uniqueness result for an inverse conductivity recovery problem with application to EEG", accepted for publication.

Pauline Le Bouteiller (IFPEN)

Title: Seismic image segmentation for objects retrieval.

Abstract: Seismic data (2D sections and 3D cubes) carry much information about the underground, part of which is still not used in geological models. This study aims at highlighting and retrieving regions of interest (ROIs) on seismic sections (2D grayscale images), in order to provide models with improved knowledge on the spatial distribution of sedimentary deposits. To do so, we develop a methodology of automatic labelling and extraction of ROIs. It is applied to former landslides, Mass Transport Deposits (MTDs).
In practice, we compute a set of 48 attributes that are built from local spatial statistics of seismic sections. These attributes are orientation- and scale- sensitive. For one image, each pixel is then represented by a 48-element feature vector.
After reducing the dimension to 7 attributes, we classify all pixels from 8 seismic sections through various classification methods: first, 1 section is trained via unsupervised classification and interpretation; based on this trained section, supervised classification is then used for all the other sections. Lastly, unsupervised classification is used to train the dataset of 8 sections, aiming to provide a larger training set for future supervised classification of the whole seismic cube. The naturally heterogeneous and multiscale aspect of MTDs makes it challenging to capture them; we thus do not expect a single cluster to allow for the characterization of MTDs, but we are looking for a combination of clusters.
Once clusters defining the ROIs have been characterized, a final segmentation is performed to retrieve their shapes, based on the level-set method. Retrieval of the ROIs' shapes has also been tested on the initial seismic sections, without success: seismic images have a complex geometry, that is hardly separable from their texture (indeed, geological structures do not always show a clear visual signature).
Next steps of this work will be, among others, a geologically-relevant 3D interpolation of 2D ROIs, and application of the same methodology to 3D seismic cubes. Furthermore, a more global point of view will have to be developed to link the various seismic facies of MTDs to their geological history.

Carla Manni (Università di Roma "Tor Vergata")

Title: Using Generalized B-splines in Isogeometric Analysis .

Abstract: Generalized splines are smooth piecewise functions with sections in spaces more general than classical algebraic polynomials. Interesting examples are spaces comprising trigonometric or exponential functions. Under suitable assumptions, generalized splines enjoy all the desirable properties of polynomial splines, including a representation in terms of basis functions (the so-called GB-splines) that are a natural extension of the polynomial B-splines. Isogeometric analysis (IgA) is a paradigm for the numerical treatment of PDEs which provides a design-through-analysis connection by exploiting a common representation model. In its original formulation IgA is based on B-splines and NURBS. Thanks to their complete structural similarity with classical B-splines, GB-splines are plug-to-plug compatible with B-splines in IgA. On the other hand, when dealing with GB-splines, the section spaces can be selected according to a problem-oriented strategy taking into account the geometrical and/or analytical peculiar issues of the specific addressed problem. The finetuning of the approximation spaces results in a gain from the accuracy point of view.
In this talk we review some isogeometric methods based on trigonometric and exponential generalized spline spaces for their relevance in practical applications, discussing the differences and the similarities with the polynomial case.

Jamila Mifdal (LMBA, Vannes)

Title: Hyperspectral and multispectral image fusion based on optimal transport.

Abstract: In this work we propose a method for the fusion of hyperspectral (HS) and multispectral (MS) satellite images. The aim of the fusion process is to merge the spectral quality of the HS images with the better spatial resolution of the MS images. The final result is an image having both high spectral and spatial resolution.
In order to perform the fusion task, we suggest an approach based on optimal transport theory that highlights the idea of energy transfer from the starting images HS and MS to the resulting final image. In this sense, the map transport can be thought as the transfer of characteristics of one image to another.

Konstantin Mischaikow (Rutgers University)

Title: Reduction and reconstruction of complex spatio-temporal data.

Abstract: It is almost cliche at this point to note that high dimensional data is being collected from experiments or generated through numerical simulation at an unprecedented rate and that this rate will continue rising extremely rapidly for the foreseeable future. Our interest is in data associated with high dimensional nonlinear complex spatiotemporal dynamics. The focus of this talk is on our efforts to use persistent homology both as a dimension reduction technique and a technique for reconstructing structures of the underlying dynamical system. I will present some results associated with dynamics of fluid convection and dense granular media and will try to highlight open questions.

Niloy J. Mitra (UCL, London)

Title: Transferring Information across Image and Model Collections.

Abstract: Large image and 3D model repositories of everyday objects are now ubiquitous and are increasingly being used in computer graphics and computer vision, both for analysis and synthesis. However, images of objects in the real world have a richness of appearance that these repositories do not capture, largely because most existing 3D models are untextured. In this work we develop an automated pipeline capable of linking the two collections, and transporting texture information from images of real objects to 3D models of similar objects. This is a challenging problem, as an object's texture as seen in a photograph is distorted by many factors, including pose, geometry, and illumination. These geometric and photometric distortions must be undone in order to transfer the pure underlying texture to a new object ? the 3D model. Instead of using problematic dense correspondences, we factorize the problem into the reconstruction of a set of base textures (materials) and an illumination model for the object in the image. By exploiting the geometry of the similar 3D model, we reconstruct certain reliable texture regions and correct for the illumination, from which a full texture map can be recovered and applied to the model. Our method allows for large-scale unsupervised production of richly textured 3D models directly from image data, providing high quality virtual objects for 3D scene design or photo editing applications, as well as a wealth of data for training machine learning algorithms for various inference tasks in graphics and vision. For more details, please visit: geometry.cs.ucl.ac.uk.

Lionel Moisan (Paris 5)

Title: The Shannon Total Variation.

Abstract: Classical numerical schemes used for total variation-based image regularization lead to images that are difficult to interpolate, thus strongly restricting their potential use in image analysis algorithms requiring sub-pixel precision. However, it is possible to avoid this issue by using the "Shannon" total variation (STV), a discretization that is inherently compatible with Shannon interpolation. We show that the STV can be numerically handled with primal-dual algorithms, and present several applications of this new scheme.
Work in collaboration with Rémy Abergel.

Anthony Nouy (Univ. Nantes)

Title: Statistical methods for high-dimensional function approximation in tree-based tensor formats..

Abstract: Tensor methods are among the most prominent tools for the numerical solution of high-dimensional problems where functions of multiple variables have to be approximated. Such high-dimensional approximation problems naturally arise in stochastic analysis and uncertainty quantification. In many practical situations, the approximation of high-dimensional functions is made computationally tractable by using rank-structured approximations. In this talk, we present algorithms for the approximation in tree-based (hierarchical) tensor format using statistical methods, with a particular focus on the tensor-train format. Adaptive strategies using statistical error estimates are proposed for the selection of the underlying bases, the ranks and also tree.

Martine Olivi (INRIA)

Title: A unified approach to Nevanlinna-Pick interpolation problems.

Abstract: This presentation deals with complex-valued interpolation by a Schur rational function of given degree at a set of nodes located in the closed lower half-plane, with prescribed maximum points for the modulus (i.e. points where it is equal to 1) on the real axis. The motivation comes from broadband matching, for which the technique we develop offers a new tool.
This is a joint work with Laurent Baratchart et Fabien Seyfert.

Thomas Oberlin (Enseeiht, Toulouse)

Title: Restoration of compressed images.

Abstract: We address the problem of restoring compressed images, obtained through a quantization in a known basis, and present a new variational approach that allows to jointly denoise and dequantize the corrupted image. This new technique makes full use of the knowledge about the compression process, which improves significantly the results.
This is a joint work with François Malgouyres and Herwig Wendt

Steve Oudot (INRIA)

Title: A theoretical framework for the analysis of Mapper.

Abstract: Mapper is probably the most widely used TDA (Topological Data Analysis) tool in the applied sciences and industry. Its main application is in exploratory analysis, where it provides novel data representations that allow for a higher-level understanding of the geometric structures underlying the data. The output of Mapper takes the form of a graph, whose vertices represent homogeneous subpopulations of the data, and whose edges represent certain types of proximity relations. Nevertheless, the inherent instability of the output and the difficult parameter tuning make the method rather difficult to use in practice. This talk will focus on the study of the structural properties of the graphs produced by Mapper, together with their partial stability properties, with a view towards the design of new tools to help users set up the parameters and interpret the outputs.

Laurent Perrinet (INT, AMU/CNRS)

Title: The flash-lag effect as a motion-based predictive shift.

Abstract: Due to its inherent neural delays, the visual system has an outdated access to sensory information about the current position of moving objects. In contrast, living organisms are remarkably able to track and intercept moving objects under a large range of challenging environmental conditions. Physiological, behavioral and psychophysical evidences strongly suggest that position coding is extrapolated using an explicit and reliable representation of object's motion but it is still unclear how these two representations interact. For instance, the so-called flash-lag effect supports the idea of a differential processing of position between moving and static objects. Although elucidating such mechanisms is crucial in our understanding of the dynamics of visual processing, a theory is still missing to explain the different facets of this visual illusion. Here, we reconsider several of the key aspects of the flash-lag effect in order to explore the role of motion upon neural coding of objects' position. First, we formalize the problem using a Bayesian modeling framework which includes a graded representation of the degree of belief about visual motion. We introduce a motion- based prediction model as a candidate explanation for the perception of coherent motion. By including the knowledge of a fixed delay, we can model the dynamics of sensory information integration by extrapolating the information acquired at previous instants in time. Next, we simulate the optimal estimation of object position with and without delay compensation and compared it with human perception under a broad range of different psychophysical conditions. Our computational study suggests that the explicit, probabilistic representation of velocity information is crucial in explaining position coding, and therefore the flash-lag effect. We discuss these theoretical results in light of the putative corrective mechanisms that can be used to cancel out the detrimental effects of neural delays and illuminate the more general question of the dynamical representation at the present time of spatial information in the visual pathways.

Miguel A. Piñar (Universidad de Granada)

Title: Estimates in Best Polynomial Approximation on the Unit Ball.

Abstract: The purpose of this talk is to show some basic properties of the best approximation by polynomials of degree at most n on the unit ball $\mathbb{B}^d$ in $\mathbb{R}^d$. For the standard Gegenbauer weight function

$$\varpi_\mu(x) = (1 - \|x\|^2)^\mu, \qquad \mu > -1, \quad x \in \mathbb{B}^d,$$

let $\|\cdot\|_\mu$ denote the norm in $L^2(\varpi_\mu;\mathbb{B}^d)$, then we determine the connection between the error of best approximation of a function in the Sobolev space

$$W_2^s(\varpi_\mu, \mathbb{B}^d) := \{f \in L^2(\varpi_\mu, \mathbb{B}^d) : \partial^{\mathbf{m}} f \in L^2(\varpi_{\mu+|\mathbf{m}|}, \mathbb{B}^d),\ |\mathbf{m}| \le s,\ \mathbf{m} \in \mathbb{N}_0^d\}.$$

and the error of best approximation of the corresponding derivatives. The case $d = 1$ is classical, the extension of this result to higher dimensions, even in the ball case, contains some subtle difficulties. In fact, to obtain our estimates we need the concourse of standard and angular derivatives.
Let $E_n(f)_\mu$ be the error of best approximation by polynomials of degree at most n in the space $L^2(\varpi_\mu, \mathbb{B}^d)$. Our main result shows that, for $s \in \mathbb{N}$,

$$E_n(f)_\mu \le \frac{c}{n^{2s}}[E_{n-2s}(\Delta^s f)_{\mu+2s} + E_n(\Delta_0^s f)_\mu],$$

where Δ and Δ_0 are the Laplace and Laplace-Beltrami operators, respectively. We also derive a bound when the right hand side contains odd order derivatives.
The proof of these results are based on the Fourier expansions in orthogonal polynomials with respect to the Gegenbauer weight functions on the unit ball. The key ingredients are the commuting relations between partial derivatives and the orthogonal projection operators, and explicit formulas for an explicit basis of orthogonal polynomials and their derivatives. The relations between the orthogonal polynomials and their derivatives depend on corresponding relations for an explicit basis of spherical harmonics, which are of independent interest.
This is a joint work with Yuan Xu.
[DaiX] F. Dai and Y. Xu, *Approximation theory and harmonic analysis on spheres and balls*, Springer Monographs in Mathematics, Springer, 2013.
[LX] H. Li and Y. Xu, Spectral approximation on the unit ball, *SIAM J. Numer. Anal.* **52** (2014), 2647–2675.
[PX16] M. Piñar and Y. Xu, Best Polynomial Approximation on the Unit Ball, arXiv:1609.05515 [math.CA]

Kevin Polisano (Grenoble)

Title: Convex super-resolution detection of lines in images.

Abstract: Recovering structures in images from lowpass and noisy measurements is a challenging issue of image processing. In this lecture, I will present a new convex formulation for the problem of recovering lines in degraded images. This optimization problem is formed by the combination of a data fidelity term and a norm-based regularizer which favors some notion of complexity. By choosing the atomic norm as penalty, we enforce the solution to be expressed in terms of atoms, lying continuously on a infinite dictionary, namely the set of line parameters. This parsimonious model enables the reconstruction of the lines from lowpass measurements, even in presence of a large amount of noise or blur. We solve the optimization problem by means of a recent primal-dual algorithm. Furthermore, a Prony method performed on rows and columns of the restored image, leads to a spectral estimation of line parameters, with subpixel accuracy. This approach is able to provides a lines estimation procedure with infinite precision, where the Hough and the Radon transform fail, due to their discrete nature. Our work is part of the super-resolution methods, which achieve this goal of recovering fine scale information lost in the data, beyond the Rayleigh or Nyquist resolution limit of the acquisition system. This kind of techniques have been intensively exploited to reconstruct 1D sparse signals like spikes, but not yet for 2D elongated structures like filaments, neurons and veins, which motivates the present work.

Hamed Rabiei (Aix-Marseille University)

Title: Spectral Shape Analysis of the Human Brain Surface.

Abstract: The human cerebral cortex is a highly folded surface. Quantification of this surface provides valuable information about changes occurring on a brain surface during the development, aging and disease. Morphometric parameters of the cerebral cortex such as volume, surface area, sulcal depth, curvature and gyrification index

(GI) are commonly used to quantify the brain structural properties. Among those, GI is directly related to the cortical foldedness and measures the degree of folding of the cerebral cortex. In this talk, I present two new GIs that take into account two different aspects of folding quantification. To this end, a very recent spectral analysis on graphs, called windowed Fourier transform, is introduced. Then, I explain how we extended this method to mesh setting to derive new GIs. The method is applied to the cortical surfaces of 124 healthy adult subjects reconstructed from magnetic resonance images (MRIs) and the average gyrification maps are presented. I also present some results about the global and local relationship between the brain volume and cortical complexity.

Hugo Raguet (Univ. Aix-Marseille)

Title: Cut-Pursuit for Convex Inverse Problems with Piecewise Constant Regularization.

Abstract: We extend the concept of "cut-pursuit" (Landrieu, 2016) to more complicated inverse problems, involving minimization with total-variation-like regularization structured on an arbitrary graph. We show that many large-scale problems of interest can be tackled by successively solving much reduced problems, with convergence guarantees. In particular, we obtain a state-of-the-art optimization method for solving graph-structured inverse or learning problems regularized by the widely used fused-LASSO. This is a joint work with Loic Landrieu.
Loic Landrieu, Guillaume Obozinski. Cut Pursuit: fast algorithms to learn piecewise constant functions on general weighted graphs. 2016.

Christoph Schnörr (Heidelberg University)

Title: A Geometric Smooth Approach to Image Labeling.

Abstract: We introduce a smooth non-convex approach in a novel geometric framework which complements established convex and non-convex approaches to image labeling. The major underlying concept is a smooth manifold of probabilistic assignments of a prespecified set of prior data (the labels) to given image data. The Riemannian gradient flow with respect to a corresponding objective function evolves on the manifold and terminates within an epsilon-neighborhood of an unique assignment (labeling). As a consequence, unlike with convex outer relaxation approaches to (non-submodular) image labeling problems, no post-processing step is needed for the rounding of fractional solutions. Our approach is numerically implemented with sparse, highly-parallel interior-point updates that efficiently converge, largely independent from the number of labels. Experiments demonstrate competitive performance.

Christian Sohler (TU Dortmund)

Title: Clustering Dynamic Data Streams.

Abstract: Clustering is the process to partition a point set into subsets of similar points while points in different subsets are supposed to be dissimilar. One formulation of clustering is the k-median problem, where we are trying to find a set C of k centers that minimizes the sum of points to their nearest centers. In my talk, I will develop a sublinear space data structure for computing an approximate solution to the k-median clustering problem for dynamic data streams, i.e. streams of insertions and deletions of points. In particular, the space complexity of our data structure will be polynomial in the dimension of the input space.
Joint work with Vladimir Braverman, Gereon Frahling, Harry Lang, and Lin Yang.

Hendrik Speleers (University of Rome Tor Vergata)

Title: Multi-degree smooth polar splines: a framework for design and analysis.

Abstract: One of the needs of CAD representations of arbitrary genus surfaces with finite number of polynomial patches is the introduction of holes surrounded by periodic configurations. Such holes can then be filled by means of polar spline surfaces, where the basic idea is to use periodic spline patches with one collapsed boundary. Applications of this approach include subdivision surfaces, free-shape modeling, and, as we demonstrate here, isogeometric analysis.
In order to obtain polar spline surfaces with specified continuity, the admissible set of control point configurations shrinks. In particular, at the collapsed boundary (invoking a singular point), imposition of C^k continuity

constrains the inner k-rings of control points surrounding the singular point to a limited number of configurations. In hole-filling applications, the outer k-rings of control points are used to match the cross-derivative information at the hole boundary.
In this work, keeping in mind applications to design as well as analysis, we construct C^k polar spline parametric patches with arbitrary degree and arbitrary number of elements at the hole boundary. We present a simple, geometric construction of basis functions over such polar parametric domains possessing interesting properties as non-negativity and partition of unity. In addition, the constructed spline spaces demonstrate optimal approximation behavior, even at the singular point.
Joint work with Deepesh Toshniwal, Rene R. Hiemstra, and Thomas J. R. Hughes.

Gabriele Steidl (Dept. of Mathematics, University of Kaiserslautern, Germany)

Title: Variational Models for Restoring Manifold-Valued Images.

Abstract: We introduce a new non-smooth variational model for the restoration of manifold-valued data which includes second order differences in the regularization term. While such models were successfully applied for real-valued images, we introduce the second order difference and the corresponding variational models for manifold data, which up to now only existed for cyclic data. The approach requires a combination of techniques from numerical analysis, convex optimization and differential geometry. First, we establish a suitable definition of absolute second order differences for signals and images with values in a manifold. Employing this definition, we introduce a variational denoising model based on first and second order differences in the manifold setup.In order to minimize the corresponding functionals, we generalize three kind of algorithms:
i) inexact cyclic proximal point algorithm,
ii) half-quadratic minimization,
iii) Douglas Rachford splitting.
We propose an efficient strategy for the computation of the corresponding proximal mappings in symmetric spaces.For the first algorithm we utilizing the machinery of Jacobi fields. We demonstrate the performance of our algorithms in particular for the n-sphere, the rotation group SO(3) and the manifold of symmetric positive definite matrices. We prove the convergence of the proposed algorithms in Hadamard spaces.
This is joint work with Miroslav Bacak (MPI Leipzig), Ronny Bergmann, Johannes Persch (U Kaiserslautern), R. Hielscher (U Chemnitz), and Andreas Weinmann (U Darmstadt).

Georg Umlauf (Institute for Optical Systems (IOS), HTWG Konstanz)

Title: Using machine learning techniques in geometric modeling.

Abstract: I will present two applications of machine learning approaches to geometric modeling problems: knot placement for b-spline approximation and shape classification of point clouds. Selecting knot values to receive good approximation results is a challenging task. Proposed approaches range from parametric averaging to genetic algorithms. We propose the use of Support Vector Machines (SVMs) for finding suitable knot vectors in B-spline curve approximation. The SVMs are trained to distinguish between locations along the curve that are well or not well suited as knots in the parametric domain. This score is based on different geometric features of a parameters corresponding point in the point cloud. A score weighted averaging technique is used to produce the final knot vector. We further propose a method to use the score weighted averaging technique for t-spline surface approximation. In the reverse engineering process one has to classify parts of point clouds with the correct type of geometric primitive. Features based on different geometric properties like point relations, normals, and curvature information can be used to train SVMs. These geometric features are estimated in the local neighborhood of a point of the point cloud. The multitude of different features makes an in-depth comparison necessary. Instead unsupervised learning methods, e.g. auto-encoders, can be used to learn the relevant features simultaneously with the classification task. These automatic features can be visualized to interpret the learned classification criteria.

Konstantin Usevich (CNRS and Université Grenoble Alpes, GIPSA-lab, France)

Title: X-rank and identifiability for a polynomial decomposition model.

Abstract: X-rank is a powerful concept coming from algebraic geometry that generalizes matrix rank and tensor rank. In this talk, we demonstrate the usefulness of this concept for studying properties of a polynomial decomposition model that arises in problems of system identification, signal processing and machine learning. We prove new results on identifiability of the model and give new bounds on maximal and generic ranks.
Joint work with Pierre Comon and Yang Qi. This work is supported by ERC AdG-2013-320594 DECODA.
References: P. Comon, Y. Qi and K. Usevich, X-rank and identifiability for a polynomial decomposition model, arXiv:1603.01566 (2016).

Samuel Vaiter (CNRS and Université de Bourgogne)

Title: CLEAR: Covariant LEAst-square Re-fitting with applications to image restoration.

Abstract: We propose a new framework to remove parts of the systematic errors affecting popular restoration algorithms, with a special focus for image processing tasks. Extending ideas that emerged for l1 regularization, we develop an approach that can help re-fitting the results of standard methods towards the input data. Total variation regularizations and non-local means are special cases of interest. We identify important covariant information that should be preserved by the re-fitting method, and emphasize the importance of preserving the Jacobian (w.r.t to the observed signal) of the original estimator. Then, we provide an approach that has a "twicing" flavor and allows re-fitting the restored signal by adding back a local affine transformation of the residual term. We illustrate the benefits of our method on numerical simulations for image restoration tasks.

Holger Wendland (University of Bayreuth)

Title: Kernel-Based Approximation Methods and their Applications.

Abstract: Kernel-based approximations are a popular meshfree method. They are used in various areas comprising, for example, scattered data approximation, computer graphics, machine learning, engineering and the geosciences. They are flexible in various ways. It is extremely easy to built arbitrarily smooth approximations in arbitrary dimensions. These methods can be built and used on manifolds, they also allow us to incorporate certain physical features into the approximation analytically.
In this talk, I will discuss the general framework of Hilbert space valued function spaces with reproducing kernels and optimal recovery in this setting. I will address various applications such as mesh deformation, image colorization, solving partial differential equations in general and from fluid dynamics. I will work out the specific features which are required in each application and how they are incorporated into the kernel and the approximation spaces.

Franck Wielonsky (Aix-Marseille University)

Title: Modified Logarithmic Potential Theory and Applications.

Abstract: Motivated by particular biorthogonal ensembles in random matrix theory, we study weighted potential theory for the modified kernel

$$\log \frac{1}{|x-y||f(x)-f(y)|w(x)w(y)},$$

where $x, y \in K$, a closed subset of $\mathbb{C}$, $f : K \to \mathbb{C}$ is continuous, and w is a weight. We consider the problem of minimizing the corresponding weighted energy and describe analogs of classical results, like the Frostman inequalities and asymptotics of the n-th diameters. We also obtain a Bernstein-Walsh inequality and a Bernstein-Markov property for functions of the form $p(g(z))q(f(z))$ where p, q are polynomials and f, g are holomorphic in a neighborhood of K. Probabilistic results such as large deviation principles can be derived.
This is a joint work with Thomas Bloom (Toronto), Norman Levenberg (Bloomington), and Vilmos Totik (Tampa and Szeged).

Kui Zhiging (Ecole Centrale Marseille)

Title: On the coupling of decimation operator with subdivision schemes for multiscale analysis.

Abstract: Subdivision schemes [1] are powerful tools for the fast generation of refined sequences ultimately representing curves or surfaces. Coupled with decimation operators, they generate multiresolution transforms that

generalize the multiresolution analysis/wavelet framework [2]. The flexibility of subdivision schemes (a subdivision scheme can be nonstationary, nonhomogeneous, position-dependent, interpolating or not, non-linear...) (e.g [3]) makes that, as a counterpart, the construction of suitable decimation operators is not direct and easy. In the paper, we propose a generic approach for the construction of decimation operators consistent with a given subdivision. The conditions under which detail coefficients go to zero when the scale parameter increases are investigated as well as stability conditions. Among others, the cases of homogeneous Lagrange interpolatory subdivision, spline subdivision, subdivision related to Daubechies scaling functions (and wavelets) and schemes switching from inter- polating to non-interpolating are revisited.